CITY OF COOS BAY, OREGON

WASTEWATER TREATMENT PLANT 1 PHASE 1A IMPROVEMENTS

SEPTEMBER 2025

SECTION 40 90 00

INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

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  - MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION
  - MAINTENANCE SUMMARY FORM
  - BILL OF MATERIALS
  - MANUALS & CUT SHEETS

OPTIMAL CONTROL SYSTEMS, INC.
2324 Three Lakes Road SE
Albany, OR 97322
Phone: (541) 967-9323
Fax: (541) 967-9485
Project No. 0723-08MSI

CITY OF COOS BAY, OREGON

WASTEWATER TREATMENT PLANT 1 PHASE 1A IMPROVEMENTS

SEPTEMBER 2025

SECTION 40 90 00

INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

- COMPONENT CODE P04, PRESSURE GAUGE 2599
  - MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION
  - MAINTENANCE SUMMARY FORM
  - BILL OF MATERIALS
  - MANUALS & CUT SHEETS
- COMPONENT CODE P09, PRESSURE TRANSMITTER 2635
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  - BILL OF MATERIALS
  - MANUALS & CUT SHEETS
- COMPONENT CODE S12, INDICATOR, FIELD MOUNT 2995
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- COMPONENT CODE T03, TEMPERATURE ELEMENT AND TRANSMITTER, RESISTANCE 3125
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  - MANUALS & CUT SHEETS
- COMPONENT CODE Y61, INSTRUMENT SUNSHADE 3141
  - MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION
  - MAINTENANCE SUMMARY FORM
  - BILL OF MATERIALS
  - MANUALS & CUT SHEETS

SPARE PARTS 3157

OPTIMAL CONTROL SYSTEMS, INC.
2324 Three Lakes Road SE
Albany, OR 97322
Phone: (541) 967-9323
Fax: (541) 967-9485
Project No. 0723-08MSI

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Control Panel	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C92CP0101	EL FSD Enclosure, NEMA 4/12 90.00" H x 72.00" W x 24.00" D	Saginaw Control & Engineering	SCE-90EL7224FSD	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
002	1	C92CP0101	Subpanel	Saginaw Control & Engineering	SCE-90P72F1	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
003	2	C92CP0101	Door Stop Kit	Saginaw Control & Engineering	SCE-DSTOPK	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
004	2	C92CP0101	Folding Shelf	Saginaw Control & Engineering	SCE-FS2424	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
005	2	C92CP0101	LED Light Fixture	Saginaw Control & Engineering	SCE-LF24NO	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
006	2	C92CP0101	LED Bulb	Saginaw Control & Engineering	SCE-LEDB24	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
007	2	C92CP0101	Light Switch Assembly	Saginaw Control & Engineering	SCE-LSA	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
008	1	C92CP0101	Filter Fan, 550 CFM	Saginaw Control & Engineering	SCE-N12FA10HF	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
009	1	C92CP0101	Filter & Grille Assembly	Saginaw Control & Engineering	SCE-N12FGA1010	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
010	1	C92CP0101	Thermostat	Saginaw Control & Engineering	SCE-TEMNO	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
011	2	C92CP0101	GFCI Receptacle, 15 Amp	Leviton	GFNT1-DIN	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
012	2	C92CP0101	Ground Bar Kit	Eaton	GBKP2120	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
013	2	C92CP0101	13-Slot ControlLogix Chassis	Allen-Bradley	1756-A13	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
014	4	C92CP0101	ControlLogix Redundant Power Supply	Allen-Bradley	1756-PA75R	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
015	4	C92CP0101	Redundant Power Supply Cable	Allen-Bradley	1756-CPR2	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
016	2	C92CP0101	Redundant Power Supply Chassis Adapter Module	Allen-Bradley	1756-PSCA2	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
017	1	C92CP0101	ControlLogix 5570 Controller	Allen-Bradley	1756-L72	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
018	4	C92CP0101	Analog Input Module, 8 Isolated Points	Allen-Bradley	1756-IF8I	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
019	2	C92CP0101	Analog Output Module, 8 Isolated Points	Allen-Bradley	1756-OF8I	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
020	6	C92CP0101	Discrete Input Module, Isolated 16 Points	Allen-Bradley	1756-IA16I	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
021	2	C92CP0101	Discrete Output Module, Isolated 16 Points	Allen-Bradley	1756-OA16I	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
022	14	C92CP0101	36-Pin Screw Clamp Block with Standard Housing	Allen-Bradley	1756-TBCH	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
023	3	C92CP0101	Dual-Port EtherNet/IP Communication Module	Allen-Bradley	1756-EN2TR	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
024	8	C92CP0101	Slot Filler Module	Allen-Bradley	1756-N2	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
025	2	C92CP0101	Performance Power Supply, 240 W	Allen-Bradley	1606-XLS240E	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
026	1	C92CP0101	Performance Redundancy Module, 480 W	Allen-Bradley	1606-XLSRED	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
027	2	C92CP0101	8-Port Gigabit Managed Industrial Ethernet Switch	Red Lion	NT24K-8TX	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
028	1	C92CP0101	Circuit Breaker, FAZ Series, 20 Amp, 1 Pole	Eaton	FAZ-C20/1-NA-SP	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
029	2	C92CP0101	Circuit Breaker, FAZ Series, 10 Amp, 1 Pole	Eaton	FAZ-C10/1-NA-SP	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
030	5	C92CP0101	Circuit Breaker, FAZ Series, 5 Amp, 1 Pole	Eaton	FAZ-C5/1-NA-SP	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
031	6	C92CP0101	Circuit Breaker, FAZ Series, 2 Amp, 1 Pole	Eaton	FAZ-C2/1-NA-SP	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
032	36	C92CP0101	Circuit Breaker, FAZ Series, 1 Amp, 1 Pole	Eaton	FAZ-C1/1-NA-SP	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
033	32	C92CP0101	General Purpose Plug-In Relay	TE Connectivity	KUP-14A45-120	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
034	32	C92CP0101	Relay Socket	TE Connectivity	27E893	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
035	32	C92CP0101	Hold-Down Spring	TE Connectivity	20C318	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
036	32	C92CP0101	Fuse Holder Terminal Block, Type ML 10/13.SFL	Entrelec	1SNA199168R0000	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
037	4	C92CP0101	Fuse Holder Terminal Block, Type ML 10/13.SFD	Entrelec	1SNA199166R2600	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
038	36	C92CP0101	Fast-Acting Glass Body Fuse, 312 Series, 1 Amp	Littelfuse	312001P	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
039	100	C92CP0101	Fuse Holder Terminal Block, Type M4/8.SFL	Entrelec	1SNA115661R2100	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
040	100	C92CP0101	Fast-Acting Glass Body Fuse, GMA Series, 2 Amp	Bussmann	GMA-2-R	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115

Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Control Panel	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
041	A/R	C92CP0101	Screw Clamp Terminal Block, Feed-Through, Gray	Entrelec	1SNA115116R0700	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
042	A/R	C92CP0101	Screw Clamp Terminal Block, Ground, Green/Yellow	Entrelec	1SNA165113R1600	Section 40 91 00	09-I-101, 09-I-106, 09-I-110 to 09-I-115
043	1	C35CS3101	Nameplate	Optimal Control Systems, Inc.	—	Section 40 91 00	09-I-106
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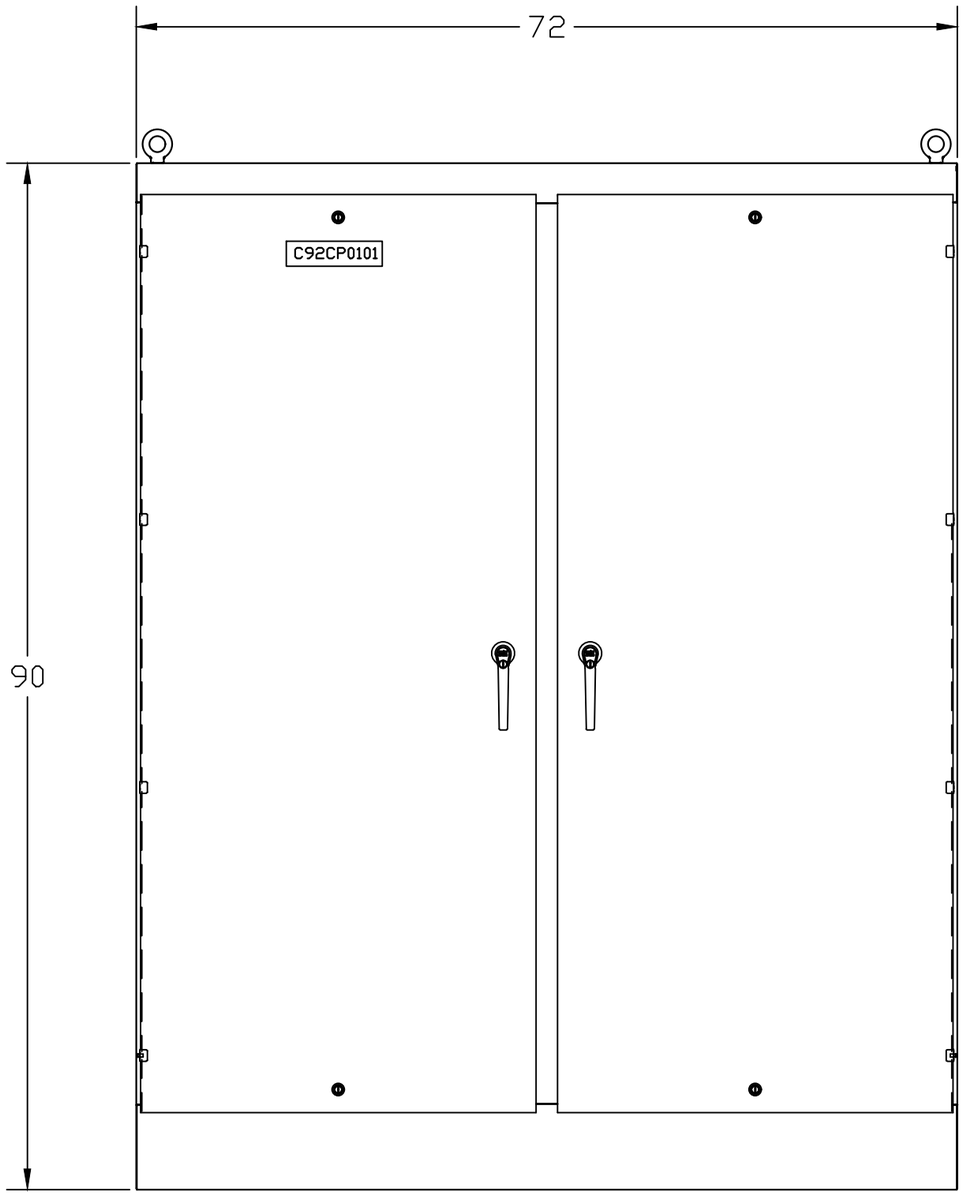

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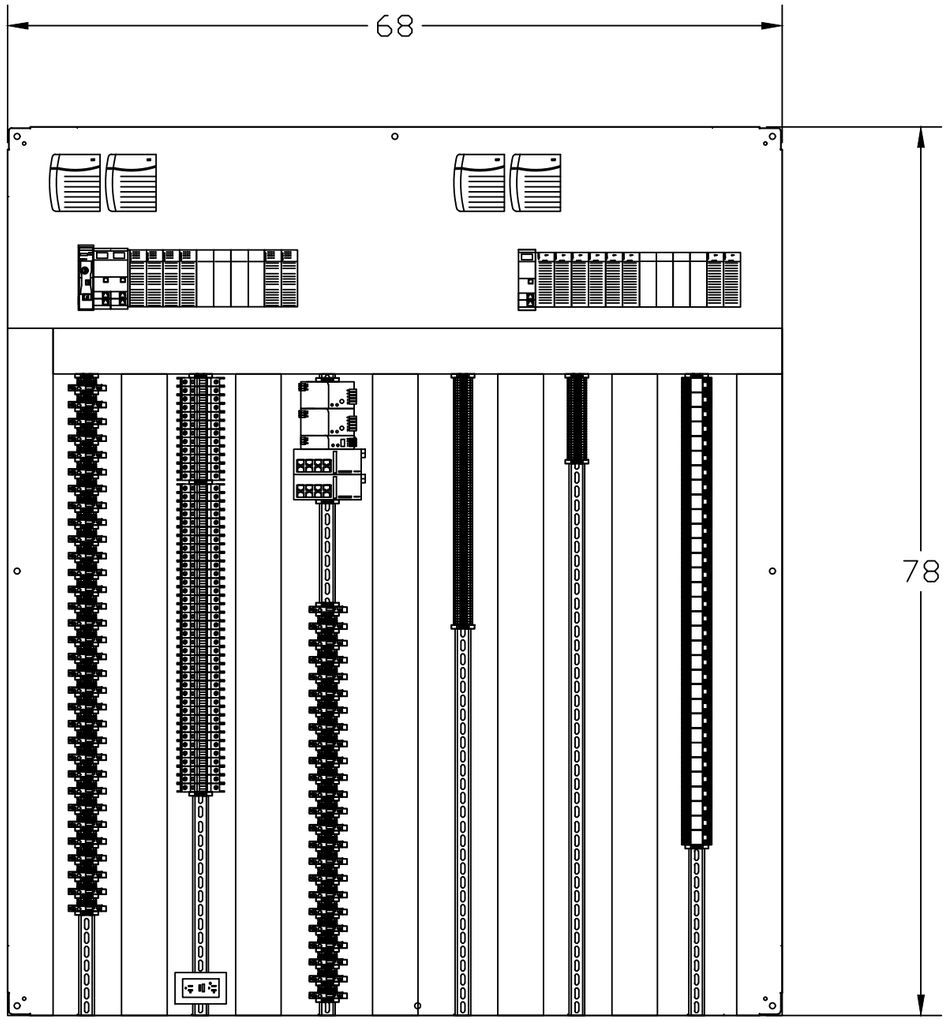

PANEL
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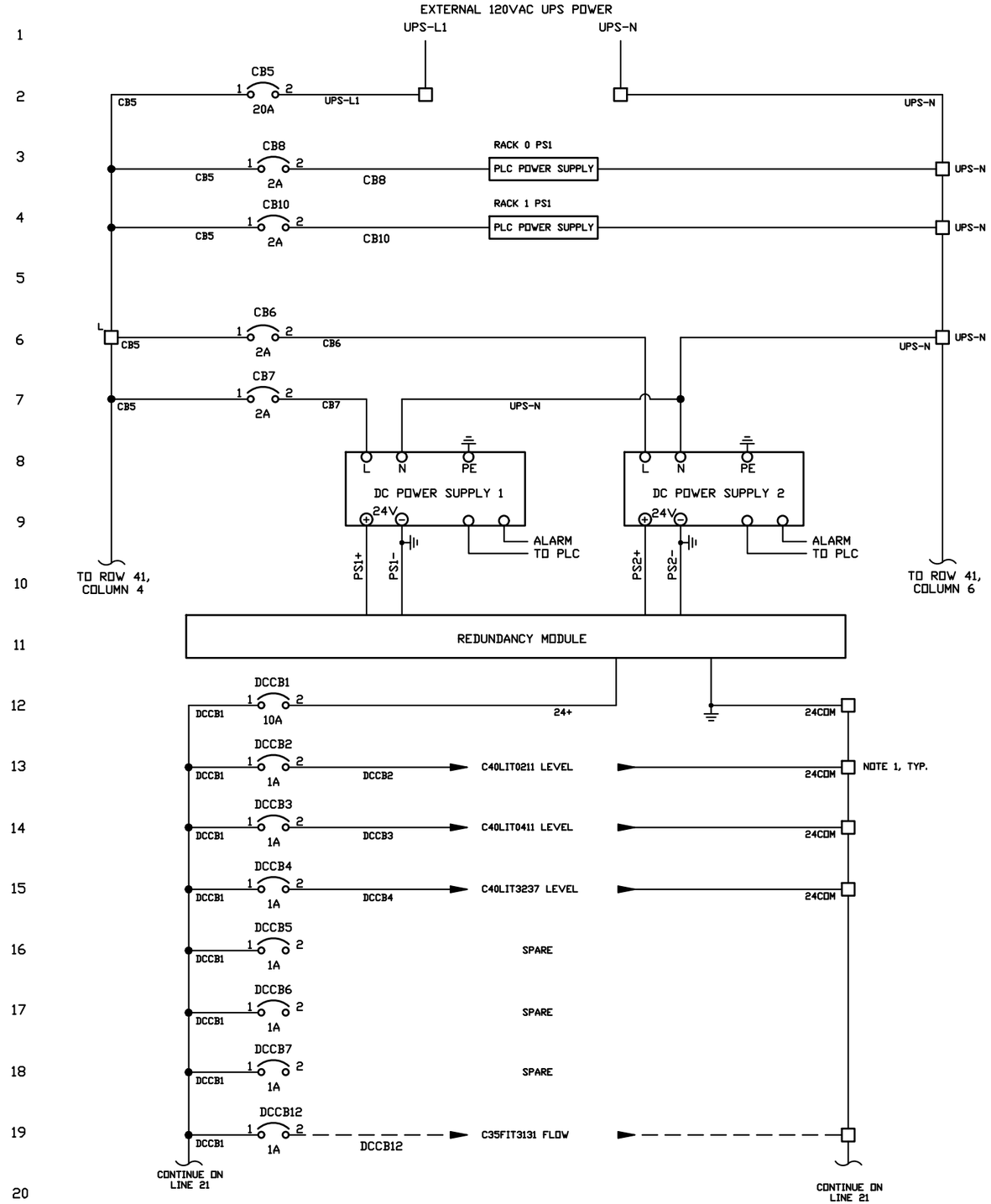
REVISIONS

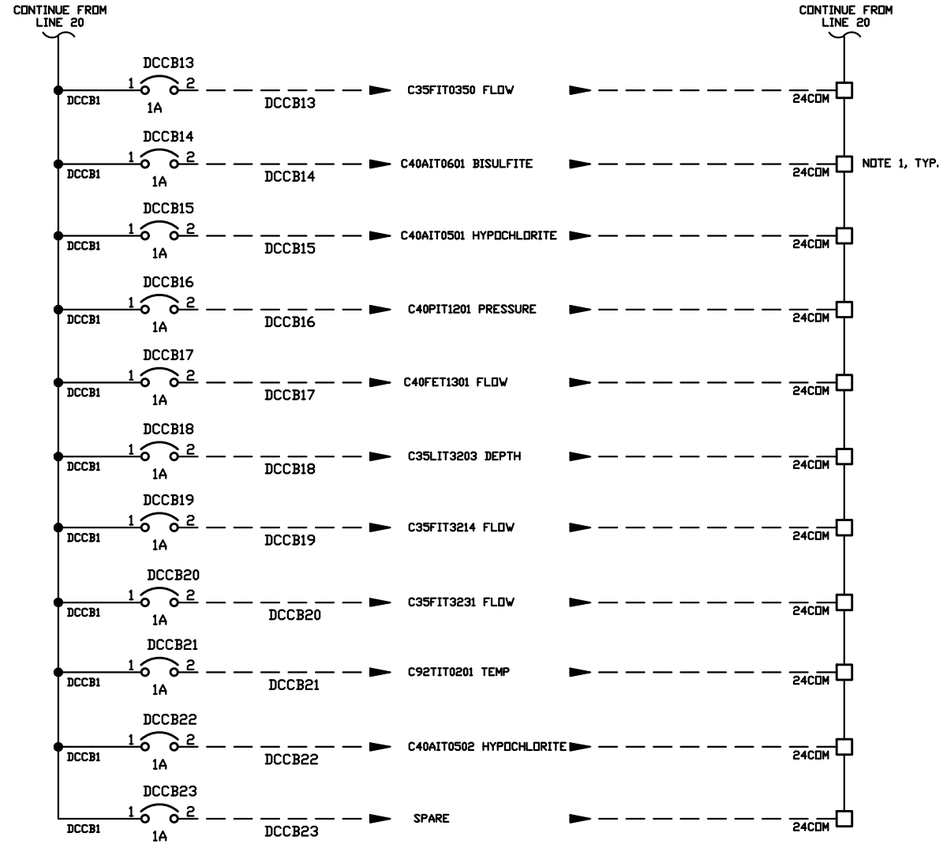
OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
C92CP0101 PANEL LAYOUT DRAWING

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C92-0101	
APPROVED HAD	SCALE NONE	SHEET 1	OF 1





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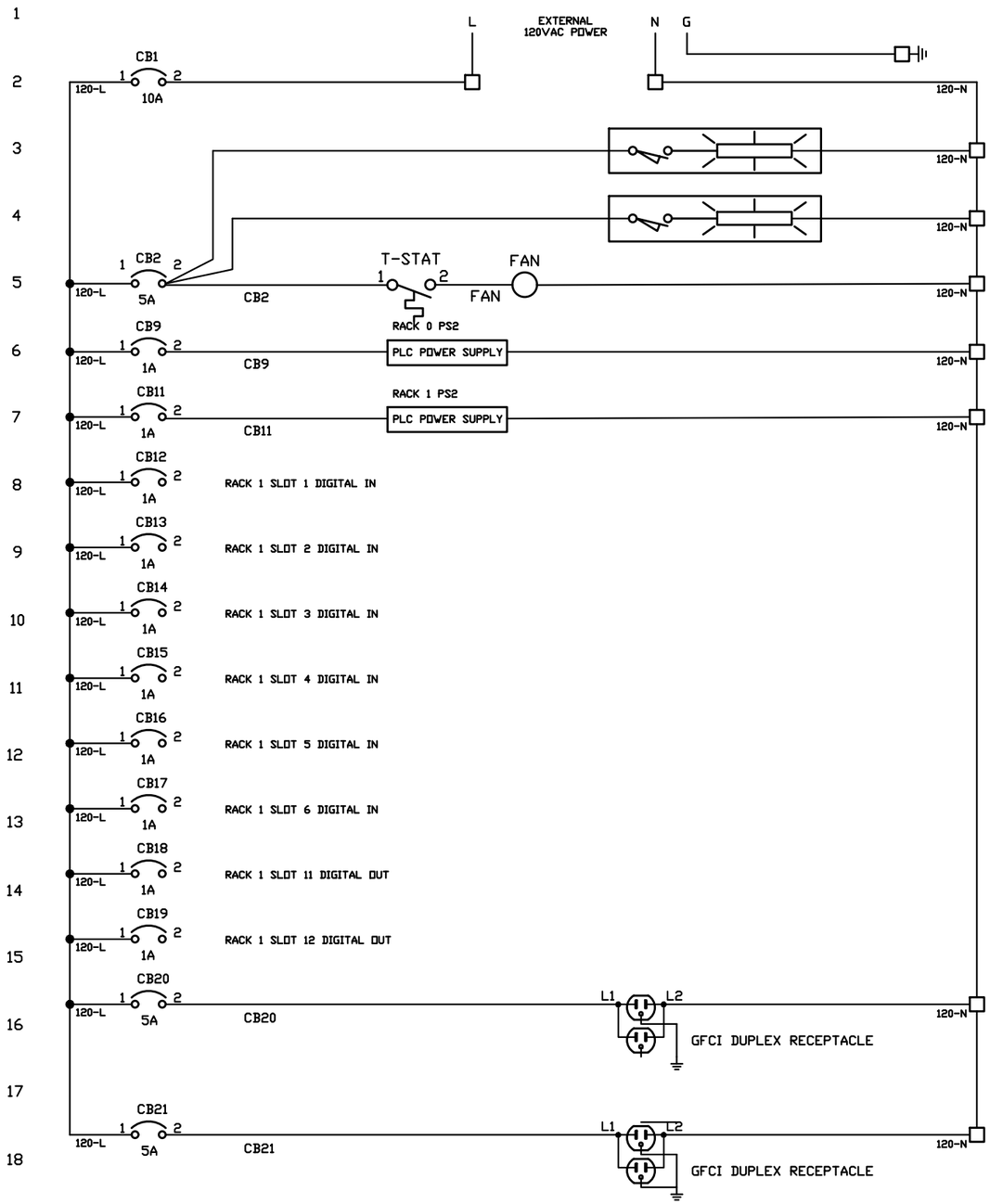
OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
POWER DISTRIBUTION DIAGRAM

DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.27.	DWG NO.: 0723-08MSI-PD	
APPROVED: HAD	SCALE: NONE	SHEET 1 OF 1	



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER PHASE 1A
POWER DISTRIBUTION DIAGRAM AC

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.27.	DWG NO. 0723-08MSI-PDAC	
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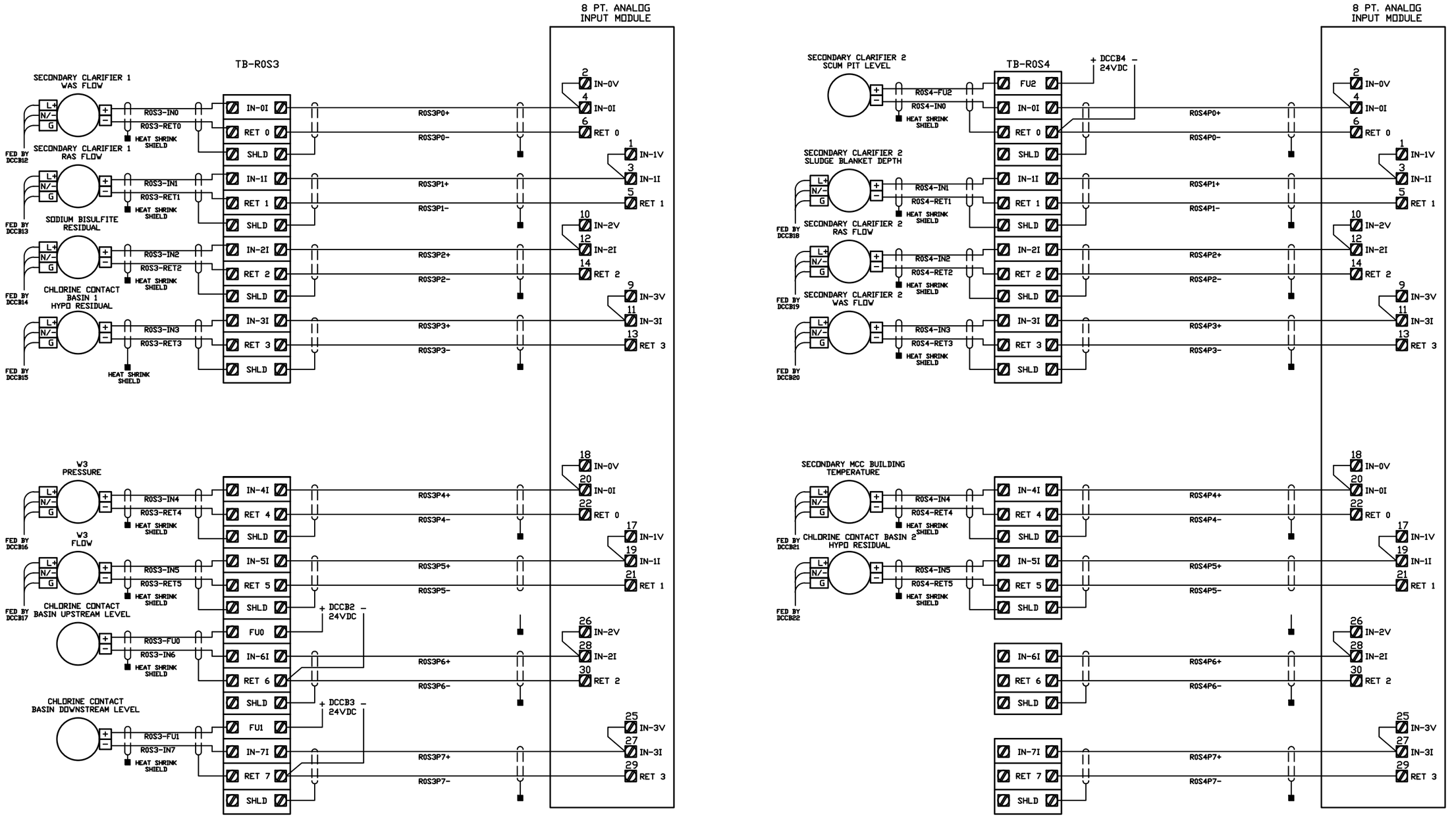

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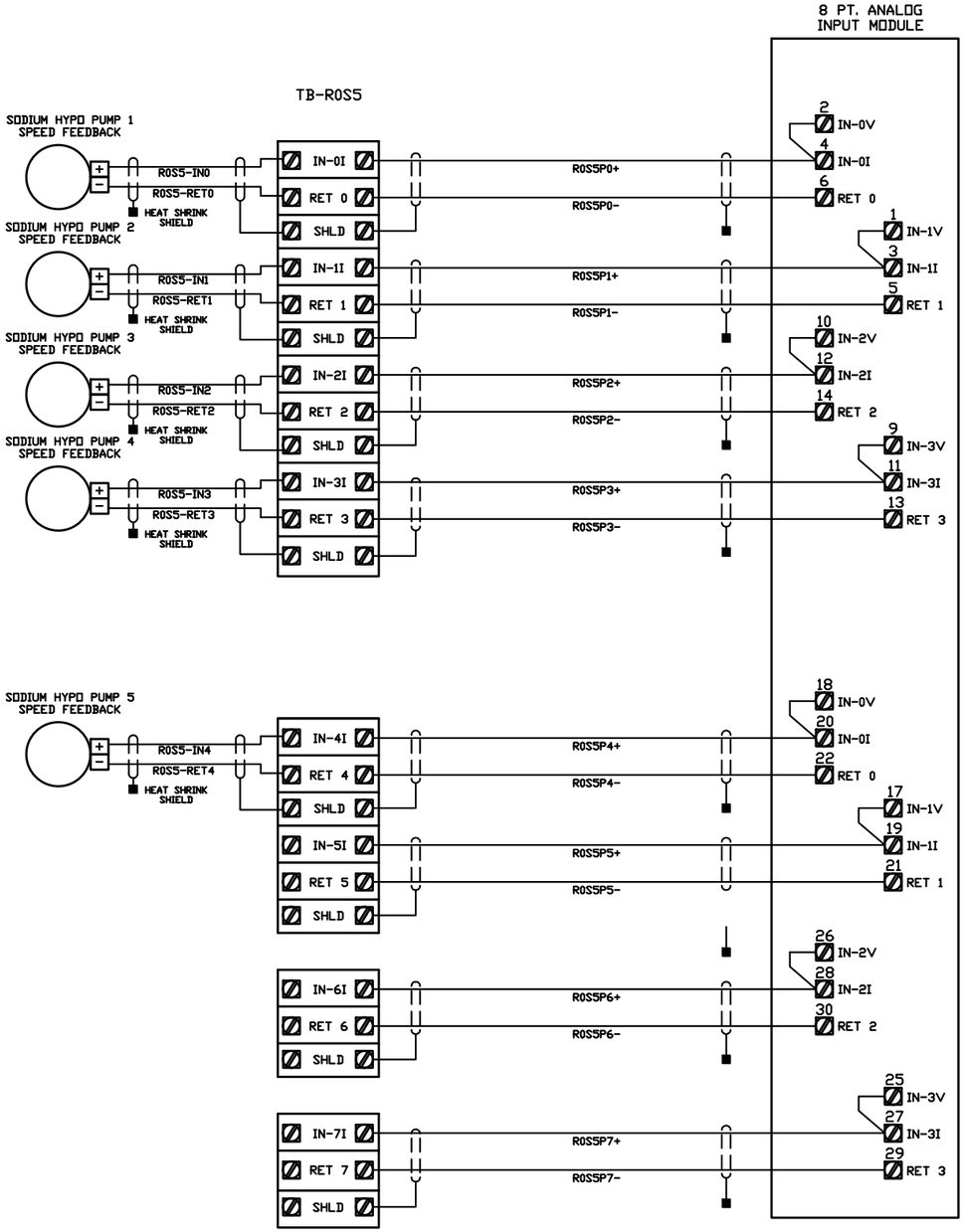
REVISIONS

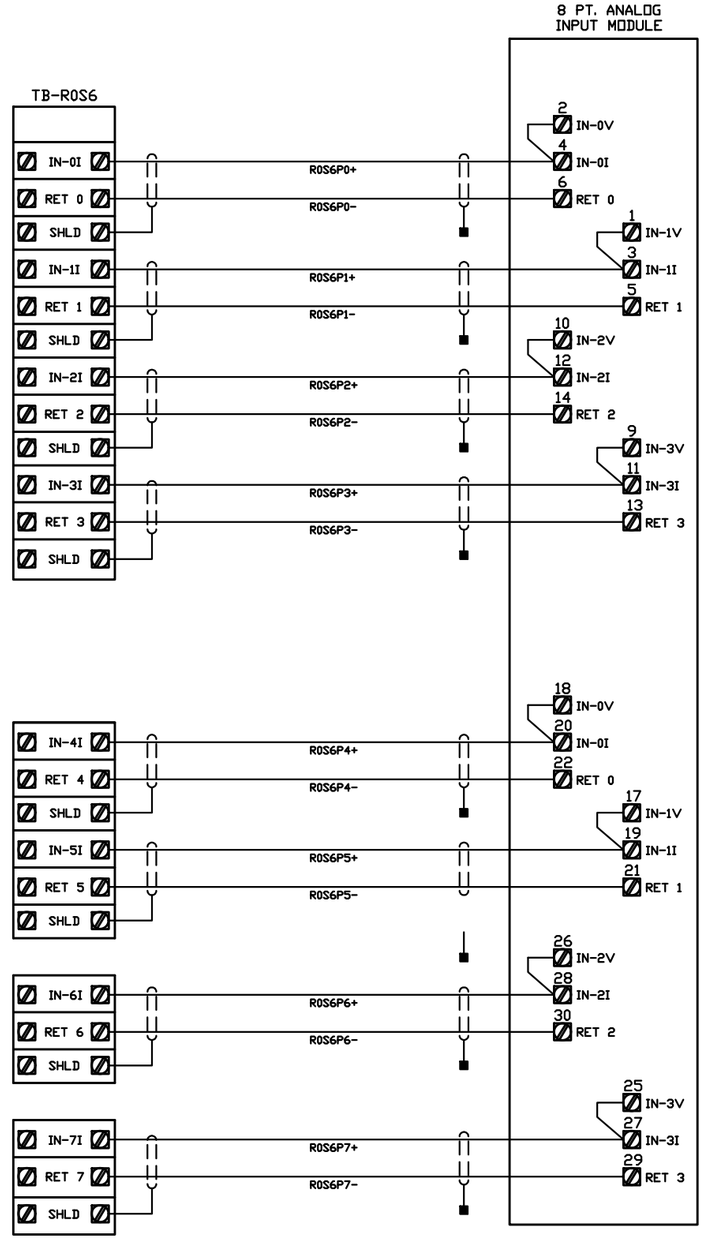
OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
ANALOG INPUT RACK 0 SLOT 3 & 4

DRAWN: KCD
CHECKED: ME
APPROVED: HAD
ISSUED DATE: 2023.10.27.
SCALE: NONE
JOB NO.: 0723-08MSI
DWG NO.: 0723-08MSI-A0
SHEET 1 OF 1





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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER PHASE 1A
ANALOG INPUT RACK 0 SLOT 5 & 6

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.27.	DWG NO. 0723-08MSI-A0	
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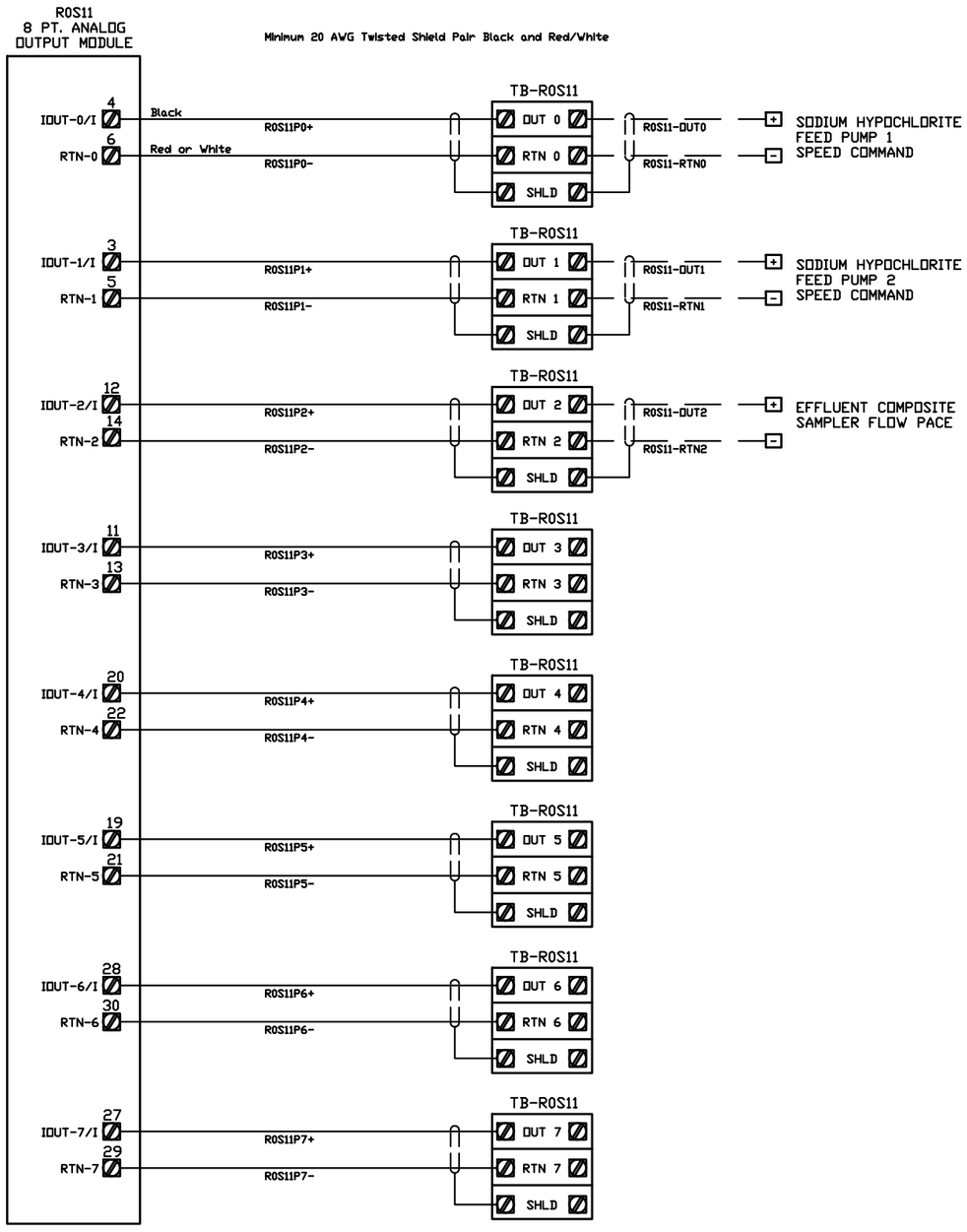

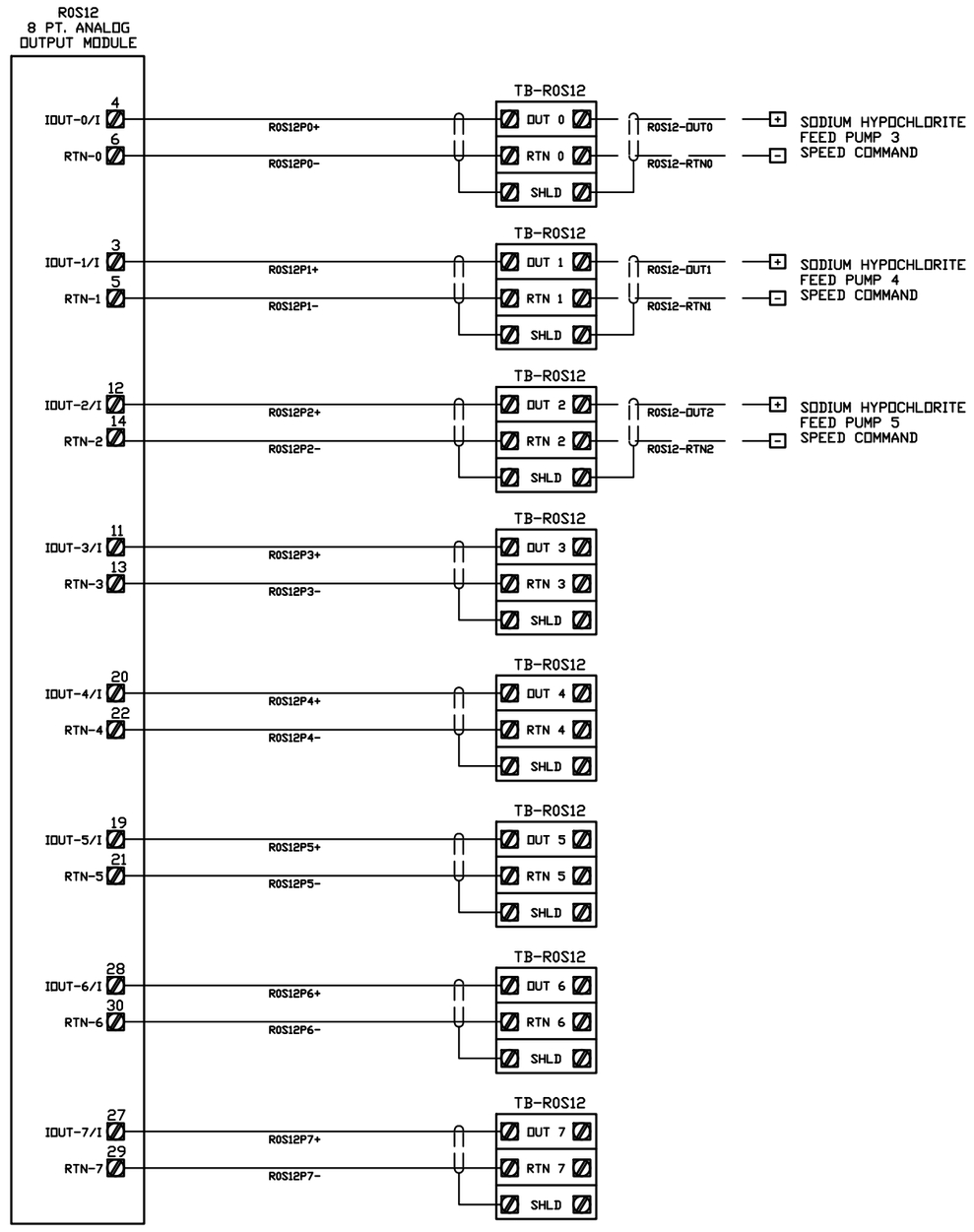

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
ANALOG OUTPUT RACK 0 SLOT 11 & 12

DRAWN: KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED: ME	DATE: 2023.10.27.	DWG NO. 0723-08MSI-A0	
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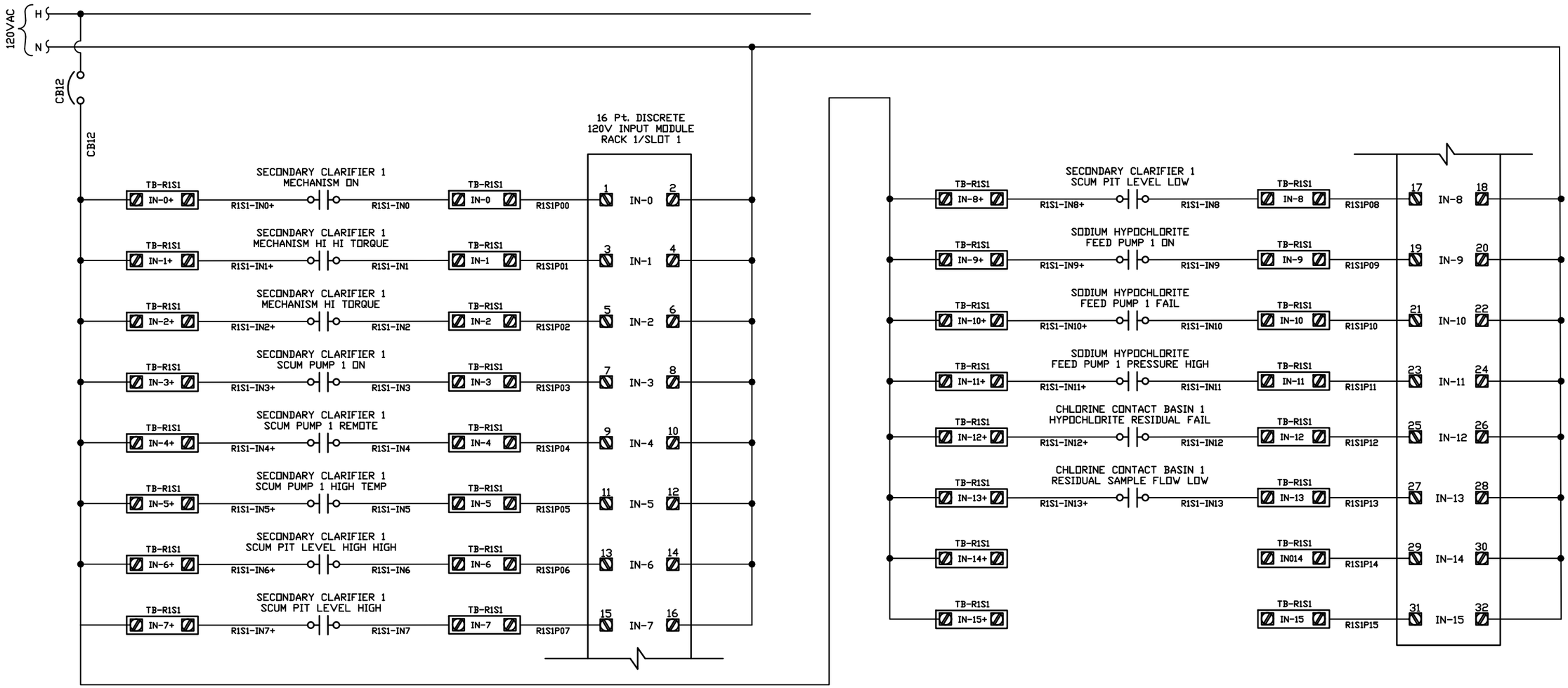

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C				TITLE COOS BAY WASTE WATER PHASE 1A DISCRETE INPUT RACK 1 SLOT 1
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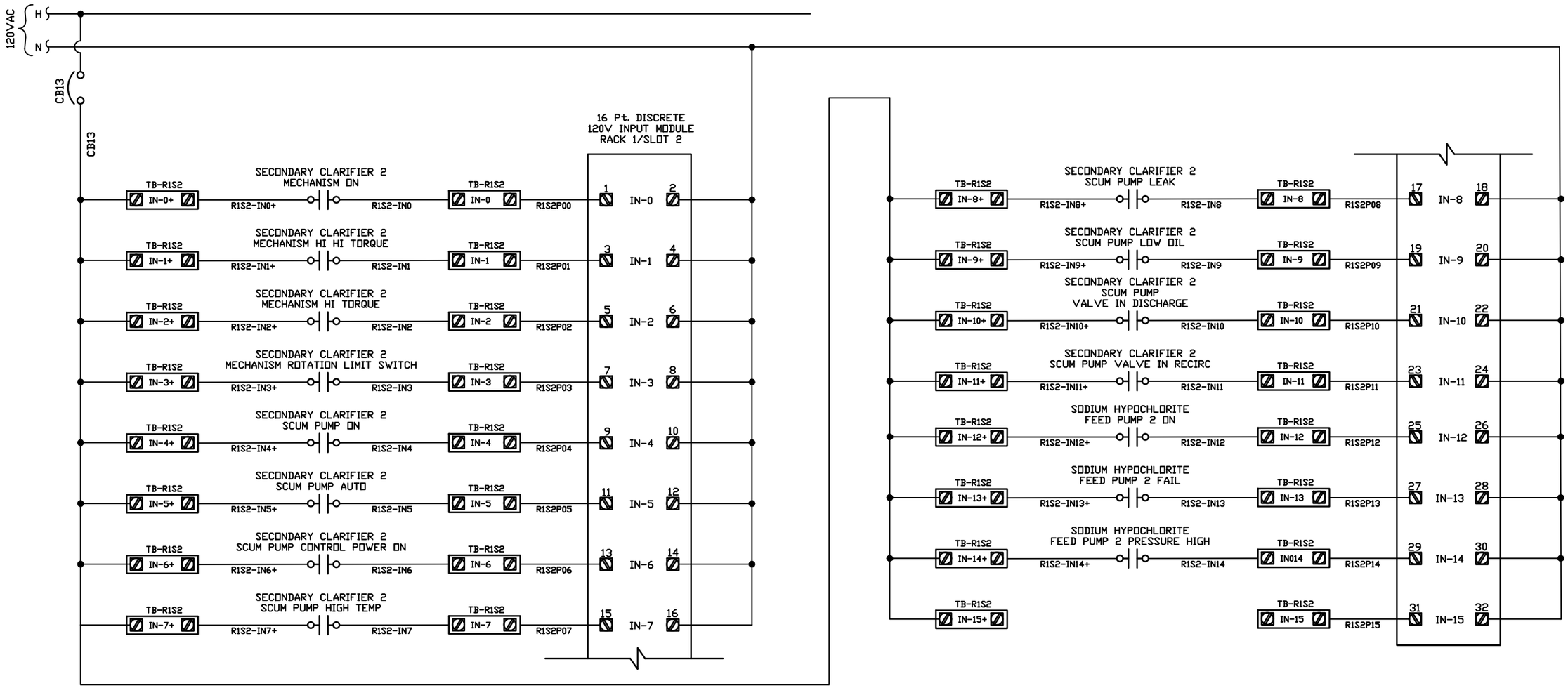
REVISIONS				APPROVED HAD / SCALE NONE / SHEET 1 OF 1



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OPTIMAL CONTROL SYSTEMS
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ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER PHASE 1A
DISCRETE INPUT RACK 1 SLOT 2

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
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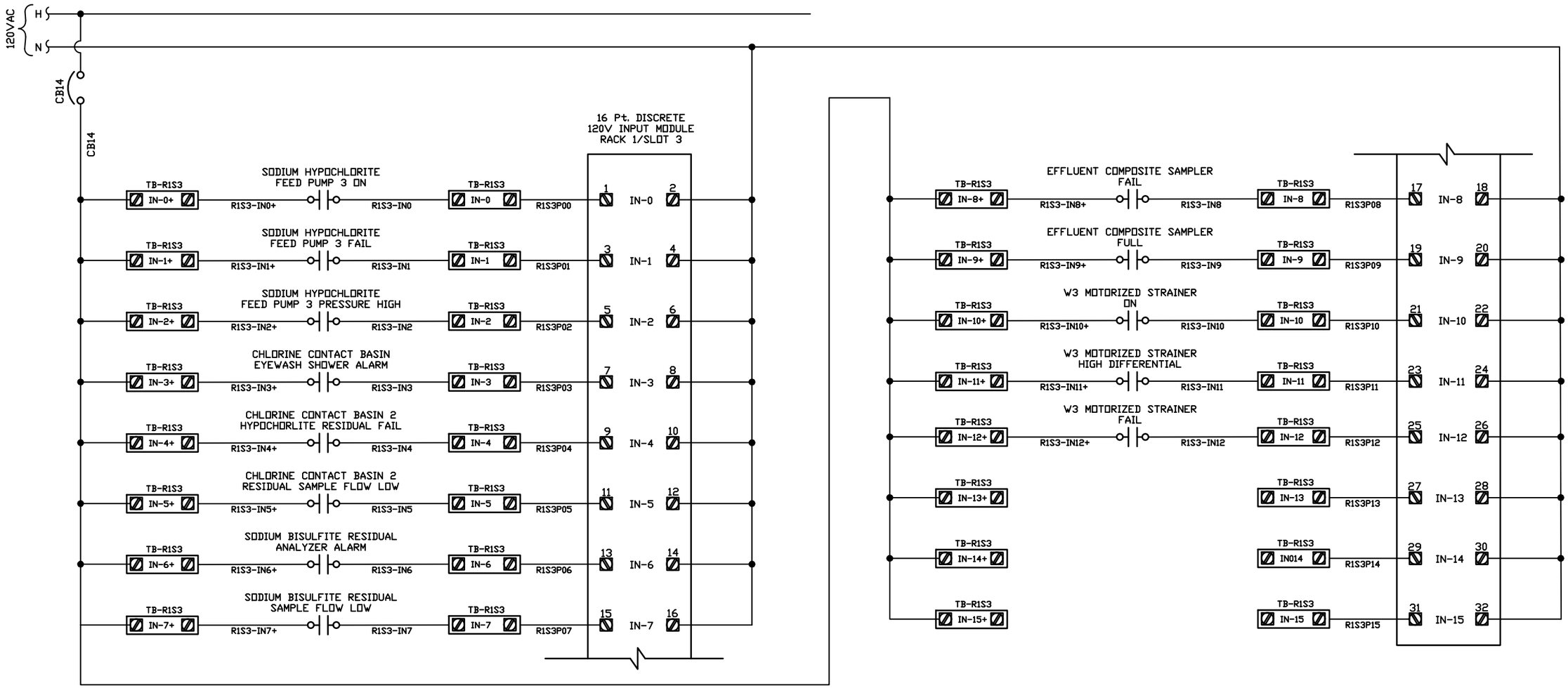

BLACK 120VAC 16AWG, WHITE 120 NEUTRAL 16AWG

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TITLE: COOS BAY WASTE WATER PHASE 1A
DISCRETE INPUT RACK 1 SLOT 3

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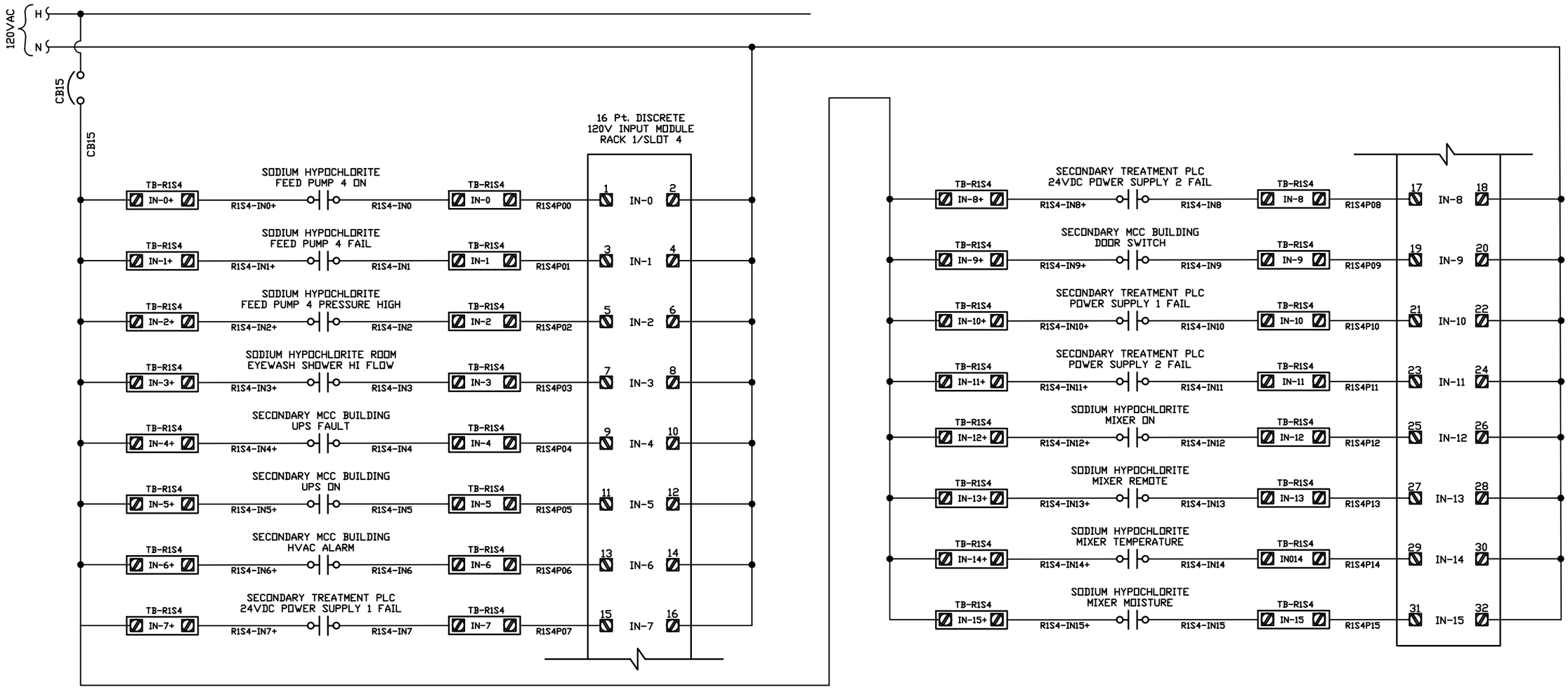

BLACK 120VAC 16AWG, WHITE 120 NEUTRAL 16AWG

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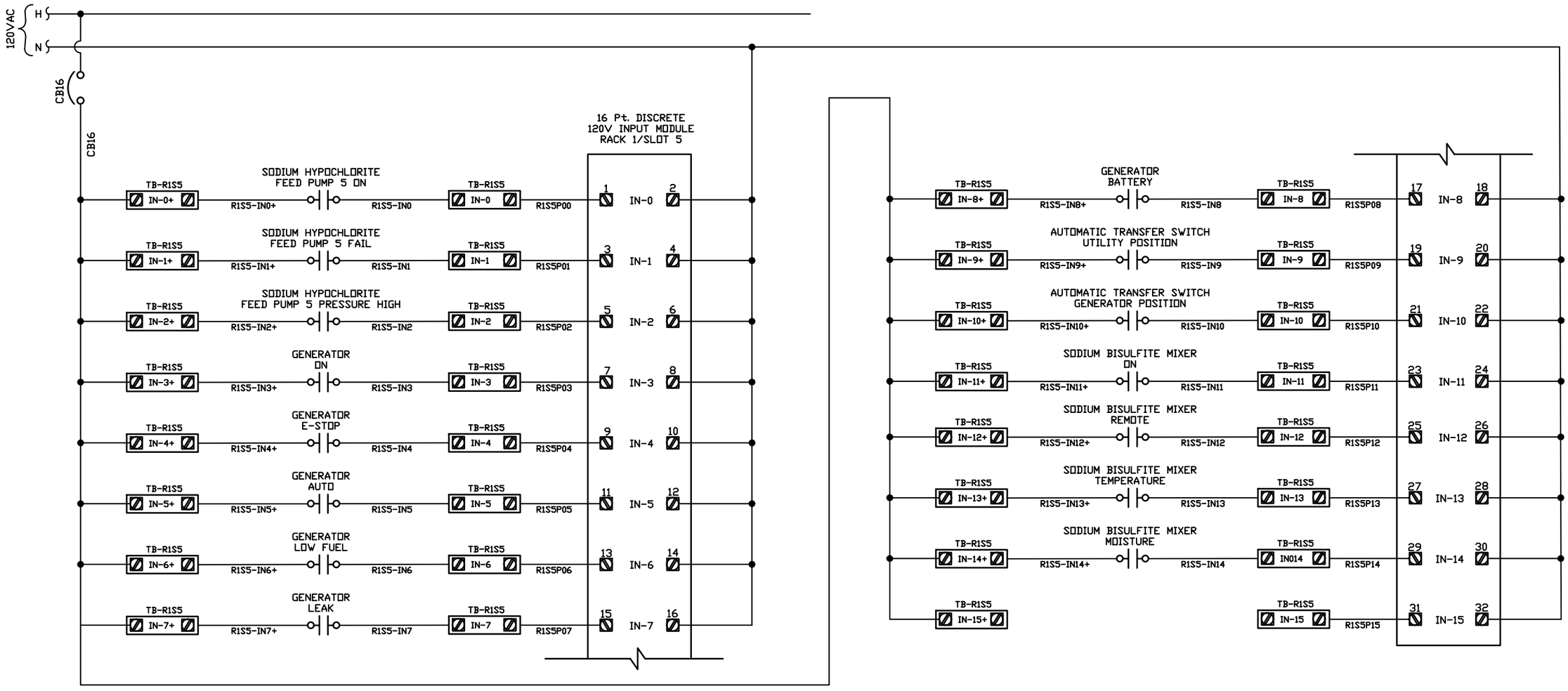
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
DISCRETE INPUT RACK 1 SLOT 4

DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.27.	DWG NO.: 0723-08MSI-PLCDI4	
APPROVED: HAD	SCALE: NONE	SHEET 1	OF 1



BLACK 120VAC 16AWG, WHITE 120 NEUTRAL 16AWG

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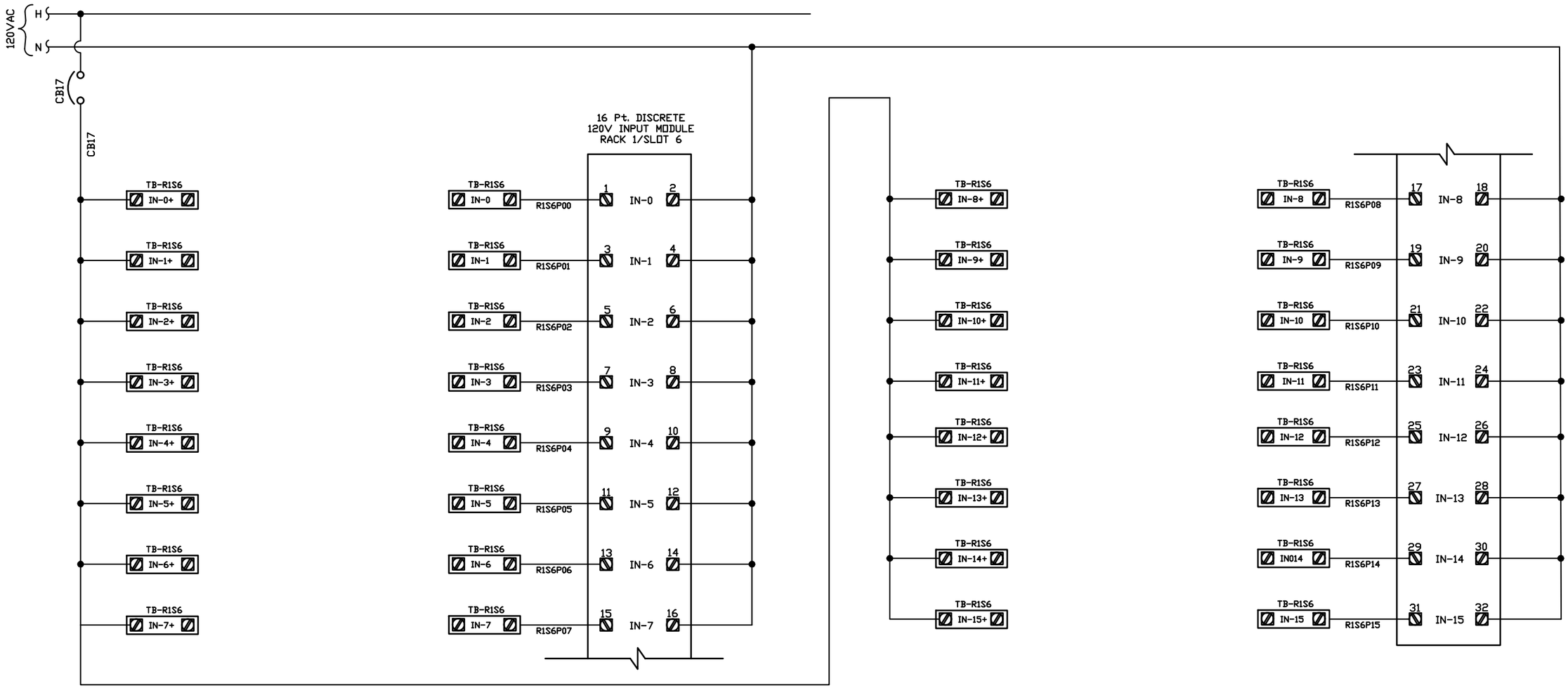
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
DISCRETE INPUT RACK 1 SLOT 5

DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.27.	DWG NO.: 0723-08MSI-PLCDI5	
APPROVED: HAD	SCALE: NONE	SHEET 1	OF 1



BLACK 120VAC 16AWG, WHITE 120 NEUTRAL 16AWG

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CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER PHASE 1A
DISCRETE INPUT RACK 1 SLOT 6

DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.27.	DWG NO.: 0723-08MSI-PLCDI6	
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120VAC
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CB18
CB18

16 Pt. DISCRETE OUTPUT MODULE RACK 1/SLOT 11

2	1 OUT-0	R1S11-P00	R1S11 OUT-0	R1S11 FU0 R1S11-FU0	SECONDARY CLARIFIER 1 SCUM PUMP 1 RUN COMMAND
					R1S11-OUT0
4	3 OUT-1	R1S11-P01	R1S11 OUT-1	R1S11 FU1 R1S11-FU1	SODIUM HYPOCHLORITE FEED PUMP 1 RUN COMMAND
					R1S11-OUT1
6	5 OUT-2	R1S11-P02	R1S11 OUT-2	R1S11 FU0 R1S11-FU2	SODIUM HYPOCHLORITE FEED PUMP 2 RUN COMMAND
					R1S11-OUT2
8	7 OUT-3	R1S11-P03	R1S11 OUT-3	R1S11 FU3 R1S11-FU3	SODIUM HYPOCHLORITE MIXER RUN COMMAND
					R1S11-OUT3
10	9 OUT-4	R1S11-P04	R1S11 OUT-4	R1S11 FU4 R1S11-FU4	SODIUM BISULFITE MIXER RUN COMMAND
					R1S11-OUT4
12	11 OUT-5	R1S11-P05	R1S11 OUT-5	R1S11 FU5 R1S11-FU5	
					R1S11-OUT5
14	13 OUT-6	R1S11-P06	R1S11 OUT-6	R1S11 FU6 R1S11-FU6	
					R1S11-OUT6
16	15 OUT-7	R1S11-P07	R1S11 OUT-7	R1S11 FU7 R1S11-FU7	
					R1S11-OUT7

16 Pt. DISCRETE OUTPUT MODULE RACK 1/SLOT 11

18	17 OUT-8	R1S11-P08	R1S11 OUT-8	R1S11 FU8 R1S11-FU8
				R1S11-OUT8
20	19 OUT-9	R1S11-P09	R1S11 OUT-9	R1S11 FU9 R1S11-FU9
				R1S11-OUT9
22	21 OUT-10	R1S11-P10	R1S11 OUT-10	R1S11 FU10 R1S11-FU10
				R1S11-OUT10
24	23 OUT-11	R1S11-P11	R1S11 OUT-11	R1S11 FU11 R1S11-FU11
				R1S11-OUT11
26	25 OUT-12	R1S11-P12	R1S11 OUT-12	R1S11 FU12 R1S11-FU12
				R1S11-OUT12
28	27 OUT-13	R1S11-P13	R1S11 OUT-13	R1S11 FU13 R1S11-FU13
				R1S11-OUT13
30	29 OUT-14	R1S11-P14	R1S11 OUT-14	R1S11 FU14 R1S11-FU14
				R1S11-OUT14
32	31 OUT-15	R1S11-P15	R1S11 OUT-15	R1S11 FU15 R1S11-FU15
				R1S11-OUT15

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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER PHASE 1A
DISCRETE OUTPUT RACK 1 SLOT 11

DRAWN KCD
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APPROVED HAD
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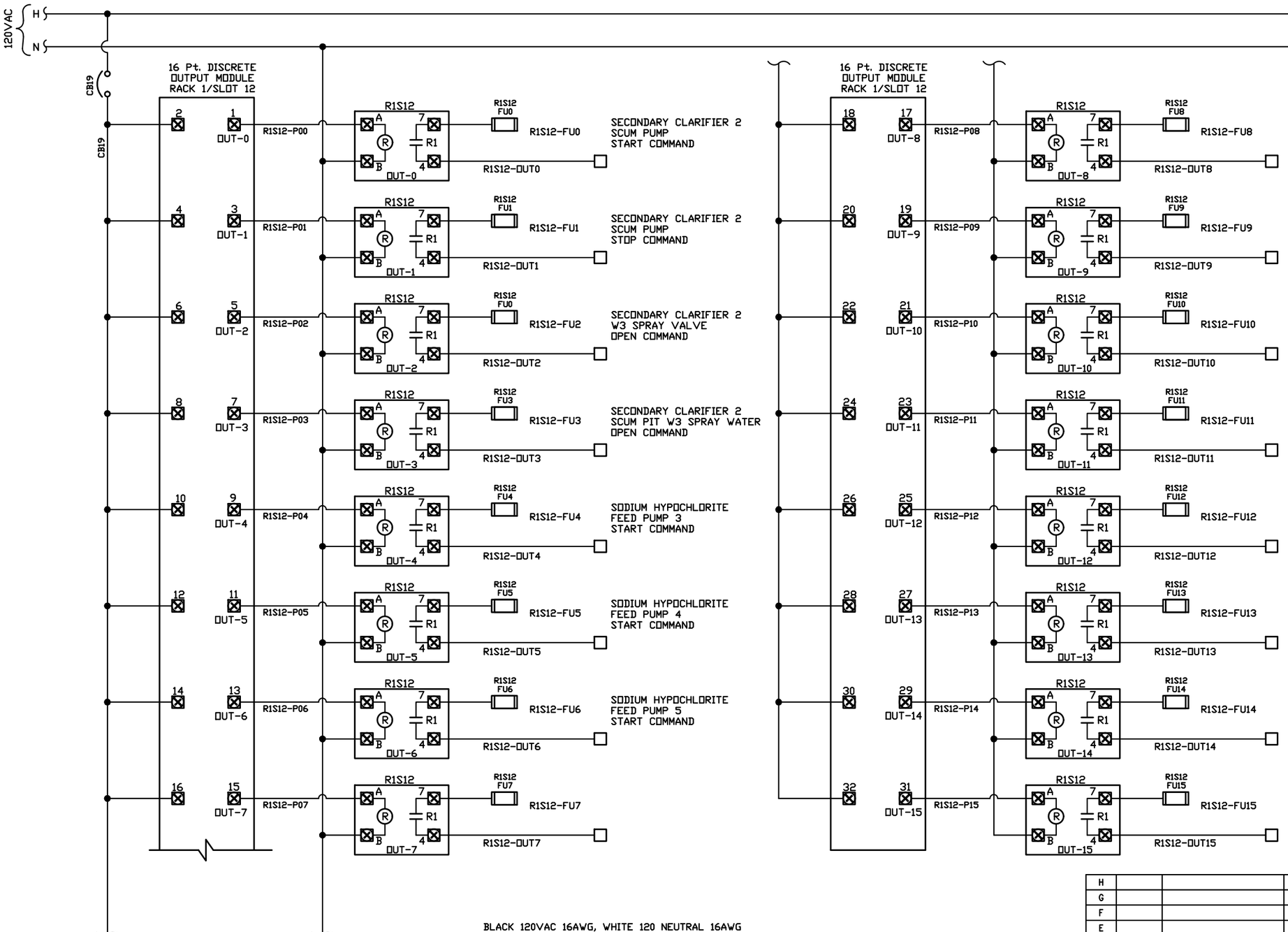
DATE 2023.10.27.
SCALE NONE
JOB NO. 0723-08MSI
DWG NO. 0723-08MSI-PLC001
SHEET 1 OF 1



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TITLE COOS BAY WASTE WATER PHASE 1A
DISCRETE OUTPUT RACK 1 SLOT 12

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.27.	DWG NO. 0723-08MSI-PLC002	
APPROVED HAD	SCALE NONE	SHEET 1 OF 1	

Saginaw Control and Engineering
95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-90EL7224FSD

Product Specifications:

Part Number: SCE-90EL7224FSD
Description: EL FSD Enclosure
Height: 90.00"
Width: 72.00"
Depth: 24.00"
Price Code: A2
List Price: $4,454.14
Catalog Page: 138
Est. Ship Weight: 815.00 lbs

Construction
- 0.104 In. carbon steel.
- Two-Door Single Access.
- Removable and inchangeable doors.
- Seams continuously welded and ground smooth.
- Lifting eyes for easy handling.
- Black zinc die cast keylocking/padlocking handle.
- 3-point latching mechanism.
- Latch rods have ramp shoes for easier door closing.
- Flange trough collar around all sides of door opening.
- Removable center post.
- Mounting channels welded horizontally on sides of interior body at top, bottom and middle for mounting optional panels or rack mounting angles.
- Pour in place oil & water resistant gasket
- Ground stud on door and body.
- Provisions for light kit.
- Concealed hinges.
- Holes plugs provided to seal holes in bottom of enclosure.
- Removable print pocket.

Application
Designed to house a variety of electrical and electronic controls and instruments. Provisions for optional surface mounting or rack mounting of almost any type of equipment. Provides protection from dust, dirt, water and oil. The enclosures are extra deep for applications requiring more interior space. For outdoor application a drip shield and drain vent is recommended.

For Details about the design, performance expectations, applications and design suggestions - See Design Considerations www.saginawcontrol.com/instman/considerations.pdf

Finish
ANSI-61 gray finish Inside and outside. Optional sub-panels are powder coated white.

Industry Standards - (IS4)
- NEMA Type 3R, 4, 12 and Type 13
- UL Listed Type 3R, 4 and 12
- CSA Type 3R, 4 and 12
- IEC 60529
- IP 66

Notes
Optional panels and accessories available.

Special Instructions apply for IS3, IS4 and IS6 to maintain the environmental rating of Type 3R for these parts. Instructions are located on the enclosure door. Drip shield is required on IS3, drip shield is recommended on IS4 and IS6. Drain holes are required on all.

Accessories Included
SCE-HS2S Hole Seal, 2 Inch Square

Installation Information
- Center Panel Support Assembly
- Heavy Duty Panel Supports - In Two Door FS Enclosure
- Rack Mounting Angles
- Swing-Out Full Panel
- Swing-Out Rack Mounting Frame
- Swing-Out Half Panel
- Drip Shield Kit Assembly
- Folding Shelf Hole Pattern
- Removable Wire Cover
- LED Light Fixture
- Hole Seal
- Free-Standing Two-Door Single Access Accessories
- Service Parts Free Standing & Floor Mount Enclosures
- Design Considerations When Specifying Your Enclosure

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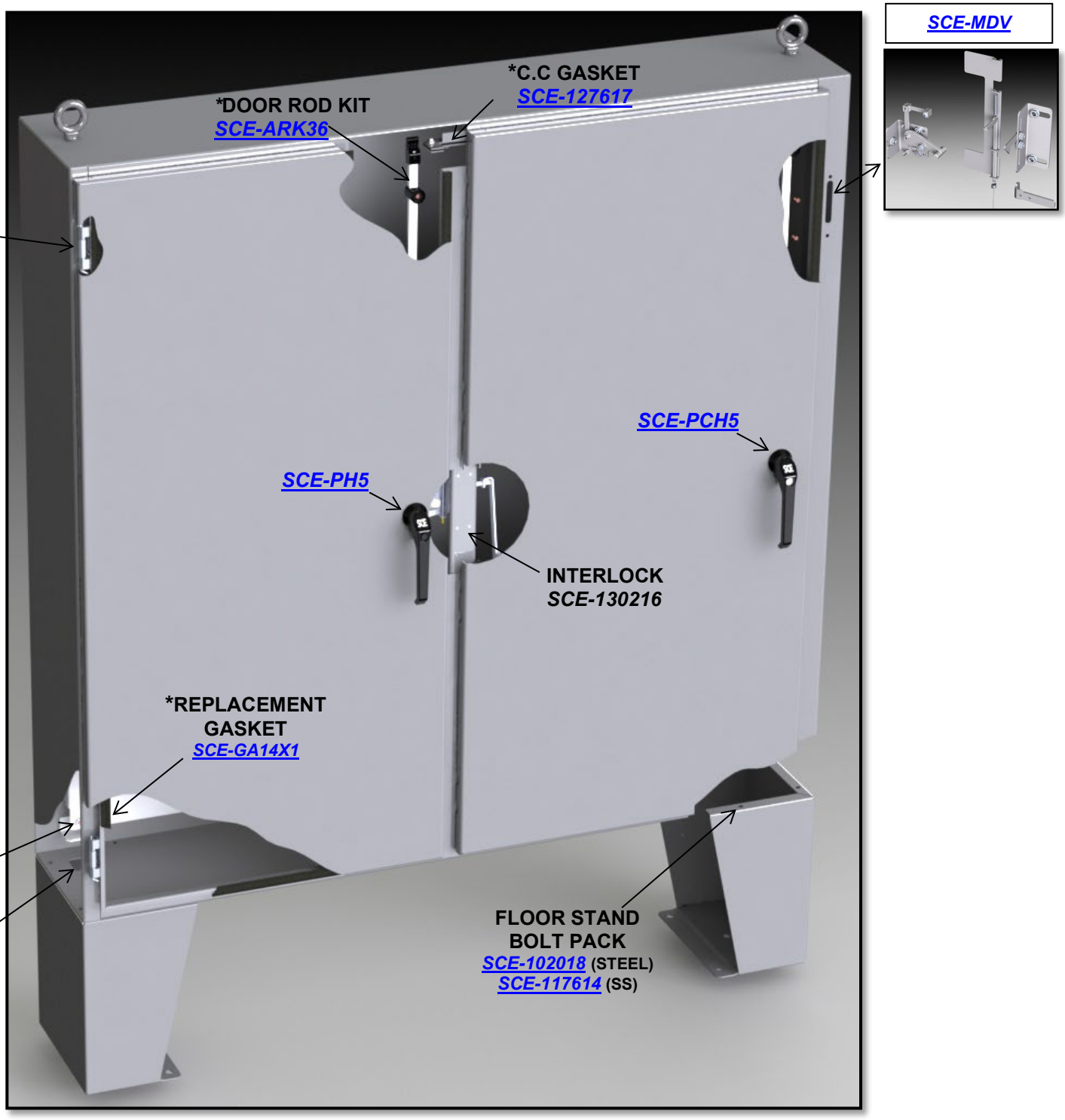
ENVIROLINE TWO DOOR ENCLOSURES FOR FLANGE MOUNTED DISCONNECTS

SERVICE PARTS 2DR



(*) PART USED IN ALL FREE-STANDING FLOOR MOUNTED ENCLOSURE MODELS.

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(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-90P72F1

Product Specifications:

Part Number: SCE-90P72F1
Description: Subpanel, Full
Height: 78.00"
Width: 68.00"
Depth: 0.88"
Price Code: P3
List Price: $724.09
Catalog Page: 148
Est. Ship Weight: 230.00 lbs

Construction
- 0.125 In. carbon steel.
- 0.125 In. Galvanized.

Application
Panels for two-door enclosures, can be positioned anywhere along the Horizontal mounting channels. Mounting hardware is included. Made of heavy gauge steel and powder coated white. GALV panels made of galvanized steel.

Industry Standards - (IS17)
- NEMA Not Applicable
- UL Not Applicable
- CSA N/A

Accessories Included
SCE-FSPS8 Kit, FS Panel Support

Installation Information
- Individual Panel Supports

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(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-DSTOPK

Product Specifications:

Part Number: SCE-DSTOPK
Description: Kit, Door Stop
Height: 9.00"
Width: 1.75"
Depth: 1.25"
Price Code: P2
List Price: $77.41
Catalog Page: 410
Est. Ship Weight: 2.00 lbs

Application
For use on most SCE Type 4, 4x and 12 enclosures to lock door in the open position. Door opening must be at least 16 inches and must open horizontally. Designed to be installed at the bottom of the door opening.

Industry Standards - (IS17)
- NEMA Not Applicable
- UL Not Applicable
- CSA N/A

Installation Information
- Door Stop Hole Pattern & Assembly

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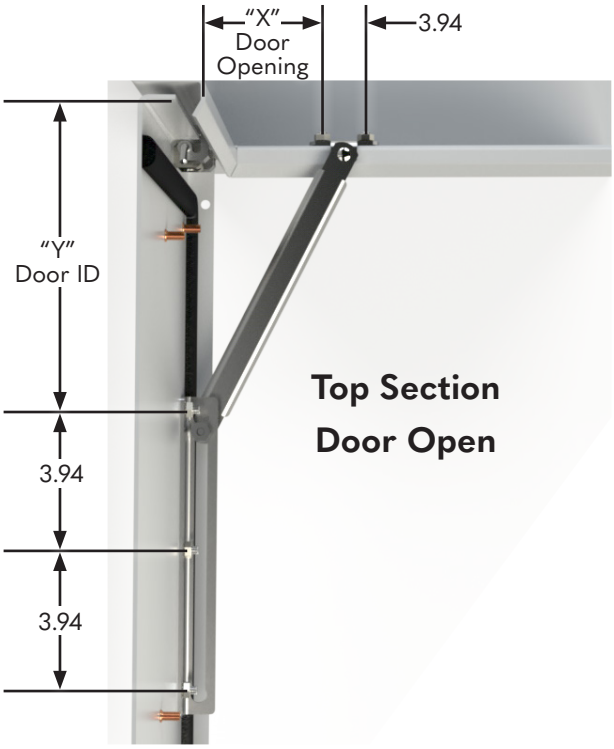
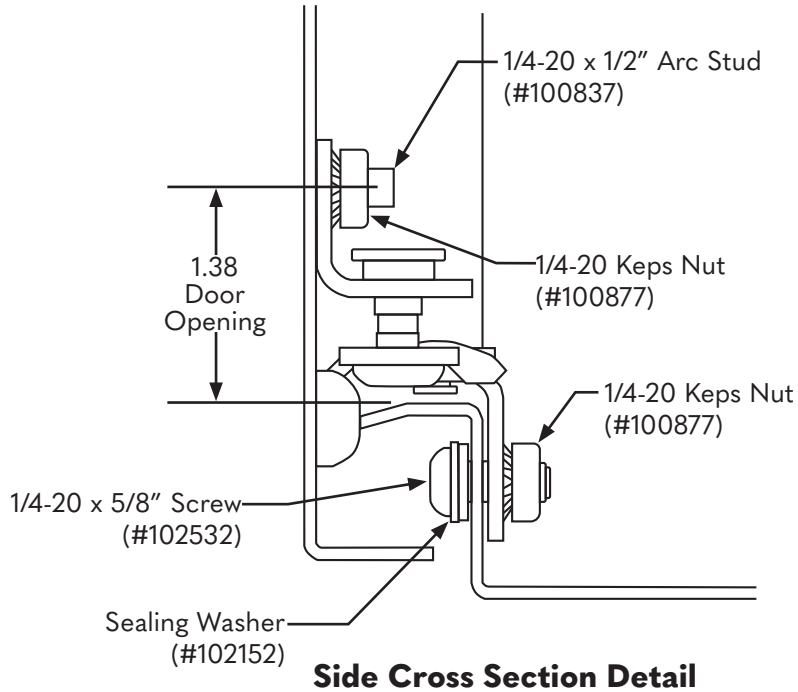
STANDARD DOOR STOP INSTALLATION INSTRUCTIONS



Top Section Door Open

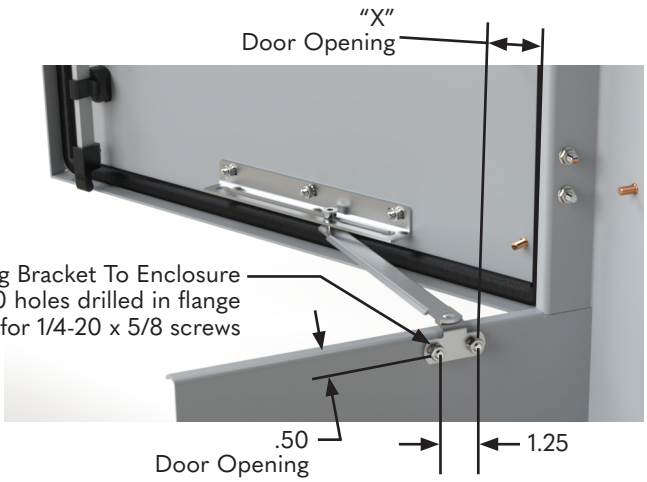


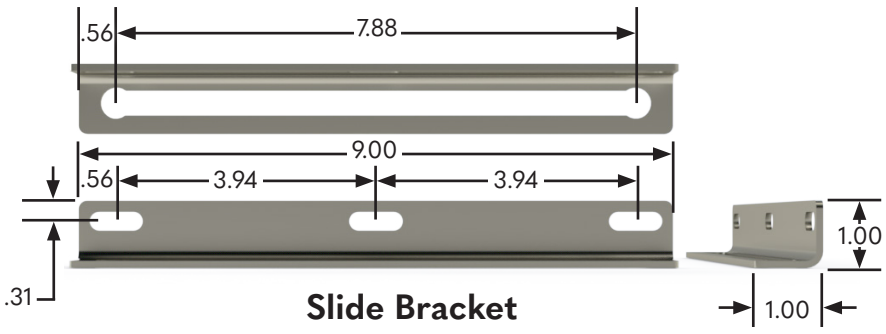
Side Cross Section Detail

Large Concealed Hinge		
Opening Angle	"X"	"Y"
90	2.45"	7.19"
105	2.45"	7.19"
120	2.45"	5.81"
135	2.45"	5.81"

Small Concealed Hinge		
Opening Angle	"X"	"Y"
90	2.45"	7.44"
105	2.45"	7.44"
120	2.45"	6.24"
135	2.45"	6.24"

Continuous Hinge		
Opening Angle	"X"	"Y"
90	2.45"	6.56"
105	2.45"	6.56"
120	2.45"	5.06"
135	2.45"	5.06"





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(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-FS2424

Product Specifications:

Part Number: SCE-FS2424
Description: Shelf, Folding
Height: 24.00"
Width: 24.00"
Depth: 1.75"
Price Code: P2
List Price: $255.16
Catalog Page: 413
Est. Ship Weight: 25.00 lbs

Application
Folding shelves can be installed on the inside or outside of large enclosures. They are designed to support test equipment and programmers. Locks in the horizontal position. When not in use, shelf can be folded down. Made of heavy gauge steel and powder coated. "SS" parts are stainless steel Type 304 with #4 brush finish.

Finish
Part number suffix indicates finish
SCE-FS****__

No suffix - White
**LG - RAL 7035 Light Gray
**09 - SCE-09 Gray
**SS - Stainless steel

Industry Standards - (IS17)
- NEMA Not Applicable
- UL Not Applicable
- CSA N/A

Notes
Provided with UL Recognized sealing washer to maintain Environmental Rating of the enclosure.

Installation Information
- Folding Shelf Hole Pattern

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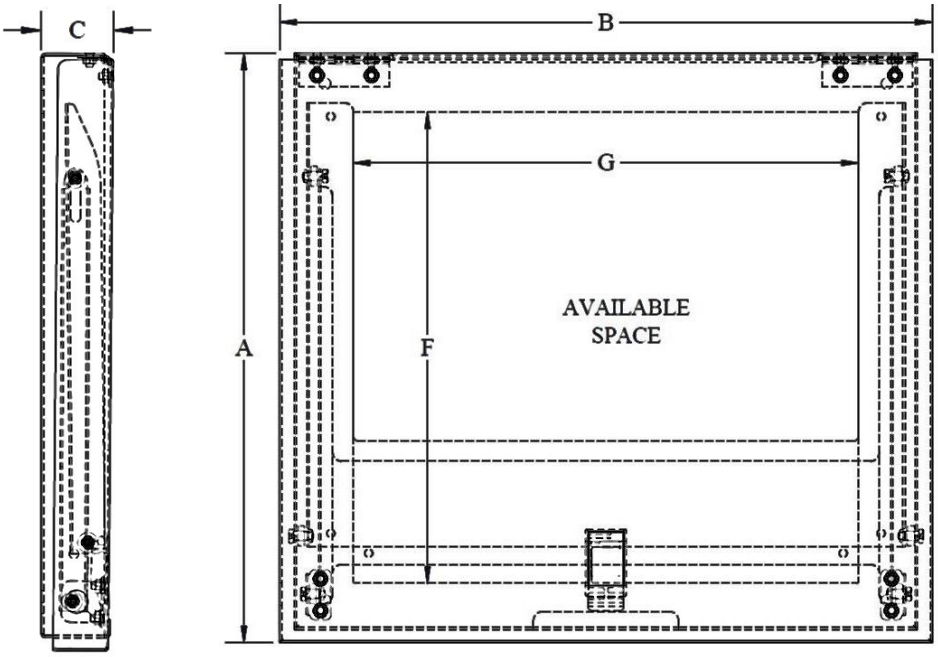
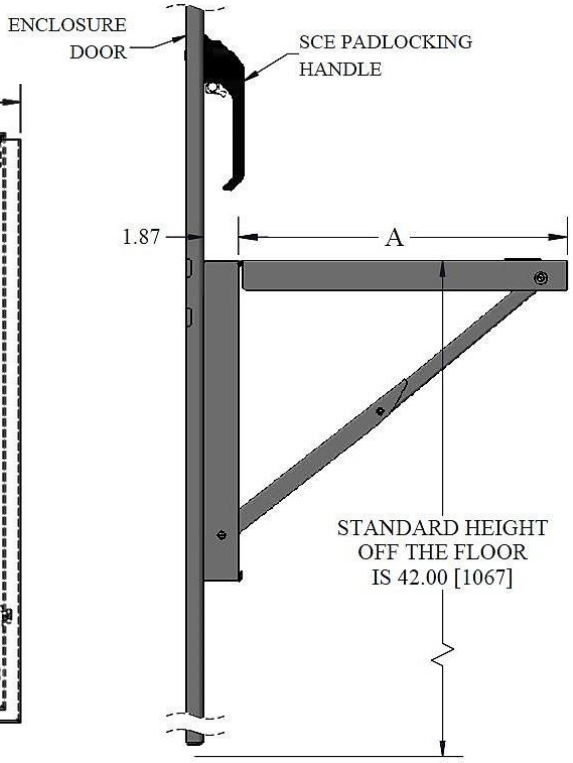
FOLDING SHELF HOLE PATTERN





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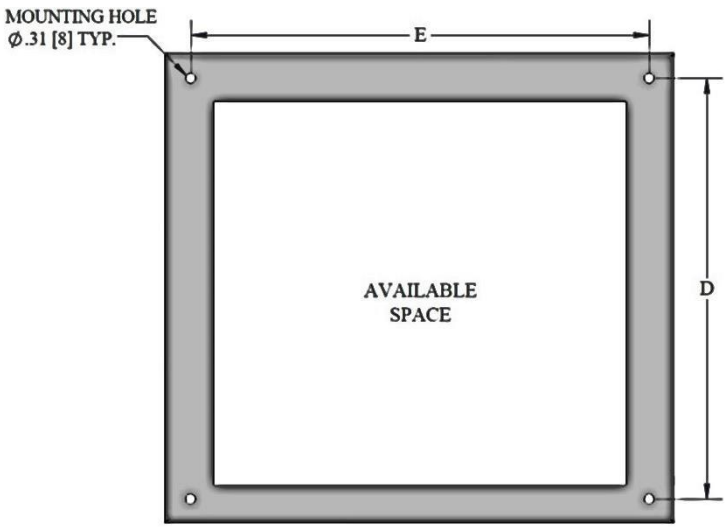
SCE-FS1818	16.43 [417]	18.00 [457]	1.92 [49]	14.25 [362]	15.50 [394]	13.00 [330]	13.94 [354]
SCE-FS2424	22.43 [570]	24.00 [610]	1.92 [49]	20.25 [514]	21.50 [546]	19.00 [483]	19.94 [507]



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(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-LF24NO

Product Specifications:

Part Number: SCE-LF24NO
Description: Fixture, LED Light w/o Outlet
Height: 2.75"
Width: 24.18"
Depth: 4.00"
Price Code: P2
List Price: $227.09
Catalog Page: 414
Est. Ship Weight: 7.00 lbs
Operating Temperature: -4 to 140 Degrees F

Construction
- 4000K Frosted White
- 18 inch 850 Lumens
- 24 inch 900 Lumens
- LF1824 24VDC 500 Lumens

Application
LED light fixture is designed to provide interior lighting for an enclosure. Can be mounted to light channels in the top of an enclosure or on the front flange of most enclosures. Door activated adjustable switch, switch can be removed and relocated. Terminal block on each end of fixture, making it easy to wire and daisy chain multiple lights continuously. LED bulb with PVC frosted white protective light diffuser included. Housing made from steel and powder coated white. Units with convenience receptacle outlet are 120 VAC with ground 50/60 HZ. Without convenience receptacle outlet 100 to 277 VAC 50/60 HZ. With the exception of SCE-LF1824VDC.

Industry Standards - (IS24)
- UL Component Recognized

Notes
Model 60

Installation Information
- LED Light Fixture

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SCE-LEDB24

Product Specifications:

Part Number: SCE-LEDB24
Description: Bulb, 24 Inch LED
Height: 24.00"
Width: 1.50"
Depth: 1.50"
Price Code: P2
List Price: $81.19
Catalog Page: 464
Est. Ship Weight: 1.00 lbs
Volt AC : 100 to 277 VAC 50/60 HZ.

Application
Replacement bulbs for LED light fixtures

Industry Standards - (IS24)
- UL Component Recognized

Notes
UL File # E364077

Installation Information
- LED Light Fixture

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LED Light Fixtures - Instruction Sheet - Stud Installation

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Stud Installation Instructions - Page 1
Unistrut Installation Instructions- Page 2

1. Safety Instructions

Read this instruction sheet before installing the light fixture.

Only specialized personnel are allowed to install, maintain and clean the fixture.

The personnel must ensure that for the duration of the installation, maintenance and cleaning, the fixture is disconnected from the electrical supply.

2. Specifications

Model	Voltage	Power	Hz	Lifespan	Luminous Flux	Max Amp Draw	Outlet Socket	L
SCE-LF18	100-125 VAC	10W	50/60	35,000 hrs	750Lm	.105	Yes	458 [18"]
SCE-LF18NO	100-240 VAC	10W	50/60	35,000 hrs	750Lm	.105	No	458 [18"]
SCE-LF24	100-125 VAC	10W	50/60	35,000 hrs	900Lm	.105	Yes	611 [24"]
SCE-LF24NO	100-240 VAC	10W	50/60	35,000 hrs	900Lm	.105	No	611 [24"]
SCE-LF1824VDC	24 VDC	6W	--------	35,000 hrs	500Lm	.300	No	458 [18"]

Electrical connection for 24 VD

3. Electrical Connections

Check the serial label before making any connections to the power supply to ensure that current and voltage ratings are met.

For convenience, the fixture has two power inlet/outlet terminal connectors. Power can be supplied to either of the two.

CAUTION: When one terminal connector is connected to the power supply the other will become LIVE. This allows connecting multiple light fixtures to each other in a daisy chain. The optional NEMA 5-15 outlet socket also becomes LIVE when either of the two terminal connectors is connected to the supply.

The electrical connections to the terminal connector for 100-240 VAC are as follows:

1 LIVE
⏚ Earth
3 Neutral

IMPORTANT NOTES:

- When connecting multiple fixtures to each other and to the NEMA 5-15 socket it is important that the total current passing through the first light fixture (which supplies the others) **does not exceed 12A.**
- The light fixture does not have an ON/OFF switch.
- The door switch only discontinues the power supply to the tube. All other connectors remain LIVE unless the power supply is disconnected **(even if the tube is off).**

4. Installation

The light fixture is to be mounted indoors in a horizontal position as shown in the picture below and is to be protected from the ingress of dust, water and corrosive agents. Only use the supplied mounting fasteners.

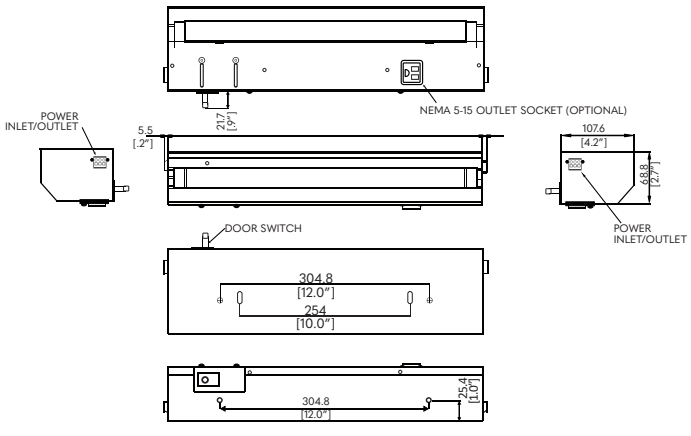
The door switch can be extended by a max distance of 1" [25.4mm].

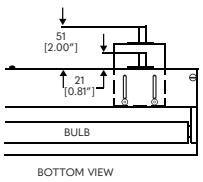
The supplies spacers can be used to slightly adjust the **vertical** fixing position of the light fixture.

Flange nuts (1/4-20) are provided for top mounting.

When installing a new tube take notice of the power enabled lamp holder (marked) on the fixture and fit the corresponding end of the tube to it. When mounted in an enclosure, this will be located on the right end of the fixture. Make sure to fix end of bulb marked "AC input from this side" to this end and twist bulb a 1/4 turn until it locks into place.

***Note:** **Light will only function with the active end of the bulb mounted in the input end of the fixture.**





	Front Mount	Top Mount
Flange ≤ 1.5"		
Flange >1.5"		USE SCE-LSMB FOR REMOTE MOUNTING OF THE SWITCH

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LED Light Fixtures - Instruction Sheet - Unistrut Installation

SAGINAW CONTROL & ENGINEERING
Your Enclosure Source ®

1. Safety Instructions

Read this instruction sheet before installing the light fixture.

Only specialized personnel are allowed to install, maintain and clean the fixture.

The personnel must ensure that for the duration of the installation, maintenance and cleaning the fixture is disconnected from the electrical supply.

2. Specifications

Model	Voltage	Power	Hz	Lifespan	Luminous Flux	Max Amp Draw	Outlet Socket	L
SCE-LF18	100-125 VAC	10W	50/60	35,000 hrs	750Lm	.105	Yes	458 [18"]
SCE-LF18NO	100-240 VAC	10W	50/60	35,000 hrs	750Lm	.105	No	458 [18"]
SCE-LF24	100-125 VAC	10W	50/60	35,000 hrs	900Lm	.105	Yes	611 [24"]
SCE-LF24NO	100-240 VAC	10W	50/60	35,000 hrs	900Lm	.105	No	611 [24"]
SCE-LF1824VDC	24 VDC	6W	--------	35,000 hrs	500Lm	.300	No	458 [18"]

Electrical connection for 24 VD

3. Electrical Connections

Check the serial label before making any connections to the power supply to ensure that current and voltage ratings are met.

For convenience, the fixture has two power inlet/outlet terminal connectors. Power can be supplied to either of the two.

CAUTION: When one terminal connector is connected to the power supply the other will become LIVE. This allows connecting multiple light fixtures to each other in a daisy chain. The optional NEMA 5-15 outlet socket also becomes LIVE when either of the two terminal connectors is connected to the supply.

The electrical connections to the terminal connector for 100-240 VAC are as follows:

1 LIVE
⏚ Earth
3 Neutral

IMPORTANT NOTES:

- When connecting multiple fixtures to each other and to the NEMA 5-15 socket it is important that the total current passing through the first light fixture (which supplies the others) **does not exceed 12A.**
- The light fixture does not have an ON/OFF switch.
- The door switch only discontinues the power supply to the tube. All other connectors remain LIVE unless the power supply is disconnected **(even if the tube is off).**

4. Installation

The light fixture is to be mounted indoors in a horizontal position as shown in the picture below and is to be protected from the ingress of dust, water and corrosive agents. Only use the supplied mounting fasteners.

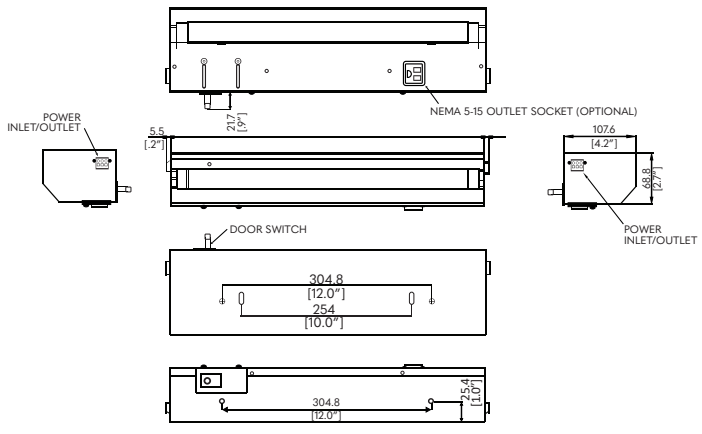
The door switch can be extended by a max distance of 1" [25.4mm].

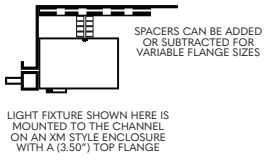
The supplies spacers can be used to adjust the **vertical** fixing position of the light fixture.

Spring channel nuts (10-32) are also provided for channel mounting.

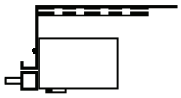
When installing a new tube take notice of the power enabled lamp holder (marked) on the fixture and fit the corresponding end of the tube to it. When mounted in an enclosure, this will be located on the right end of the fixture. Make sure to fix end of bulb marked "AC input from this side" to this end and twist bulb a 1/4 turn until it locks into place.

***Note: Light will only function with the active end of the bulb mounted in the input end of the fixture.**

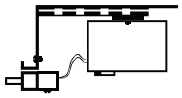




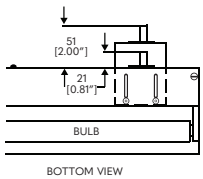
LIGHT FIXTURE SHOWN HERE IS MOUNTED TO THE CHANNEL ON AN XM STYLE ENCLOSURE WITH A (3.50") TOP FLANGE



LIGHT FIXTURE SHOWN MOUNTED TO FLANGE



USE SCE-LSMB FOR REMOTE MOUNTING OF THE SWITCH



BOTTOM VIEW

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SCE-LSA

Product Specifications:

Part Number: SCE-LSA
Description: Assembly, Light Switch
Height: 2.00"
Width: 2.68"
Depth: 1.00"
Price Code: P2
List Price: $44.26
Catalog Page: 414
Est. Ship Weight: 1.00 lbs

Application
Complete Light Switch Assembly. Designed to remote mount the light switch when space is limited. And easily mounted to single door enclosures with SCE concealed hinges.

Industry Standards - (IS24)
- UL Component Recognized

Notes
Lamb E-Switch PP1
UL File # E194579
Honywell Micro Switch 1DM1
UL File # E313809

Installation Information
- Light Switch Mounting Bracket (Video)

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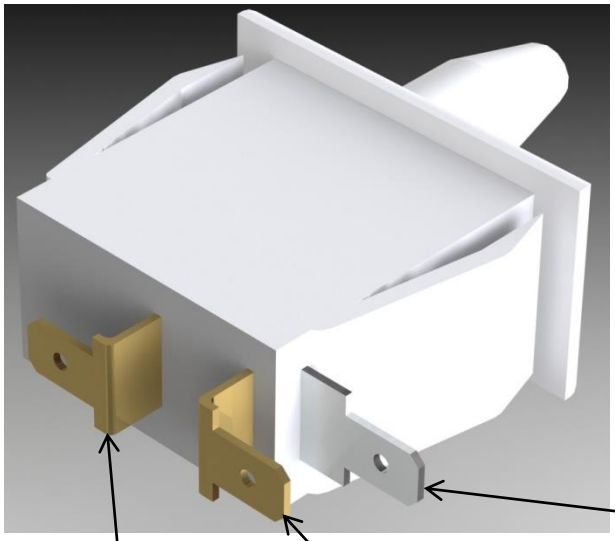
SCE-LSA, SCE-LSMB, INSTALL MANUAL

SCE-LSA
COMPLETE LIGHT SWITCH ASSEMBLY

SCE-LSMB
LIGHT SWITCH MOUNTING BRACKET

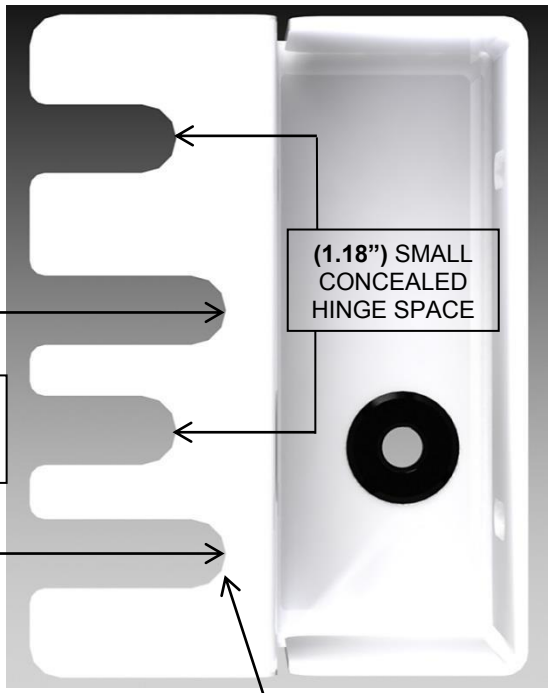
100-277 VAC & 24 VDC
10 AMP MAX
ALL MOUNTING HARDWARE SUPPLIED WITH LIGHT FIXTURE.



POWER INPUT

CONTACT OPEN
USED WITH THERMAL MANAGEMENT
POWER OFF WHEN DOOR IS OPEN

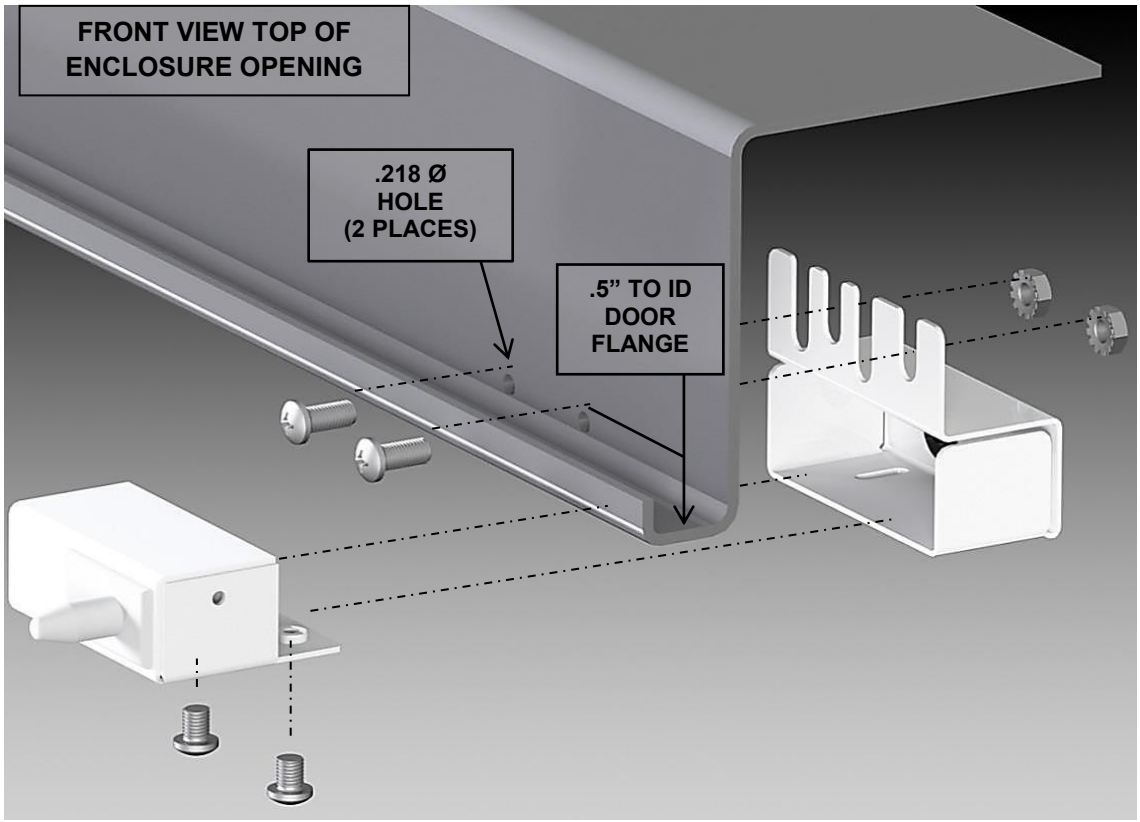
CONTACT CLOSED
USED WITH LIGHTING
POWER ON WITH DOOR OPEN



(1.18") SMALL CONCEALED HINGE SPACE

(.99") LARGE CONCEALED HINGE SPACE

Ø .281 TYP.



CLICK HERE
FOR INSTALL VIDEO

FRONT VIEW HINGE SIDE OF
ENCLOSURE OPENING

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SCE-N12FA10HF

Product Specifications:

Part Number: SCE-N12FA10HF
Description: Filter Fan. (550 CFM) 115V
Height: 12.80"
Width: 12.80"
Depth: 6.24"
Price Code: P1
List Price: $978.89
Catalog Page: 398
Est. Ship Weight: 9.37 lbs
Model: FL-4883A3003-SG
Voltage: 50/60hz
CFM: 483/547

Application
Easy to install snap fit design for use in enclosures that require cooling but have limited space in NEMA 1 and 12 applications. Housing and grille are made of black heat resistant (ABS-FR), self-extinguishing material. Fans are available in 115 or 230 volt AC, 60/50 Hertz (HZ) single phase or 24 volt DC. Filter Class G3 EN 779 - Filter Fire Class F1 DIN 53438 Self-extinguishing.

Industry Standards - (IS24)
- UL Component Recognized

Notes
Type 12 - IEC 60529 IP 54
cULus Listed E498756
cULus File Component Recognized E358386
Motor w/ Thermal Protection

Installation Information
- Type 12 Fan / Filter Package
- Type 12 Fan / Filter Package
- Thermal Management Chart

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SCE-N12FGA1010

Product Specifications:

Part Number: SCE-N12FGA1010
Description: Filter & Grille Assy. (Black)
Height: 12.80"
Width: 12.80"
Depth: 1.34"
Price Code: P1
List Price: $103.36
Catalog Page: 398
Est. Ship Weight: 3.00 lbs
Model: 4000 40003-S

Application
Easy to install snap fit design for use on air discharge side of fan package for NEMA 1 and 12 applications. Housing and grille are made of black heat resistant (ABS-FR), self-extinguishing material. Filter Class G3 EN 779 - Filter Fire Class F1 DIN 53438 Self-extinguishing.

Industry Standards - (IS24)
- UL Component Recognized

Notes
Type 12 - IEC 60529 IP 54
cULus File Component Recognized SA32278
cULus Listed E498756

Installation Information
- Type 12 Fan / Filter Package
- Type 12 Fan / Filter Package
- Thermal Management Chart

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FAN FILTERS

c UL us LISTED

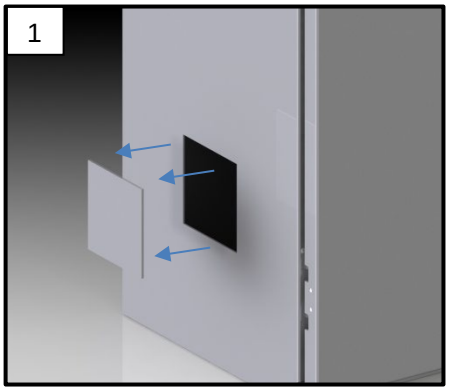
SCE SAGINAW CONTROL & ENGINEERING
Your Enclosure Source

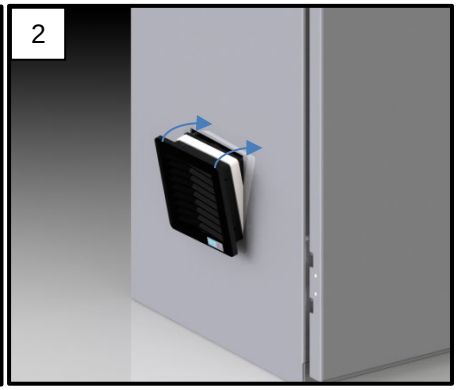
MOUNTING INSTRUCTIONS

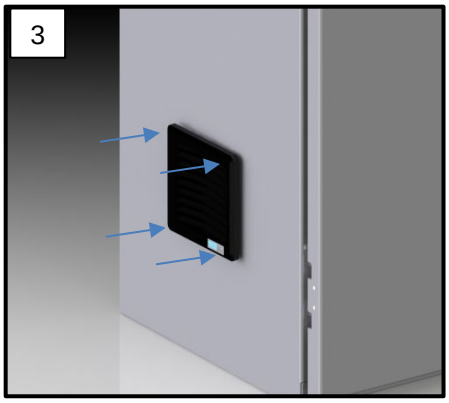
1. Cut the mounting hole (when required) in the enclosure using the dimensions shown, respecting the tolerances indicated.
2. Insert the filter into the mounting hole.
   Note: the bottom side is marked by the SCE logo plate down on the right.
3. Push on each corner of the cover so that the filter is correctly clamped.
   Attention: Press on the filter up to the required depth so that the clips return to their original position. Fix the filter using the clips provided or four screws in each corresponding hole within the corners of the base.

We recommend wearing suitable protective clothing:

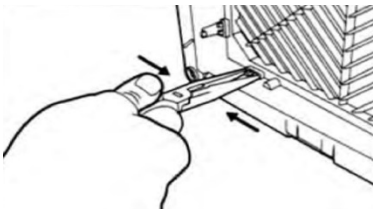
- Gloves EN 420 and EN 388
- Safety glasses ENC 166 - 170





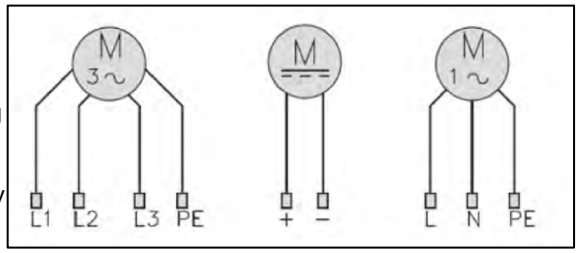


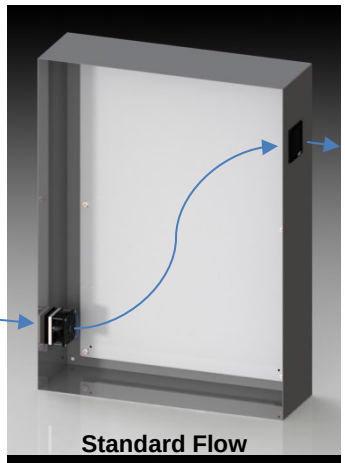
DISMOUNTING
If filter cannot be removed from seat: Using fine-nose pliers, apply pressure to the clips while pushing inwards towards the enclosure. This will release the clips from the base.

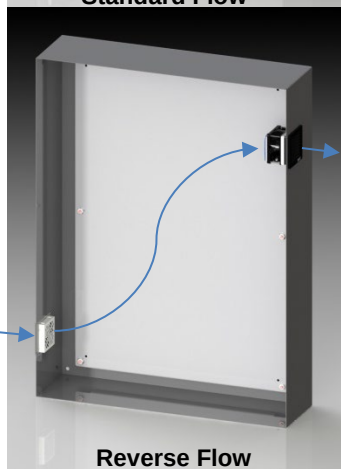


ELECTRICAL CONNECTION TO THE FAN FILTERS

The feed voltage and frequency must be according to the rated values stated on the name plates.
The electrical connection must be carried out according to the local norms and safety regulations which govern the use of electrical material.
Electrical connection and repairs must be carried out by qualified personnel only.



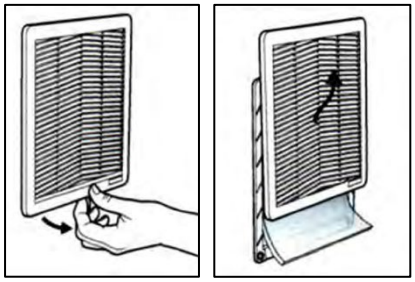

Standard Flow


Reverse Flow

REPLACEMENT AND CLEANING OF THE FILTER MEDIA

To remove the filter media, (See fig. A) slide the cover on the base by raising the bottom tongue and pushing it upwards.
The filter media can be cleaned by rinsing, spraying or beating.
Re-insert the cover into the base after cleaning media. The frequency with which the filter media must be replaced depends on the amount of dust accumulated, operating period, and specific working conditions encountered by the user.
Note: an unclean filter media reduces the efficiency of the filter causing insufficient or finally a total lack of ventilation

A

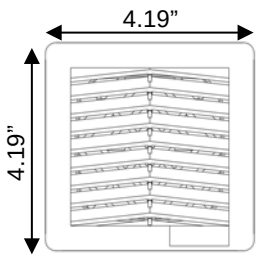


FAN FILTERS

Filter Assemblies	Detail	Max Material Thickness	UL Type	Fan and Filter Assembly	Voltage	Airflow CFM (m^3/hr)	Noise dB(A)	Power (W)	Current (A)	Weight lbs (Kg)
Exhaust Filter: SCE-N12FGA33	1	0.078	12	SCE-N12FA33	115 50/60hz	13 / 15	37 / 42	12/10	0.145 / 0.127	1.19 (0.54)
				SCE-N12FA33-230	230V 50/60hz	13 / 15	37 / 42	12/11	0.780 / 0.680	1.19 (0.54)
				SCE-N12FA33-24VDC	24V DC	29	59	15	0.610	0.77 (0.35)
Exhaust Filter: SCE-N12FGA44	2	0.125	12	SCE-N12FA44	115 50/60hz	26.5 / 29.4 (45 / 50)	46 / 49	16 / 15	0.20 / 0.18	1.67 (0.76)
				SCE-N12FA44-230	230V 50/60hz	39 / 47 (66 / 80)	40 / 44	16 / 15	0.13 / 0.10	1.67 (0.76)
				SCE-N12FA44-24VDC	24V DC	28 (47)	42	7.4	0.309	1.10 (0.50)
Exhaust Filter: SCE-N3FGA44	2	0.125	3R	SCE-N3RFA44	115V 50/60hz	39 / 47 (66 / 80)	46 / 49	16 / 15	0.20 / 0.18	1.67 (0.76)
				SCE-N3RFA44-230	230V 50/60hz		40 / 44	16 / 15	0.13 / 0.10	1.67 (0.76)
Exhaust Filter: SCE-N12FGA44LG	2	0.125	12	SCE-N12FA44LG	115V 50/60hz	26.5 / 29.4	46 / 49	16 / 15	0.20 / 0.18	1.67 (0.76)
				SCE-N12FA44-24VLG	24V DC	28 (47)	42	7.4	0.309	1.10 (0.50)
Exhaust Filter: SCE-N12FGA66	3	0.125	12	SCE-N12FA66	115V 50/60hz	135.4 / 158.9 (230 / 270)	60.0 / 69.2	39 / 41	0.36 / 0.36	3.09 (1.40)
				SCE-N12FA66-230	230V 50/60hz		65.3 / 68.1	42 / 48	0.18 / 0.19	3.09 (1.40)
				SCE-N12FA66-24VDC	24V DC	86 (146)	42	17	0.71	3.09 (1.40)
Exhaust Filter: SCE-N3RFGA66	3	0.125	3R	SCE-N3RFA66	115V 50/60hz	135.4 / 158.9 (230 / 270)	60.0 / 69.2	39 / 41	0.36 / 0.36	3.09 (1.40)
				SCE-N3RFA66-230	230V 50/60hz		65.3 / 68.1	42 / 48	0.18 / 0.19	3.09 (1.40)
Exhaust Filter: SCE-N12FGA66LG	3	0.125	12	SCE-N12FA66LG	115V 50/60hz	135.4 / 158.9	60.0 / 69.2	39 / 41	0.36 / 0.36	3.09 (1.40)
				SCE-N12FA66-24VLG	24V DC	86 (146)	42	17	0.71	3.09 (1.40)
Exhaust Filter: SCE-N12FGA1010	4	0.125	12	SCE-N12FA1010	115V 50/60hz	306.1 / 341.4 (520 / 580)	60.0 / 69.2	74 / 83	0.63 / 0.73	6.83 (3.10)
				SCE-N12FA1010-230	230V 50/60hz		65.3 / 68.1	70 /85	0.31 / 0.35	6.83 (3.10)
				SCE-N12FA10HF	115V 50/60hz	483 / 547 (820 / 929)	70 / 72	125 / 172	1.1 / 1.5	9.37 (4.25)
				SCE-N12FA10HF-230	230V 50/60hz		70 / 71	125 / 166	0.67 / 0.75	9.37 (4.25)
				SCE-N12FA10HF-460	460V 50/60hz 3~		70 / 71	110 / 175	0.34 / 0.38	9.37 (4.25)
Exhaust Filter: SCE-N3RFGA1010	4	0.125	3R	SCE-N3RFA1010	115V 50/60hz	306.1 / 341.4 (520 / 580)	60.0 / 69.2	74 / 83	0.63 / 0.73	6.83 (3.10)
				SCE-N3RFA1010-230	230V 50/60hz		65.3 / 68.1	70 / 85	0.31 / 0.35	6.83 (3.10)
				SCE-N3RFA10HF	115V 50/60hz	435 / 494 (739 / 839)	74 / 79	165 / 215	1.47 / 1.84	9.40 (4.26)
				SCE-N3RFA10HF-230	230V 50/60hz		66 / 69	155 / 195	0.67 / 0.85	9.40 (4.26)
Exhaust Filter: SCE-N12FGA1010LG	4	0.125	12	SCE-N12FA1010LG	115V 50/60hz	306.1 / 341.4 (520 / 580)	60.0 / 69.2	74 / 83	0.63 / 0.73	6.83 (3.10)

Operating temperature range 14°F to 131°F (-10°C to 55°C)

1



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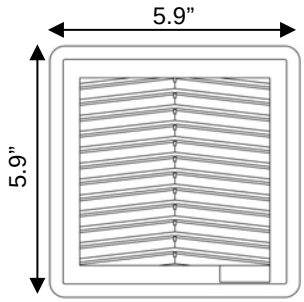

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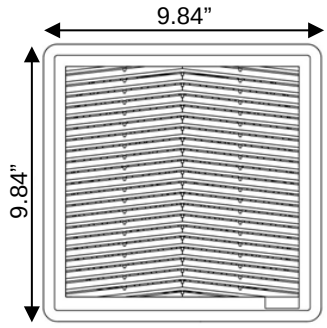

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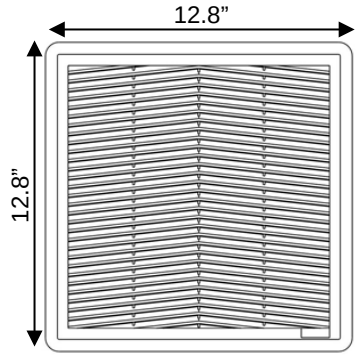

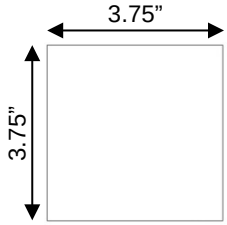

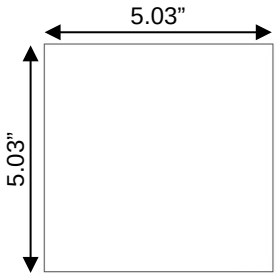

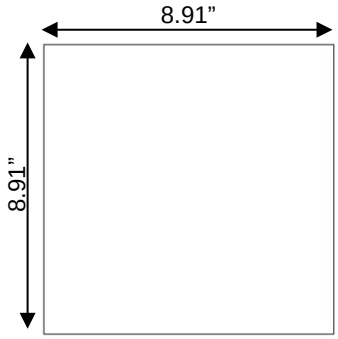

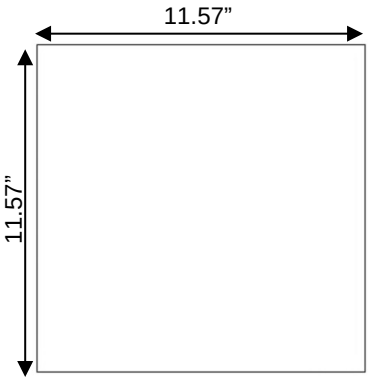

Saginaw Control and Engineering
95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-TEMNO

Product Specifications:

Part Number: SCE-TEMNO
Description: Thermostat (Normally Open)
Height: 2.40"
Width: 1.26"
Depth: 1.42"
Price Code: P1
List Price: $57.93
Catalog Page: 396
Est. Ship Weight: 1.00 lbs

Application
Designed to regulate air temperature in enclosures that operate with heaters or fans. This mechanical bi-metallic thermostat has a set point range of 30° to 140° F and is easily installed on 35mm mounting rail. (NC) contact normally closed, or (NO) contact normally open, switch capacity 10 amp 120-250 VAC Resistive load and 1 amp 120-250VAC Inductive load, 1.25 amp 24VDC.

Industry Standards - (IS24)
- UL Component Recognized

Notes
UL File # E358385

Installation Information
- Thermostat
- Thermostat

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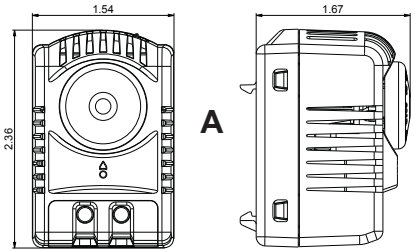
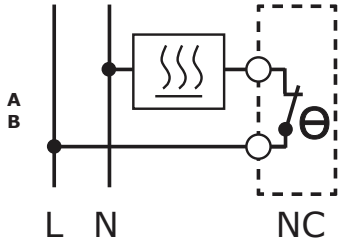
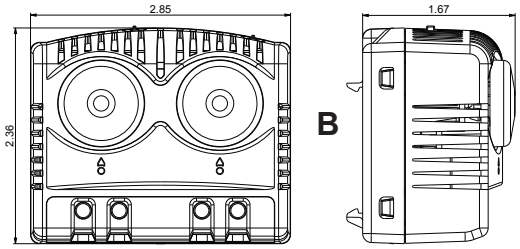
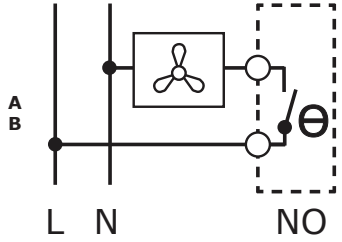
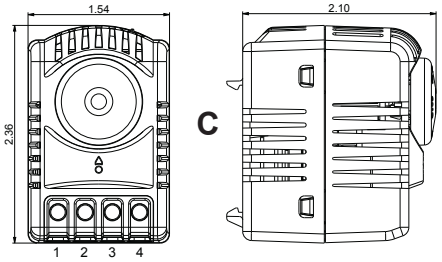
Thermostats

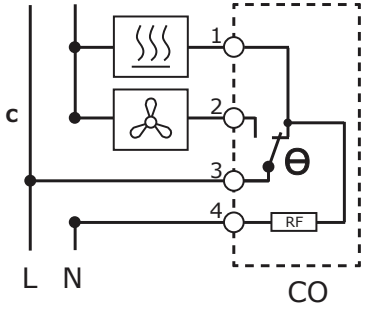


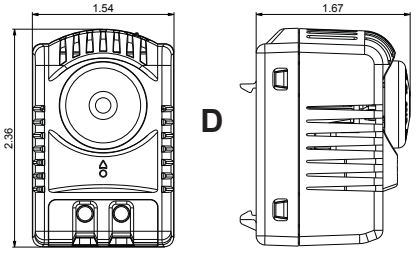


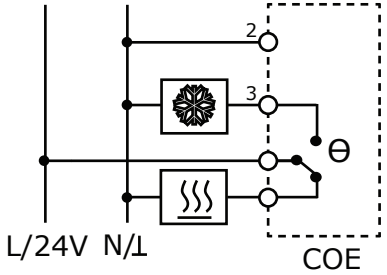






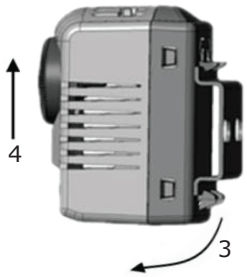






1 + 2 Installation

3 + 4 Removal



Control Range		
A	SCE-TEMNC	14 – 176°F
	SCE-TEMNO	14 – 176°F
B	SCE-TEMD	14 – 176°F
C	SCE-CTEM	32 – 140°F
D	SCE-TEMEVDC	14 – 176°F

Safety Information

This component must be installed/serviced by qualified personnel complying with the relevant safety regulations in force and in accordance with the wiring diagram shown on the housing and represented in this manual. Ensure manuals are kept in a secure place accessible to servicing/installing personnel.

Device Description

This device has been designed specifically for cabinet temperature control.

Manually Adjustable Thermostat

Knob Color	With temperature rising, at the set temperature:
Red NC	Breaks Contact
Blue NO	Makes Contact
White CO	Breaks Contact 3 to 1 Makes Contact 3 to 2
White COE	Electronic Adjustable Thermostat

Installation

The device has been designed for installation on a DIN EN 60715 compliant standard rail. Preferably, it should be installed in the upper part of the cabinet with maximum separation from heat generating components. Thermostat's ventilation slots must not be covered.

Switching Capacity			pf 0.95	pf 0.75
AC	max. 250 V 50/60 Hz	A/B	16 A	2 A
		C	10 A	2 A
DC	A/B/C	max. 72 V DC / max. 30 W		
	D	24 V DC, 16 A resistive load		

	A / B	C	D
Hysteresis	7K ±3K	7K	±3K / 5%
Switching Tolerance	±4K	±3K	±3K / 5%

Operating/Storage Temperature:

A/B: -49°F – 248°F
C: 32°F – 140°F
D: -13°F – 158°F

Connection: 0.5 – 2.5mm^2 / 14 – 20 AWG

Housing Material: Plastic UL94V-2

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IceQube Sizing Calculator

Heat Calculator

Units: Standard

Location of Enclosure: Indoors

Physical outside dimensions of the enclosure

Height (inch)	Width (inch)	Depth (inch)	Area (Sq. Ft.)
90	72	24	144.00

Insulation R-Value: None

Various

Desired internal enclosure temperature	104	°F
Minimum ambient temperature	72	°F
Heat dissipated by electronic equipment (watts)	3600	
OR BTU Per Hour	12276.0	

Hz Operation: (•) 60Hz ( ) 50Hz

Recommended Heating Capacity in Watts

-2102.0 W

Calculate Reset Visit IceQube.com Submit by Email Print

https://www.iceqube.com?icq=cDA6OTA6NzI6MjQ6MTA0OjcyOjM2MDA=

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Total Load

3206 WATTS

Internal Temp w/o Cooling

354° F

CUSTOMER INFORMATION

Recommended Open-Loop Products

Recommended Capacity: 493 CFM

90 in H x 72 in W x 24 in D / Gray / Side Mount / R0 = 0in. / 115 volt AC 50/60 hz

144 sq ft total surface area

45 sq ft surface area for heat transfer

72 °F Max temp outside Enclosure

104 °F Max desired temp inside enclosure

Min outside temp below 50 °F? No

Enclosure Location : Indoor

US/Canada/Mexico

Internal heat load = 3600 Watts

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DIN-Rail Self-Test GFCI Receptacles

GFNT2-DIN

Specifications

AC Horsepower Rating	
At Rated Voltage	1 HP
Electrical Specifications	
Grounding	Self-Grounding
Pole	2
Wire	3
Short Circuit Current Rating	10kA
Environmental Specifications	
Flammability	Rated V-0 per UL94
Operating Temperature	-35°C to +66°C
Material Specifications	
Face Material	PBT
Enclosure Base	Polycarbonate
Enclosure Cover	Polycarbonate
Line Contacts	Brass
Mechanical Specifications	
Product ID.	Ratings are permanently marked on device
Standards & Certifications	
NEMA	WD-1 & WD-6
ANSI	C-73
Certification/Listing	cURus
Applicable Standards	UL 943, UL 498, CSA C22.2 No. 42 & 144, FedSpec W-C-596
Warranty	
Product Warranty	2 Year Limited

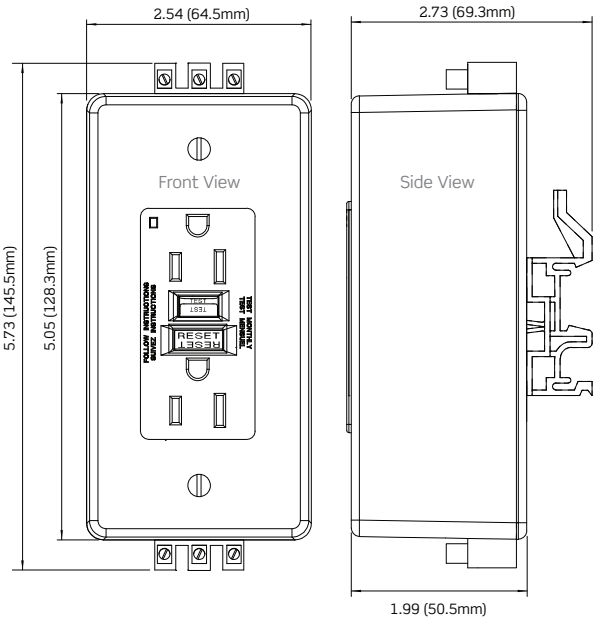
Ordering Information

Extra-Heavy Duty Industrial Grade DIN-Rail Self-Test GFCI Receptacle		
Color	**Cat. No.**	**Cat. No.**
	NEMA 5-15R	NEMA 5-20R
	15A-125V @ Receptacle 20A-125V Feed-Through	20A-125V @ Receptacle 20A-125V Feed-Through
Black	GFNT1-DIN	GFNT2-DIN

Additional Features & Benefits

- Mounting clip provides easy installation in equipment cabinets
- GFCI has two terminal blocks, one for the line side and one for feed-thru
- Terminal block accepts #22-#12 AWG conductors

Typical for GFNT1-DIN



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LEVITON

smartlockpro™

Installing and Testing a DIN Rail Mount GFCI Receptacle

Please read this leaflet completely before getting started.

PK-A3094-10-00-0C

⚠ CAUTION

- To prevent severe shock or electrocution always turn the power OFF at the service panel before working with wiring.
- Use this GFCI with copper or copper-clad wire. Do not use it with aluminum wire.
- Do not install this GFCI receptacle on a circuit that powers life support equipment because if the GFCI trips it will shut down the equipment.
- For installation in wet locations, protect the GFCI receptacle with a weatherproof enclosure that will keep both the receptacle and any plugs dry.
- Must be installed in accordance with national and local electrical codes.

1. What is a GFCI?

A GFCI receptacle is different from conventional receptacles. In the event of a ground fault, a GFCI will trip and quickly stop the flow of electricity to prevent serious injury.

Definition of a ground fault:
Instead of following its normal safe path, electricity passes through a person's body to reach the ground. For example, a defective appliance can cause a ground fault.

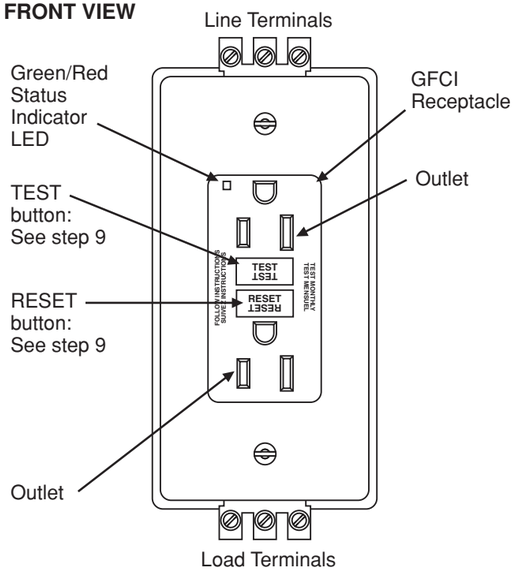
A GFCI receptacle does **NOT** protect against circuit overloads, short circuits, or shocks. For example, you can still be shocked if you touch bare wires while standing on a non-conducting surface, such as a wood floor.

GFCI's contain a lockout feature that will prevent RESET if:

- There is no power being supplied to the GFCI.
- The GFCI is miswired due to reversal of the LINE and LOAD leads.
- The GFCI cannot pass its internal test, indicating that it may not be able to provide protection in the event of a ground fault.

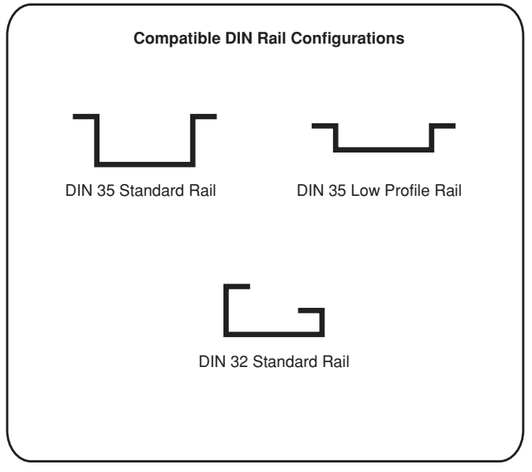
2. GFNT1-DIN (with GFCI) features:

FRONT VIEW



3. Compatible DIN Rail Configurations

The device mounts using two DIN clips attached to its back. It will properly mount using any of the following DIN rail configurations:



4. Should <u>you</u> install it?

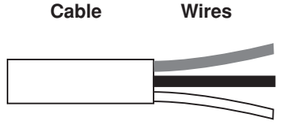
Installing a GFNT1-DIN or GFNT2-DIN, with GFCI receptacle, can be more complicated than installing a conventional receptacle.

Make sure that you:

- Understand basic wiring principles and techniques
- Can interpret wiring diagrams
- Have circuit wiring experience
- Are prepared to take a few minutes to test your work, making sure that you have wired the device (with GFCI) correctly

5. LINE vs. LOAD

A cable consists of 2 or 3 wires.

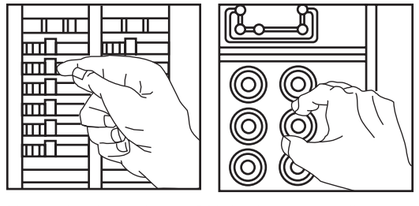


LINE cable:
Delivers power from the service panel (breaker panel or fuse box) to the device. If there is only one cable entering the electrical box/enclosure, it is the LINE cable. This cable should be connected to the device's LINE terminals only.

LOAD cable:
Delivers power from the device (with GFCI) to another receptacle in the circuit. This cable should be connected to the device's LOAD terminals only.

6. Turn the power OFF

Plug an electrical device, such as a lamp or radio, into the receptacle on which you are working. Turn the lamp or radio ON. Then, go to the service panel. Find the breaker or fuse that protects that receptacle. Place the breaker in the OFF position or completely remove the fuse. The lamp or radio must turn OFF.



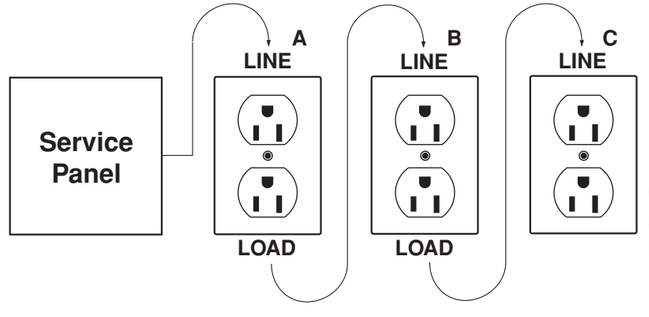
Next, plug in and turn ON the lamp or radio at the receptacle's other outlet to make sure the power is OFF at both outlets. If the power is not OFF, stop work and call an electrician to complete the installation.

7. Placement in circuit

The GFCI's place in the circuit determines if it protects other receptacles in the circuit.

Placing the GFCI in position A will also provide protection to "load side" receptacles B and C. On the other hand, placing the GFCI in position C will not provide protection to receptacles A or B. Remember that receptacles A, B, and C can be in different rooms.

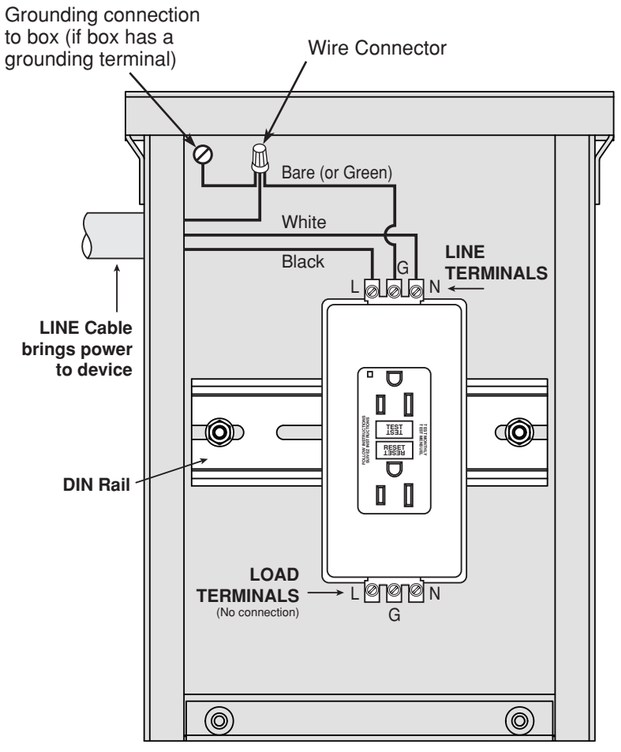
Sample circuit:



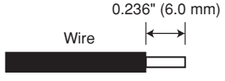
WEB VERSION

8. Connect the wires (choose A or B)... only after reading other side completely

A: Non-Feed-thru Installation



About Wire Connections To Device:			
Device	**Current (A)**	**Voltage (V)**	**AWG**
GFNT1-DIN	15	125	14-10
GFNT2-DIN	20	125	12-10



Connect the LINE cable wires to the device LINE terminals:
- The white wire connects to the Neutral (N) terminal.
- The black wire connects to the Line (L), or Hot terminal.

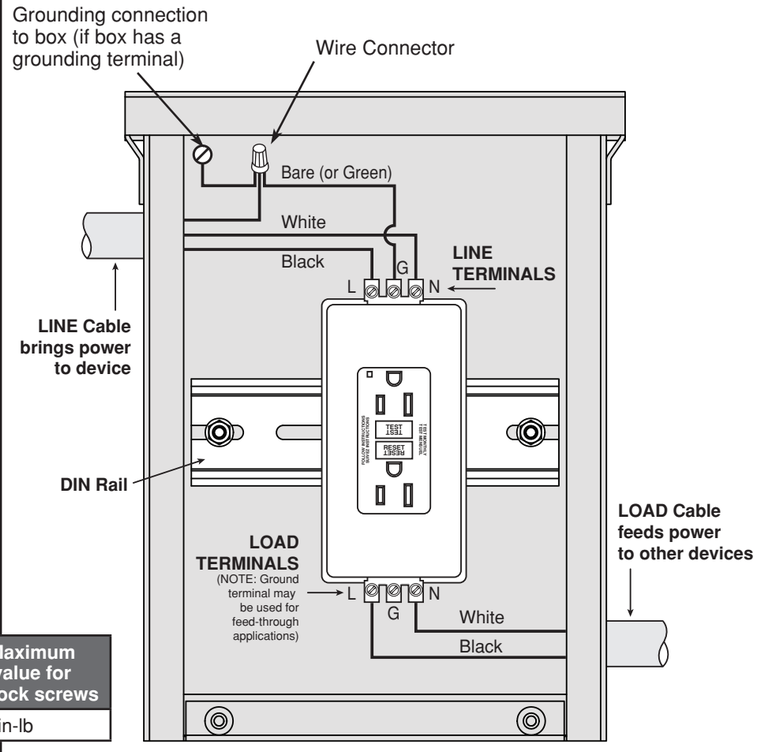
Connect the grounding wire (only if there is a grounding wire):
- For installations with no grounding terminal in enclosure (diagram not shown): Connect the LINE cable's bare copper (or GREEN) wire directly to the grounding terminal on the device.
- For installations with a grounding terminal in enclosure (diagram shown above): Connect a bare copper (or GREEN) 10, 12 or 14 AWG wire to the grounding terminal on the device. Also connect a similar wire to the grounding terminal on the box/enclosure. Connect the ends of these wires to the LINE cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

Complete the installation:
- Test your work. Go to step 9.

NOTE: Maximum torque value for terminal block screws

4.5 in-lb

B: Feed-thru (provides downstream protection)



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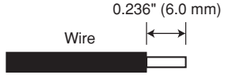
GFNT2-DIN	20	125	12-10



Connect the LINE cable wires to the device LINE terminals:
- The white wire connects to the Neutral (N) terminal.
- The black wire connects to the Line (L), or Hot terminal.

Connect the LOAD cable wires to the device LOAD terminals:
- The white wire connects to the Neutral (N) terminal.
- The black wire connects to the Line (L), or Hot terminal.

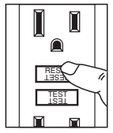
Connect the grounding wires (only if there is a grounding wire):
- Connect a bare copper (or GREEN) 10, 12 or 14 AWG wire to the grounding terminal on the device. If the box/enclosure has a grounding terminal, also connect a similar wire to the grounding terminal on the box/enclosure. Connect the ends of these wires to the LINE or LOAD cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

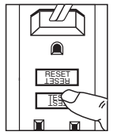
Complete the installation:
- Test your work. Go to step 9.

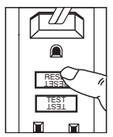
9. Test your work

Why perform this test?

- If you miswired the device with GFCI, it may not prevent personal injury or death due to a ground fault (electrical shock).
- If you mistakenly connect the LINE wires to the LOAD terminals, the GFCI will not reset and will not provide power to either the GFCI receptacle face or the LOAD terminals. The LED indicator light will be ON.







Procedure:

(a) This device (with GFCI) is shipped from the factory in the tripped condition and cannot be reset until it is wired correctly and power is supplied to the device. Plug a lamp or radio into the GFCI (and leave it plugged in). Turn the power ON at the service panel. Ensure that the GFCI is still in the tripped condition by pressing the TEST button. If the lamp or radio is OFF, and the GFCI will not reset, go to the Troubleshooting section as the Line and Load connections are reversed.

(b) Press the RESET button **fully** and release. If the Status Indicator Light turns Green and the lamp or radio is ON, the GFCI has been installed correctly. If the Status Indicator Light turns or continuously blinks Red, or the GFCI cannot be reset, go to the Self-Test Operation section.

(c) If you installed your GFCI using step 8B, plug a lamp or radio into surrounding receptacles to see which one(s), in addition to the GFCI, lose power when you press the GFCI TEST button. Place a "GFCI PROTECTED OUTLET" sticker on every receptacle that lost power, then press the RESET button to reset the GFCI. DO NOT plug life saving devices into any of the receptacles that lost power.

(d) Press the TEST button (then RESET button) **every month** to assure proper operation. If the Status Indicator Light does not turn Green when the RESET button is depressed and then released, or the GFCI cannot be reset, it must be replaced.

TROUBLESHOOTING

Turn the power OFF and check the wire connections against the appropriate wiring diagram in step 8A or 8B. Make sure that there are no loose wires or loose connections. If the Status Indicator Light is not ON and the device is unable to reset this could be a result of no power available. Start the test from the beginning of step 9 if you rewired any connections to the GFCI.

SELF-TEST OPERATION

- A Self-Test GFCI receptacle has all the features of a conventional GFCI receptacle. In addition, this receptacle tests itself periodically to confirm the GFCI electronics are functional. The Status Indicator Light will be solid green when the GFCI is powered from Line side and working correctly.
- **Self-Test Indications:** If the Status Indicator Light is solid or flashing RED a problem may exist. Press the TEST button to trip the GFCI. If unable to Reset, replace the GFCI. **NOTE:** The status indicator may flash Red at power "ON" and Reset.

Self Test Cat. No.	Description
GFNT1-DIN	15A-125VAC, 60Hz DIN Rail Mount GFCI
GFNT2-DIN	20A-125VAC, 60Hz DIN Rail Mount GFCI
All devices rated 20A feed-through when using #12 or #10 AWG conductors	

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LIMITED 2 YEAR WARRANTY AND EXCLUSIONS

Leviton warrants to the original consumer purchaser and not for the benefit of anyone else that this product at the time of its sale by Leviton is free of defects in materials and workmanship under normal and proper use for two years from the purchase date. Leviton's only obligation is to correct such defects by repair or replacement, at its option. **For details visit www.leviton.com or call 1-800-824-3005.** This warranty excludes and there is disclaimed liability for labor for removal of this product or reinstallation. This warranty is void if this product is installed improperly or in an improper environment, overloaded, misused, opened, abused, or altered in any manner, or is not used under normal operating conditions or not in accordance with any labels or instructions. **There are no other or implied warranties of any kind, including merchantability and fitness for a particular purpose**, but if any implied warranty is required by the applicable jurisdiction, the duration of any such implied warranty, including merchantability and fitness for a particular purpose, is limited to two years. **Leviton is not liable for incidental, indirect, special, or consequential damages, including without limitation, damage to, or loss of use of, any equipment, lost sales or profits or delay or failure to perform this warranty obligation.** The remedies provided herein are the exclusive remedies under this warranty, whether based on contract, tort or otherwise.

For Technical Assistance Call: 1-800-824-3005 (U.S.A. Only) 1 800 405-5320 (Canada Only) www.leviton.com

FCC STATEMENT

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

IC STATEMENT

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Patents covering this product, if any, can be found on Leviton.com/patents.

FOR CANADA ONLY

For warranty information and/or product returns, residents of Canada should contact Leviton in writing at **Leviton Manufacturing of Canada ULC to the attention of the Quality Assurance Department, 165 Hymus Blvd, Pointe-Claire (Quebec), Canada H9R 1E9** or by telephone at **1 800 405-5320.**

WEB VERSION

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Product Cleaning Instructions

Directives de nettoyage

Instrucciones de Limpieza del Producto

PK-A3339-10-02-0B

INSTRUCTIONS — English

- To avoid damage to the product, **DO NOT** use disinfecting products, including foggers, sprays or other types of atomized cleaning agents.
- **DO NOT** spray liquid onto the product.
- To clean use a damp cloth with mild soap.

DIRECTIVES — Français

- Pour éviter d'endommager le produit décrit aux présentes, il ne faut PAS se servir de produits désinfectants atomisés en pulvérisateur, en vaporisateur ou autre.
- **NE PAS** vaporiser de liquide sur le produit.
- Utiliser un chiffon humide avec du savon doux pour le nettoyage.

INSTRUCCIONES — Español

- Para evitar dañar el producto, **NO** utilice productos de desinfección, incluyendo nebulizadores, sprays u otros tipos de agentes de limpieza atomizados.
- **NO** rocíe líquido sobre el producto.
- Para limpiarlo, utilice un paño húmedo con jabón suave.

WEB VERSION

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GBKP14

Plug-on Neutral Ground Bar Kits

Description (See Legend)	Length Inches (mm)	Ordering Quantity ①	Catalog Number
●○○○○○●○○○○○	4.05	1	**GBKP10** ②
●○○○○○●○○○○○	5.05	1	**GBKP1020** ②
●○○○○○●○○○○○■	4.05	1	**GBKP10P** ②③
●○○○○○●○○○○○○○○○	5.39	1	**GBKP14** ②
●○○○○○●○○○○○○○○○■	6.39	1	**GBKP1420** ②
●○○○○○●○○○○○○○○○	5.39	1	**GBKP14P** ②③
●○○○○○●○○○○○○○○○○○○○	7.72	1	**GBKP21** ②
●○○○○○●○○○○○○○○○○○○○■	8.72	1	**GBKP2120** ②
●○○○○○●○○○○○○○○○○○○○	7.72	1	**GBKP21P** ②③
●○○○○○●	2.39	1	**GBKP5** ②
●○○○○○●■	3.39	1	**GBKP520** ②
●○○○○○●	2.39	1	**GBKP5P** ②③

Ground Bar Legend

○ = (3) #14–#10 Cu/Al or (1) #14–#4 Cu/Al
■ = (1) #6–2/0 Cu/Al
● = Mounting hole

Notes

① Must be purchased in multiples of ordering quantities indicated.
② Distance between mounting holes is 2 inches (50.8 mm).
③ Individually packaged.
④ Distance between mounting holes is 1-3/4 inches (44.5 mm).

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Product specifications

Eaton GBKP2120

Catalog Number: GBKP2120

Eaton PON Accessories - 21 Terminal Ground Bar,(1) 2/0 lug - CH/BR plug-on neutral,Ground bar,21 Circuits,21 terminals

General specifications

Product Name	**Catalog Number**
Eaton ground bar	GBKP2120
UPC	**Product Length/Depth**
786689053772	8.8 in
Product Height	**Product Width**
1.2 in	0.6 in
Product Weight	**Certifications**
0.25 lb	Contact Manufacturer

Powering Business Worldwide

Product specifications

Type

Ground bar

Number of circuits

21

Resources

Brochures

Loadcenters and Circuit Breakers

Specifications and datasheets

Eaton Specification Sheet - GBKP2120

Eaton Corporation plc
Eaton House
30 Pembroke Road
Dublin 4, Ireland
Eaton.com

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Eaton.com/socialmedia

Technical Data

Original Instructions

1756 ControlLogix Chassis Specifications

Catalog Numbers 1756-A4/B, 1756-A4K/B, 1756-A4/C, 1756-A4K/C, 1756-A7/B, 1756-A7K/B, 1756-A7/C, 1756-A7K/C, 1756-A7XT/C, 1756-A7ZXT, 1756-A10/B, 1756-A10K/B, 1756-A10/C, 1756-A10K/C, 1756-A10XT/C, 1756-A10ZXT, 1756-A13/B, 1756-A13K/B, 1756-A13/C, 1756-A13K/C, 1756-A17/B, 1756-A17K/B, 1756-A17/C, 1756-A17K/C

Topic	Page
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ControlLogix-XT Chassis Specifications	4
Spacing Requirements	6
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Series C ControlLogix Chassis with Standard and Slim Power Supply Mounting Dimensions	11
Series D ControlLogix Chassis with Standard and Slim Power Supply Mounting Dimensions	14
ControlLogix Chassis with Redundant Power Supply Mounting Dimensions	16
ControlLogix Chassis Accessories	19
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The ControlLogix® system is a modular system that requires a 1756 ControlLogix chassis. The chassis are designed for only horizontal back-panel mounting. Place any module into any slot. The backplane provides a high-speed communication path between modules.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Corrected Minimum Cabinet Size Technical Specifications	2, 4
Corrected Cabinet Clearance Spacing Requirements	6, 7
Added 1756-A7ZXT and 1756-A10ZXT chassis information	Throughout

Standard ControlLogix Chassis Specifications

The chassis backplane provides a high-speed communication path between modules and distributes power to each of the modules installed within the chassis.

Technical Specifications - ControlLogix Standard Chassis

Attribute	1756-A4, 1756-A4K	1756-A7, 1756-A7K	1756-A10, 1756-A10K	1756-A13, 1756-A13K	1756-A17, 1756-A17K
Backplane current, chassis/slot max @ 1.2V DC	1.5 A/–				
Backplane current, chassis/slot max @ 3.3V DC	4 A/4 A				
Backplane current, chassis/slot max @ 5.1V DC	15 A/6 A				
Backplane current, chassis/slot max @ 24V DC	2.8 A/2.8 A				
Power dissipation, max	4 W	4.5 W	5 W	5.4 W	6 W
Isolation voltage	Determined by installed power supply and modules				
Slots	4	7	10	13	17
Mounting method	Only horizontal				
Cabinet size (HxWxD), min	50.8 x 50.8 x 20.3 cm (20 x 20 x 8 in.)	50.8 x 61.0 x 20.3 cm (20 x 24 x 8 in.)	50.8 x 71.1 x 20.3 cm (20 x 28 x 8 in.)	50.8 x 81.3 x 20.3 cm (20 x 32 x 8 in.)	50.8 x 96.5 x 20.3 cm (20 x 38 x 8 in.)
Weight, approx	0.75 kg (1.7 lb)	1.10 kg (2.4 lb)	1.45 kg (3.2 lb)	1.90 kg (4.2 lb)	2.20 kg (4.8 lb)
Location	Panel				
Wire size	Functional earth ground - 8.3 mm^2 (8 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater Protective earth ground - 2.1 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater				
North American temperature code	T5 (Series B) T4 (Series C)				
IEC temperature code	T4	T5 (Series B) T4 (Series C)			
Enclosure type rating	None (open-style)				

Environmental Specifications - ControlLogix Standard Chassis

Attribute	Series B		Series C	
	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	1756-A4K, 1756-A7K, 1756-A10K, 1756-A13K, 1756-A17K	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	1756-A4K, 1756-A7K, 1756-A10K, 1756-A13K, 1756-A17K
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0...60 °C (32...140 °F)		-25...+60 °C (-13...+140 °F)	
Temperature, surrounding air max	60 °C (140 °F)			
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)			
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing			
Conformal Coated	–	Yes	–	Yes
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz			
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g			
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g		30 g	
Emissions	IEC 61000-6-4			
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges			
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz			

Certifications - ControlLogix Standard Chassis

Certification[1]	Series B		Series C
	1756-A4, 1756-A4K	1756-A7, 1756-A7K, 1756-A10, 1756-A10K, 1756-A13, 1756-A13K, 1756-A17, 1756-A17K	1756-A4, 1756-A4K, 1756-A7, 1756-A7K, 1756-A10, 1756-A10K, 1756-A13, 1756-A13K, 1756-A17, 1756-A17K
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.		
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations.		
CE	European Union 2014/30/EU EMC Directive (EMC), compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)		
RCM	Australian Radiocommunications Act, compliant with: EN 61000-6-4; Industrial Emissions		
Ex	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" • EN 60079-0; General Requirements • II 3 G Ex nA IIC T4 Gc X		European Union 2014/34/EU Directive, compliant with: • EN 60079-7; Potentially Explosive Atmospheres, Protection "e" • EN 60079-0; General Requirements • II 3 G Ex ec IIC T4 Gc • UL22ATEX2734X
IECEx	–		IECEx System, compliant with: • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • IEC 60079-0; General Requirements • II 3 G ec IIC T4 Gc • IECExUL22.0025X
UKEx	In conformity with the following UKEx Statutory Instruments and their amendments: • Schedule 1 of the UKEx Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2451X • Zone 2 classification according to UKEx Regulation 2016 No. 1107		
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment		
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3		
CCC	CCC 2020122309111998 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products		
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements		

(1) See the Product Certification website at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

ControlLogix-XT Chassis Specifications

The ControlLogix-XT™ chassis support extreme temperature environments. Series C XT chassis are conformally coated for increased survivability in ISA G3 environments. ControlLogix-ZXT chassis are conformally coated to resist corrosion in ISA GX environments.

Technical Specifications - ControlLogix-XT Chassis

Attribute	1756-A7XT	1756-A10XT	1756-A7ZXT	1756-A10ZXT
Backplane current, chassis/slot max @ 1.2V DC	1.5 A/–			
Backplane current, chassis/slot max @ 3.3V DC	4 A/4 A			
Backplane current, chassis/slot max @ 5.1V DC	15 A/6 A			
Backplane current, chassis/slot max @ 24V DC	2.8 A/2.8 A			
Power dissipation, max	4.5 W	5 W	4.5 W	5 W
Isolation voltage	Determined by installed power supply and modules			
Slots	7	10	7	10
Mounting method	Horizontal only			
Cabinet size (HxWxD), min	50.8 x 71.1 x 20.3 cm (20 x 28 x 8 in.)	50.8 x 86.4 x 20.3 cm (20 x 34 x 8 in.)	50.8 x 71.1 x 20.3 cm (20 x 28 x 8 in.)	50.8 x 86.4 x 20.3 cm (20 x 34 x 8 in.)
Weight, approx	1.09 kg (2.4 lb)	1.91 kg (4.2 lb)	1.09 kg (2.4 lb)	1.91 kg (4.2 lb)
Location	Panel			
Wire size	Functional earth ground - 8.3 mm^2 (8 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater Protective earth ground - 2.1 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater			
Temperature code	T4			
Enclosure type rating	None (open-style)			

Environmental Specifications - ControlLogix-XT Chassis

Attribute	1756-A7XT, 1756-A10XT	1756-A7ZXT, 1756-A10ZXT
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25...+70 °C (-13...+158 °F)	
Temperature, surrounding air max	70 °C (158 °F)	
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing	
Conformal Coated	Yes	
Corrosive Atmosphere ASTM B845-97 Method K Accelerated Test (30-Day Exposure) plus additional Rockwell Automation proprietary accelerated corrosive environment test protocol for specific industries with sources of gaseous sulfur compounds.	–	Severity Level GX(1) (2) per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX(1) per IEC 60721-3-3:2019, Chemically Active Substances
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Emissions	IEC 61000-6-4	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz	

(1) Port plugs/covers must remain installed in unused ports at all times, once the XT packaging seal is broken, for the product to maintain its corrosive atmosphere rating.
(2) Up to 2100 angstroms of film growth per 30 days of copper and/or silver reactivity.

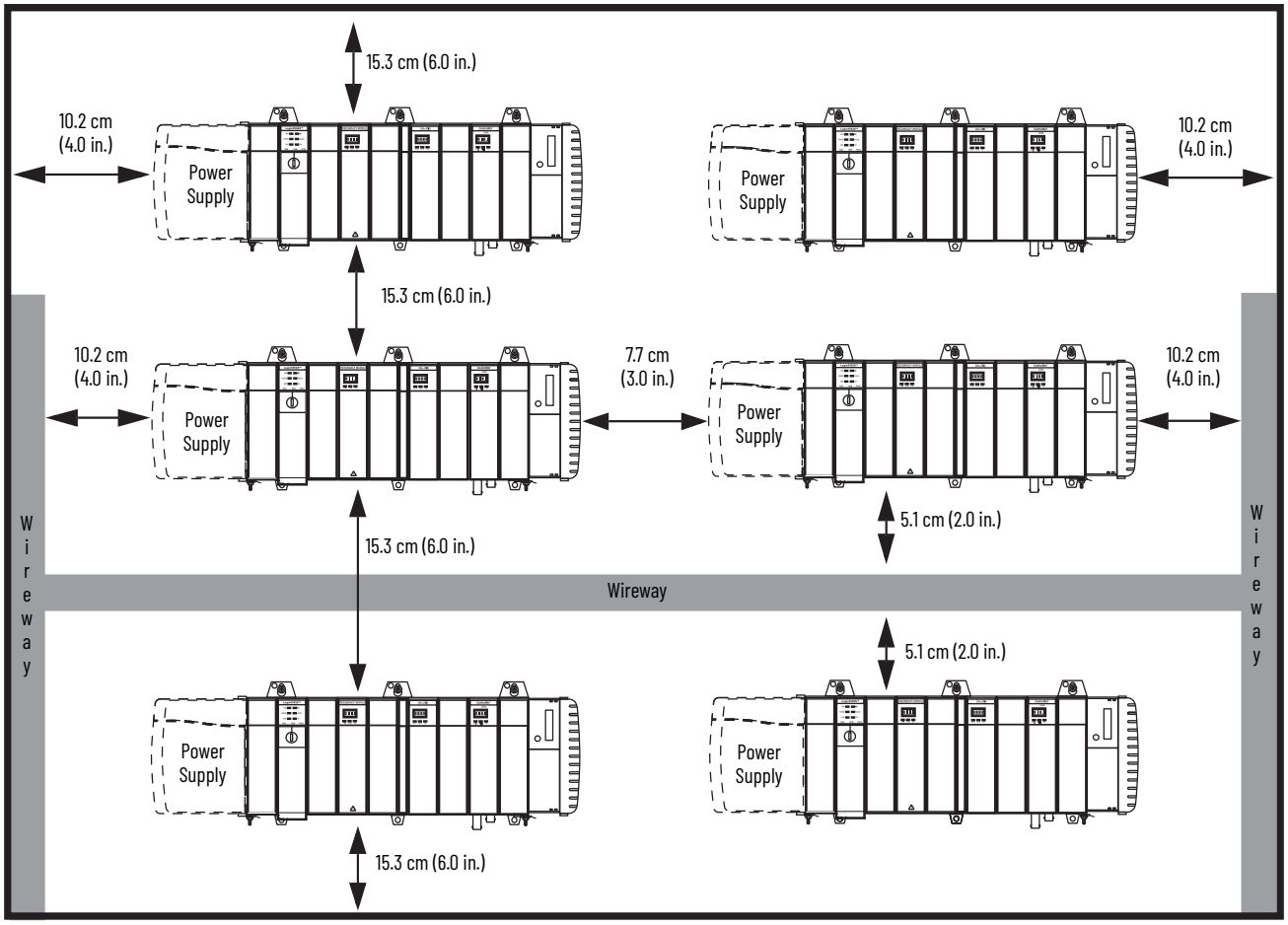
Certifications - ControlLogix-XT Chassis

Certification[1]	1756-A7XT, 1756-A10XT, 1756-A7ZXT, 1756-A10ZXT
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations.
CE	European Union 2014/30/EU EMC Directive (EMC), compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
RCM	Australian Radiocommunications Act, compliant with: EN 61000-6-4; Industrial Emissions
Ex	European Union 2014/34/EU Directive, compliant with: • EN 60079-7; Potentially Explosive Atmospheres, Protection “e” • EN 60079-0; General Requirements • II 3 G Ex ec IIC T4 Gc • UL22ATEX2734X
IECEx	IECEx System, compliant with: • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • IEC 60079-0; General Requirements • II 3 G ec IIC T4 Gc • IECExUL22.0025X
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3
UKEx	In conformity with the following UKEx Statutory Instruments and their amendments: • Schedule 1 of the UKEx Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2451X • Zone 2 classification according to UKEx Regulation 2016 No. 1107
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
CCC	CCC 202012230911998 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements

(1) See the Product Certification website at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

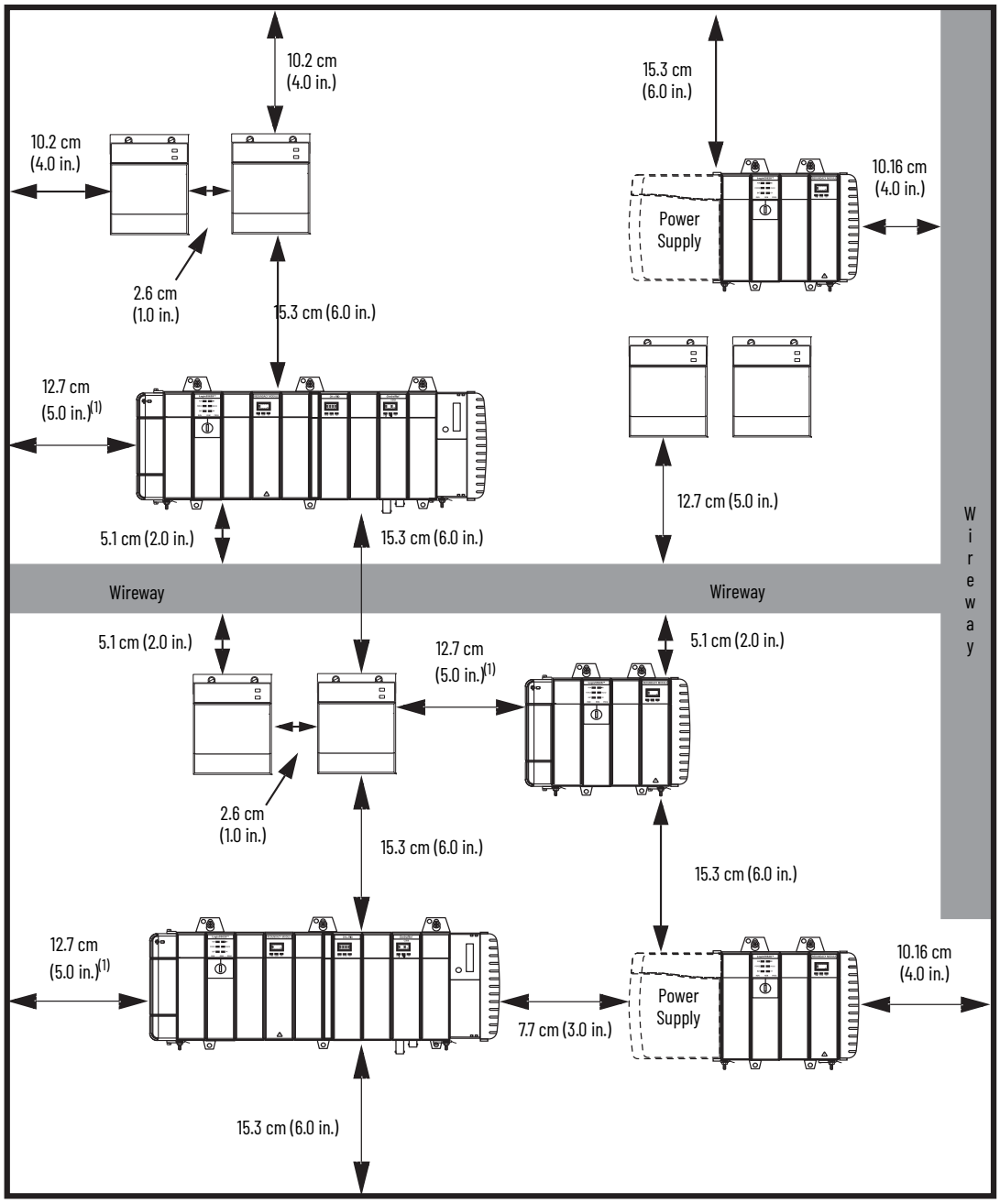
Spacing Requirements

ControlLogix Chassis with a Non-Redundant Power Supply (Series C Chassis Depicted)



IMPORTANT	The 1756-CPR2 cable has a bend radius of 12.7 cm (5.0 in.). The chassis must have a minimum clearance of 12.7 cm (5.0 in.) on the left side to route and connect the 1756-CPR2 cable. The redundant power supplies must have a minimum clearance of 12.7 cm (5.0 in.) below the supply to route and connect the 1756-CPR2 cable.

ControlLogix Chassis with a Redundant Power Supply and a Chassis Adapter (Series C Chassis Depicted)

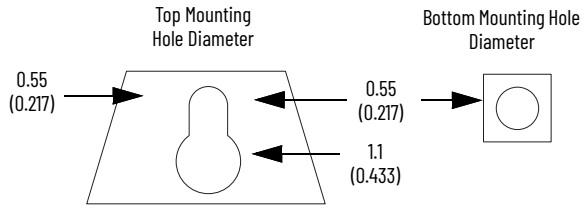


(1) The measurements for systems that use 1756-CPR2D or 1756-CPR2U cables are 10.2 cm (4.0 in.).

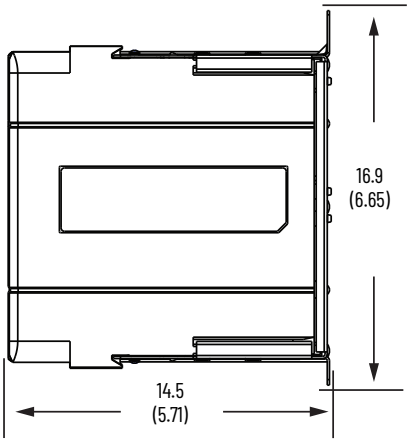
Series B ControlLogix Chassis with Standard and Slim Power Supply Mounting Dimensions

Dimensions are in cm (in.).

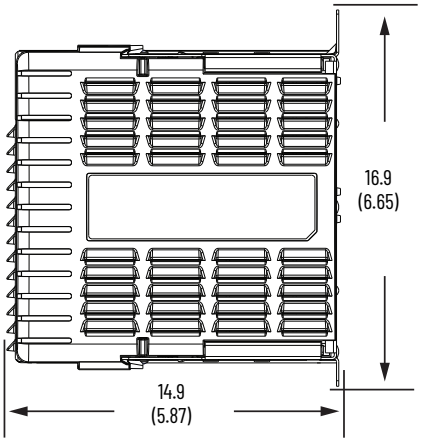
Chassis Common Dimensions



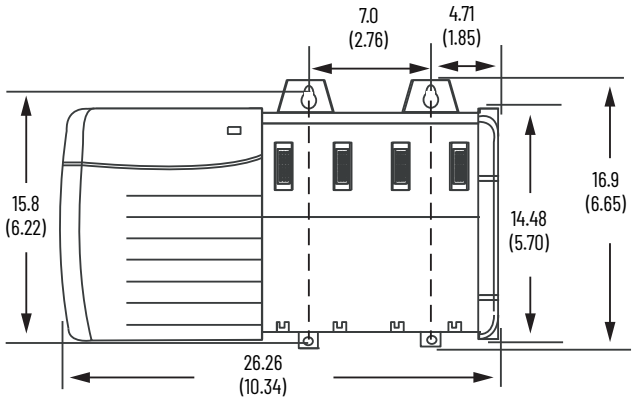
Right-side View of All Standard Chassis



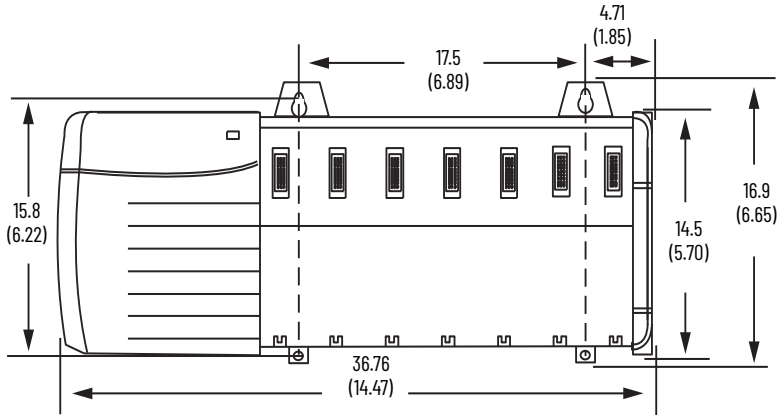
Right-side View of All ControlLogix-XT Chassis



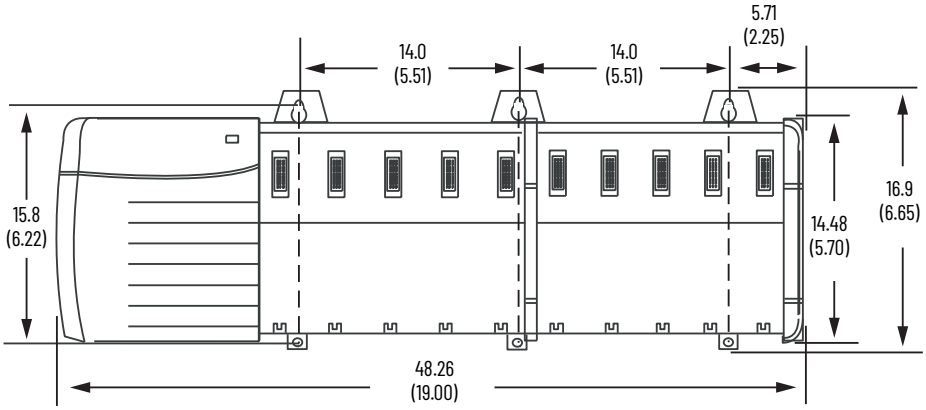
1756-A4/B Chassis and Power Supply



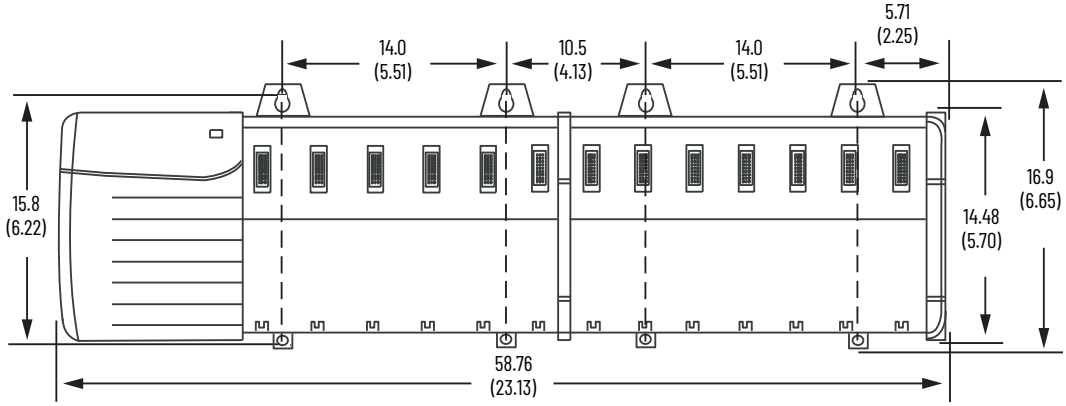
1756-A7/B Chassis and Power Supply



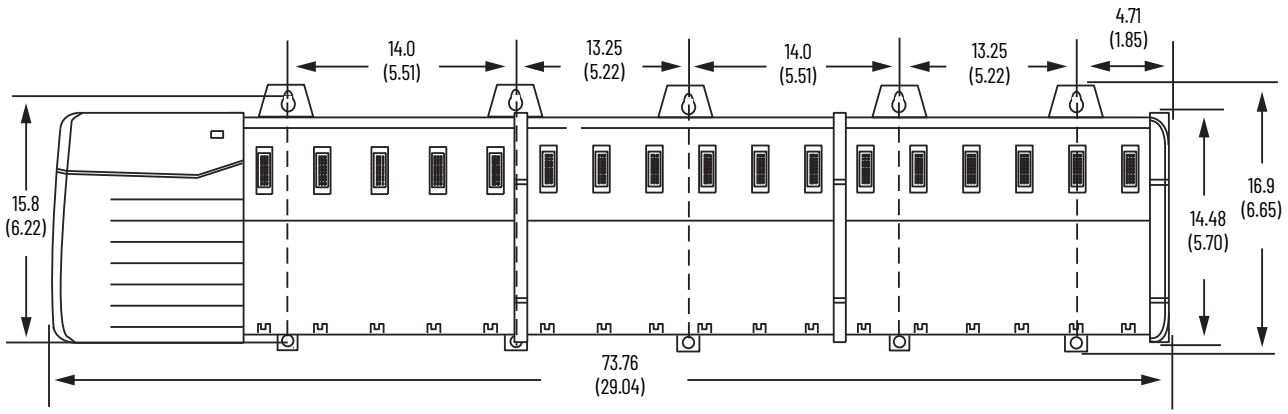
1756-A10/B Chassis and Power Supply



1756-A13/B Chassis and Power Supply



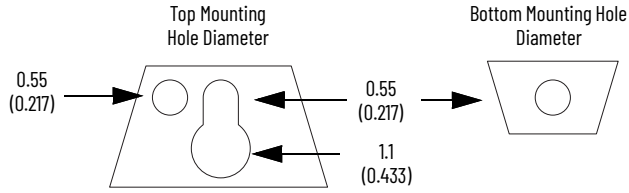
1756-A17/B Chassis and Power Supply



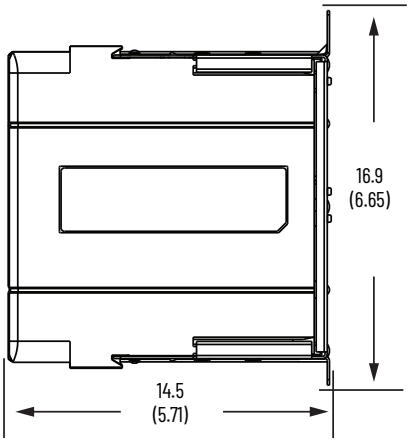
Series C ControlLogix Chassis with Standard and Slim Power Supply Mounting Dimensions

Dimensions are in cm (in.).

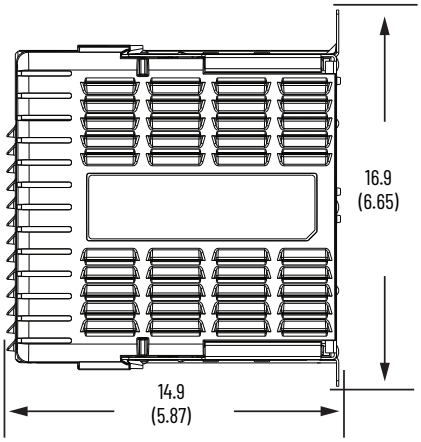
Chassis Common Dimensions



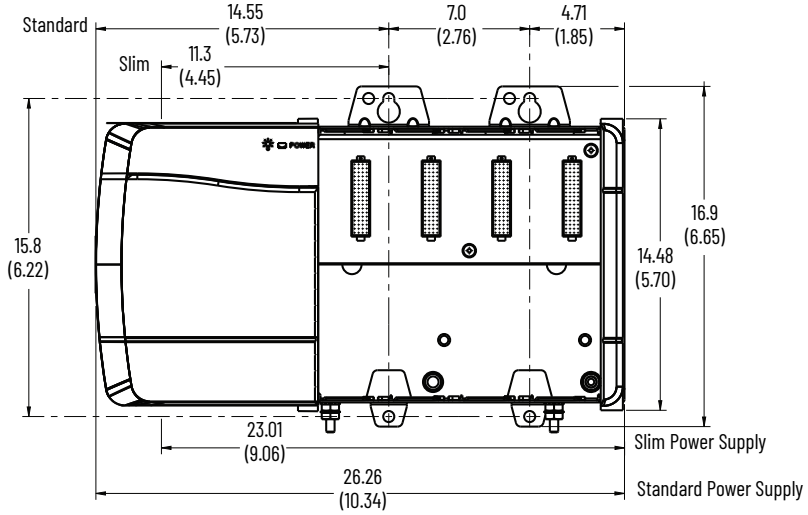
Right-side View of All Standard Chassis



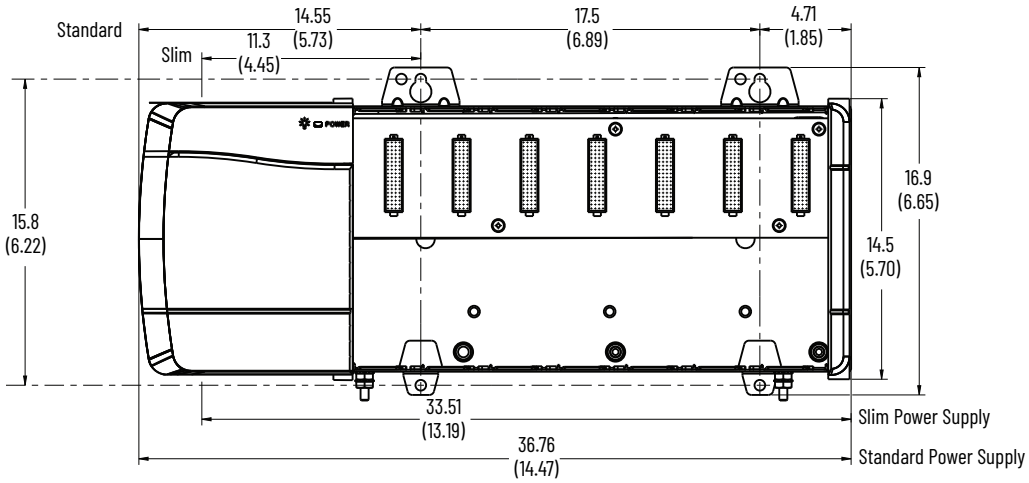
Right-side View of All ControlLogix-XT Chassis



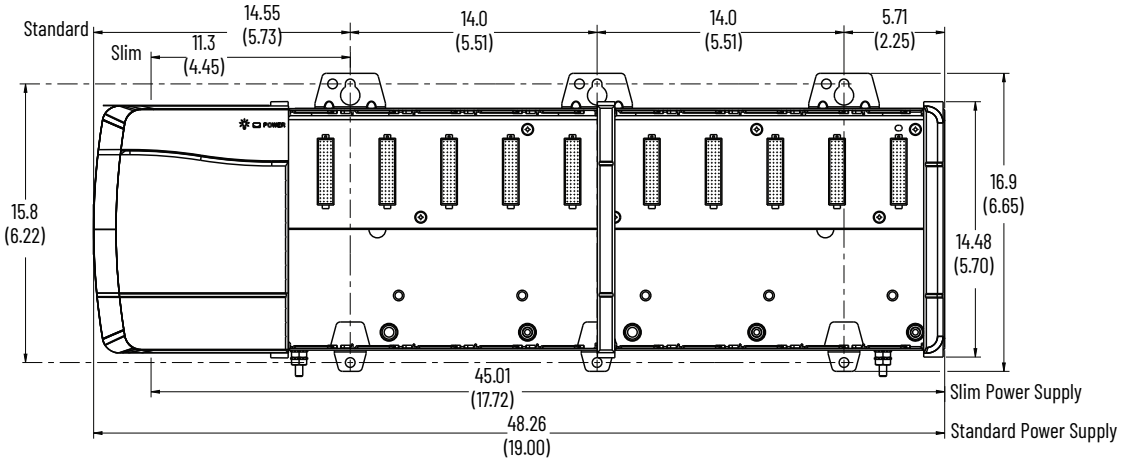
1756-A4/C Chassis and Power Supply



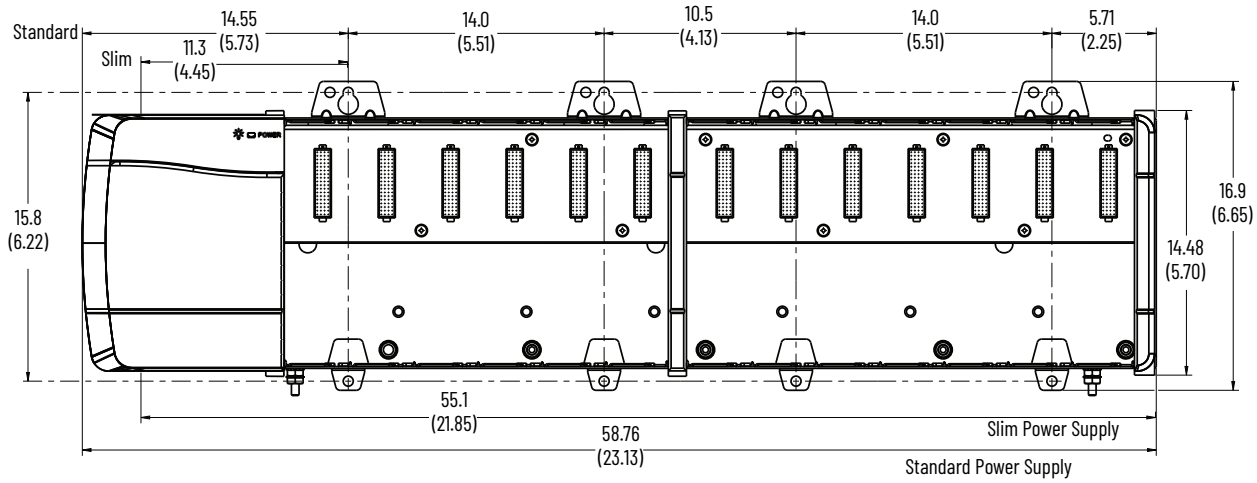
1756-A7/C Chassis and Power Supply



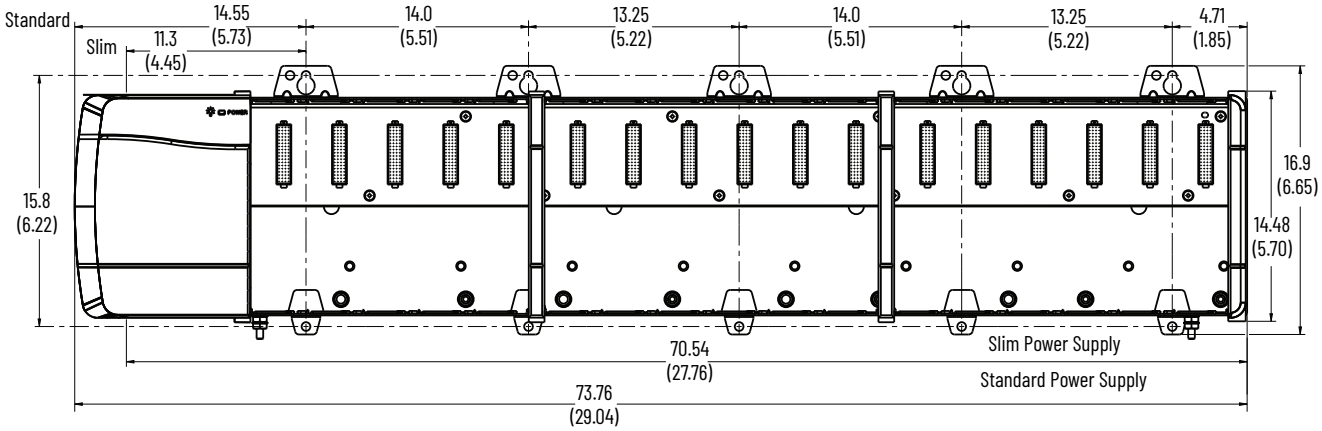
1756-A10/C Chassis and Power Supply



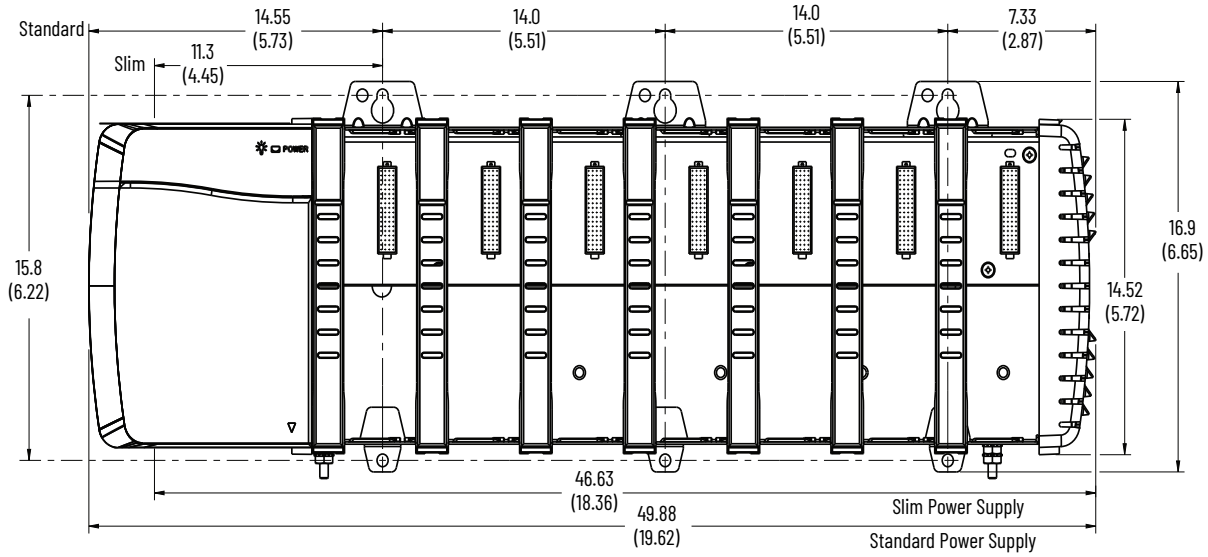
1756-A13/C Chassis and Power Supply



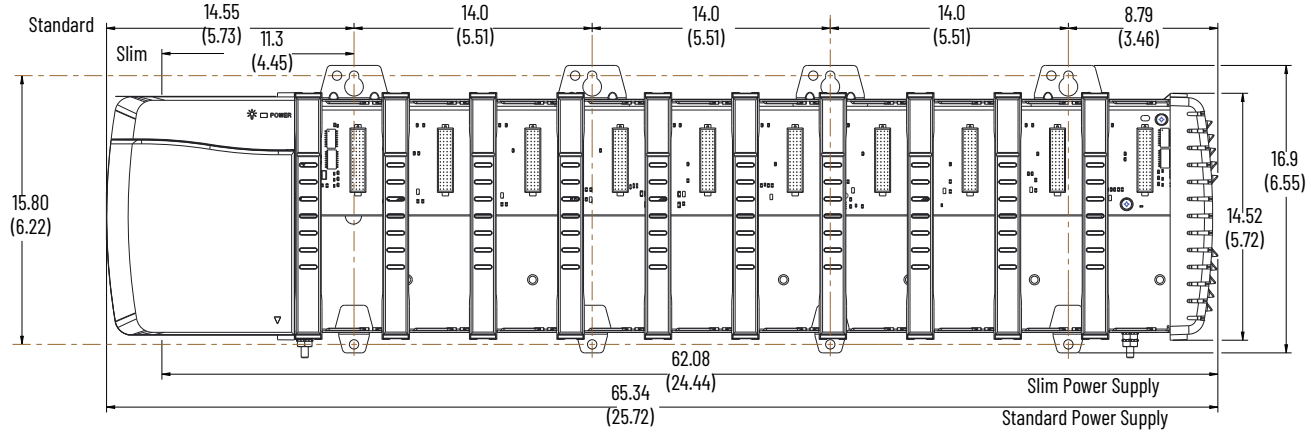
1756-A17/C Chassis and Power Supply



1756-A7XT/C Chassis and Power Supply



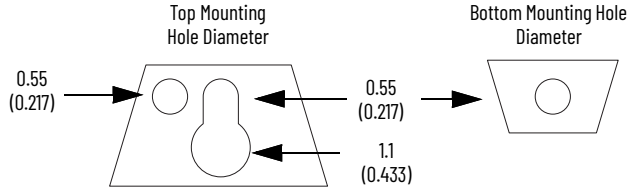
1756-A10XT/C Chassis and Power Supply



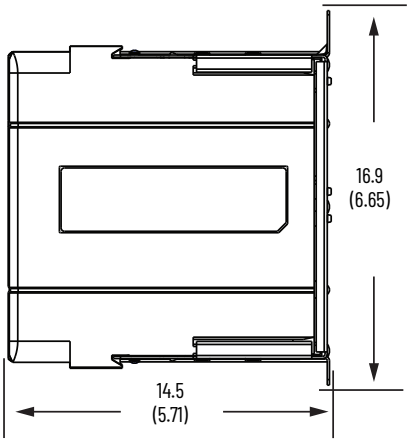
Series D ControlLogix Chassis with Standard and Slim Power Supply Mounting Dimensions

Dimensions are in cm (in.).

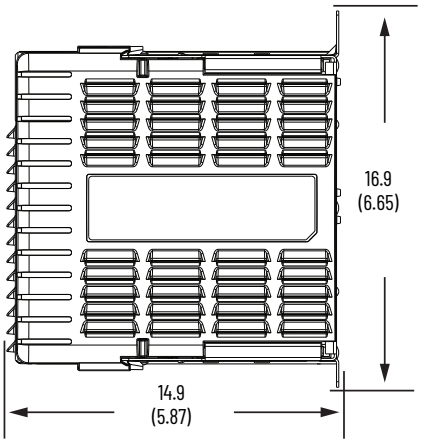
Chassis Common Dimensions



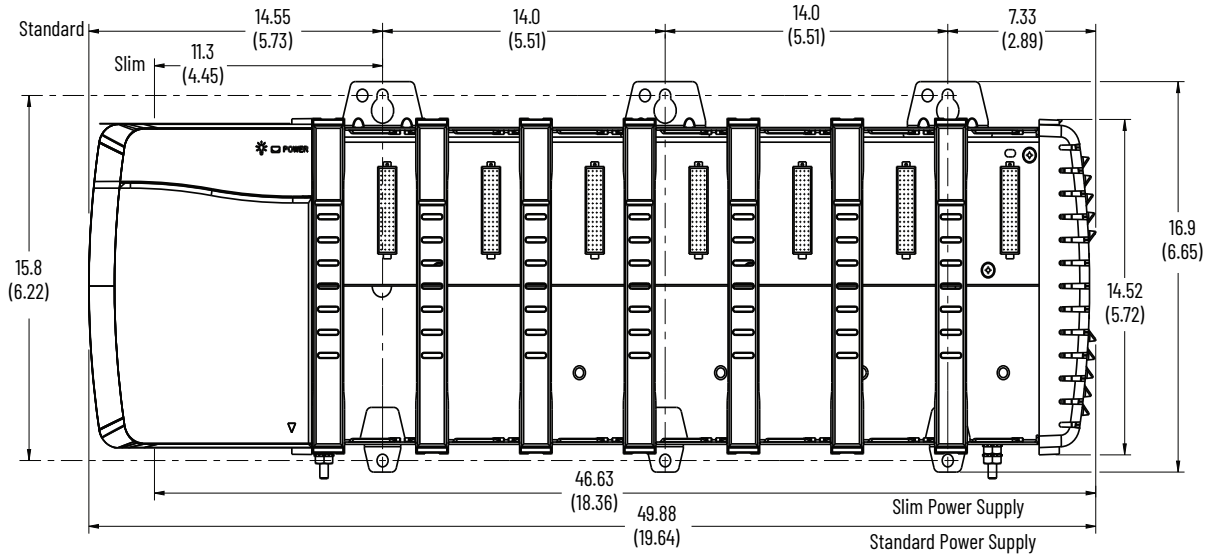
Right-side View of All Standard Chassis



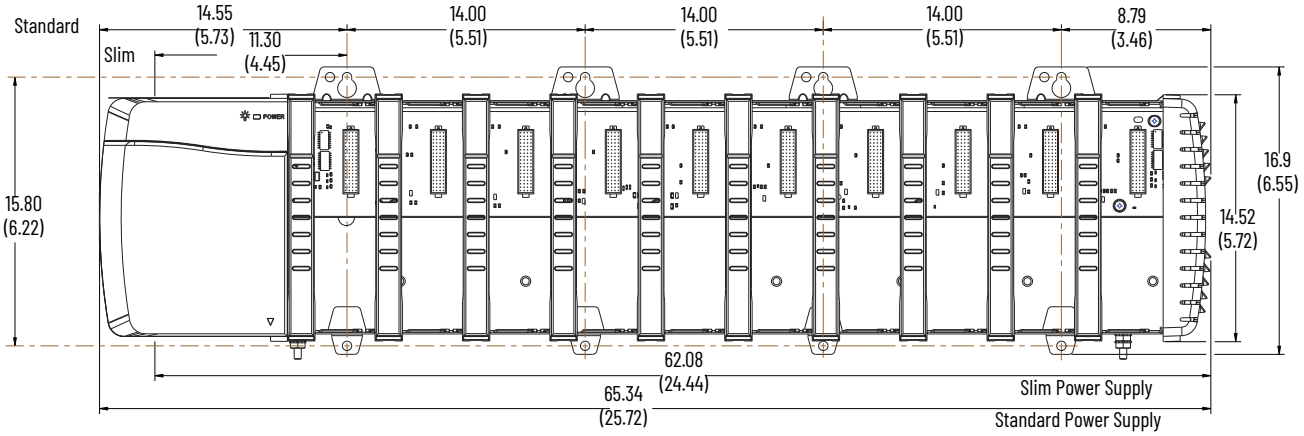
Right-side View of All ControlLogix-XT Chassis



1756-A7ZXT/D Chassis and Power Supply



1756-A10ZXT/D Chassis and Power Supply

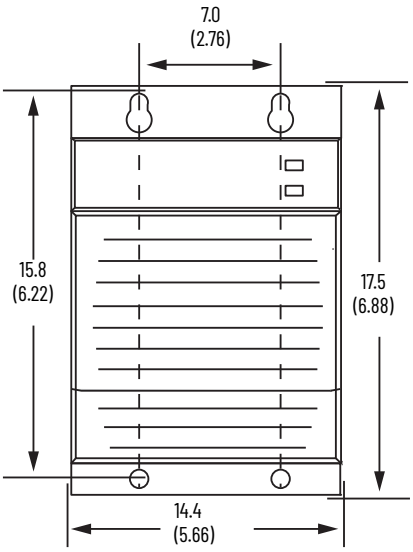


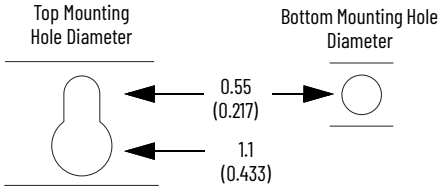
ControlLogix Chassis with Redundant Power Supply Mounting Dimensions

IMPORTANT The 1756-CPR2 cable has a bend radius of 12.7 cm (5.0 in.). The chassis must have a minimum clearance of 12.7 cm (5.0 in.) on the left side to route and connect the 1756-CPR2 cable. The redundant power supplies must have a minimum clearance of 12.7 cm (5.0 in.) below the supply to route and connect the 1756-CPR2 cable.

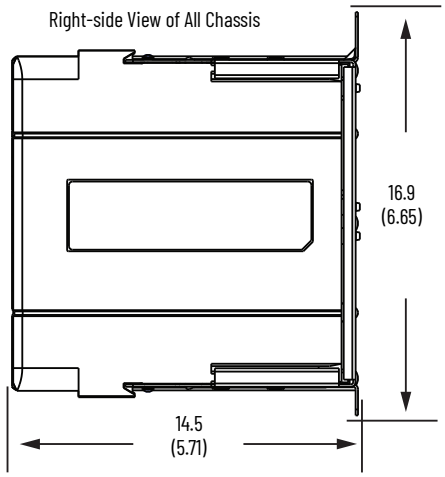
Dimensions are in cm (in.).

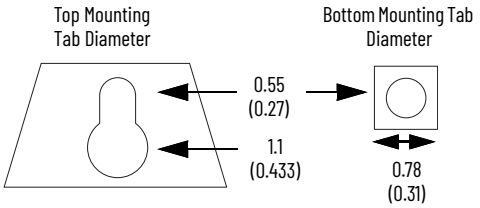
Redundant Power Supplies



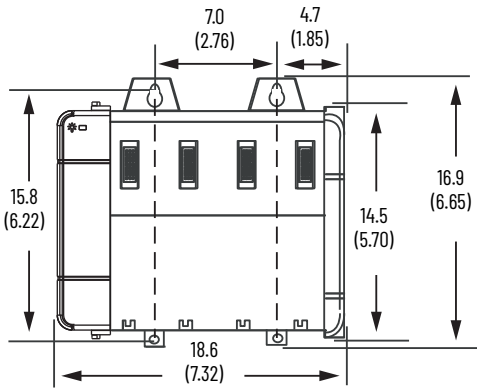


Chassis Common Dimensions

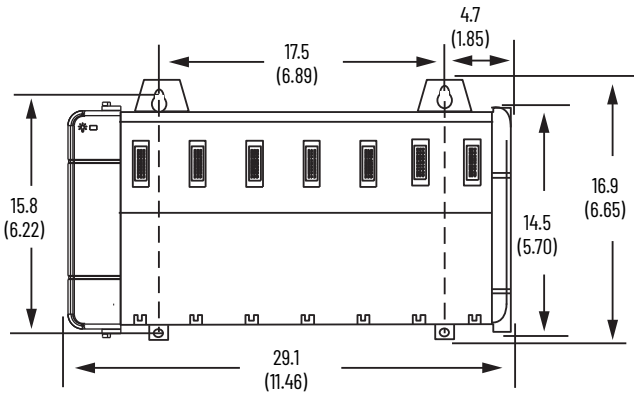




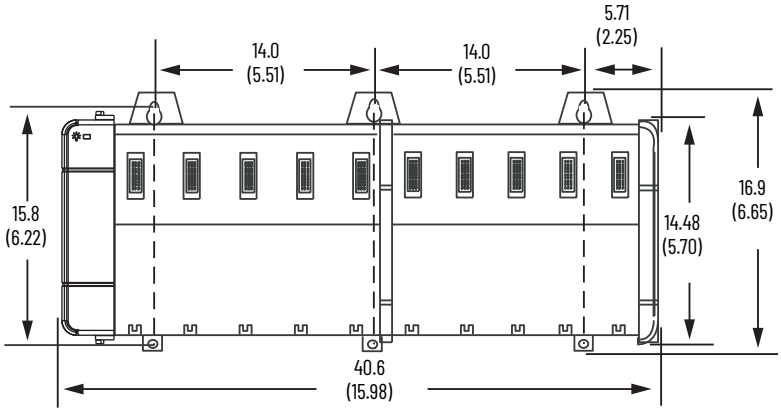
1756-A4/B Chassis and Chassis Adapter Module



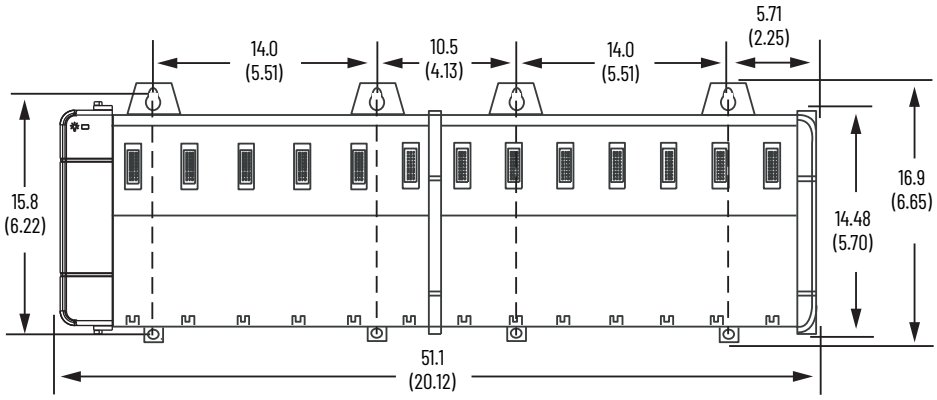
1756-A7/B Chassis and Chassis Adapter Module



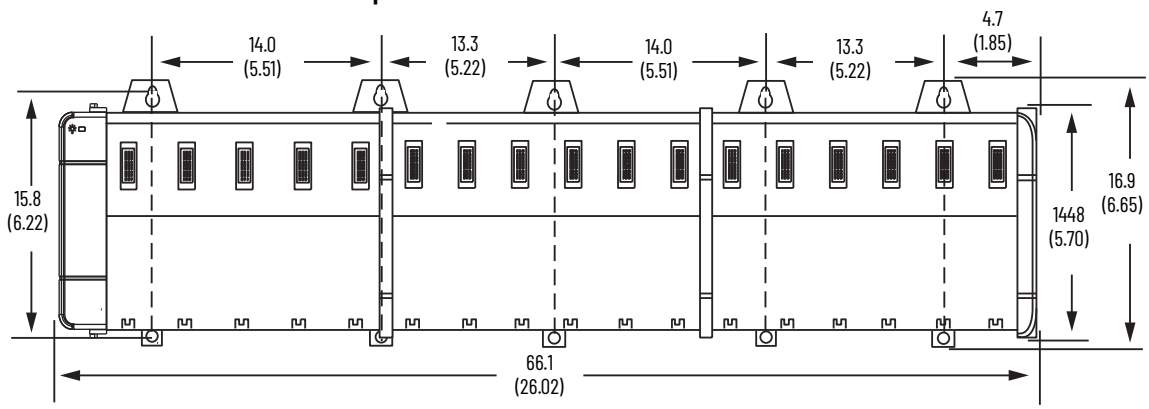
1756-A10/B Chassis and Chassis Adapter Module



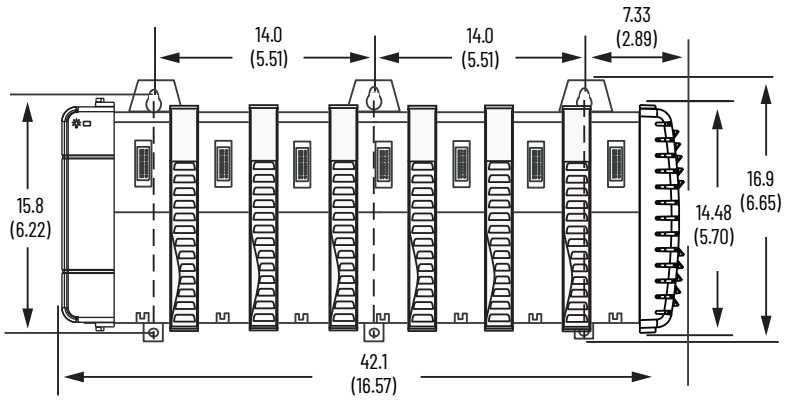
1756-A13/B Chassis and Chassis Adapter Module



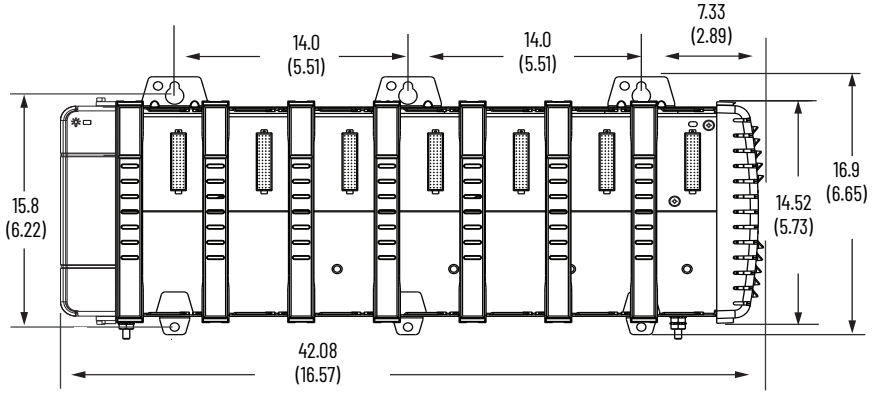
1756-A17/B Chassis and Chassis Adapter Module



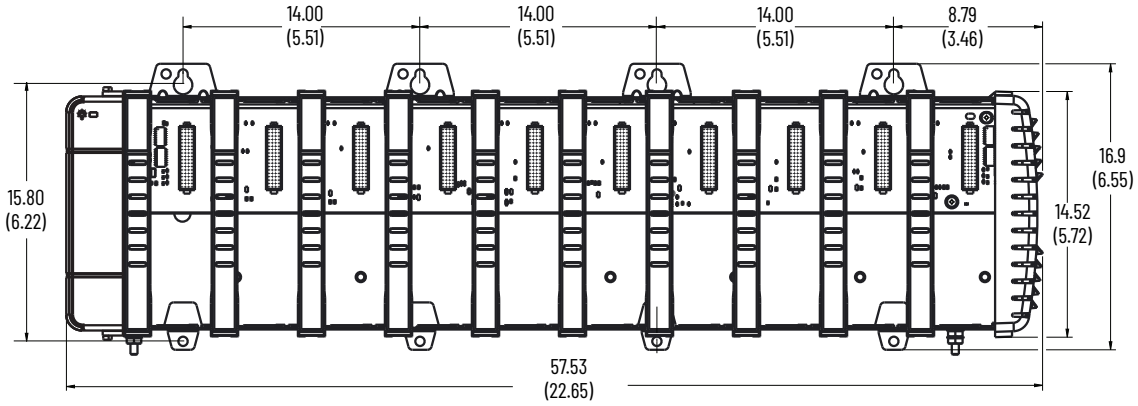
1756-A7XT/B Chassis and Chassis Adapter Module



1756-A7XT/C Chassis and Chassis Adapter Module



1756-A10XT/C Chassis and Adapter Module



ControlLogix Chassis Accessories

Use a slot filler module to fill empty slots.

Cat. No.	Description
1756-N2	Slot filler module for empty slots in standard ControlLogix chassis
1756-N2XT	Slot filler module for empty slots in ControlLogix-XT and ControlLogix-ZXT chassis

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at rok.auto/literature.

Resource	Description
ControlLogix System User Manual, publication 1756-UM001	Describes how to use a ControlLogix® system
ControlLogix Selection Guide, publication 1756-SG002	Provides overview of the ControlLogix system and its products.
ControlLogix Power Supplies Specifications Technical Data, publication 1756-TD005	Provides technical specifications for ControlLogix power supplies.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

ControlLogix Chassis

Standard Catalog Numbers:	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17
Harsh Environment Catalog Numbers:	1756-A4K, 1756-A7K, 1756-A10K, 1756-A13K, 1756-A17K, 1756-A7XT, 1756-A10XT, 1756-A7ZXT, 1756-A10ZXT

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Product Overview

The ControlLogix® system is a modular system that requires a 1756 ControlLogix chassis. The chassis are designed for only horizontal back-panel mounting. Place any module into any slot. The backplane provides a high-speed communication path between modules.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and isn't intended to reflect all changes.

Topic	Page
Updated Operating Temperature test type in Specifications - ControlLogix Standard Chassis	15
Added 1756-A7ZXT and 1756-A10ZXT chassis information	Throughout

Rockwell Automation

ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

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본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於 「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安装、調整、交付使用、使用、組裝、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

Product Advisories

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

Environment and Enclosure

ATTENTION:
This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment isn't intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to help prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to help prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA Standard 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures.

UK and European Hazardous Location Approval

The following applies to products marked Ex, II 3 G. Such products:

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection is <Ex ec IIC T4 Gc> Equipment protection by increased safety "e".
- Equipment protection by increased safety "e", reference certificate number UL 22 ATEX 2734X and UL22UKEX2451X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

IEC Hazardous Location Approval

The following applies to products with IECEx certification:

- Such products are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection is <Ex ec IIC T4 Gc>.
- IECEx certificate number IECEx UL 22.0025X.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in a UKEX/ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 140% of the peak rated voltage when applied in Zone 2 environments.
- The instructions in the user manual shall be observed.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

ATTENTION:

- If this equipment is used in a manner that is not specified by the manufacturer, the protection that is provided by the equipment may be impaired.
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with an applicable code of practice. In case of malfunction or damage, no attempts at repair should be made. The chassis should be returned to the manufacturer for repair. Do not dismantle the chassis.
- Non-XT ControlLogix series C chassis are certified for use only within the surrounding air temperature range of -25...+60 °C (-13...+140 °F). The equipment must not be used outside of this range.
- ControlLogix-XT series C chassis are certified for use only within the surrounding air temperature range of -25...+70 °C (-13...+158 °F). The equipment must not be used outside of this range.
- ControlLogix-ZXT chassis are certified for use only within the surrounding air temperature range of -25...+70 °C (-13...+158 °F). The equipment must not be used outside of this range.
- Use only a soft dry cloth to wipe down equipment. Do not use any cleaning agents.

Tools Required

When installing your chassis and power supplies, the following items are required:

- 3.18 mm (0.125 in.) slotted screwdriver
- 6.35 mm (0.25 in.) slotted or #2 Phillips screwdriver
- Torque screwdriver
- 11/32" socket
- Needle-nose pliers
- Crimper
- Wire stripper
- Drill

Parts Required

These parts aren't included with the chassis and must be ordered separately.

Parts Required Per Mounting Tab

Tab Position	With SEM Screws[1]	Without SEM Screws
Top	1 Phillips screw 1 flat washer 1 split-lock washer	N/A
Bottom	1 SEM screw	1 Phillips screw 1 star washer

(1) Phillips screw with attached star washer.

Total Parts Required Per Chassis

Chassis	Number of Mounting Tabs	With SEM Screws	Without SEM Screws
1756-A4, 1756-A4K, 1756-A7, 1756-A7K	2 top 2 bottom	• 2 Phillips screws • 2 flat washers • 2 split-lock washers • 2 SEM screws	• 4 Phillips screws • 2 flat washers • 2 split-lock washers • 2 star washers
1756-A7XT, 1756-A7ZXT, 1756-A10, 1756-A10K	3 top 3 bottom	• 3 Phillips screws • 3 flat washers • 3 split-lock washers • 3 SEM screws	• 6 Phillips screws • 3 flat washers • 3 split-lock washers • 3 star washers
1756-A10XT, 1756-A10ZXT, 1756-A13, 1756-A13K	4 top 4 bottom	• 4 Phillips screws • 4 flat washers • 4 split-lock washers • 4 SEM screws	• 8 Phillips screws • 4 flat washers • 4 split-lock washers • 4 star washers
1756-A17, 1756-A17K	5 top 5 bottom	• 5 Phillips screws • 5 flat washers • 5 split-lock washers • 5 SEM screws	• 10 Phillips screws • 5 flat washers • 5 split-lock washers • 5 star washers

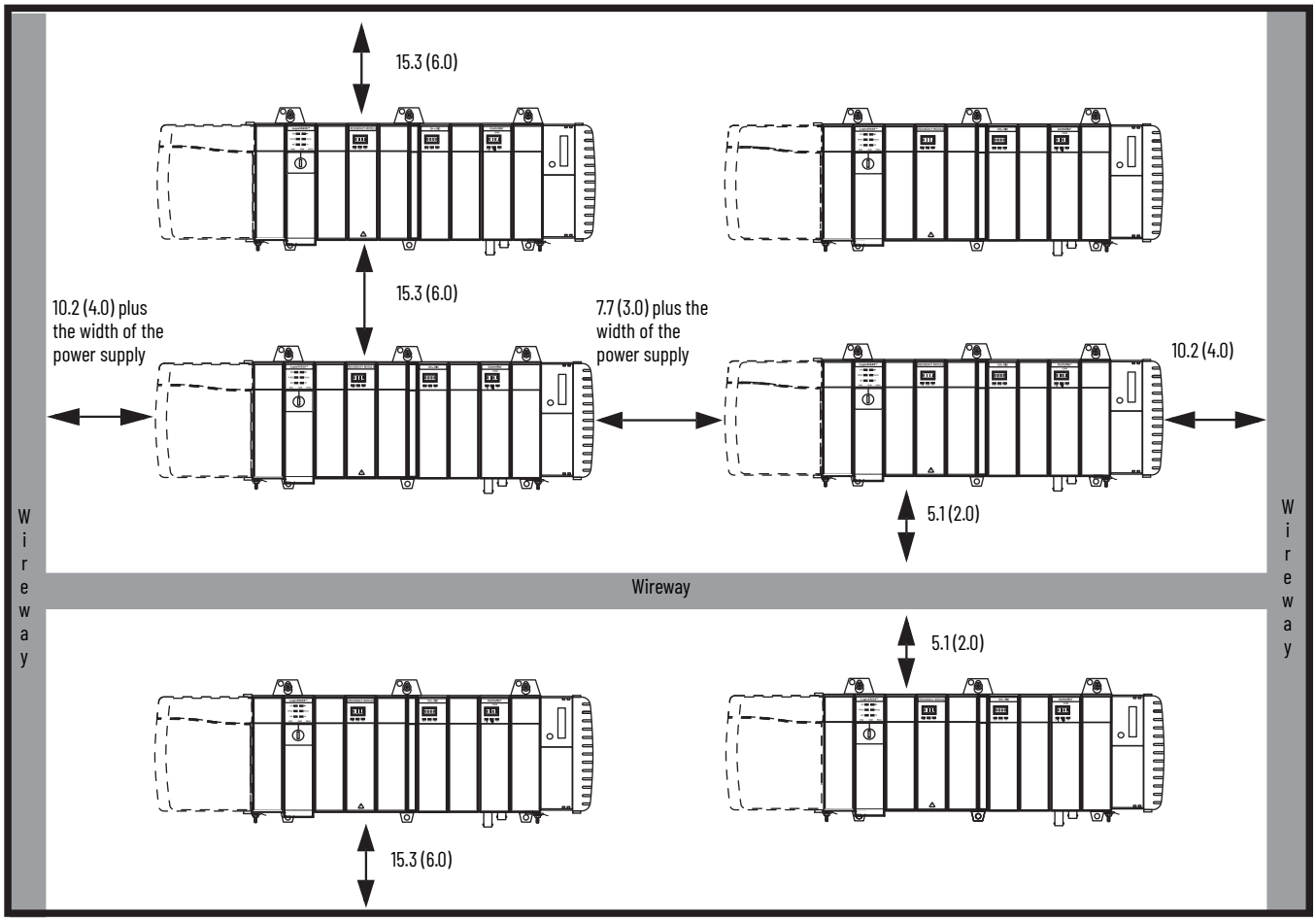
ATTENTION: ControlLogix-ZXT chassis are shipped with backplane connector covers installed to provide a layer of protection from corrosive atmospheres. Once the factory packaging seal is broken, these covers must remain installed in unused slots at all times for the chassis to maintain its corrosive atmosphere rating. Remove the backplane connector cover when installing a module, controller, or other system component into a chassis slot. If a module, controller, or other system component is later removed, reinstall a backplane connector cover in the vacated slot to maintain the corrosive atmosphere rating of the chassis.

Chassis Mounting System Spacing Requirements

Spacing Requirements for a System with a Non-redundant Power Supply

Dimensions are in cm (in.).

IMPORTANT Make sure that you meet the minimum spacing requirements specified.
Allow 15.3 cm (6.0 in.) between a cabinet, another chassis, or other heat source and the top or bottom of a chassis.
Allow 5.1 cm (2.0 in.) between a wireway and the top or bottom of a chassis.
Chassis are intended to be mounted only horizontally. Do not mount vertically.



Spacing Requirements for a System with Redundant Power Supplies

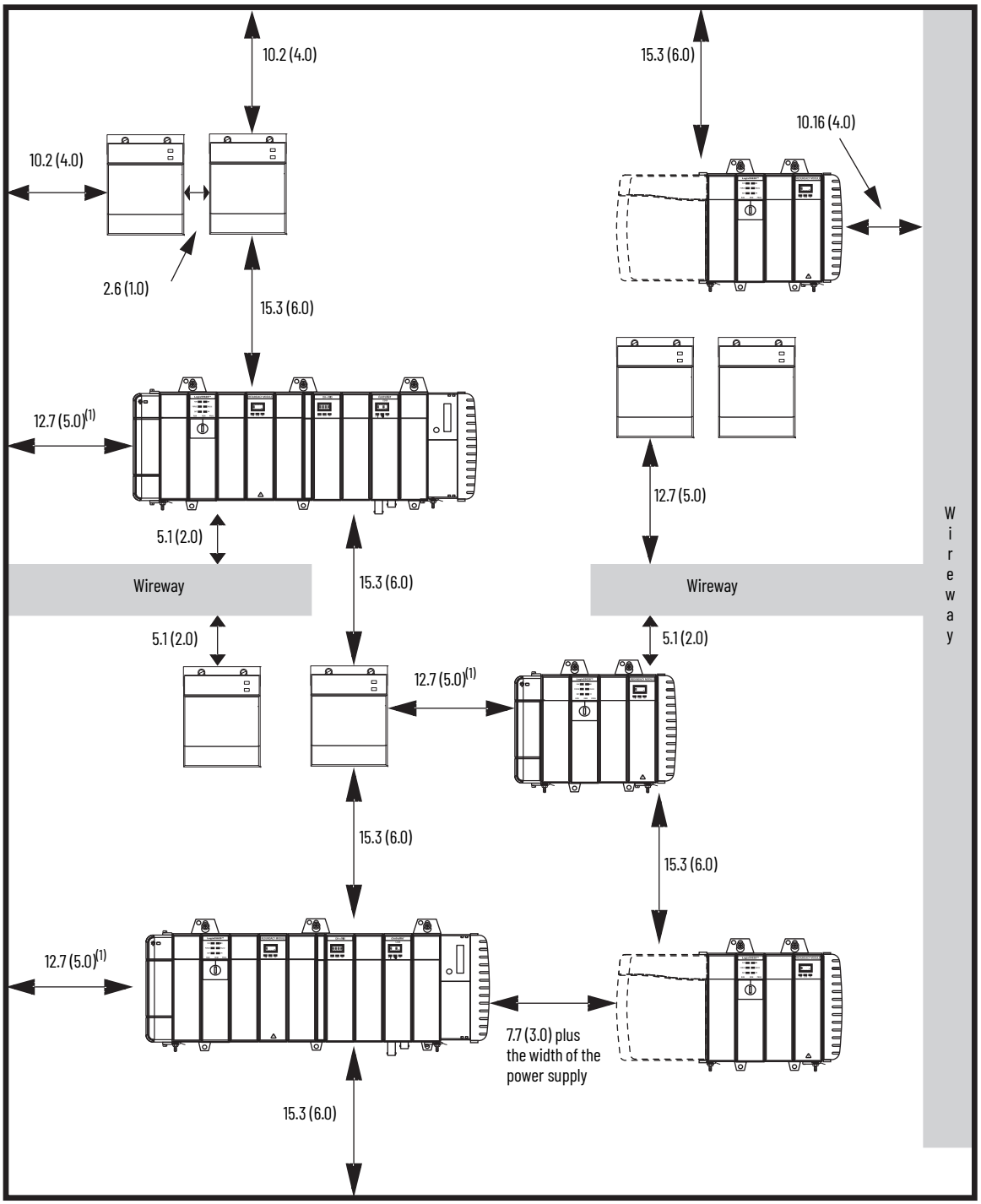
Dimensions are in cm (in.).

IMPORTANT Make sure that you meet the minimum spacing requirements specified.

Chassis and redundant power supplies are intended to be mounted only horizontally. Do not mount vertically.

The 1756-CPR2 cable has a bend radius of 12.7 cm (5.0 in.). The chassis must have a minimum clearance of 12.7 cm (5.0 in.) on the left side to route and connect the 1756-CPR2 cable. The redundant power supplies must have a minimum clearance of 12.7 cm (5.0 in.) below the supply to route and connect the 1756-CPR2 cable.

The 1756-CPR2D and 1756-CPR2U cables have right-angle connectors. The chassis must have a minimum clearance of 10.16 cm (4.0 in.) on the left side to route and connect the 1756-CPR2D and 1756-CPR2U cables.

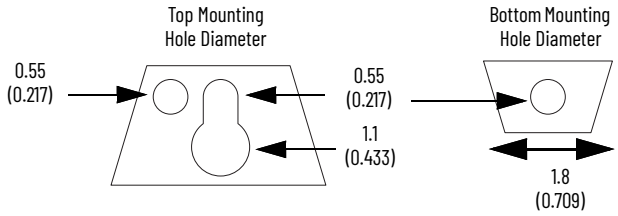


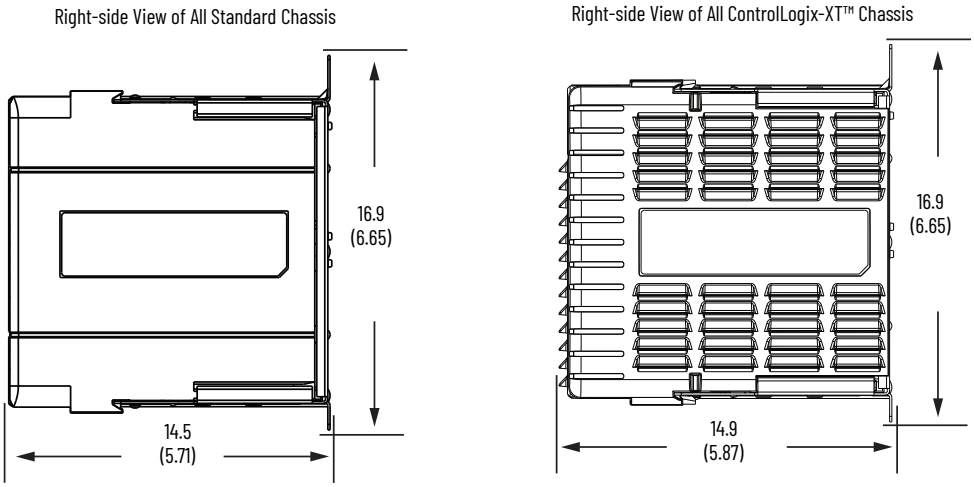
(1) The measurements for systems that use 1756-CPR2D or 1756-CPR2U cables are 10.2 cm (4.0 in.).

Mounting Dimensions

Dimensions are in cm (in.).

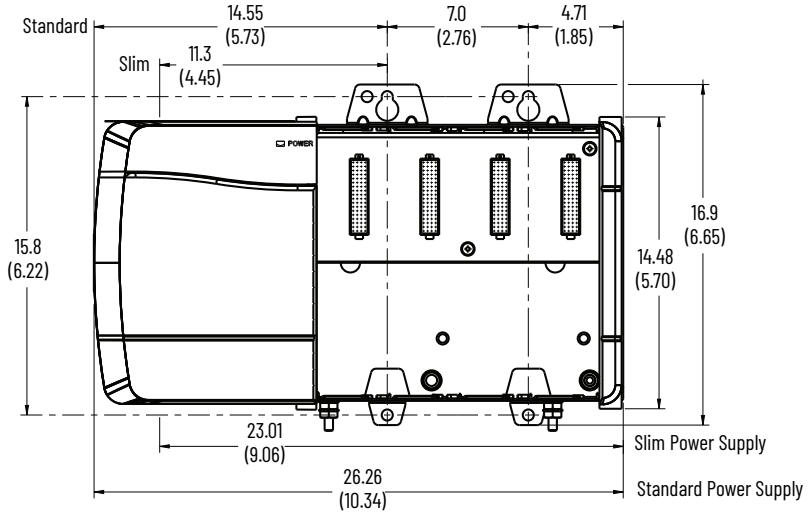
Chassis Common Dimensions



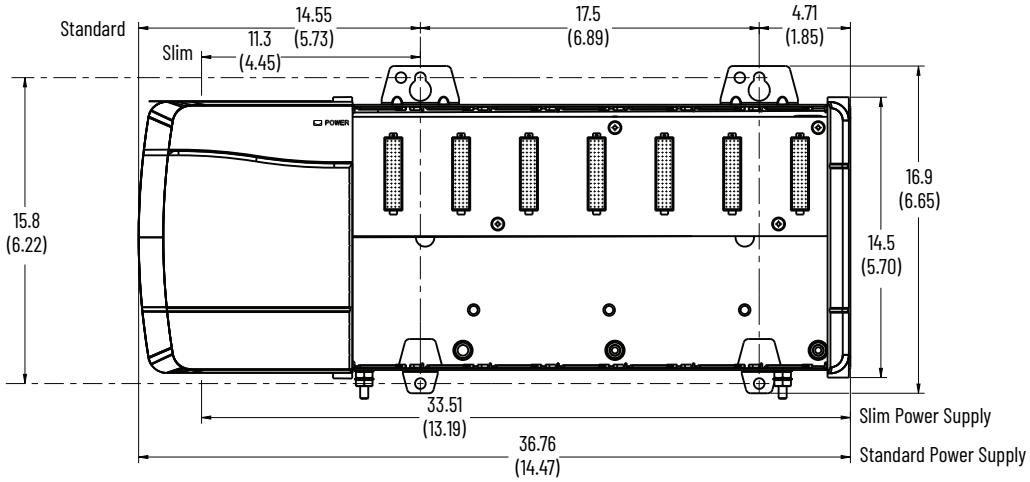


Standard refers to a standard power supply, and slim refers to a reduced-width power supply.

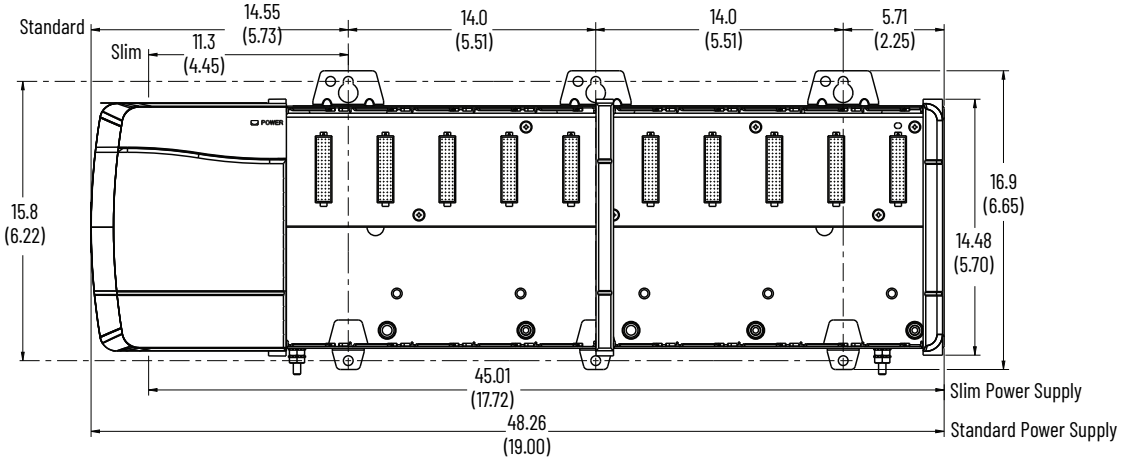
1756-A4 Chassis and Power Supply



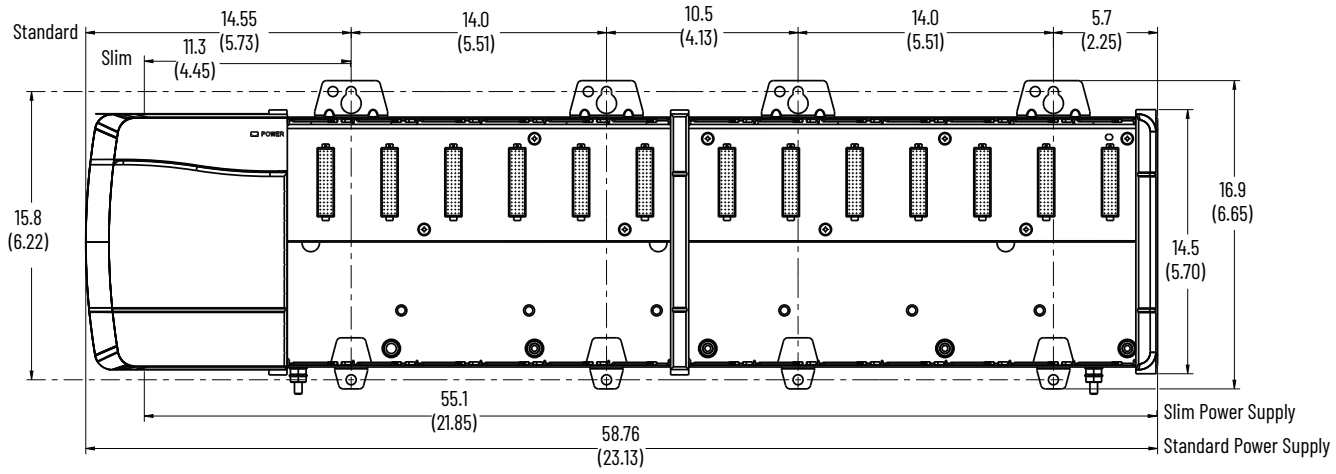
1756-A7 Chassis and Power Supply



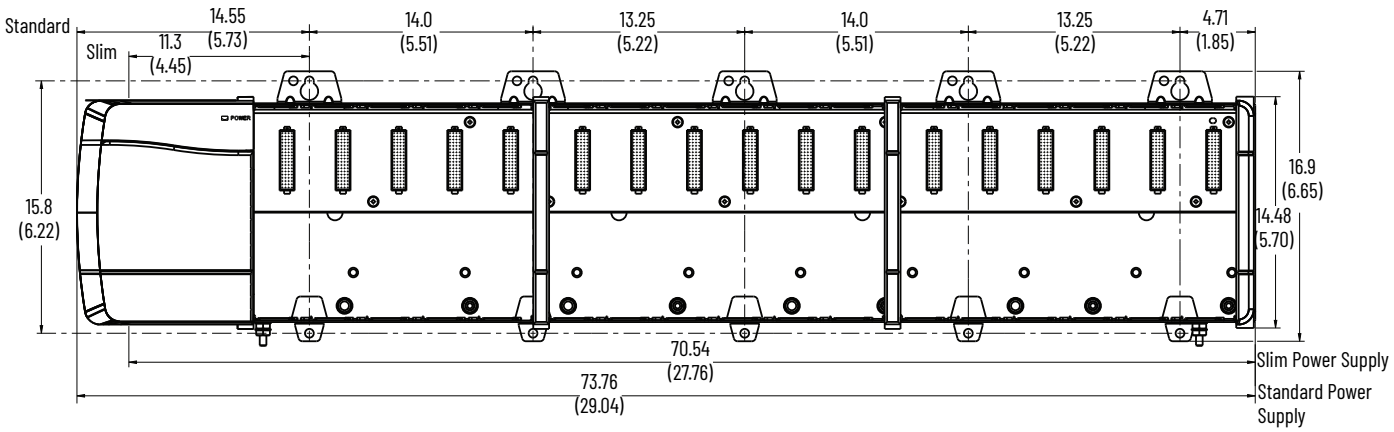
1756-A10 Chassis and Power Supply



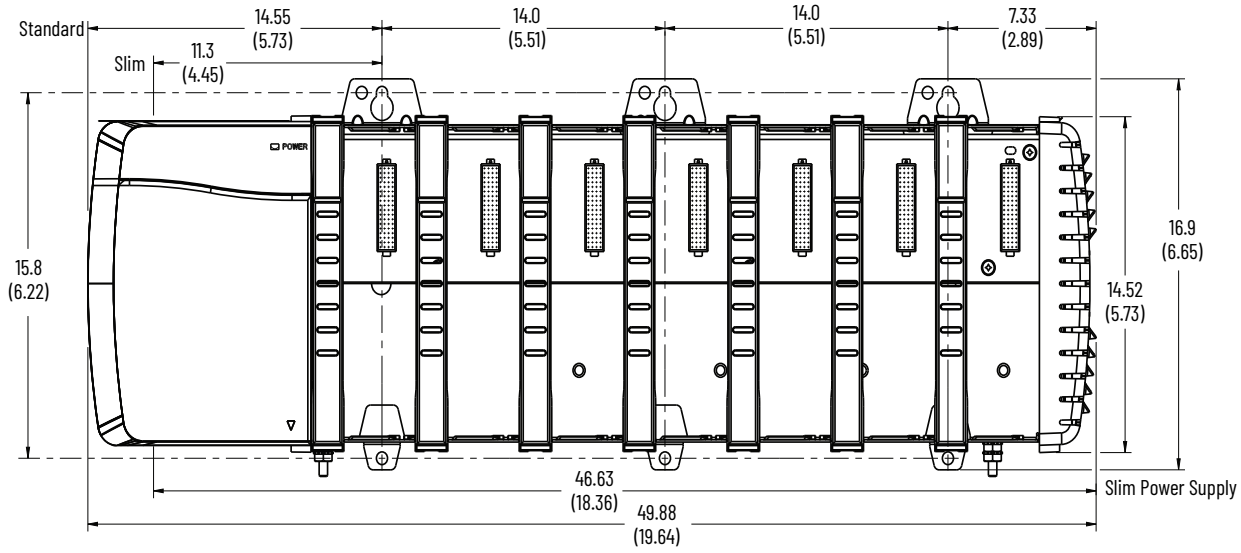
1756-A13 Chassis and Power Supply



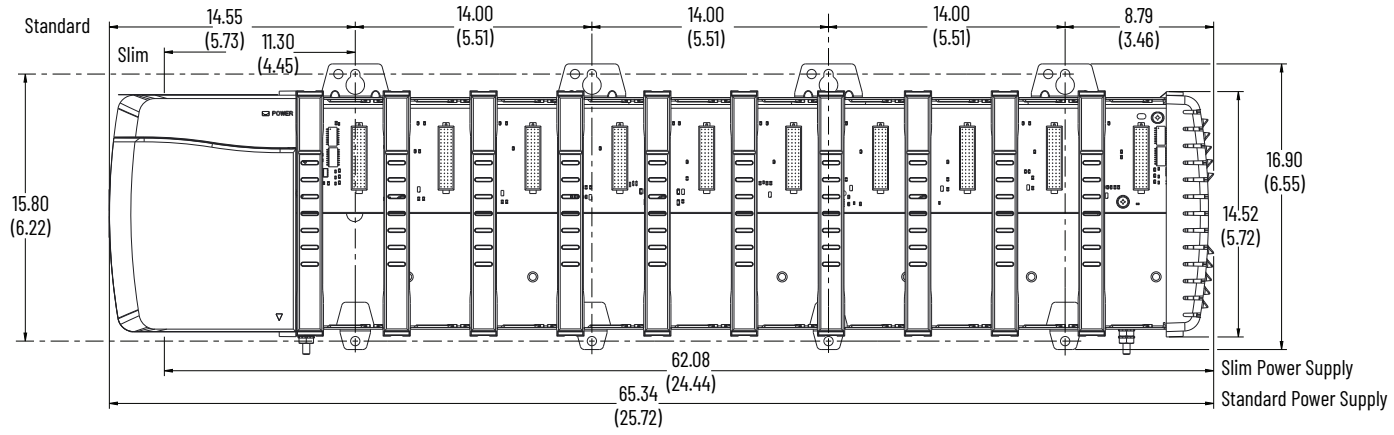
1756-A17 Chassis and Power Supply



1756-A7XT or 1756-A7ZXT Chassis and Power Supply



1756-A10XT or 1756-A10ZXT Chassis and Power Supply



Install the Chassis

After planning your system, use these instructions to install the chassis.

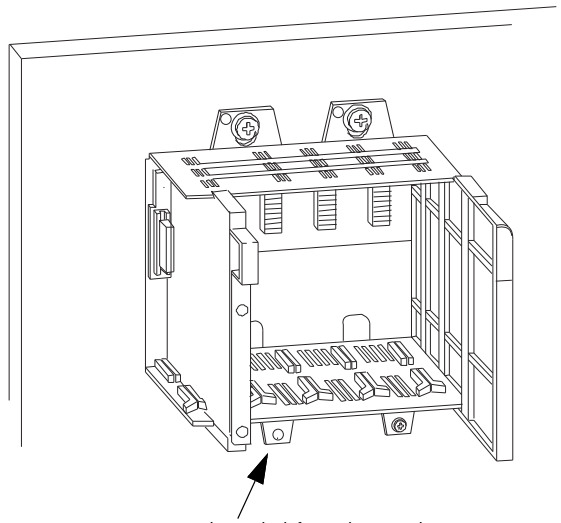
ATTENTION: Chassis are shipped with a paper debris label attached to the top side. Leave the debris label in place during chassis installation. After installation, remove the debris label from the top of the chassis. Failure to remove this label will affect thermal performance, cause components to overheat, and result in damage to the system.

IMPORTANT Chassis are intended to be mounted only horizontally. Do not mount vertically.

1. Drill holes in the back panel of the enclosure for the chassis mounting tabs.
2. Scrape paint off the back panel for an electrical connection between the chassis and back panel.
3. Hold the chassis in place against the holes.

ATTENTION: If the chassis mounting tabs do not lay flat before the screws are tightened, use additional washers as shims so the chassis isn't warped by tightening the screws.
Warping a chassis can damage the backplane and cause intermittent operation.

4. Install the hardware for the top mounting tabs and tighten. See Parts Required on page 5 for more information.
5. Install the remaining tab screws, but leave the leftmost bottom tab open for the functional ground.



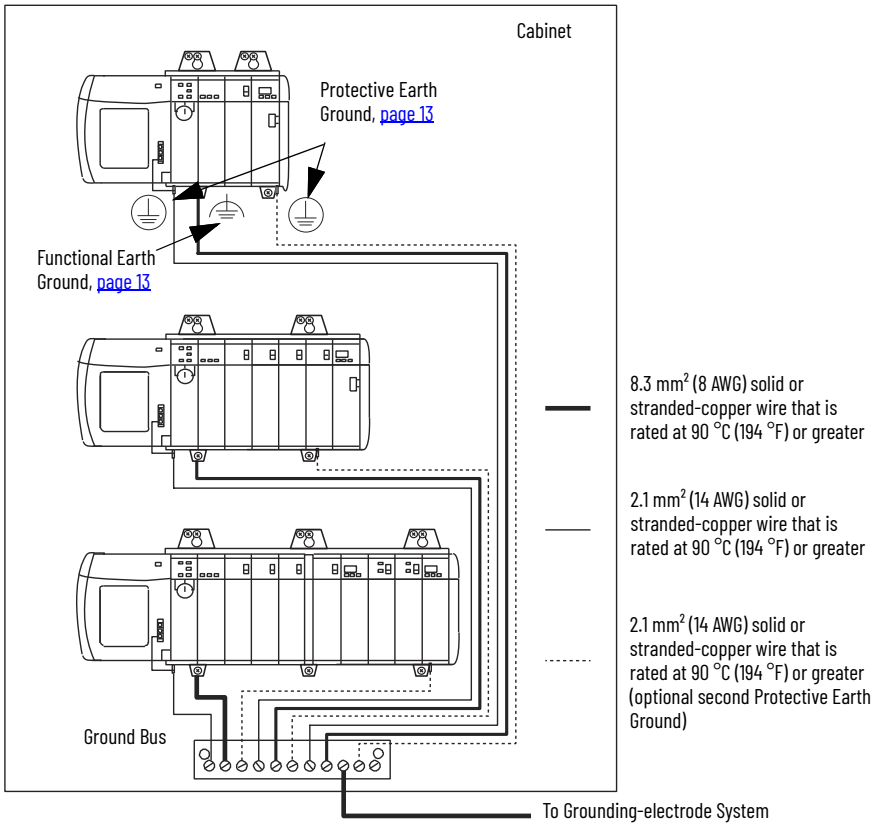
ATTENTION: Do not drill holes above an installed chassis. Metal chips from drilling can damage the backplane and cause intermittent operation.

Ground the Chassis

This figure shows an example grounding configuration. After you complete the grounding steps, your system looks similar to this figure.

To minimize the resistance between the chassis and ground connection, keep wire lengths as short as possible.

Grounding Configuration Example



Use these guidelines when connecting the grounding:

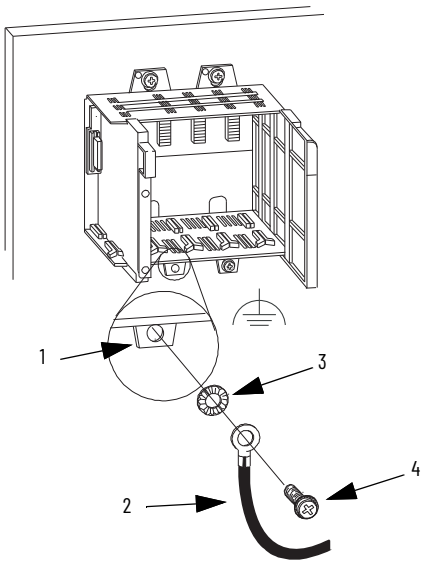
- Use a steel enclosure to guard against electromagnetic interference (EMI).
- Install a bonding wire for electrical contact between the enclosure door and the enclosure; do not rely on the hinge.
- Make sure the enclosure-door viewing window is a laminated screen or a conductive optical substrate (to block EMI).

Install a Central Ground Bus

Each enclosure must contain a central ground bus. The ground bus is the common connection for each chassis within the enclosure and the enclosure itself. For more information on how to install a central ground bus, see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Connect the Functional Earth Ground on the Chassis

Use 8.3 mm^2 (8 AWG) solid or stranded-copper wire that is rated at 90 °C (194 °F) or greater to connect the functional earth ground as shown in the following figure.

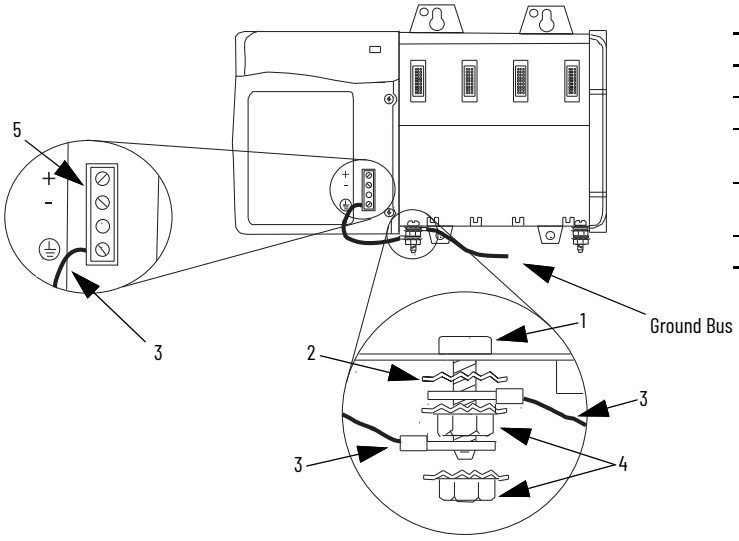


Item	Description
1	Chassis mounting tab
2	Equipment grounding conductor (ground lug with 8.3 mm^2 [8 AWG] solid or stranded-copper wire that is rated at 90 °C [194 °F] or greater)
3	M4 or M5 (#10 or #12) flat or star washer
4	M4 or M5 (#10 or #12) Phillips screw and flat or star washer (or SEM screw)

Connect the Protective Earth Ground

Use 2.1 mm^2 (14 AWG) solid or stranded-copper wire that is rated at 90 °C (194 °F) or greater to connect the protective earth ground. Tighten the nuts on the protective earth ground terminal stud to a torque of 1.35 N•m (12 lb•in). Connect the functional earth ground as shown in this figure.

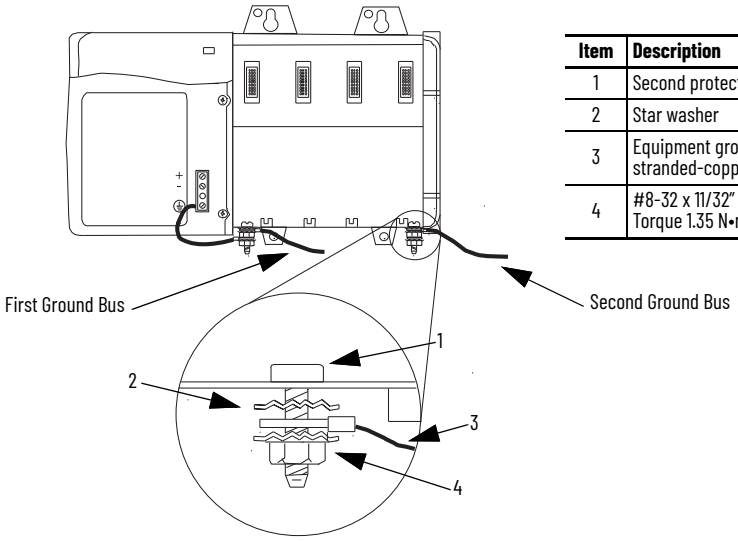
Protective Earth Ground Connection



Item	Description
1	Protective earth ground terminal stud
2	Star washer
3	Equipment grounding conductor (ground lug with 2.1 mm^2 [14 AWG] solid or stranded-copper wire that is rated at 90 °C [194 °F] or greater)
4	#8-32 x 11/32″ nut with captive star washer Torque 1.35 N•m (12 lb•in)
5	Wiring terminal block (bottom terminal is protective earth ground)

IMPORTANT If your application requires a second protective earth ground connection, use the additional protective earth ground terminal stud to connect the chassis to the ground bus as shown in this figure.

Second Protective Earth Ground Connection

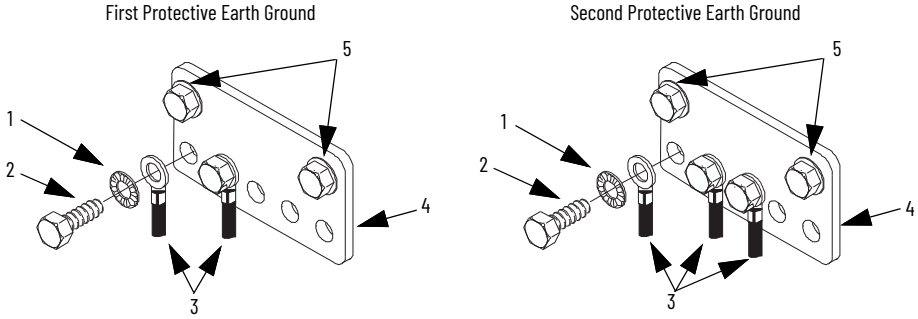


Item	Description
1	Second protective earth ground terminal stud
2	Star washer
3	Equipment grounding conductor (ground lug with 2.1 mm² [14 AWG] solid or stranded-copper wire that is rated at 90 °C [194 °F] or greater)
4	#8-32 x 11/32″ nut with captive star washer Torque 1.35 N•m (12 lb•in)

Connect the Grounding Conductors to the Ground Bus

Connect the equipment grounding conductors (functional and protective earth ground) directly from each chassis to an individual bolt on the ground bus.

Ground Bus Connection



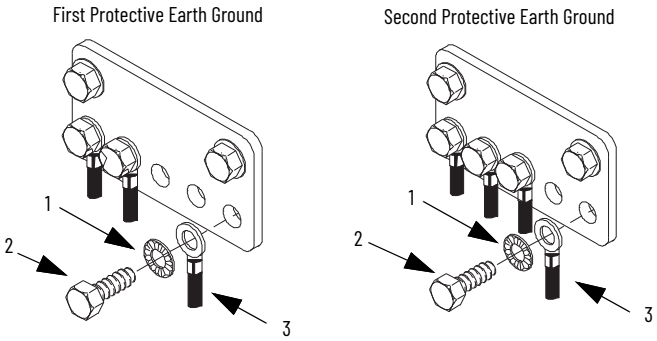
Item	Description
1	Flat or star washer
2	Bolt
3	Equipment grounding conductor (from protective and functional earth ground connections)
4	Ground bus
5	Ground bus mounting

Connect Ground Bus to Grounding-electrode System

Use a grounding-electrode conductor to connect the ground bus to the grounding-electrode system.

At minimum, use 8.3 mm² (8 AWG) solid or stranded-copper wire that is rated at 90 °C (194 °F) or greater for the grounding-electrode conductor to guard against EMI. The National Electrical Code specifies safety requirements for the grounding-electrode conductor.

Grounding-electrode System Connection



Item	Description
1	Flat or star washer
2	Bolt
3	Equipment grounding conductor (ground lug with minimum 8.3 mm² [8 AWG] solid or stranded-copper wire that is rated at 90 °C [194 °F] or greater)

Specifications - ControlLogix Standard Chassis

Attribute	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17
Backplane current, chassis/slot max @ 1.2V DC	1.5 A/–
Backplane current, chassis/slot max @ 3.3V DC	4A/4A
Backplane current, chassis/slot max @ 5.1V DC	15 A/6 A
Backplane current, chassis/slot max @ 24V DC	2.8 A/2.8 A
Isolation voltage	Determined by installed power supply and modules
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25...+60 °C (-13...+140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Conformal Coated	No
Enclosure type rating	None (open-style)
Wire size	Functional Earth Ground: 8.3 mm^2 (8 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater Protective Earth Ground: 2.1 mm^2 (14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater
Temperature code	T4

Specifications - ControlLogix Harsh Environment Chassis

Attribute	1756-A4K, 1756-A7K, 1756-A10K, 1756-A13K, 1756-A17K	1756-A7XT, 1756-A10XT	1756-A7ZXT, 1756-A10ZXT
Backplane current, chassis/slot max @ 1.2V DC	1.5 A/–		
Backplane current, chassis/slot max @ 3.3V DC	4A/4A		
Backplane current, chassis/slot max @ 5.1V DC	15 A/6 A		
Backplane current, chassis/slot max @ 24V DC	2.8 A/2.8 A		
Isolation voltage	Determined by installed power supply and modules		
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25...+60 °C (-13...+140 °F)	-25...+70 °C (-13...+158 °F)	
Temperature, surrounding air, max	60 °C (140 °F)	70 °C (158 °F)	
Conformal Coated	Yes		
Corrosive Atmosphere • ASTM B845-97 Method K Accelerated Test (30-Day Exposure) plus additional Rockwell Automation proprietary accelerated corrosive environment test protocol for specific industries with sources of gaseous sulfur compounds.	–		Severity Level GX(1)(2) per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX(1) per IEC 60721-3-3:2019, Chemically Active Substances
Enclosure type rating	None (open-style)		
Wire size	Functional Earth Ground: 8.3 mm^2 (8 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater Protective Earth Ground: 2.1 mm^2 (14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater		
Temperature code	T4		

(1) Port plugs/covers must remain installed in unused ports at all times, once the XT packaging seal is broken, for the product to maintain its corrosive atmosphere rating.
(2) Up to 2100 angstroms of film growth per 30 days of copper and/or silver reactivity.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
ControlLogix Chassis Specifications Technical Data, publication 1756-TD006	Provides technical specifications for ControlLogix chassis.
ControlLogix Power Supplies Specifications Technical Data, publication 1756-TD005	Provides technical specifications for ControlLogix power supplies.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Provides information on how to install ControlLogix standard power supplies.
ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620	Provides information on how to install ControlLogix redundant power supplies.
ControlLogix System User Manual, publication 1756-UM001	Provides instructions for installation and use of ControlLogix Systems, application design, and other general information for these systems.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.
For technical support, visit rok.auto/support.

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Technical Data

Original Instructions

1756 ControlLogix Power Supplies Specifications

Standard Power Supplies	1756-PA72, 1756-PA72K, 1756-PA75, 1756-PA75K, 1756-PB72, 1756-PB72K, 1756-PB75, 1756-PB75K,1756-PC75, 1756-PH75
Standard Slim Power Supplies	1756-PA50, 1756-PA50K, 1756-PB50, 1756-PB50K
ControlLogix-XT Power Supplies	1756-PAXT, 1756-PBXT
ControlLogix-XT Slim Power Supplies	1756-PA30XT, 1756-PB30XT
Redundant Power Supplies	1756-PA75R, 1756-PA75RK, 1756-PB75R, 1756-PB75RK
Redundant Power Supplies Chassis Adapter	1756-PSCA2, 1756-PSCA2K
ControlLogix-XT Redundant Power Supplies	1756-PAXTR, 1756-PBXTR
ControlLogix-XT Redundant Power Supplies Chassis Adapter	1756-PSCA2XT
Redundant Power Supply Power Cable	1756-CPR2, 1756-CPR2D, 1756-CPR2U

Topic	Page
Redundant Power Supplies	12
Power Load and Transformer Sizing	20
Additional Resources	23

Redundant Power Supplies

To build a redundant power supply system, you need the following.

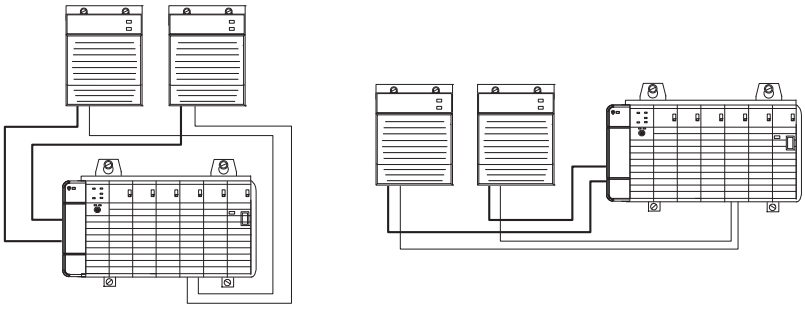
Cat. No.	Description	Amount
1756-PA75R/A, 1756-PA75RK/A, 1756-PAXTR, 1756-PB75R/A, 1756-PB75RK/A, or 1756-PBXTR	Redundant power supply	2
1756-CPR2[1] 1756-CPR2D[2] or 1756-CPR2U[2]	Redundant power supply cable (Length = 0.91 m [3 ft])	2
1756-PSCA2, 1756-PSCA2K, or 1756-PSCA2XT	Redundant power supply chassis adapter[3]	1
User-supplied	Annunciator wiring[4] (Length, max = 10 m [32.8 ft])	2

(1) Cable bend radius is 12.7 cm (5.0 in.).
(2) Requires 10.16 cm (4.0 in.) of clearance next to the chassis adapter.
(3) The 1756-PSCA2 or 1756-PSCA-2XT chassis adapter is a passive device. The adapter funnels power from the redundant power supplies to the single power connector on the ControlLogix® series B chassis backplane.
(4) Optional user-provided annunciator wiring can be connected to the solid-state relay for status and troubleshooting.

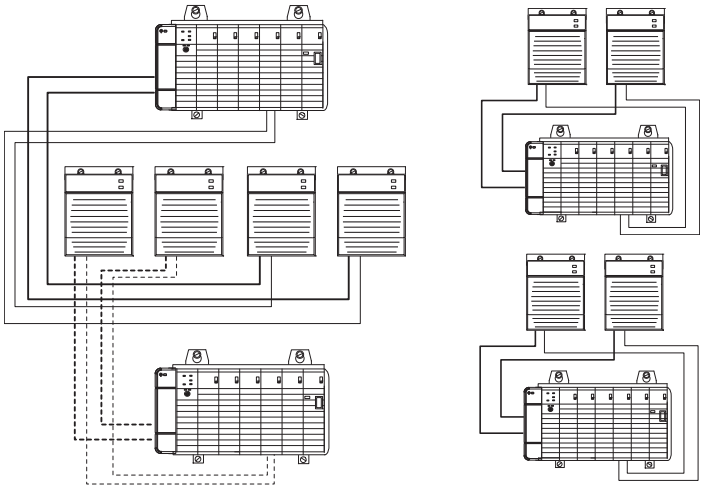
System Configuration Recommendations

We recommend that you use one of these methods to configure your redundant power supply system.

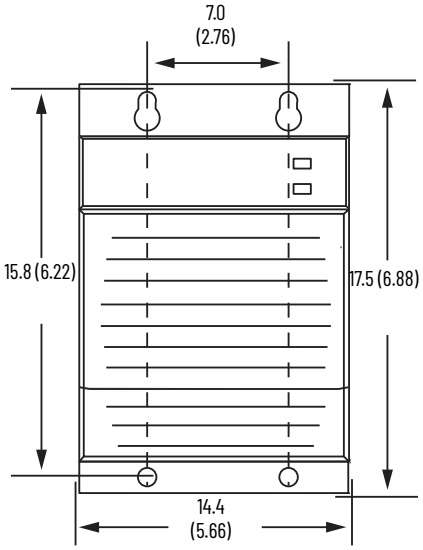
Recommended Configurations for a System That Uses One Chassis

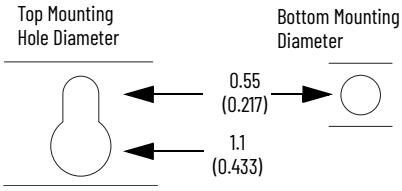


Recommended Configurations for a System That Uses Two Chassis



Mounting Dimensions





Dimensions are in cm (in.).

Redundant Power Supply Features

The redundant power supplies offer the same features as the standard power supplies, and the following:

- Redundant operation
- Automatic chassis load sharing between the redundant power supplies
- Status indicators for visual operating status of the pair
- Solid-state relay for system recognition of supply status when wired to an input module
- The ControlLogix redundant power supply system is designed to account for operational anomalies in only the power supply (the chassis adapter and power supply cables are excluded)

Technical Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R, 1756-PA75RK	1756-PB75R, 1756-PB75RK
Input voltage range	85...265V AC(1)	18...32V DC(2)
Input voltage	120V/240V AC, 50/60 Hz	24V DC
Input frequency range	47...63 Hz	–
Input power, max	120VA 115 W	110 W
Output power, max	75 W @ 0...60 °C (32...140 °F)	
Inrush current, max	20 A	30 A
Hold up time(3)	2 cycles @ 60 Hz 2 cycles @ 50 Hz	20 ms
Current capacity @ 1.2V	1.5 A	
Current capacity @ 3.3V	4 A	
Current capacity @ 5.1V	13 A	
Current capacity @ 24V	2.8 A	
Annunciator power	240V AC 50/60 Hz, 240V DC, 50 mA, resistive only	90V DC for ATEX/IECEx
Isolation voltage	250V (continuous), Reinforced Insulation Type, Power Input to Backplane, Power Input to Annunciator, Annunciator to Backplane Type tested at 3250V DC for 60 s	
Dimensions (HxWxD), approx	17.5 x 14.5 x 13.7 cm (6.9 x 5.7 x 5.4 in.)	
Weight, approx	1.45 kg (3.2 lb)	

Technical Specifications - ControlLogix Redundant Power Supplies (Continued)

Attribute	1756-PA75R, 1756-PA75RK	1756-PB75R, 1756-PB75RK
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	
Wire size	Power: 2.5 mm^2 (14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Annunciator: 0.25…2.5 mm^2 (22…14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
Wire category (4)	3 - on annunciator ports 1 - on power ports 3 - on 1756-CPR2 connections	
Pilot duty rating	Annunciator - not rated	
Conductor screw torque	0.565 N•m (5 lb•in)	
North American temperature code	T3C	T4
ATEX temperature code	–	T4
IEC temperature code	–	T4
Enclosure type rating	None (open-style)	

(1) UL certification for 120/240V AC, 50/60 Hz nominal. Rockwell Automation specified 85…265V AC, 47…63 Hz.
(2) UL certification for 24V DC nominal. Rockwell Automation specified 18…32V DC.
(3) The hold up time is the time between input voltage removal and DC power failure.
(4) Use this conductor category information to plan conductor routing. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R, 1756-PA75RK	1756-PB75R, 1756-PB75RK
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Temperature, surrounding air, max	60 °C 140 °F)	
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…+85 °C (-40…+185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions	IEC 61000-6-4	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000…2700 MHz	
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports ±4 kV at 5 kHz on annunciator ports	
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports	
Conducted RF immunity IEC 61000-4-6	15V rms with 1 kHz sine wave 80% AM from 150 kHz…80 MHz	

Environmental Specifications - ControlLogix Redundant Power Supplies (Continued)

Attribute	1756-PA75R, 1756-PA75RK	1756-PB75R, 1756-PB75RK
Conducted audio immunity IEC 945	2 W max from rated frequency to the 200th harmonic on AC supply ports	
Voltage variation IEC 61000-4-11	30% dips for 1 period at 0° and 180° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports	–
Voltage variation IEC 61000-4-29	–	10 ms interruption on DC supply ports(1) 60% dips for 100 ms on DC supply ports 100% dips for 50 ms on DC supply ports ±20% fluctuations for 15 min on DC supply ports 5 s interruptions on DC supply ports(2)

(1) Short interruption test verifies ride-through. The supply remains fully functional under this condition.
(2) Long interruption test verifies that repetitive inrush surge currents do not create any unsafe conditions. The supply fully shuts down and starts up in this test.

Certifications - ControlLogix Redundant Power Supplies

Certification(1)	1756-PA75R, 1756-PA75RK	1756-PB75R, 1756-PB75RK
c-UL-us	UL Listed Industrial Control Equipment, which is certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, which are certified for U.S. and Canada. See UL File E194810.	
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.	
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment	
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations	
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2014/35/EU LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)	
RCM	Australian Radiocommunications Act, compliant with: • EN 61000-6-4; Industrial Emissions	
Ex	–	European Union 2014/34/EU ATEX Directive, compliant with: • EN IEC 60079-0; General Requirements • EN IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • UL 22 ATEX 2819X
IECEx	–	IECEx System, compliant with: • IEC 60079-0; General Requirements • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • IECEx UL 22.0064X
UKEX	–	In conformity with the following UKex Statutory Instruments and their amendments: • Schedule 1 of the UKEX Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2605X • Zone 2 classification according to UKEX Regulation 2016 No. 1107
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: • Article 58-2 of Radio Waves Act, Clause 3	
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation	
CCC	CCC 2020122309111830, 2020122309111998, 2020122309113868 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products	

(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

Redundant Power Supply Chassis Adapters

Technical Specifications - Redundant Power Supply Chassis Adapters

Attribute	1756-PSCA2, 1756-PSCA2K	1756-PSCA2XT
Current capacity @ 1.2V DC	1.5 A	
Current capacity @ 3.3V DC	4 A	
Current capacity @ 5.1V DC	15 A	
Current capacity @ 24V DC	2.8 A	
Wire category (1)	3 - on 1756-CPR2 connections	
North American temperature code	T5	T4A
ATEX temperature code	T4	
IEC temperature code	T4	
Enclosure type rating	None (open-style)	

(1) Use this conductor category information to plan conductor routing. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications - Redundant Power Supply Chassis Adapters

Attribute	1756-PSCA2, 1756-PSCA2K	1756-PSCA2XT
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0...60 °C (32...140 °F)	-25...+70 °C (-13...+158 °F)
Temperature, surrounding air, max	60 °C (140 °F)	70 °C (158 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions	IEC 61000-6-4	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz	

Certifications - Redundant Power Supply Chassis Adapters

Certification[1]	1756-PSCA2, 1756-PSCA2K	1756-PSCA2XT
c-UL-us	UL Listed Industrial Control Equipment, which is certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, which are certified for U.S. and Canada. See UL File E194810.	
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.	–
UKEX	In conformity with the following UKex Statutory Instruments and their amendments: • Schedule 1 of the UKEX Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2605X • Zone 2 classification according to UKEX Regulation 2016 No. 1107	
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment	
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations	–
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)	
RCM	Australian Radiocommunications Act, compliant with: • EN 61000-6-4; Industrial Emissions	
Ex	European Union 2014/34/EU ATEX Directive, compliant with: • EN IEC 60079-0; General Requirements • EN IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • UL 22 ATEX 2819X	
IECEx	IECEx System, compliant with: • IEC 60079-0; General Requirements • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • IECEx UL 22.0064X	
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: • Article 58-2 of Radio Waves Act, Clause 3	
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation	
CCC	CCC 2020122309111830, 2020122309111998, 2020122309113868 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products	

(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

Power Load and Transformer Sizing

The following graphs show the input power requirements for slim and standard power supplies, given the power that they're providing to the modules in the chassis.

Follow these steps to determine the power requirements for your chassis.

1. Calculate the Backplane Power load by adding the power draw (in watts) for all planned modules.

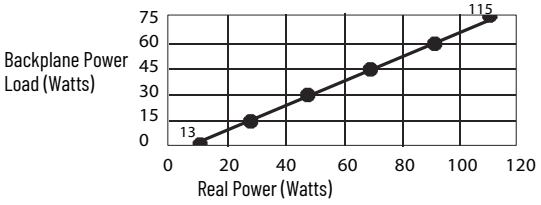
   For module power draws, refer to the module specification tables in the ControlLogix Selection Guide, publication 1756-SG001.

2. Locate the Backplane Power load on the vertical (y) axis of the graph and determine the corresponding Real Power (input-power) rating on the horizontal (x) axis.

   The Real Power value is the amount of power that is consumed by the power supply.

Standard Power Supply Power Requirements

1756-PA75R/A, 1756-PA75RK/A(AC)



Apparent Power (Watts) = Transformer Load (VA) = Real Power (Watts)

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
ControlLogix Chassis Specifications Technical Data, publication 1756-TD006	Provides technical specifications for ControlLogix chassis.
ControlLogix Selection Guide, publication 1756-SG001	Provides overview of the ControlLogix system and its products.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Provides information on how to install ControlLogix standard power supplies.
ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620	Provides information on how to install ControlLogix redundant power supplies.
ControlLogix Chassis Installation Instructions, publication 1756-IN621	Provides information on how to install ControlLogix chassis.
ControlLogix System User Manual, publication 1756-UM001	Provides information on how to install, configure, program, and use ControlLogix systems.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

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Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

ControlLogix Redundant Power Supply

Catalog Numbers 1756-PA75R, 1756-PB75R, 1756-PSCA2, 1756-PBXTR, 1756-PSCA2XT, 1756-PAXTR, 1756-PA75RK, 1756-PB75RK, 1756-PSCA2K

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The redundant power supply system provides additional uptime protection for chassis that are used in critical applications. The two remotely mounted supplies are designed to share the current required by the chassis. Two supplies are available in AC (catalog number 1756-PA75R/A or 1756-PAXTR) and DC (catalog number 1756-PB75R/A or 1756-PBXTR) versions that can be mixed or matched when used in tandem.

If one power supply fails, the remaining supply accommodates the entire load of the chassis without disruption to chassis activity. The ControlLogix® redundant power supply system is designed to account for operational anomalies in only the power supply (the chassis adapter and power supply cables are excluded).

The 1756-PSCA2 chassis adapter is a passive device. The chassis adapter funnels power from one or two ControlLogix redundant power supplies to the single power connector on the ControlLogix chassis backplane.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and isn't intended to reflect all changes.

Topic	Page
Added UKEX information to ATEX, IECEx, and UKEX Hazardous Location Conformity	4
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Redundant Power Supply and Chassis Compatibility

Your chassis series determines the redundant power supply that you can use. This table lists the chassis that can be installed with each redundant power supply.

Power Supply Cat. No.	Chassis Cat. No.
1756-PA75R	1756-A4/B, 1756-A7/B, 1756-A10/B, 1756-A13/B, 1756-A17/B 1756-A4/C, 1756-A7/C, 1756-A10/C, 1756-A13/C, 1756-A17/C
1756-PB75R	
1756-PAXTR(1)	1756-A4/B, 1756-A7/B, 1756-A10/B, 1756-A13/B, 1756-A17/B, 1756-A4LXT/B, 1756-A5XT/B, 1756-A7LXT/B, 1756-A7XT/B, 1756-A4/C, 1756-A7/C, 1756-A10/C, 1756-A13/C, 1756-A17/C, 1756-A7XT/C, 1756-A10XT/C
1756-PBXTR(1)	

(1) The 1756-PAXTR and 1756-PBXTR redundant power supplies are only rated from 0…60 °C (32…140 °F) when used in non-XT chassis.

Rockwell Automation

ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

설치 , 조정 , 가동 , 사용 , 조립 , 분해 , 유지보수 등 모든 작업은 관련 규정에 따라 적절한 교육을 받은 사용자를 통해서만 수행해야 합니다 .

본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於 「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安装、調整、交付使用、使用、組装、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

Product Advisories

Before You Begin

ATTENTION:
Before installing, configuring, operating, or maintaining this product, read this document and the documents that are listed in the additional resources section for installing, configuring, or operating equipment. Users should familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice. In case of malfunction or damage, no attempts at repair should be made. The module should be returned to the manufacturer for repair. Do not dismantle the module.

This equipment is certified for use only within the surrounding air temperature range of 0...60 °C (32...140 °F) [PA75R, PB75R, PSCA2] -25...+70 °C (-13...+158 °F) [PAXTR, PBXTR, PSCA2XT]. The equipment must not be used outside of this range.

Annunciator cable length should be less than 10 m (32.8 ft).

Use only a soft dry anti-static cloth to wipe down equipment. Do not use any cleaning agents.

Environment and Enclosure

ATTENTION:
This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment isn't intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA Standard 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

UK and European Hazardous Location Approval

The following applies to products marked Ⓔx, II 3 G. Such modules:

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection is <Ex ec IIC T4 Gc> Equipment protection by increased safety "e".
- Equipment protection by increased safety "e", reference certificate number UL 22 ATEX 2819X and UL22UKEX2605X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

IEC Hazardous Location Approval

The following applies to products with IECEx certification.

- Such products are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection is <Ex ec IIC T4 Gc>.
- IECEx certificate number IECEx UL 22.0064X.

ATEX, IECEx, and UKEX Hazardous Location Conformity

Model	Protection Type	ATEX Certificate	IECEx Certificate	UKEX Certificate
1756-PSCA2	Ex ec IIC T4 Gc	UL 22 ATEX 2819X	IECEx UL 22.0064X	UL22UKEX2605X
1756-PSCA2XT	Ex ec IIC T4 Gc	UL 22 ATEX 2819X	IECEx UL 22.0064X	UL22UKEX2605X
1756-PAXTR	None	–	–	–
1756-PBXTR	Ex ec IIC T4 Gc	UL 22 ATEX 2819X	IECEx UL 22.0064X	UL22UKEX2605X
1756-PA75R	None	–	–	–
1756-PB75R	Ex ec IIC T4 Gc	UL 22 ATEX 2819X	IECEx UL 22.0064X	UL22UKEX2605X

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an UKEX/ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment must be used only with UKEX/ATEX/IECEx certified Rockwell Automation® backplanes.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 140% of the peak rated voltage when applied in Zone 2 environments.
- The instructions in the user manual shall be observed.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Removable Terminal Blocks (RTBs) for I/O Connections

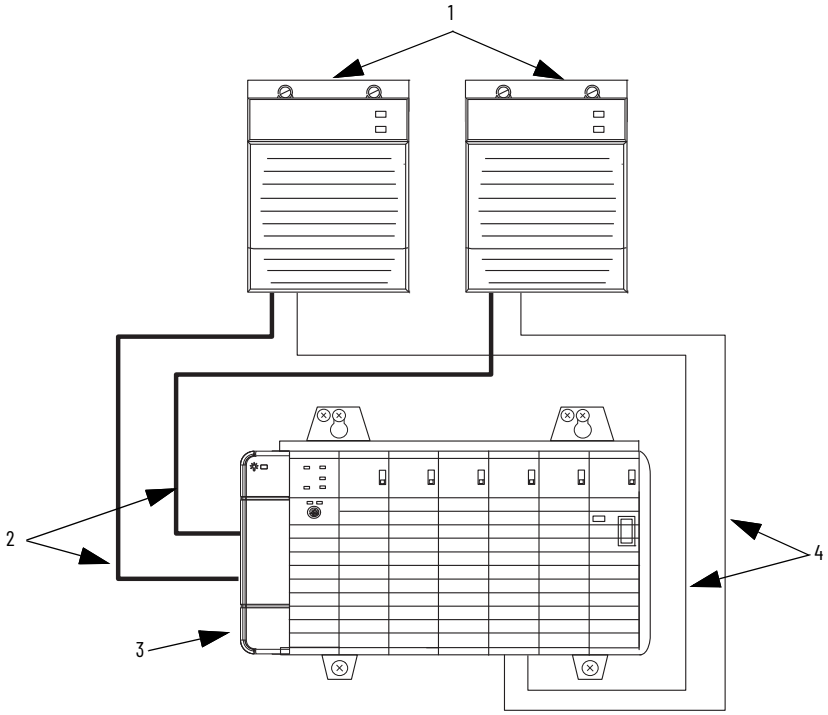
WARNING:

When you connect or disconnect the removable terminal block (RTB) with field side power applied, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Components of the Redundant System

This figure shows the components of a redundant system in a typical configuration.



IMPORTANT The ControlLogix redundant power supply system is designed to account for operational anomalies in only the power supply. The chassis adapter and power supply cables are excluded.

Item	Description	Cat. No.
1	Redundant power supply	1756-PA75R/A and/or 1756-PB75R/A or 1756-PAXTR and/or 1756-PBXTR
2	Redundant power supply cable (Length = 0.91 m [3 ft])	1756-CPR2[1][2] or 1756-CPR2D[2][3] or 1756-CPR2U[2][3]
3	Redundant power supply chassis adapter	1756-PSCA2 or 1756-PSCA2XT
4	Annunciator[4] wiring (Maximum length = 10 m [32.8 ft])	User-supplied

(1) Cable bend radius is 12.7 cm (5.0 in.).
(2) Cable bend radius can be greater than or less than the minimum mounting clearance of the chassis. Always maintain chassis minimum mounting clearance.
(3) Requires 10.16 cm (4.0 in.) of clearance next to the chassis adapter.
(4) Optional user-provided annunciator wiring can be connected to the solid-state relay for status and for troubleshooting. See page 8 for more information.

Tools Required

When installing your chassis and power supplies, the following items are required:

- 3.18 mm (0.125 in.) slotted screwdriver
- 6.35 mm (0.25 in.) slotted or #2 Phillips screwdriver
- Torque screwdriver
- Needle-nose pliers
- Crimper
- Wire stripper
- Drill

ATTENTION: Do not remove the protective label until the chassis is mounted and all panel fabrication is complete. This label protects the power supply from metal shavings falling inside the power supply and damaging it during operation.

Parts Required

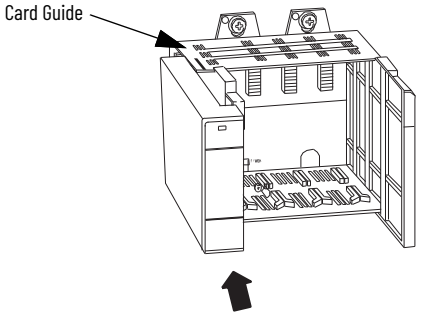
Each redundant power supply requires four #10 Phillips screws for installation. Eight #10 Phillips screws are required to install two redundant power supplies.

Install the Chassis

IMPORTANT Install the chassis in the enclosure and make sure that you follow the minimum spacing requirements.
See the ControlLogix Chassis Installation Instructions, publication 1756-IN621 for more information.

Install the Chassis Adapter

1. Align the circuit board of the 1756-PSCA2 or 1756-PSCA2XT chassis adapter with the card guides on the left side of the chassis.
2. Slide the adapter back until it's flush with the front of the chassis.



Install the Redundant Power Supplies

IMPORTANT Install the redundant power supplies in the enclosure and make sure that you follow the minimum spacing requirements.
See the ControlLogix Chassis Installation Instructions, publication 1756-IN621, for more information.

Follow these steps to install your redundant power supplies.

1. Drill holes in the back panel of the enclosure for the redundant power supply.

ATTENTION: Do not drill holes for a redundant power supply above installed equipment. Metal chips from drilling can damage the backplane and cause intermittent operation.

2. Insert the #10 Phillips screws into the top mounting holes, but do not tighten completely.
3. Slide the redundant power supply over the installed screws and tighten the screws.
4. Insert the bottom screws and tighten them.
5. Repeat these steps for additional power supplies.

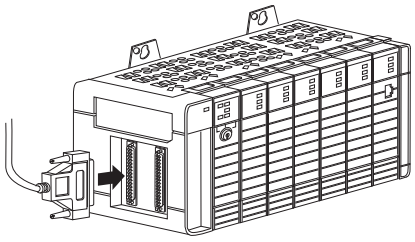
Connect the Power Supply to the Chassis

WARNING: If you connect or disconnect the 1756-CPR2 cables while either backplane power source is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Repeated electric arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.
Be sure that power is removed or the area is nonhazardous before proceeding.

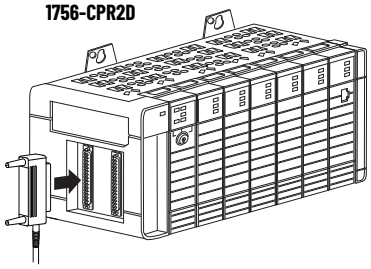
Use the 1756-CPR2, 1756-CPR2D, or 1756-CPR2U cable to connect your redundant power supply to the 1756-PSCA2 or 1756-PSCA2XT chassis adapter.

1. Connect the male end of the power cable to the chassis adapter.

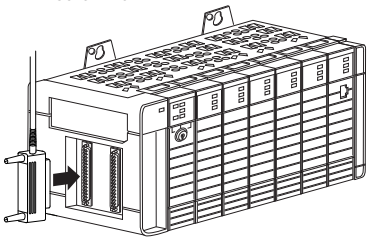
1756-CPR2



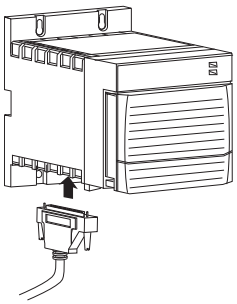
1756-CPR2D



1756-CPR2U



2. Connect the female end of the power cable to the redundant power supply.



3. Tighten the screws securely to hold the cable in place for the life of the product.
4. Repeat these steps with the second redundant power supply.

Connect the Line Power to the Power Supply

WARNING: If you connect or disconnect wiring while the field-side power is on, an electric arc can occur. This can cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

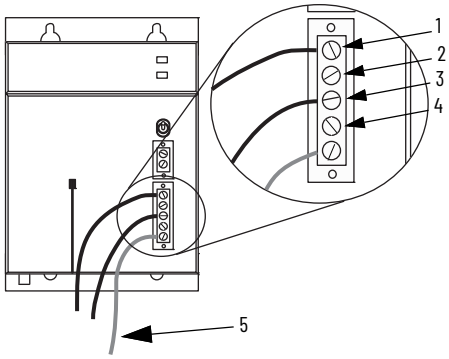
ATTENTION: Do not wire more than one conductor on any single terminal.
Use a 15 A time-delay type fuse in all ungrounded power connections.

Use 2.5 mm^2 (14 AWG) solid or stranded-copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation maximum to connect power.

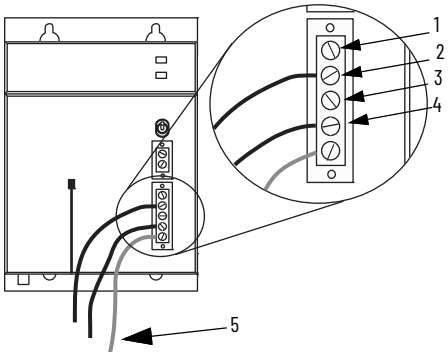
1. Connect the power as shown in this figure.
2. Tighten the terminals to a torque of 0.565 N•m (5 lb•in).

IMPORTANT The voltage input connections of the power supplies are auto-sensing.
Do not use a jumper, for example, a 120/240V AC jumper, when connecting external power to the power supply.

1756-PA75R (AC)



1756-PB75R (DC)



Item	Description, 1756-PA75R (AC)	Description, 1756-PB75R (DC)
1	L1 (high side of line power)	Not used
2	Not used	DC+ (positive supply)
3	L2 (low side of line power)	Not used
4	Not used	DC- (negative supply return)
5	Protective Earth. Attach to chassis ground lug or ground bus. See the ControlLogix Chassis Installation Instructions, publication 1756-IN621, for details.	

Connect the Solid-state Relay

A solid-state relay on your redundant power supplies can be connected to any compatible monitoring or signaling device. This connection indicates if the supplies are functioning properly.

The relays are closed during standard operation. The solid-state relay contacts open if one of these events occurs:

- One or more of the supplies fail.
- In this case, the contact opens on the failed supply (or supplies), and the input module alerts you to the failure through the controller program.
- The connected redundant power supplies are turned OFF.

When you use the solid-state relay annunciator function, connect a compatible source voltage to a contact terminal. Then connect the other terminal to the monitoring or signaling device.

ATTENTION: Annunciator cable length must be less than 10 m (32.8 ft).
The annunciator output is rated only for resistive loads. Do not use it to drive the coil of an electromagnetic relay.

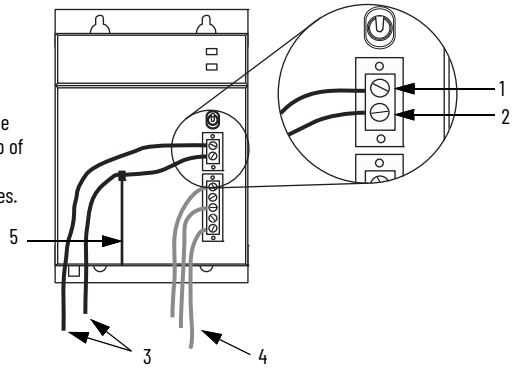
Connect the solid-state relay as shown in this figure.

Solid-state Relay Connection

Configuration 1

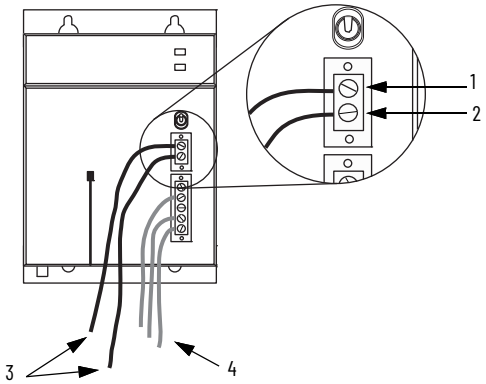
Routing of annunciator cable when annunciator voltage and power supply input voltage are **different**.

The annunciator wiring must be tucked under the tab at the top of the plastic barrier and routed separately from the power wires.



Configuration 2

Routing of annunciator cable when annunciator voltage and power supply input voltage are the **same**.

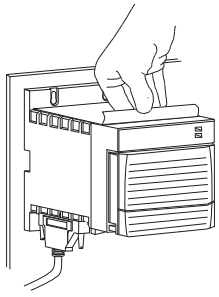


Item	Description
1	Source voltage terminal
2	Annunciator to input module terminal
3	Annunciator wiring, 0.25…2.5 mm^2 (22…14 AWG) solid or stranded-copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max
4	Power supply input wiring
5	Plastic barrier

Remove the Protective Label

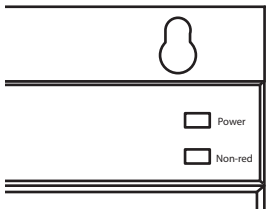
ATTENTION: Make sure that the power supply is mounted and all panel fabrication is complete before you remove the protective label. This label protects the power supply from metal shavings falling inside the power supply and damaging it during operation.

Remove the protective label from the top of the power supply.



Troubleshoot the Redundant Power Supplies

The redundant power supplies have a green status indicator for power and a yellow status indicator for non-redundancy.



This table describes how to use the status indicators to troubleshoot your redundant power supplies.

Status Indicators

Power Indicator	Non-red Indicator	Description	Take This Action
Steady green	Off	The power supplies are operating properly.	None
Steady green	Steady yellow	This power supply is operating properly, but is the only power supply providing power to the chassis adapter.	Check the other power supply.
Off	Steady yellow	All possible connections are made, but the power supply is turned off.	Turn the power supply ON. If the power supply does not turn ON, follow these steps. 1. Remove the input power from the power supply. 2. Wait 30 seconds. 3. Reconnect the input power. 4. Turn the power supply ON. If the power supply still does not turn ON, it can require replacement.
Off	Off	Any of the following conditions can apply:	Take the corresponding action:
		• The supply is turned OFF.	• Turn the power supply ON.
		• Line voltage isn't within the specified range.	• Verify that line power is in the specified range. If the indicators remain OFF, cycle power.
		• All connections are made, but input power isn't supplied.	• Verify that input power is supplied and turn the power supply ON.
		• All connections are made, including input power, but the output cable (1756-CPR2) isn't connected.	• Connect the output cable and turn the power supply ON.
		• The power supply is ON but defective.	• The power supply can require replacement.

Chassis Adapter Status Indicator

The chassis adapter has a green power status indicator. When the status indicator is steady green, the chassis is receiving power from the redundant power supplies. If the indicator is off, the chassis isn't receiving power from the redundant power supplies. See the previous table to troubleshoot the redundant power supplies.

Remove or Replace a Redundant Power Supply

WARNING: Removal or replacement of a power supply in a hazardous area can cause an electric arc across the contacts if backplane power is still applied. Remove or replace power supplies only when backplane and power supply power are removed or the area is known to be nonhazardous.

IMPORTANT You can replace one redundant power supply while the other supply is operating in non-redundant mode without any effect on chassis operation. If you must only replace a redundant power supply cable, we recommend that you do this replacement when the conditions permit the removal of all system power.

Remove a Redundant Power Supply

Follow these steps to remove the redundant power supply.

1. Turn the redundant power supply OFF.
2. Disconnect the line power source voltage from the redundant power supply and annunciator.
3. Remove the wiring terminal blocks.
4. Unscrew and disconnect the 1756-CPR2, 1756-CPR2D, or 1756-CPR2U cable at the power supply.
5. Remove the bottom mounting screws.
6. Loosen the top mounting screws and slide the supply up and off the mounting screws.

Replace a Redundant Power Supply

Follow these steps to replace a redundant power supply.

1. Slide the redundant power supply over the top mounting screws and tighten them.
2. Install the bottom mounting screws.
3. Reconnect the 1756-CPR2, 1756-CPR2D, or 1756-CPR2U cable at the power supply.
4. Install the wiring terminal blocks.
5. Connect the line power source voltage to the redundant power supply and annunciator.
6. Turn the redundant power supply ON.

   When you turn ON the replacement redundant power supply, the connected chassis automatically draws power from the redundant power supplies.

Remove or Replace a Chassis Adapter

Use this information to remove or replace a chassis adapter.

Remove a Chassis Adapter

Follow these steps to remove a chassis adapter.

1. Turn the redundant power supplies OFF.
2. Disconnect the power cable at the chassis adapter.
3. Push the top and bottom locking tabs on the chassis adapter to the side and pull the module off the chassis.

Replace a Chassis Adapter

1. Align the circuit board of the adapter with the card guides on the left side of the chassis.
2. Slide the adapter back until it's flush with the front of the chassis.

Specifications

Attribute	1756-PSCA2 1756-PSCA2K	1756-PSCA2XT	1756-PAXTR	1756-PBXTR	1756-PA75R 1756-PA75RK	1756-PB75R 1756-PB75RK
Voltage and current ratings Input	N/A	N/A	120/240V AC, 50/60 Hz, 75VA, 65 W	24V DC, 81 W	120/240V AC, 50/60 Hz, 120VA, 115 W	24V DC, 110 W
Output (current capacity)	2.8 A, 24V DC; 15.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC	2.8 A, 24V DC; 15.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC	1.75 A, 24V DC; 8.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC; 42 W max, 20 A inrush max	2.1 A, 24V DC; 10.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC; 52 W max, 30 A inrush max	2.8 A, 24V DC; 13.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC; 75 W max, 20 A inrush max	2.8 A, 24V DC; 13.0 A, 5.1V DC; 4.0 A, 3.3V DC; 1.5 A, 1.2V DC; 75 W max, 20 A inrush max
Annunciator	N/A	N/A	240V AC 50/60 HZ, 240V DC, 50 mA, resistive only	240V AC 50/60 HZ, 240V DC, 50 mA, resistive only 90V DC for ATEX/IECEx	240V AC 50/60 HZ, 240V DC, 50 mA, resistive only	240V AC 50/60 HZ, 240V DC, 50 mA, resistive only 90V DC for ATEX/IECEx
Isolation voltage	N/A		250V (continuous), Reinforced Insulation Type, Power Input to Backplane, Power Input to Annunciator, Annunciator to Backplane			
All supply frequencies or frequency ranges, if AC supply is used	N/A		47...63 Hz	N/A	47...63 Hz	N/A
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ +60 °C (32 °F ≤ Ta ≤ +140 °F)	-25 °C ≤ Ta ≤ +70 °C (-13°F ≤ Ta ≤ +158 °F)			0 °C ≤ Ta ≤ +60 °C (32 °F ≤ Ta ≤ +140 °F)	
Temperature, surrounding air, max	60 °C (140 °F)	70 °C (158 °F)			60 °C (140 °F)	
Enclosure type rating	None (open-style)					
Torque	N/A		0.565 N•m (5 lb•in)			
Wire size	N/A		Power: 2.5 mm^2 (14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Annunciator: 0.25...2.5 mm^2 (22...14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max			
Protective earth ground	N/A		2.5 mm^2 (14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater			
Pilot duty rating	N/A		Annunciator: Not Rated			
North American temperature code	T5	T4A			T3C	T4
ATEX temperature code	T4		-	T4	-	T4
IECEx temperature code	T4		-	T4	-	T4

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix Communication Modules Specifications Technical Data, publication 1756-TD003	Describes Ethernet communication module specifications.
ControlLogix Chassis Installation Instructions, publication 1756-IN621	Provides information on installing ControlLogix chassis.
ControlLogix System User Manual, publication 1756-UM001	Provides instructions for installation and use of ControlLogix Systems, application design, and other general information for these systems.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Technical Data

Original Instructions

ControlLogix and GuardLogix Controllers

Bulletin 1756

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ControlLogix 5570 Controllers	8
Controller Compatibility	43
ControlLogix Controller Accessories	48

Catalog Numbers

This publication is applicable to these controllers and modules.

ControlLogix Standard Controller Catalog Numbers:	1756-L61, 1756-L62, 1756-L63, 1756-L63XT, 1756-L64, 1756-L65, 1756-L71, 1756-L72, 1756-L73, 1756-L74, 1756-L75, 1756-L81E, 1756-L82E, 1756-L83E, 1756-L84E, 1756-L85E
ControlLogix Conformal Coated Catalog Numbers:	1756-L71K, 1756-L72K, 1756-L73K, 1756-L74K, 1756-L75K, 1756-L81EK, 1756-L82EK, 1756-L83EK, 1756-L84EK, 1756-L85EK
No Stored Energy (NSE) Catalog Numbers:	1756-L81E-NSE, 1756-L82E-NSE, 1756-L83E-NSE, 1756-L84E-NSE, 1756-L85E-NSE
ControlLogix-XT Catalog Numbers:	1756-L73XT, 1756-L81EXT, 1756-L82EXT, 1756-L83EXT, 1756-L84EXT, 1756-L85EXT
Process Catalog Numbers:	1756-L81EP, 1756-L83EP, 1756-L85EP
GuardLogix Controller Catalog Numbers:	1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP, 1756-L71S, 1756-L72S, 1756-L73S, 1756-L7SP, 1756-L73SXT, 1756-L7SPXT, 1756-L81ES, 1756-L82ES, 1756-L83ES, 1756-L84ES, 1756-L8SP
GuardLogix Conformal Coated Catalog Numbers:	1756-L71SK, 1756-L72SK, 1756-L73SK, 1756-L7SPK, 1756-L81ESK, 1756-L82ESK, 1756-L83ESK, 1756-L84ESK, 1756-L8SPK
GuardLogix XT 5580 Catalog Numbers:	1756-L81EXTS, 1756-L82EXTS, 1756-L83EXTS, 1756-L84EXTS, 1756-L8XTSP
Armor™ ControlLogix Catalog Numbers:	1756-L72EROM, 1756-L73EROM
Armor™ GuardLogix® Catalog Numbers:	1756-L72EROMS, 1756-L73EROMS
ControlLogix Redundancy Modules Catalog Numbers:	1756-RM2, 1756-RM2K, 1756-RM2XT

ControlLogix Controllers

The ControlLogix® controller provides a scalable controller solution that is capable of addressing many I/O points. You can place the ControlLogix controller into any slot of a ControlLogix I/O chassis, and install multiple controllers in the same chassis.

ControlLogix controllers can monitor and control I/O across the ControlLogix backplane, and over network links. The ControlLogix 5580 controllers have an embedded Ethernet port for a direct connection to Ethernet-enabled devices and networks, and also support communication interface modules in the local chassis. To provide communication for ControlLogix 5570 or ControlLogix 5560 controllers, install the appropriate communication interface module into the local chassis.

The ControlLogix 5580 No Stored Energy (NSE) controllers are intended for use in applications that require the installed controller to deplete its residual stored energy to specific levels before transporting it into or out of your application.

These ControlLogix controllers have a conformal coating that adds a layer of protection when exposed to harsh, corrosive environments:

- ControlLogix 5580 Standard controllers with a 'K' in the catalog number, ControlLogix NSE controllers, ControlLogix-XT™ controllers, and ControlLogix Process controllers.
- GuardLogix® 5580 controllers with a 'K' or 'XT' in the catalog number.
- ControlLogix 5570 and GuardLogix 5570 controllers with a 'K' or 'XT' in the catalog number.

ATTENTION: ControlLogix 5580 and 5570 conformal coated products are shipped with port protection plugs installed to provide a layer of protection from corrosive environments. In order to meet the corrosive atmospheres. Port plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating. If temporary access is required, plugs can be removed, and should be reinserted after temporary access is complete.

ControlLogix 5570 Controllers

ControlLogix 5570 Controllers Features

Feature	1756-L71, 1756-L71K, 1756-L72, 1756-L72K, 1756-L73, 1756-L73K, 1756-L74, 1756-L74K, 1756-L75, 1756-L75K
Controller tasks	• 32 tasks, including a combination of continuous (1), periodic, and event tasks • 32 programs/tasks prior to RSLogix 5000® programming software, version 15.01.00 • 100 programs/task beginning with RSLogix 5000 programming software, version 15.01.00 • 1000 programs/task beginning with Logix Designer application, version 24.00.00
Built-in communication ports	1-port USB(1)
Communication options	• EtherNet/IP • ControlNet • DeviceNet • Data Highway Plus • Remote I/O • SERCOS • Third-party process and device networks
USB port communication	Programming, configuration, firmware update, and online edits only
Controller connections supported max(2)	500
Network connections, per network module	• 528 EtherNet/IP; 512 TCP (1756-EN4TR) • 256 EtherNet/IP; 128 TCP (1756-EN2x) • 128 EtherNet/IP; 64 TCP (1756-ENBT) • 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB/D, 1756-CNB/E) • 128 ControlNet (1756-CN2/B)
Controller redundancy	Full support
Integrated motion	• SERCOS interface • Analog options (encoder input, LDT input, SSI input) • Integrated Motion on the EtherNet/IP network
Programming languages	• Relay ladder logic • Structured text • Function Block Diagram • Sequential function chart (SFC)

(1) The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.
(2) ControlLogix 5570 controllers use connections to establish communication links between devices. For more information on how to use and calculate connections, see the ControlLogix System User Manual, publication 1756-UM001.

Technical Specifications - ControlLogix 5570 Controllers

Attribute	1756-L71, 1756-L71K	1756-L72, 1756-L72K	1756-L73, 1756-L73K	1756-L74, 1756-L74K	1756-L75, 1756-L75K
User memory	2 MB	4 MB	8 MB	16 MB	32 MB
I/O memory	0.98 MB				
Optional nonvolatile memory storage	1 GB (1784-SD1 ships with every controller) 2 GB (1784-SD2)				
Digital I/O max	128,000				
Analog I/O max	4000				
Total I/O max	128,000				
Energy storage module	• 1756-ESMCAP, 1756-ESMCAPK capacitor energy storage module (removable, ships installed with every controller) • 1756-ESMNSE, 1756-ESMNSEK capacitor energy storage module (removable, no residual WallClockTime power backup) • 1756-ESMNRM, 1756-ESMNRMK capacitor energy storage module (nonremovable, helps prevent USB connection and SD card use to help secure the controller)				
Current draw @ 1.2V DC	5 mA				
Current draw @ 5.1V DC	800 mA				
Power dissipation	2.5 W				
Thermal dissipation	8.5 BTU/hr				
Isolation voltage	30V (continuous), basic insulation type, USB port-to-system Compliant and tested according to IEC/UL 61010-1				
USB port(1)	USB 2.0, full speed (12 Mbps)				
Weight approx	0.25 kg (0.55 lb)				
Slot width	1				
Module location	Chassis-based, any slot				

Technical Specifications - ControlLogix 5570 Controllers (Continued)

Attribute	1756-L71, 1756-L71K	1756-L72, 1756-L72K	1756-L73, 1756-L73K	1756-L74, 1756-L74K	1756-L75, 1756-L75K
Chassis	1756-A4, 1756-A4K, 1756-A7, 1756-A7K, 1756-A10, 1756-A10K, 1756-A13, 1756-A13K, 1756-A17, 1756-A17K				
Power supply, standard	1756-PA50, 1756-PA72, 1756-PA72K, 1756-PA75, 1756-PA75K, 1756-PB50, 1756-PB72, 1756-PB72K, 1756-PB75, 1756-PB75K, 1756-PH75				
Power supply, redundant	1756-PA75R, 1756-PA75RK, 1756-PB75R, 1756-PB75RK, 1756-PSCA2, 1756-PSCA2K				
Wire category(2)	3 - on USB port				
North American temperature code	T4A				
ATEX temperature code	T4				
IECEx temperature code	T4				
Enclosure type rating	None (open-style)				

(1) The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.
(2) Use this conductor category information to plan conductor routing. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications - ControlLogix 5570 Controllers

Attribute	1756-L71, 1756-L71K, 1756-L72, 1756-L72K, 1756-L73, 1756-L73K, 1756-L74K, 1756-L74, 1756-L75, 1756-L75K
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ +60 °C (+32 °F ≤ Ta ≤ +140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)
Temperature, surrounding air max	60 °C (140 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing
Corrosive Atmosphere(1) (2) • ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX(3) per IEC 60721-3-3:2019, Chemically Active Substances
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g (45 g with SD card installed)
Emissions	IEC 61000-6-4
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz
Conducted RF Immunity IEC 61000-4-6	Not applicable: USB is a temporary programming port.

(1) Only applicable to modules that end with a 'K'.
(2) Port Plugs must remain installed in unused ports at all times during storage and operation for the product to meet it's corrosive atmosphere rating.
(3) Up to 9.6 microns per year, corrosion rate of copper.

Certifications - ControlLogix 5570 Controllers

Certification[1]	1756-L71, 1756-L71K, 1756-L72, 1756-L72K, 1756-L73, 1756-L73K, 1756-L74, 1756-L74K, 1756-L75, 1756-L75K
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CE	European Union 2014/30/EU EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
RCM	Australian Radiocommunications Act, compliant with EN 61000-6-4; Industrial Emissions
Ex	European Union 2014/34/EU ATEX Directive, compliant with: EN 60079-0; General Requirements EN 60079-7; Potentially Explosive Atmospheres, Protection “e” II 3 G Ex ec IIC T4 Gc UL 22 ATEX 2817X
IECEx	IECEx System, compliant with: IEC 60079-7; Potentially Explosive Atmospheres, Protection “e” IEC 60079-0; General Requirements II 3 G Ex ec IIC T4 Gc IECEx UL 22.0062X
UKEx	In conformity with the following UKEx Statutory Instruments and their amendments: • Schedule 1 of the UKEx Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2601X • Zone 2 classification according to UKEx Regulation 2016 No. 1107
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres • Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with Article 58-2 of Radio Waves Act, Clause 3
CCC	CCC 2020122309111830, 202012230911998, 2020122309113868 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation

(1) When marked. See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

Controller Compatibility

The following tables provide compatibility with I/O modules, display devices, and other controllers and communication devices.

Control Distributed I/O Modules

The controller can control these distributed I/O modules via the I/O Configuration tree in the programming software.

I/O Modules	EtherNet/IP	ControlNet	DeviceNet	Remote I/O
Chassis-based I/O				
1715 Redundant I/O	Yes	No	No	No
1746 SLC™ I/O	Yes	No	No	Yes
1756 ControlLogix I/O	Yes	Yes	No	Yes
1769 Compact I/O™	Yes	No	Yes	Yes(1)
1771 Universal I/O	No	Yes	No	Yes
In-cabinet I/O				
1734 POINT I/O™	Yes	Yes	Yes	No
1734D POINTBlock I/O	No	No	Yes	No
1790, 1790D, 1790P CompactBlock™ LDX I/O	No	No	Yes	No
1791D, 1791P, 1791R CompactBlock™ I/O	No	No	Yes	No
1794 FLEX™ I/O	Yes	Yes	Yes	Yes
1797 FLEX Ex™ I/O	No	Yes	No	No
5069 Compact 5000™ I/O (2)	Yes	No	No	No
5094 FLEX 5000® I/O(2)	Yes	No	No	No
On-Machine™ I/O				
1732 ArmorBlock® I/O	Yes	No	Yes	No
1738 ArmorPOINT® I/O	Yes	Yes	Yes	No
1792D ArmorBlock® MaXum™ I/O	No	No	Yes	No
1799 Embedded I/O	No	No	Yes	No

(1) With a third-party module.
(2) Compatible with ControlLogix 5580 controllers only.

Control Safety Distributed I/O Modules

The GuardLogix controller can control these safety distributed I/O modules in a safety system.

I/O Modules	EtherNet/IP	ControlNet	DeviceNet
In-cabinet I/O			
1791DS CompactBlock™ Guard I/O™	No	No	Yes
1791ES CompactBlock Guard I/O	Yes	No	No
1734 POINT Guard I/O™	Yes	No	Yes
5069 Compact 5000 Safety I/O(1)	Yes	No	No
5094 FLEX 5000 Safety I/O(1)	Yes	No	No
On-Machine™ I/O			
1732DS ArmorBlock® Guard I/O™	No	No	Yes
1732ES ArmorBlock Guard I/O	Yes	No	No

(1) Compatible with ControlLogix 5580 controllers only.

Communicate with Display Devices

The controller can communicate with these display devices.

Display Devices	EtherNet/IP	ControlNet	DeviceNet	DH+	Remote I/O	RS-232 (DF1)
Industrial Computers						
Allen-Bradley® industrial computers (all)(1)	Yes	Yes	Yes	Yes	Yes	Yes
Graphic Terminals						
PanelView™ Plus and PanelView e terminals	Yes	Yes	Yes	Yes	Yes	Yes
PanelView Standard terminals	Yes	Yes	Yes	Yes	Yes	Yes
PanelView e terminals	No	Yes	No	Yes	Yes	No
Message Displays						
InView™ message displays	Yes	Yes	Yes	Yes	Yes	Yes

(1) Includes Allen-Bradley integrated display rotating media (HDD) and solid state (SSD) computers, Rockwell Automation® non-display computers, and Allen-Bradley integrated display computers with keypad.

Communicate with Other Controllers

The controller can communicate with these programmable controllers.

Controller	EtherNet/IP	ControlNet	DeviceNet	DH+™	RS-232 (DF1)	DH-485[1]
1756 ControlLogix 1756 GuardLogix	Yes	Yes	Yes	Yes	Yes	Yes
5069 CompactLogix™ 5069 Compact GuardLogix	Yes	No	No	No	No	No
1768, 1769 CompactLogix 1768, 1769 Compact GuardLogix	Yes	Yes	Yes	No	Yes	Yes
1789 SoftLogix™ 5800	Yes	Yes	Yes	No	Yes	No
1794 FlexLogix™	Yes	Yes	Yes	No	Yes	Yes
PowerFlex® with DriveLogix™	Yes	Yes	Yes	No	Yes	Yes
1785 PLC-5®[2][3][4]	Yes	Yes	Yes	Yes	Yes	No
1747 SLC™[5]	Yes	Yes	Yes	Yes	Yes	Yes
1761 MicroLogix™[5]	Yes	No	Yes	No	Yes	Yes
1762 MicroLogix[5]	Yes	No	Yes	No	Yes	Yes
1763 MicroLogix[5]	Yes	No	Yes	No	Yes	Yes
1764 MicroLogix[5]	Yes	No	Yes	No	Yes	Yes
1772 PLC-2®	No	No	No	Yes	Yes	No
1775 PLC-3®	No	No	No	Yes	Yes	No
5250 PLC-5/250	No	No	No	Yes	Yes	No

(1) The 1756-DH485 module supports full DH-485 functionality.
(2) The Ethernet PLC-5 controller must be series C, firmware revision N.1 or later; series D, firmware revision E.1 or later; or series E, firmware revision D.1 or later.
(3) The 1785-ENET Ethernet communication interface module must be series A, firmware revision D or later.
(4) The PLC-5, SLC, and MicroLogix processors appear as I/O points to the Logix controller. Use the appropriate DeviceNet interface for the controller.
(5) Use a 1747-L55x controller with OS501 or later.

Communicate with Other Communication Devices

The controller can communicate with these communication devices.

Communication Device	EtherNet/IP	ControlNet	DeviceNet	DH+
Linking device	–	1788-CN2DN 1788-CN2FF	1788-EN2DNR 1788-EN2DNROM (on-machine version) 1788-CN2DN	–
PCMCIA card	–	1784-PCC	1784-PCD	1784-PCMK
PCI card	–	1784-PCIC 1784-PCICS	1784-PCID 1784-PCIDS 1784-CPCIDS	–
Drives SCANport™ module[1]	1203-EN1 1203-CN1	1203-FM1 1203-FB1	–	–
Communication module[2]	–	1770-KFC15 1770-KFCD15 1747-KFC15	1770-KFD 1770-KFG	1770-KF2
Communication card	–	1784-PKTCS 1784-KTCS 1784-KTCX15	1784-PKTX 1784-PKTXD	–
USB communication device	–	1784-U2CN	1784-U2DN	1784-U2DHP

(1) Use a CIP™ generic MSG instruction to communicate with the 1203-FM1 SCANport™ module on a DIN rail that is remote to the controller. The remote DIN rail also requires a 1794-ACN15 or 1794-ACNR15 ControlNet adapter.
(2) Use the generic module configuration to configure the 1203-CN1 module and a CIP generic MSG instruction to communicate with the module.

ControlLogix Controller Accessories

You can use these accessories with ControlLogix controllers.

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Memory Cards

Memory cards offer nonvolatile memory to store a user program and tag data on a controller.

- The ControlLogix 5560 controllers support optional 1784-CF128 CompactFlash cards purchased separately.
- The ControlLogix 5570 controllers come with the 1784-SD1 Secure Digital (SD) card installed and support optional 1784-SD2 cards purchased separately.
- The ControlLogix 5580 controllers come with the 1784-SD2 Secure Digital (SD) card installed and support optional 1784-SDHC8 and 1785-SDHC32 cards purchased separately.

The memory cards are installed in a socket on the controller. Through the programming software, you can manually trigger the controller to save to, or load from, nonvolatile memory or configure the controller to load from nonvolatile memory on powerup.

Technical Specifications - 1784 Memory Cards

Attribute	1784-CF128	1784-SD1	1784-SD2	1784-SDHC8	1784-SDHC32
Memory	128 MB	1 GB	2 GB	8 GB	32 GB
Supported controllers	1756-L6, 1756-L6S(1)	1756-L71, 1756-L71K, 1756-L71S, 1756-L71SK, 1756-L72, 1756-L72K, 1756-L72S, 1756-L72SK,1756-L72EROM, 1756-L72EROMS, 1756-L73, 1756-L73K, 1756-L73S, 1756-L73SK, 1756-L73EROM, 1756-L73EROMS, 1756-L73XT, 1756-L73SXT, 1756-L74, 1756-L74K, 1756-L75, 1756-L75K		—	
		1756-L81E, 1756-L81EK, 1756-L81ES, 1756-L81ESK,1756-L82E, 1756-L82EK, 1756-L82ES, 1756-L82ESK, 1756-L83E, 1756-L83EK, 1756-L83ES, 1756-L83ESK, 1756-L84E, 1756-L84EK, 1756-L84ES, 1756-L84ESK, 1756-L85E, 1756-L85EK			
Weight, approx	14.20 g (0.50 oz)	1.76 g (0.06 oz)			

(1) For safety controllers using RSLogix 5000 programming software version 18 or later.

Environmental Specifications - 1784 Memory Cards

Attribute	1784-CF128, 1784-SD1, 1784-SD2, 1784-SDHC8, 1784-SDHC32
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25...+70 °C (-13...+158 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions CISPR 11	Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz

Certifications - 1784 Memory Cards

Certification(1)	1784-CF128, 1784-SD1, 1784-SD2, 1784-SDHC8, 1784-SDHC32
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61000-6-4; Industrial Emissions • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
RCM	Australian Radiocommunications Act, compliant with EN 61000-6-4; Industrial Emissions
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with Article 58-2 of Radio Waves Act, Clause 3

(1) See the Product Certification website at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

1756 ControlLogix Batteries

Each ControlLogix 5560 controller ships with a battery. The ControlLogix 5560 controllers have nonvolatile memory if you install a 1784-CF128 industrial CompactFlash card. With nonvolatile memory, the controller can be used without a battery. If you do not use a battery, current tag data remains in the state it was when the nonvolatile memory was saved. This table summarizes battery life, replacement battery compatibility, and recommendations for use of an externally-mounted battery assembly.

Technical Specifications - 1756 ControlLogix Batteries (1)

Attribute	1756-BA1	1756-BA2	1756-BATM(2)	1756-BATA
Description	Lithium battery (0.59 g)	Lithium battery (0.59 g)	Externally mounted battery assembly	Replacement lithium battery for 1756-BATM (5 g max lithium per each D cell; contains 2 D cells)
ControlLogix controllers	1756-L61, 1756-L62, 1756-L63 controllers, series A	1756-L61, 1756-L62, 1756-L63 controllers, series B 1756-L64, 1756-L65 controllers	1756-L61, 1756-L62, 1756-L63 controllers, series A	1756-BATM battery module
GuardLogix controllers	–	1756-L61S, 1756-L62S, 1756-L63S	–	–
Supported legacy controllers	1756-L55M controllers(3) 1756-L60M03SE controller	–	1756-L55M controllers(2) 1756-L60M03SE controller	1756-BATM battery module

(1) To ship lithium batteries globally, there can be specific restrictions and special packaging requirements. Contact the shipping company for packaging and shipping guidelines and restrictions.
(2) The 1756-BATM externally mounted battery assembly is recommended for use with all 1756-L55x controllers, and is highly recommended for use with all series A 1756-L6x controllers, and provides longer battery life than the 1756-BA1 battery. The 1756-BATM assembly includes one 1756-BATA lithium battery assembly and a 1 m (3.28 ft) cable to connect housing to the controller.
(3) The 1756-L55M22, 1756-L55M23, and 1756-L55M24 controllers have nonvolatile memory and can be used without a battery.

Serial Communication Cables

The 1756-L6 and 1756-L6S controllers have a built-in serial port.

Technical Specifications - 1756 Serial Cables

Attribute	1756-CP3	1747-CP3
Connector type	Female 9-pin D-shell	
Connector angle	Right-angle connector to controller, straight to serial port	
Length	3 m (9.84 ft)	

Ethernet and USB Port Protection Plugs

These controllers are shipped with port protection plugs installed to provide a layer of protection from corrosive atmospheres:

ControlLogix 5580 Catalog Numbers:	1756-L81EK, 1756-L82EK, 1756-L83EK, 1756-L84EK, 1756-L85EK 1756-L81E-NSE, 1756-L82E-NSE, 1756-L83E-NSE, 1756-L84E-NSE, 1756-L85E-NSE 1756-L81EXT, 1756-L82EXT, 1756-L83EXT, 1756-L84EXT, 1756-L85EXT 1756-L81EP, 1756-L83EP, 1756-L85EP
GuardLogix 5580 Catalog Numbers:	1756-L81ESK, 1756-L82ESK, 1756-L83ESK, 1756-L84ESK, 1756-L8SPK 1756-L81EXTS, 1756-L82EXTS, 1756-L83EXTS, 1756-L84EXTS, 1756-L8XTSP
ControlLogix 5570 Catalog Numbers:	1756-L71K, 1756-L72K, 1756-L73K, 1756-L74K, 1756-L75K 1756-L73XT
GuardLogix 5570 Catalog Numbers:	1756-L71SK, 1756-L72SK, 1756-L73SK, 1756-L7SPK 1756-L73SXT, 1756-L7SPXT

You can order replacement plugs directly from the distributor.

Rockwell Automation Part Number	Description	Supplier	Supplier Part Number	Distributor
PN-579024	Plug for Ethernet Port	Würth Elektronik	726154101	Digi-Key: 726154101
PN-579028	Plug for USB Port	Essentra Components	CP-USB-B-429(1)	Essentra Components: CP-USB-B-429

(1) The USB port plug must be part number **CP-USB-B-429** (material: Ethylene Propylene Diene Monomer). Do not order part number CP-USB-B, as it is made of silicone rubber.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

ControlLogix 5570 Controllers

Catalog Numbers 1756-ESMCAP, 1756-ESMCAPK, 1756-ESMCAPXT, 1756-ESMNRM, 1756-ESMNRMK, 1756-ESMNRMXT, 1756-ESMNSE, 1756-ESMNSEK, 1756-ESMNSEXT, 1756-L71, 1756-L71K, 1756-L72, 1756-L72K, 1756-L73, 1756-L73K, 1756-L73XT, 1756-L74, 1756-L74K, 1756-L75, 1756-L75K

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ControlLogix® 5570 Controllers provide a common control engine with a common development environment for all control disciplines.

- Supports Integrated Motion on EtherNet/IP™, integrated Sercos motion, and analog motion
- Supports full controller redundancy and Removal and Insertion Under Power (RIUP)
- Communicates via EtherNet/IP, ControlNet®, DeviceNet®, Data Highway Plus™, Remote I/O, SynchLink™, and third-party process and device networks
- Controllers with a 'K' in the catalog are conformal coated for extended protection in harsh, corrosive environments.
- ControlLogix-XT™ controllers are designed for temperature extremes.
- Offers chassis with up to 17 slots in standard, conformal coated, and extreme temperature versions

Summary of Changes

This manual contains new and updated information as indicated in the following table.

Topic	Page
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Rockwell Automation

ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

설치 , 조정 , 가동 , 사용 , 조립 , 분해 , 유지보수 등 모든 작업은 관련 규정에 따라 적절한 교육을 받은 사용자를 통해서만 수행해야 합니다 .

본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於 「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安装、調整、交付使用、使用、組裝、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

ATTENTION:
- Before installing, configuring, operating, or maintaining this product, read this document and the documents that are listed in the additional resources section for installing, configuring, or operating equipment. Users must familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice. In case of malfunction or damage, no attempts at repair must be made. The module must be returned to the manufacturer for repair. Do not dismantle the module.
- If this equipment is used in a manner that is not specified by the manufacturer, the protection that is provided by the equipment can be impaired.
- This equipment is certified for use only within the surrounding air temperature range of 0…60 °C (32…140 °F) [1756-L71, 1756-L72, 1756-L73, 1756-L74, 1756-L75, 1756-L71K, 1756-L72K, 1756-L73K, 1756-L74K, 1756-L75K, 1756-ESMCAP, 1756-ESMNSE, and 1756-ESMNRM modules] or -25…+70 °C (-13…+158 °F) [1756-L73XT, 1756-ESMCAPXT, 1756-ESMNRMXT, and 1756-ESMNSEXT modules]. The equipment must not be used outside of this range.
- Use only a soft dry anti-static cloth to wipe down equipment. Do not use any cleaning agents.
- The USB port is intended for temporary local programming purposes only and not intended for permanent connection.
- The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

Environment and Enclosure

ATTENTION:
This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in EN/IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts.

The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:
- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA Standard 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosures.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

UK and European Hazardous Location Approval

The following applies to products marked Ⓔx, II 3 G. Such modules:
- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection is <Ex ec IIC T4 Gc> Equipment protection by increased safety "e".
- Equipment protection by increased safety "e", reference certificate number UL22ATEX2817X and UL22UKEX2601X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

IEC Hazardous Location Approval

The following applies to products with IECEx certification.

- Such products are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection is <Ex ec IIC T4 Gc>.
- IECEx certificate number IECEx UL 22.0062X.

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an UKEX/ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage at the supply terminals to the equipment.
- The instructions in the user manual shall be observed.
- This equipment must be used only with UKEX/ATEX/IECEx certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

WARNING: When you connect or disconnect the battery, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.
For safety information on the handling of lithium batteries, including handling and disposal of leaking batteries, see Guidelines for Handling Lithium Batteries, publication AG-5.4.

Removal and Insertion Under Power (RIUP)

WARNING: When you insert or remove the energy storage module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electric arcing causes excessive wear to contacts on both the module and its mating connector.

IMPORTANT Any illustrations, charts, sample programs, and layout examples that are shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements that are associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use, based on the examples that are shown in this publication.

Energy Storage Module

This product may contain an Energy Storage Module (ESM).

WARNING: If your application requires an ESM to deplete its residual stored energy to 40 µJ or less before you add or remove it from the application, use the 1756-ESMNSE(XT) module as the primary controller and the 1756-SPESMNSE(XT) module as the safety partner, and complete these steps before moving the ESM:

1. Turn off power to the chassis.

   The OK status indicator on the chassis transitions from green to steady red to OFF.
2. Wait at least 20 minutes for the residual stored energy to decrease to 40 µJ or less before you move the ESM.

   There's no visual indication of when the 20 minutes have passed. You must track the time.

IMPORTANT The ESM begins charging when one of these actions occurs:

- The controller and ESM are installed into a powered chassis.
- Power is applied to the chassis that contains a controller with the ESM installed.
- An ESM is installed into a powered controller.
- After power is applied, the ESM charges for up to 2 minutes as indicated by CHRG or ESM Charging on the status display.

Insert the Controller Into the Chassis

ATTENTION: The ControlLogix 5570 controllers that are listed on page 1 of this document that end with a 'K' or 'XT' are shipped with port protection plugs installed to provide a layer of protection from corrosive atmospheres. Port plugs must remain installed in unused ports during storage and operation for the product to meet its corrosive atmosphere rating. If temporary access is required, plugs can be removed, then reinserted after temporary access is complete.

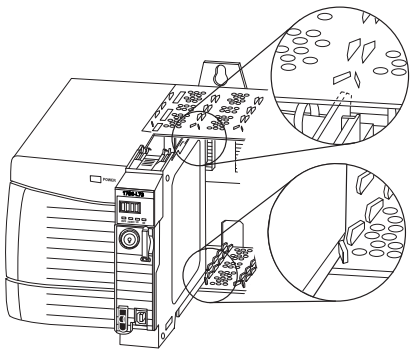
When installing a ControlLogix® controller, you can do the following:

- Place the controller in any slot.
- Use multiple controllers in the same chassis.

You can install or remove a ControlLogix controller while chassis power is on and the system is operating.

To insert the controller into the chassis, complete these steps.

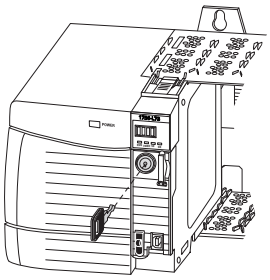
1. Align the circuit board with the top and bottom guides in the chassis.



2. Slide the module into the chassis until it snaps into place.
3. Verify that the controller is flush with the power supply or other modules.

Insert the Key

After the controller is installed, insert the key.

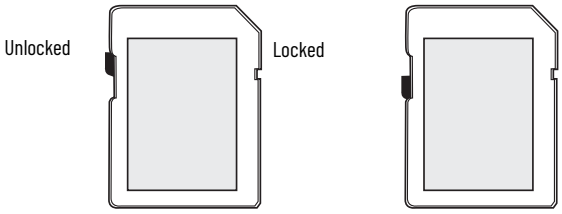


Install the SD Card

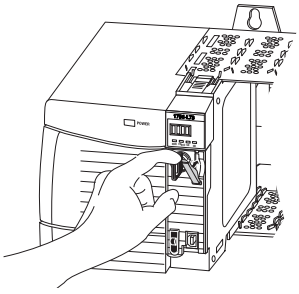
Complete these steps to install the SD card in the 1756-L7*x* controllers.

WARNING: When you insert or remove the Secure Digital (SD) memory card while power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

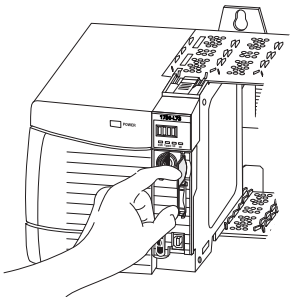
1. Verify that the SD card is locked or unlocked according to your preference.



2. Open the door for the SD card.



3. Insert the SD card into the SD card slot.
4. Gently press the card until it clicks into place.



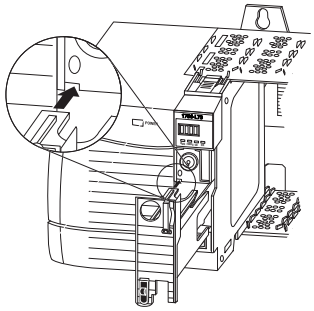
5. Close the SD card door.

Install the ESM

To install an ESM in the 1756-L7*x* controller, complete these steps.

ATTENTION: To avoid potential damage to the product when inserting the ESM, align it in the track and slide forward with minimal force until the ESM snaps into place.

1. Align the tongue-and-groove slots of the ESM and controller.



2. Slide the ESM back until it snaps into place.

   The ESM begins charging after installation. One of these status messages indicates charging status:

   - ESM Charging
   - CHRG

   After you install the ESM, it can take up to 15 seconds for the charge status messages to display.

ATTENTION: Allow the ESM to finish charging before removing power from the controllers. Failure to do so can result in the loss of the application program. A type 1, code 40 major fault is logged on power-up.
To verify that the ESM is fully charged, confirm that CHRG or ESM charging messages aren't indicated on the status display.

Specifications

Attribute	1756-L71, 1756-L71K, 1756-L72, 1756-L72K, 1756-L73, 1756-L73K, 1756-L74, 1756-L74K, 1756-L75, 1756-L75K
Input and current ratings	1.2V DC: 5 mA, 5.1V DC: 800 mA
Power dissipation	2.5 W
Thermal dissipation	8.5 BTU/hr
Temperature, operating • IEC 60068-2-1 (Test Ae, Operating Cold) • IEC 60068-2-2 (Test Be, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ +60 °C (+32 °F ≤ Ta ≤ +140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Corrosive Atmosphere[1] ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3[2] per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX[2][3] per IEC 60721-3-3:2019, Chemically Active Substances
Enclosure type rating	None (open-style)
Isolation voltage	30V (continuous), basic insulation, USB port to backplane
Temperature code	T4

(1) Only applicable to modules that end with a 'K' or 'XT'.
(2) Port Plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating.
(3) Up to 9.6 microns per year, corrosion rate of copper.

Attribute	1756-L73XT
Input and current ratings	1.2V DC: 5 mA, 5.1V DC: 800 mA
Power dissipation	2.5 W
Thermal dissipation	8.5 BTU/hr
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold) IEC 60068-2-2 (Test Be, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25°C ≤ Ta ≤ +70 °C (-13 °F ≤ Ta ≤ +158 °F)
Temperature, surrounding air, max	70 °C (158 °F)
Corrosive Atmosphere[1] ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3[2] per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX[2][3] per IEC 60721-3-3:2019, Chemically Active Substances
Enclosure type rating	None (open-style)
Isolation voltage	30V (continuous), basic insulation, USB port to backplane
Temperature code	T4

(1) Only applicable to modules that end with a 'K' or 'XT'.
(2) Port Plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating.
(3) Up to 9.6 microns per year, corrosion rate of copper.

Attribute	1756-ESMCAP, 1756-ESMNRM, 1756-ESMCAPK, 1756-ESMNRMK	1756-ESMNSE, 1756-ESMNSEK	1756-ESMCAPXT, 1756-ESMNRMXT	1756-ESMNSEXT
Input and current ratings	5.1V DC: 330 mA	5.1V DC: 300 mA	5.1V DC: 330 mA	5.1V DC: 300 mA
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold) IEC 60068-2-2 (Test Be, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ +60 °C (+32 °F ≤ Ta ≤ +140 °F)		-25°C ≤ Ta ≤ +70 °C (-13 °F≤ Ta ≤ +158 °F)	
Temperature, surrounding air, max	60 °C (140 °F)		70 °C (158 °F)	
Corrosive Atmosphere[1] ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3[2] per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX[2][3] per IEC 60721-3-3:2019, Chemically Active Substances			
Enclosure type rating	None (open-style)			
Temperature code	T4			

(1) Only applicable to modules that end with a 'K' or 'XT'.
(2) Port Plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating.
(3) Up to 9.6 microns per year, corrosion rate of copper.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix Controllers Specifications Technical Data, publication 1756-TD001	Contains technical specifications, environmental specifications, and certifications for ControlLogix controllers.
1756 ControlLogix Controllers User Manual, publication 1756-UM001	Describes how to configure and use ControlLogix controllers.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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ControlLogix 5570 and 5560 Controllers

Catalog Numbers 1756-L71, 1756-L72, 1756-L73, 1756-L73XT, 1756-L74, 1756-L75, 1756-L72EROM, 1756-L73EROM, 1756-L61, 1756-L62, 1756-L63, 1756-L63XT, 1756-L64, 1756-L65

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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Notes:

This publication provides this information:

- Design and planning considerations
- Installation procedures
- Configuration procedures
- Maintenance and troubleshooting methods

This publication is designed for use by anyone responsible for planning and implementing a ControlLogix® system:

- Application engineers
- Control engineers
- Instrumentation technicians

The contents of this publication are for anyone who already has an understanding of Logix 5000® control systems, programming techniques, and communication networks.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Removed Redundant Systems chapter and replaced with reference to the Redundancy Systems User Manual, publication 1756-UM015	11
Updated references to ControlLogix chassis and power supply installation instructions	13, 17, 31
Updated the number of programs per task for ControlLogix 5570 controllers	83
Added SD Card Unprotected message	175

ControlLogix Controllers

There are five types of ControlLogix controllers available. These types include the following:

- Standard ControlLogix controllers
- Extreme environment ControlLogix controllers
- Armor™ ControlLogix controllers
- Standard GuardLogix® controllers
- Armor GuardLogix controllers

This manual explains how to use standard, extreme environment, and Armor ControlLogix controllers.

For detailed information about GuardLogix and Armor GuardLogix safety controllers, see the following publications.

Resource	Description
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, and operate GuardLogix 5570 controllers in Studio 5000® projects, version 21 or later.
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Reference Manual, publication 1756-RM099	Provides information on how to meet safety application requirements for GuardLogix 5570 controllers in Studio 5000 projects, version 21 or later.
GuardLogix Controllers User Manual, publication 1756-UM020	Provides information on how to install, configure, and operate GuardLogix 5560 and GuardLogix 5570 controllers in RSLogix 5000® projects, version 20 or earlier.
GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093	Provides information on how to meet safety application requirements for GuardLogix 5560 and GuardLogix 5570 controllers in RSLogix 5000 projects, version 20 or earlier.
GuardLogix Safety Application Instruction Set Safety Reference Manual, publication 1756-RM095	Provides programmers with details about the GuardLogix safety application instruction set.

Standard ControlLogix Controllers

The following table describes ControlLogix 5560 and 5570 catalog numbers.

Table 1 - ControlLogix Catalog Numbers

Controller Family	Cat. No.
ControlLogix 5560	1756-L61, 1756-L62,1756-L63, 1756-L64,1756-L65
ControlLogix 5570	1756-L71, 1756-L72, 1756-L73,1756-L74, 1756-L75

The standard ControlLogix controllers share many similar features, but also have some differences. The following table provides an overview of the differences between the controllers. For further details about these features and differences, see the appropriate chapters of this manual.

Table 2 - Differences between ControlLogix 5570 and 5560 Controllers

Feature	ControlLogix 5570	ControlLogix 5560
Clock support and backup for memory retention at powerdown	Energy Storage Module (ESM)	Battery
Communication ports (built-in)	USB	Serial
Connections, controller	500	250
Memory, nonvolatile	Secure Digital (SD) card	CompactFlash card
Status display and status indicators	Scrolling status display and four status indicators	Six status indicators
Unconnected buffer defaults	20 (40, max)	10 (40, max)

For information on using ControlLogix controllers in SIL 2 applications, see the ControlLogix SIL 2 Applications Safety Reference Manual, publication 1756-RM001.

Redundant ControlLogix Controllers

Certain ControlLogix controllers are also supported for use in redundancy systems. For more information about controllers and redundancy systems, see the Redundancy Systems User Manual, publication 1756-UM015.

Extreme Environment ControlLogix Controllers

The extreme environment ControlLogix controllers, catalog numbers 1756-L73XT and 1756-L63XT, provide the same functionality as the 1756-L73 and 1756-L63 controllers, but are designed to withstand temperatures -25...+70 °C (-13...+158 °F).

Armor ControlLogix Controllers

The Armor ControlLogix controller combines a 1756-L72 or 1756-L73 ControlLogix controller with two EtherNet/IP™ DLR-capable 1756-EN3TR communication modules in an IP67-rated housing for mounting on a machine. For more information about the Armor ControlLogix controllers, catalog numbers 1756-L72EROM and 1756-L73EROM, refer to the Armor ControlLogix Controller Installation Instructions, publication 1756-IN061.

Though the 1756-L72EROM and 1756-L73EROM controllers have functionality identical to that of the 1756-L72 and 1756-L73 controllers, the Armor controller energy storage modules (ESM) cannot be removed or replaced.

Before You Begin

Before you begin using your ControlLogix controller, verify that you have the applications that are required to configure and program the controller.

Required Software

Use Table 3 to identify the minimum software versions that are required to use your ControlLogix controller.

Table 3 - Required Software for Controller Use

Cat. No.	Studio 5000 Environment	RSLogix 5000 Software	RSLinx® Classic
1756-L61/A	—	Version 12.06.00 or later	Any version
1756-L61/B	—	Version 13.04.00 or later	
1756-L62/A	—	Version 12.06.00 or later	
1756-L62/B	—	Version 13.04.00 or later	
1756-L63/A	—	• If not using a CompactFlash card, version 10.07.00 or later • If using a CompactFlash card, version 11.16.00 or later	
1756-L63/B	—	Version 13.04.00 or later	
1756-L63XT/B	—	Version 13.04.00 or later	Version 2.55.00 or later
1756-L64/B	—	Version 16.03.00 or later	Any version
1756-L65/B	—	Version 17.01.02 or later	
1756-L71	Version 21.00.00 or later	Version 20.01.02	Version 2.59.00 or later
1756-L72		Version 19.01.00 or later	Version 2.57.00 or later
1756-L73			
1756-L73XT			
1756-L74			
1756-L75			
1756-L72EROM			2.59.02 or later
1756-L73EROM			

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix and GuardLogix Controllers Technical Data, publication 1756-TD001	Provides specifications for ControlLogix and GuardLogix controllers.
1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002	Provides specifications for ControlLogix I/O modules.
ControlLogix 5570 Controllers Installation Instructions, publication 1756-IN088	Provides installation instructions for ControlLogix 5570 controllers.
Armor ControlLogix Controllers Installation Instructions, publication 1756-IN061	Provides information about how to install the Armor ControlLogix controllers.
ControlLogix Battery Module Installation Instructions, publication 1756-IN576	Provides information for battery module installation.
ControlLogix Chassis Installation Instructions, publication1756-IN621	Describes how to install and troubleshoot standard and ControlLogix-XT™ versions of the 1756 chassis.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Provides information on how to install ControlLogix standard power supplies.
ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620	Provides information on how to install ControlLogix redundant power supplies.
ControlLogix Analog I/O Modules User Manual, publication 1756-UM009	Provides information about analog I/O module configuration properties.
ControlLogix Configurable Flowmeter Module User Manual, publication 1756-UM010	Provides information about configurable flowmeter configuration properties.
ControlLogix Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514	Provides information about Data Highway Plus™ communication and remote I/O communication module configuration properties.
ControlLogix DH-485 Communication Module User Manual, publication 1756-UM532	Describes how to connect a 1756-DH485 module to a DH-485 network with multiple controllers.
ControlLogix Digital I/O Modules User Manual, publication 1756-UM058	Provides information about digital I/O module configuration properties.
ControlLogix HART Analog I/O Modules User Manual, publication 1756-UM533	Describes how to use HART analog I/O modules.
ControlLogix High-speed Analog I/O Module User Manual, publication 1756-UM005	Provides information about high-speed analog I/O module configuration properties.
ControlLogix High-speed Counter Module User Manual, publication 1756-UM007	Provides information about high-speed counter-module configuration properties.
ControlLogix Low-speed Counter Module User Manual, publication 1756-UM536	Provides information about low-speed counter-module configuration properties.
ControlLogix Peer I/O Control Application Technique, publication 1756-AT016	Describes typical peer control applications and provides details about how to configure I/O modules for peer control operation.
ControlLogix Programmable Limit Switch Module User Manual, publication 1756-UM002	Provides information about programmable limit switch configuration properties.
Redundancy Systems User Manual, publication 1756-UM015	Describes how to set up, configure, program, monitor, and troubleshoot Logix SIS, ControlLogix 5580, and ControlLogix 5570 redundancy systems.
ControlLogix Redundancy System User Manual, publication 1756-UM523	Provides information about ControlLogix standard redundancy systems.
ControlLogix Remote I/O Communication Module User Manual, publication 1756-UM534	Provides information for remote I/O network communication configuration.
ControlLogix SIL 2 System Configuration Using RSLogix 5000 Subroutines Application Technique, publication 1756-AT010	Provides information about ControlLogix SIL 2-certified fault-tolerant systems.
ControlLogix SIL 2 System Configuration Using SIL 2 Add-On Instructions Application Technique, publication 1756-AT012	Provides information about ControlLogix SIL 2-certified fault-tolerant systems.
ControlLogix System Selection Guide, publication 1756-SG001	Describes how to design and select components for your ControlLogix system.
ControlNet Network Configuration User Manual, publication CNET-UM001	Describes how to use ControlNet® modules.
DeviceNet Network Configuration User Manual, publication DNET-UM004	Provides information about DeviceNet® modules and devices.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Provides additional information about network design for your system.
EtherNet/IP and ControlNet to FOUNDATION Fieldbus Linking Device User Manual, publication 1788-UM057	Describes in detail how to use the available Foundation Fieldbus devices.
EtherNet/IP Network Configuration User Manual, publication ENET-UM001	Provides information about EtherNet/IP communication modules.
FOUNDATION Fieldbus Design Considerations Reference Manual, publication PROCES-RM005	Describes in detail how to use the available Foundation Fieldbus devices.

Resource	Description
Guidelines for Handling Lithium Batteries Technical Data, publication AG-5.4	Describes how to store, handle, transport, and dispose of lithium batteries.
Integrated Architecture and CIP Sync™ Configuration Application Technique, publication IA-AT003	Describes how to configure CIP Sync™ with Integrated Architecture® products and applications.
Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003	Details how to design your ControlLogix system for Integrated Motion on the EtherNet/IP network applications.
Logix 5000 Controllers Add-On Instructions Programming Manual, publication 1756-PM010	Describes in detail how to use Add-On instructions.
Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides more information about GSV instructions, SSV instructions, objects, and attributes.
Logix 5000 Controllers I/O and Tag Data Programming Manual, publication 1756-PM004	Describes how to create and configure program tags for optimal task and program execution.
Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014	Provides more information for I/O faults.
Logix 5000 Controllers Messages Programming Manual, publication 1756-PM012	Provides information for controller messages.
Logix 5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002	Provides programmers with details about the motion instructions that are available for a Logix 5000 controller.
Logix 5000 Controllers Nonvolatile Memory Card Programming Manual, publication 1756-PM017	Provides information about changing the project that is available to load from nonvolatile memory,
Logix 5000 Controllers Produced and Consumed Tags Programming Manual, publication 1756-PM011	Provides more information for produced and consumed tags.
Motion Coordinate System User Manual, publication MOTION-UM002	Details how to create and configure a coordinated motion application system.
PhaseManager™ User Manual, publication LOGIX-UM001	Provides more information about instructions for use with equipment phases.
SERCOS and Analog Motion Configuration and Startup User Manual, publication MOTION-UM001	Details how to configure a sercos motion application system.
ControlLogix SIL 2 Applications Safety Reference Manual, publication 1756-RM001	Provides specific configuration and programming considerations.
Using Logix 5000 Controllers as Masters or Slaves on Modbus Application Solution, publication CIG-AP129	Describes how to use Modbus sample programs.
Industrial Automation Wiring and Grounding Guidelines Application Data, publication 1770-4.1	Provides general guidelines to install a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at https://www.rockwellautomation.com/global/literature-library/overview.page To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Install a ControlLogix 5570 Controller

ATTENTION: Personnel responsible for the application of safety-related programmable electronic systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

Environment and Enclosure

ATTENTION:

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to help prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to help prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional installation requirements
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosure

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**WARNING:** RISQUE D'EXPLOSION • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP54 (as defined in IEC60529) and used in an environment of not more than Pollution Degree 2 (as defined in IEC 60664-1) when applied in Zone 2 environments. The enclosure must utilize a tool removable cover or door.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- This equipment must be used only with ATEX certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Before You Begin

To install a ControlLogix® chassis and power supply before you install your controller and power supply, see the following publications:

- ControlLogix Chassis Installation Instructions, publication 1756-IN621
- ControlLogix Power Supply Installation Instructions, publication 1756-IN619
- ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620

ControlLogix 5570 Controller Parts

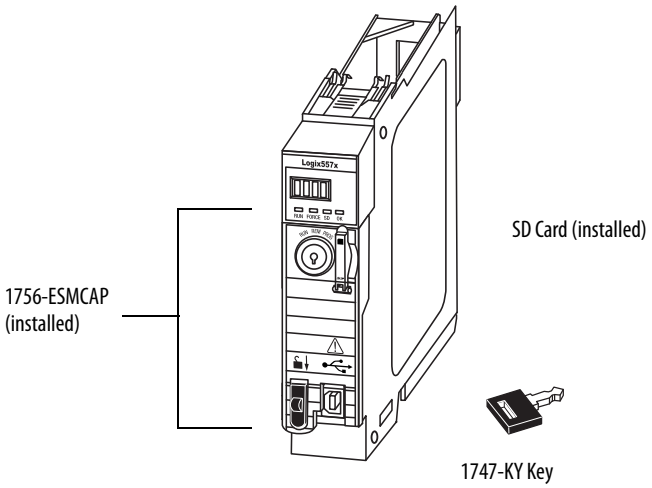
These sections describe parts that are included with ControlLogix 5570 controllers and available accessory parts.

Parts Included with ControlLogix 5570 Controllers

These parts are included with the controller:

- 1756-ESMCAP capacitor-based energy storage module (ESM)
- 1784-SD1 Secure Digital (SD) card, 1 GB
- 1747-KY controller key

Figure 1 - Parts with the ControlLogix 5570 Controller



IMPORTANT The controllers ship with an SD card installed. We recommend that you leave the SD card installed.

Parts Available for Use with ControlLogix 5570 Controllers

You can choose to use the parts included with the controller and these parts specific to your application.

If your application requires	Then use this part
USB connection from a computer to the controller	USB cable(1)
Nonvolatile memory	1784-SD1 (1 GB) or 1784-SD2 (2 GB)
ESM without WallClockTime back-up power	1756-ESMNSE This ESM does not have WallClockTime back-up power. Use this ESM if your application requires that the ESM ESM depletes its residual stored energy to 40 µJ or less before transporting it into or out of your application.(2) Additionally, you can use this ESM with only a 1756-L73 (8 MB) or smaller memory-sized controller.
ESM that secures the controller by blocking the USB connection and SD card use(2) This ESM provides your application an enhanced degree of security.	1756-ESMNRM

(1) The USB port is intended only for temporary local programming purposes and not intended for permanent connection. The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

(2) For information about the hold-up time of the ESMs, see Estimate the ESM Support of the WallClockTime on page 73 and stored energy depletion rate on page 25.

WARNING: Do not use the USB port in hazardous locations.

ATTENTION:

- The USB port is intended only for temporary local programming purposes and not intended for permanent connection.
- The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

Controller Installation

To install the controller, complete the tasks summarized in this table.

✓	Task	Page
	Insert the Controller into the Chassis	19
	Insert the Key	20
	Install the SD Card	21
	Remove the SD Card	23
	Install the ESM	24

Insert the Controller into the Chassis

When installing a ControlLogix controller, you can do the following:

- Place the controller in any slot.
- Use multiple controllers in the same chassis.

You can install or remove a ControlLogix controller while chassis power is on and the system is operating.

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the controller and its mating connector on the chassis. Worn contacts may create electrical resistance that can affect controller operation.

Table 4 - Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

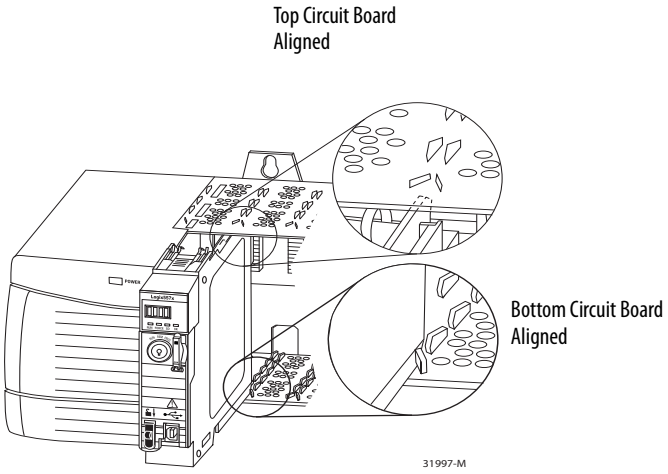
- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

IMPORTANT The ESM begins charging when one of these actions occurs:

- The controller and ESM are installed into a powered chassis.
- Power is applied to the chassis that contains a controller with the ESM installed.
- An ESM is installed into a powered controller.

After power is applied, the ESM charges for up to two minutes as indicated by CHRG or ESM Charging on the status display.

1. Align the circuit board with the top and bottom guides in the chassis.

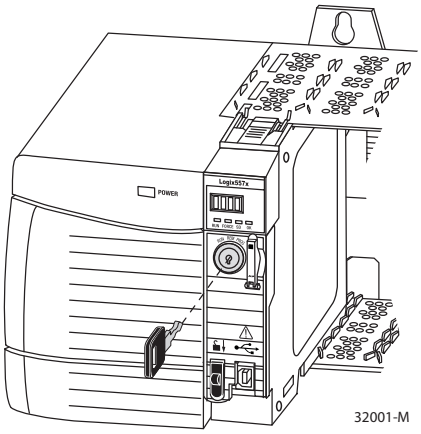


2. Slide the module into the chassis until it snaps into place.
3. Verify that the controller is flush with the power supply or other installed modules.

After you have inserted the controller into the chassis, reference the Troubleshoot the Module on page 171 for information to interpret the status indicators.

Insert the Key

After the controller is installed, insert the key.



Install the SD Card

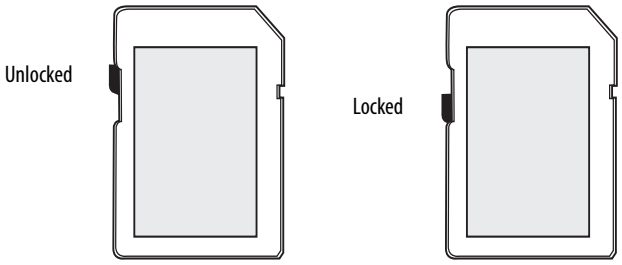
Complete these steps to install the SD card in the controller.

We recommend that you leave the SD card in the controller, even when it is not used. If the controller experiences a major nonrecoverable fault, fault information is saved to the card.

WARNING: When you insert or remove the Secure Digital (SD) memory card while power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

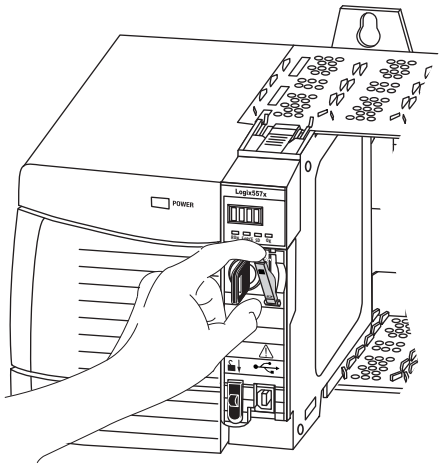
Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference.



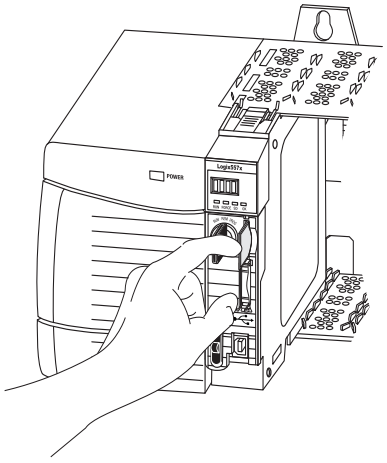
   For more information about the lock/unlock memory settings, see the Load or Store to the Memory Card on page 66.

2. Open the door for the SD card.

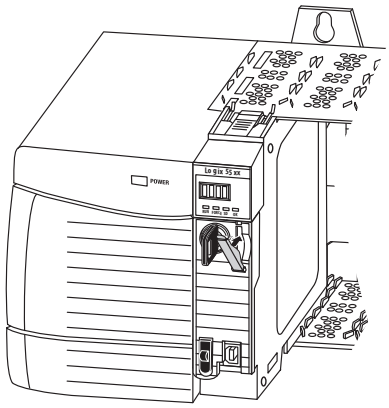


3. Insert the SD card into the SD card slot.

4. Gently press the card until it clicks into place.



5. Close the SD card door.



Remove the SD Card

The controller ships with an SD card installed. Complete these steps to remove the SD card from the controller.

WARNING: When you insert or remove the Secure Digital (SD) memory card while power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

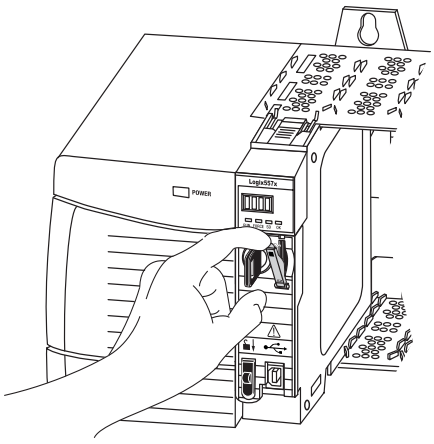
IMPORTANT

- Verify that the SD card status indicator is off and that the card is not in use before removing it.
- We recommend that you do the following:
  - Leave an SD card installed.
  - Use the SD cards available from Rockwell Automation (catalog number 1784-SD1 or 1784-SD2).
- While other SD cards can be used with the controller, Rockwell Automation has not tested the use of those cards with the controller. If you use an SD card other than those cards that are available from Rockwell Automation, you can experience data corruption or loss.
- Also, SD cards that are not provided by Rockwell Automation do not have the same industrial, environmental, and certification ratings as those cards that are available from Rockwell Automation.

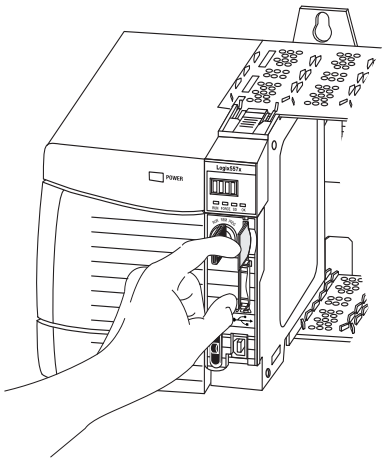
1. Verify that the SD card is not in use by checking to be sure that the SD indicator is Off.

   TIP You can also put the controller into Hard Run mode to keep the controller from writing to the SD card while it is removed.

2. Open the door to access the SD card.



3. Press and release the SD card to eject it.



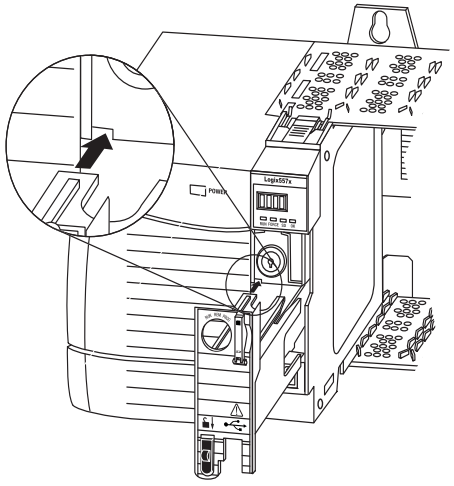
4. Remove the SD card and close the door.

Install the ESM

To install an ESM in the controller, complete these steps.

ATTENTION: To avoid potential damage to the product when inserting the ESM, align it in the track and slide forward with minimal force until the ESM snaps into place.

1. Align the tongue-and-groove slots of the ESM and controller.



2. Slide the ESM back until it snaps into place.

   The ESM begins charging after installation. The following status messages indicate charging status:

   - ESM Charging
   - CHRG

After you install the ESM, it can take up to 15 seconds for the charging status messages to display.

IMPORTANT Allow the ESM to finish charging before removing power from the controller. Failure to do so can result in the loss of the application program. A type 1, code 40 major fault is logged on powerup.

To verify that the ESM is fully charged, check the status display to confirm that messages CHRG or ESM charging are no longer indicated.

TIP We recommend that you check the WallClockTime object attributes after installing an ESM to verify that the time of the controller is correct.

The ESM contains a real-time clock. If the ESM is new or came from another controller, the WallClockTime object attributes for your controller can change.

Uninstall the ESM

WARNING: If your application requires the ESM to deplete its residual stored energy to 40 µJ or less before you transport it into or out of the application, use only the **1756-(SP)ESMNSE(XT)** module. In this case, complete these steps before you remove the ESM.

- Turn power off to the chassis.

After you turn power off to the chassis, the controller's OK status indicator transitions from green to steady red to OFF.

- Wait **at least 20 minutes** for the residual stored energy to decrease to 40 µJ or less before you remove the ESM.

There is no visual indication of when the 20 minutes has expired. **You must track that time period**.

WARNING: When you insert or remove the energy storage module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector.

IMPORTANT Before you remove an ESM, make the necessary adjustments to your program to account for potential changes to the WallClockTime attribute.

Consider these points before removing the ESM:

- The following ESM modules can be currently installed in your 1756-L7*x* or 1756-L7*x*XT controller:
  - 1756-ESMCAP
  - 1756-ESMNSE
  - 1756-ESMCAPXT
  - 1756-ESMNSEXT
- The 1756-L7*x* controllers come with the 1756-ESMCAP module installed. The 1756-L7*x*XT extreme temperature controller ships with a 1756-ESMCAPXT module installed. For more information on how to use a 1756-ESMNSE, 1756-ESMNRM, 1756-ESMNSEXT, or 1756-ESMNRMXT module, see page 24.
- After the 1756-L7*x* or 1756-L7*x*XT controllers lose power, because the chassis power is turned off or the controller has been removed from a powered chassis, do not immediately remove the ESM.

  Wait until the OK status indicator on the controller transitions from green to steady red to OFF before you remove the ESM.
- You can use the 1756-ESMNSE module with only a 1756-L73 (8 MB) or smaller memory-sized controller.
- Use the 1756-ESMNSE module if your application requires that the ESM depletes its residual stored energy to 40 µJ or less before transporting it into or out of your application.
- Once it is installed, you cannot remove the 1756-ESMNRM or 1756-ESMNRMXT module from a 1756-L7*x* or 1756-L7*x*XT controller.
- The Armor™ controller energy storage modules (ESM) cannot be removed or replaced.

Complete these steps to remove an ESM module from the controller.

1. Remove the key from the mode switch.

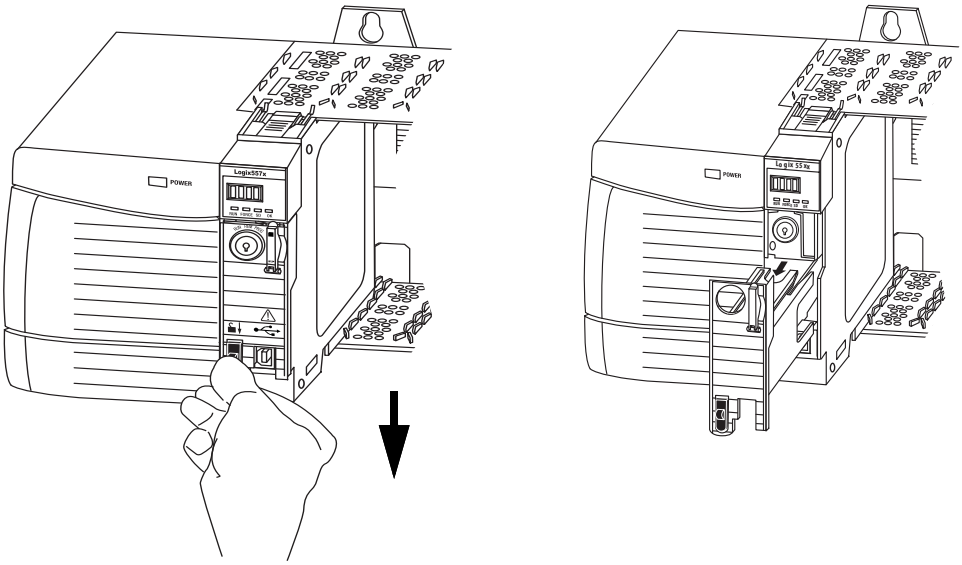
IMPORTANT The next step depends on which of the following conditions applies to your application.

- If you are removing the ESM from a powered 1756-L7*x* controller, go to step 2.
- If you are removing the ESM from a 1756-L7*x* controller that is not powered, because the chassis power is turned off or the controller has been removed from a powered chassis, **do not immediately remove** the ESM.

Wait until the OK status indicator on the controller transitions from green to steady red to OFF before you remove the ESM.

After the OK status indicator transitions to Off, go to step 2.

2. Use your thumb to press down on the black release and pull the ESM away from the controller.



Notes:

Install a ControlLogix 5560 Controller

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

Environment and Enclosure

ATTENTION:

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This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

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In addition to this publication, see the following:

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The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**WARNING:** RISQUE D'EXPLOSION • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP54 (as defined in IEC60529) and used in an environment of not more than Pollution Degree 2 (as defined in IEC 60664-1) when applied in Zone 2 environments. The enclosure must utilize a tool removable cover or door.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- This equipment must be used only with ATEX certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Before You Begin

To install a ControlLogix® chassis and power supply before you install your controller and power supply, see the following publications:

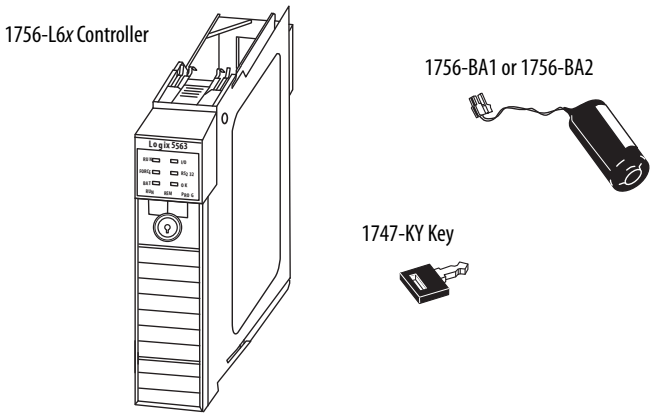
- ControlLogix Chassis Installation Instructions, publication 1756-IN621
- ControlLogix Power Supply Installation Instructions, publication 1756-IN619
- ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620

ControlLogix 5560 Controller Parts

These sections describe parts that are included with ControlLogix 5560 controllers and available accessory parts:

- One of the following batteries is included with your controller:
  - For series A controllers, catalog number 1756-BA1
  - For series B controllers, catalog number 1756-BA2
- Key, catalog number 1747-KY

Figure 2 - Parts Included with ControlLogix 5560 Controllers



Parts Not Included with the Controller

You can choose to use the parts included with the controller and these parts specific to your application.

If your application requires	Then use this component
RS-232 connection to the controller	1756-CP3 serial cable
Nonvolatile memory	1784-CF128 CompactFlash card
Expanded battery life for extended memory retention	1756-BATM battery module(1)

(1) The 1756-BATM can be used with series A controllers, but it cannot be used with series B controllers. Series B controllers use battery power differently than previous controllers and therefore battery considerations for this series controller vary. For more information to determine what battery to use, see the ControlLogix Controllers Selection Guide, publication 1756-SG001.

Controller Installation

To install the controller, complete the tasks summarized in this table.

✓	Task	Page
	CompactFlash Card Installation and Removal	32
	Battery Connection and Replacement	36
	Insert the Controller into the Chassis	38
	Remove the Controller from the Chassis	40

CompactFlash Card Installation and Removal

The installation and removal of a CompactFlash card depends on the controller.

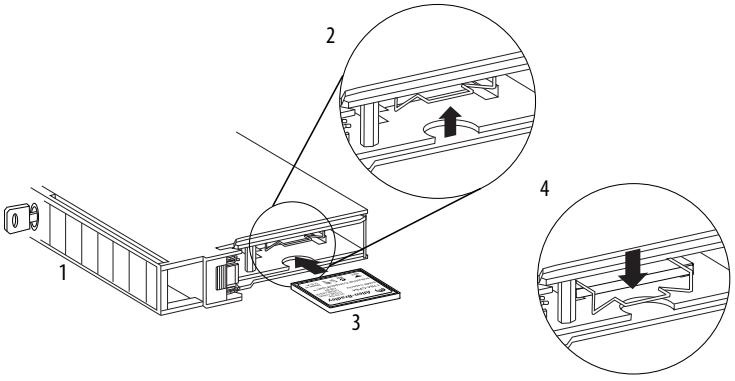
WARNING: When you insert or remove the CompactFlash card while power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

- If you are using a series A controller, reference these sections:
  - Install a CompactFlash Card in a Series A Controller on page 33.
  - Remove a CompactFlash Card from a Series A Controller on page 33.
- If you are using a series B controller, reference these sections:
  - Install a CompactFlash Card in a Series B Controller on page 34.
  - Remove a CompactFlash Card from a Series B Controller on page 35.

Install a CompactFlash Card in a Series A Controller

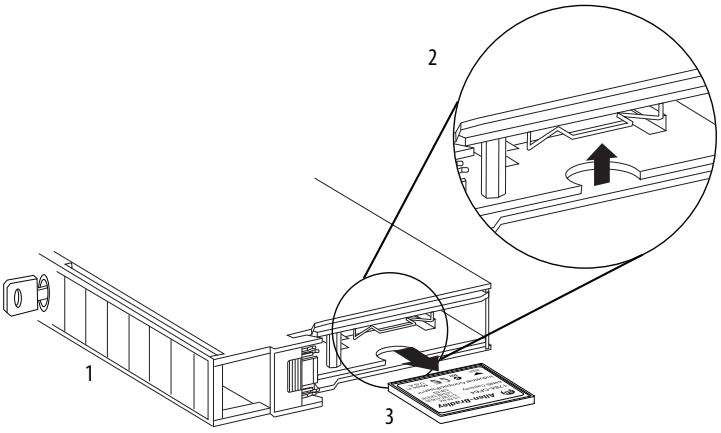
Complete these steps to install a CompactFlash card in a series A controller.



1. Lay the controller on its side with the front facing to the left.
2. Raise the locking clip.
3. Insert the CompactFlash card into the slot at the bottom of the controller.
4. Pull the clip forward and downward until it snaps into place over the card.

Remove a CompactFlash Card from a Series A Controller

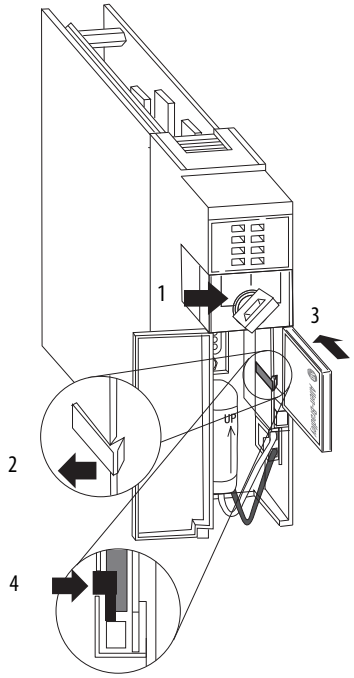
Complete these steps to remove a CompactFlash card from a series A controller.



1. Lay the controller in its side with the mode switch facing left.
2. Raise the locking clip.
3. Gently pull the card out of the slot.

Install a CompactFlash Card in a Series B Controller

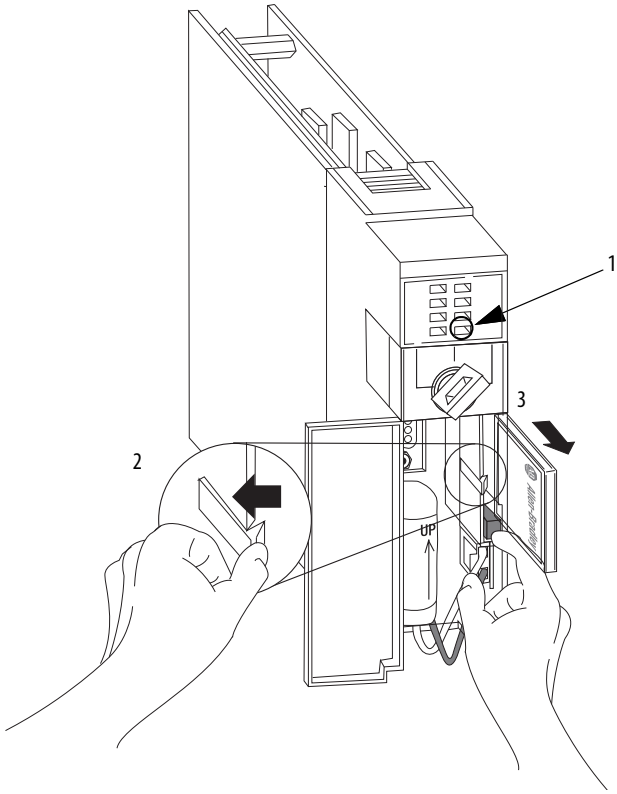
Complete these steps to install a CompactFlash card in a series B controller.



1. Open the door of the controller and push the CompactFlash latch to the left.
2. Insert the CompactFlash card with the Allen-Bradley® logo pointing left.
3. Release the latch and secure it over the CompactFlash card.

Remove a CompactFlash Card from a Series B Controller

Complete these steps to remove a CompactFlash card from a series B controller.



1. Verify that the OK indicator is steady green and open the door of the controller.
2. Push and hold the CompactFlash latch to the left.
3. Push the eject button and remove the card.
4. Release the latch.

Battery Connection and Replacement

This product contains a hermetically sealed lithium battery that may need to be replaced during the life of the product.

At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.

The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

WARNING: When you connect or disconnect the battery an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

For safety information on the handling of lithium batteries, including handling and disposal of leaking batteries, see Guidelines for Handling Lithium Batteries, publication AG-5.4.

IMPORTANT To help prevent program loss, replace a 1756-BA1 or 1756-BA2 battery according to the following schedule even if the BAT status indicator is Off.

If the temperature 2.54 cm (1 in.) below the chassis is	Replace the battery within
-25…+35 °C (-13…+95 °F)	No replacement required
36…40 °C (96.8…104 °F)	3 years
41…45 °C (105.8…113 °F)	2 years
46…50 °C (114.8…122 °F)	16 months
51…55 °C (123.8…131 °F)	11 months
56…70 °C (132.8…158 °F)	8 months

ATTENTION: Store batteries in a cool, dry environment. We recommend 25 °C (77 °F) with 40…60% relative humidity. You can store batteries for up to 30 days between -45…+85 °C (-49…+185 °F), such as during transportation. To avoid leakage or other hazards, **do not** store batteries above 60 °C (140 °F) for more than 30 days.

Connection of the battery varies depending on your controller series:

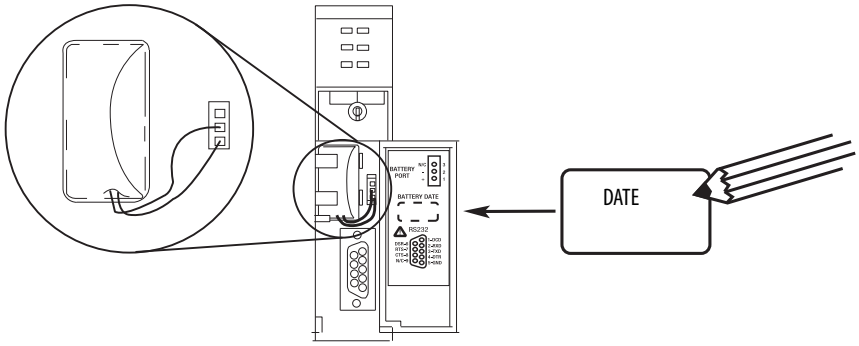
- If you are using a series A controller, see page 37.
- If you are using a series B controller, see page 38.

Install the Battery on a Series A Controller

Complete these steps to install a 1756-BA1 battery on a series A controller.

For information to install a 1756-BATM battery module or replace a 1756-BATM assembly, see the ControlLogix Battery Module Installation Instructions, publication 1756-IN576.

ATTENTION: For a series A controller, connect only a 1756-BA1 battery or a 1756-BATM battery module. The use of other batteries can damage the controller.



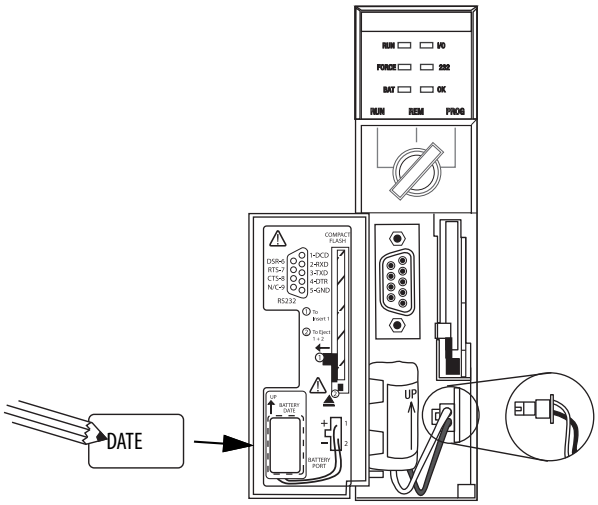
Wire Terminal Location	Connected Wire
Top	No connection
Middle	Black lead (-)
Bottom	Red lead (+)

1. Connect the battery connector to the port to the right of the battery slot.
2. Snap the battery into the battery slot.
3. Write the date on the battery label.
4. Attach the label to the inside of the controller door.

Install the Battery on a Series B Controller

Complete these steps to install the battery on a series B controller.

ATTENTION: For a series B controller, connect only a 1756-BA2 battery. The use of other batteries can damage the controller.



1. Plug the battery connector into the battery port (+ Red, - Black).
2. Insert the battery, with the arrow pointing up, into the battery slot.
3. Write the date on the battery label.
4. Attach the label to the inside of the controller door.

Insert the Controller into the Chassis

When installing a ControlLogix controller, you can do the following:

- Place the controller in any slot.
- Use multiple controllers in the same chassis.

You can install a ControlLogix controller while chassis power is on and the system is operating.

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Repeated electrical arcing causes excessive wear to contacts on both the controller and its mating connector on the chassis. Worn contacts may create electrical resistance that can affect controller operation.

Table 5 - Prevent Electrostatic Discharge

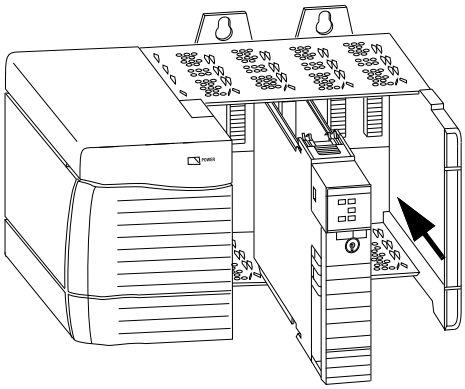
ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

ATTENTION: If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment can be impaired.

Complete these steps to insert the controller into the chassis.

1. Insert the key into the controller.
2. Turn the key to the PROG position.
3. Align the circuit board with the top and bottom guides in the chassis.
4. Slide the module into the chassis.



5. Verify that the controller is flush with the power supply or other installed modules.
6. Verify that the top and bottom latches are engaged.

After you have inserted the controller into the chassis, review the state of the controller information in Troubleshoot the Module on page 171.

Remove the Controller from the Chassis

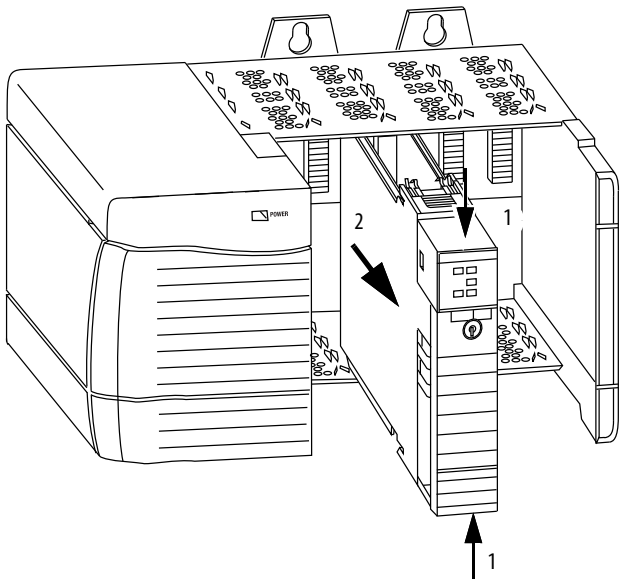
You can remove a controller while chassis power is on and the system is operating. The devices that are owned by the controller go to their configured fault state if you remove the controller.

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Repeated electrical arcing causes excessive wear to contacts on both the controller and its mating connector in the chassis. Worn contacts may create electrical resistance that can affect controller operation.

Complete these steps to remove the controller from the chassis.

1. Press the locking tabs on the top and bottom of the controller.
2. Slide the controller out of the chassis.



Start Using the Controller

Make Connections

Before you can begin using your controller, you must make a connection to the controller.

ControlLogix 5570 Connection Options

Connection options with the ControlLogix® 5570 controller include the following:

- Connect by using a **USB cable** as described in Connect to a ControlLogix 5570 Controller on page 42.
- Install and configure a **communication module** in the chassis with the controller as described in the installation instructions for the communication module.

For information on Double Data Rate (DDR) backplane communication usage, see Double Data Rate (DDR) Backplane Communication on page 90.

ControlLogix 5560 Connection Options

Connection options with the ControlLogix 5560 controller include the following:

- Connect by using a **serial cable** as described in Connect to a ControlLogix 5560 Controller on page 45.
- Install and configure a **communication module** in the chassis with the controller as described in the installation instructions for the communication module.

TIP When upgrading your 1756-L6*x* controller firmware, we recommend that you use a network connection other than the serial cable. Serial connections are slower than other communication connections.

Connect to a ControlLogix 5570 Controller

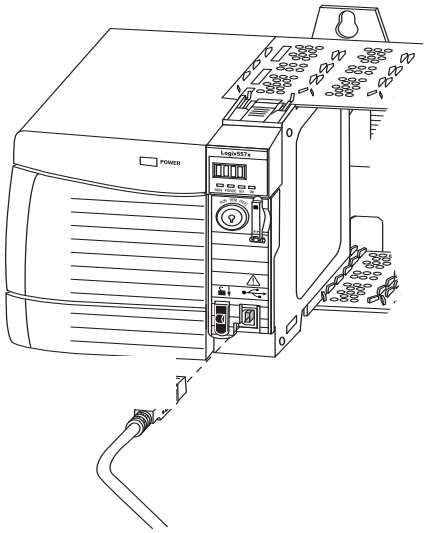
The controller has a USB port that uses a Type B receptacle. The port is USB 2.0 compatible and runs at 12 Mbps.

To use the USB port of the controller, you must have RSLinx® software, version 2.56 or later, installed on your workstation. Use a USB cable to connect your workstation to the USB port. With this connection, you can update firmware and download programs to the controller directly from your workstation.

ATTENTION: The USB port is intended only for temporary local programming purposes and not intended for permanent connection. The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

WARNING: Do not use the USB port in hazardous locations.

Figure 3 - USB Connection



Configure the USB Driver

To configure RSLinx software to use a USB port, first configure a USB driver.

To configure a USB driver, perform this procedure.

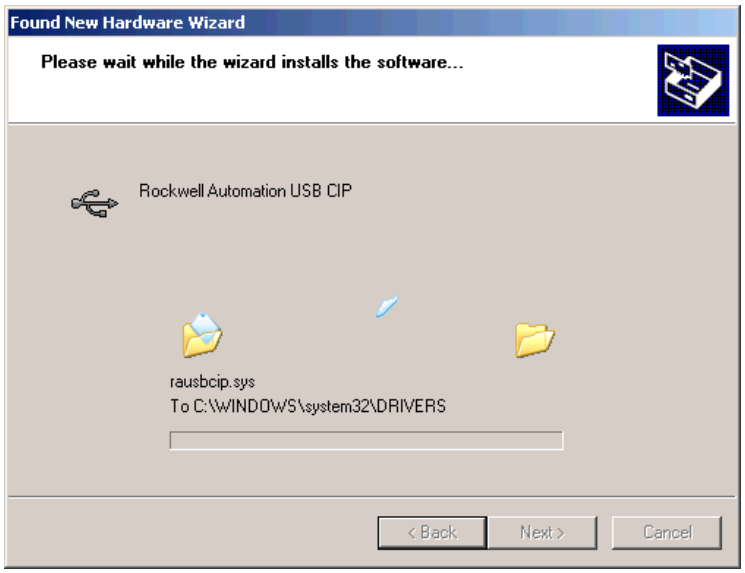
1. Connect your controller and workstation by using a USB cable.

   The Found New Hardware Wizard dialog box appears.

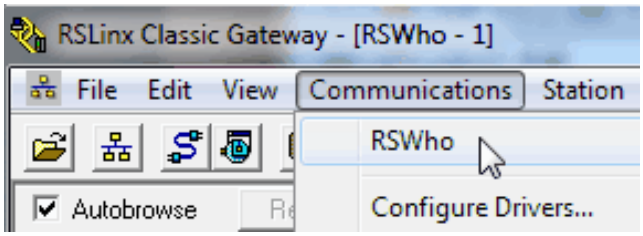
2. Click any of the Windows® Update connection options and click Next.

   TIP If the software for the USB driver is not found and the installation is canceled, verify that you have installed RSLinx Classic software, version 2.57 or later.

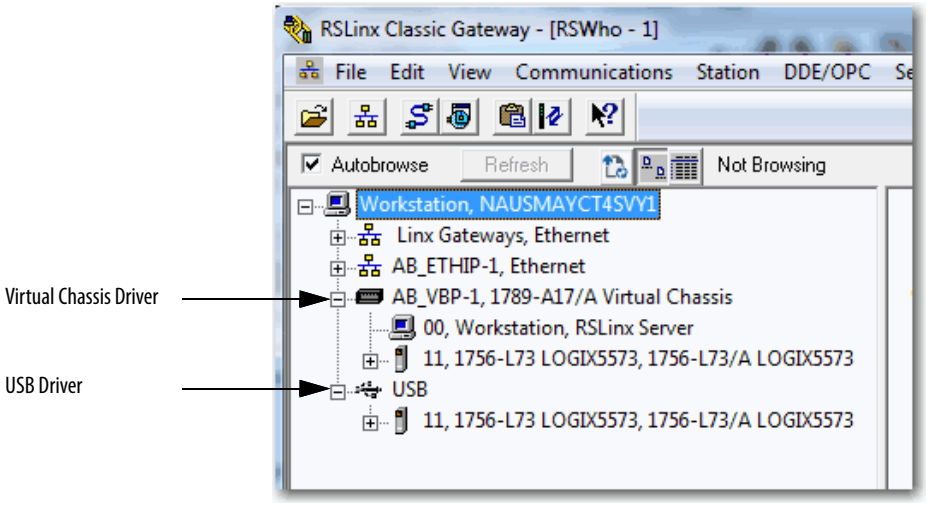
3. Click Install the software automatically (Recommended) and click Next. The software is installed.



4. Click Finish to configure your USB driver.
5. From the Communications dropdown menu, choose RSWho.



The USB port driver appears.



Your controller appears under two drivers, a virtual chassis and the USB port. You can use either driver to browse to your controller.

Connect to a ControlLogix 5560 Controller

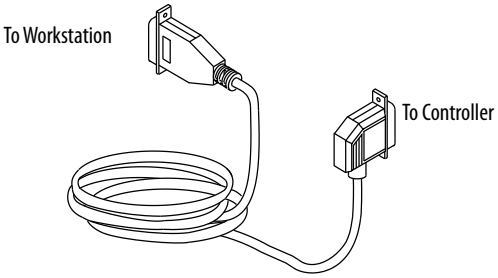
The ControlLogix® 5560 controller uses a serial port for workstation connections.

WARNING: If you connect or disconnect the serial cable with power applied to this module or the serial device on the other end of the cable, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

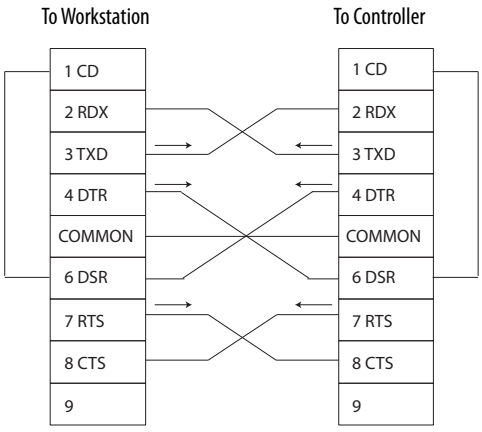
To connect a workstation to the serial port, you can make your own serial cable or use one of these cables:

- 1756-CP3 serial cable
- 1747-CP3 cable from the SLC™ product family (if you use this cable, it can be difficult to close the controller door)

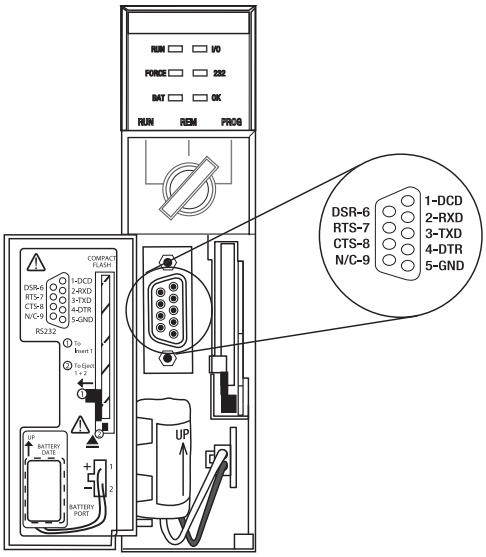


Follow these guidelines if you make your own serial cable:

- Limit the length to 15.2 m (50 ft).
- Wire the connectors as shown.
- Attach the shield to the connectors.



Plug the controller end of the serial cable into the RS-232 port on the front of the controller.

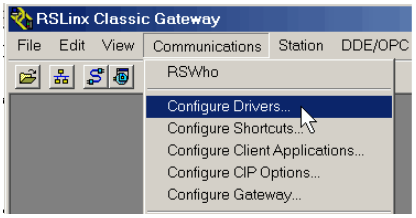


Configure the Serial Driver

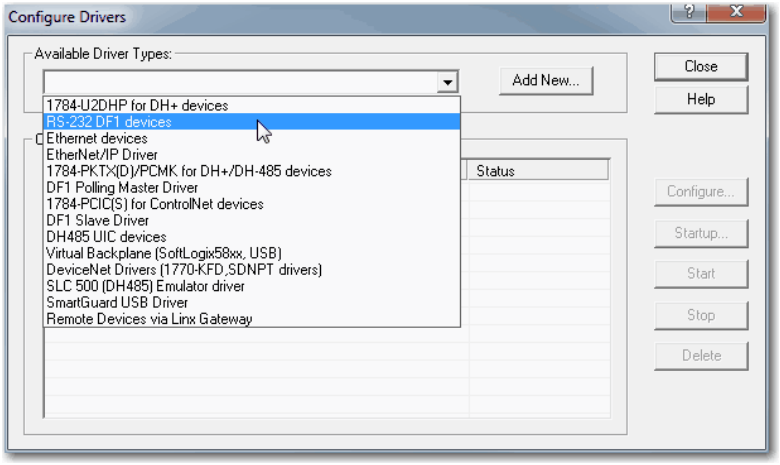
Use RSLinx software to configure the RS-232 DF1 device driver for serial communication.

To configure the driver, perform this procedure.

1. In RSLinx software, from the Communications menu, choose Configure Drivers.

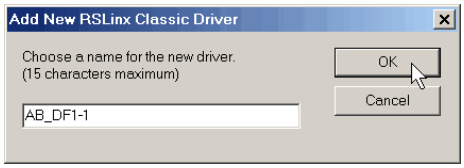


2. From the Available Driver Types dropdown menu, choose the RS-232 DF1 device driver.



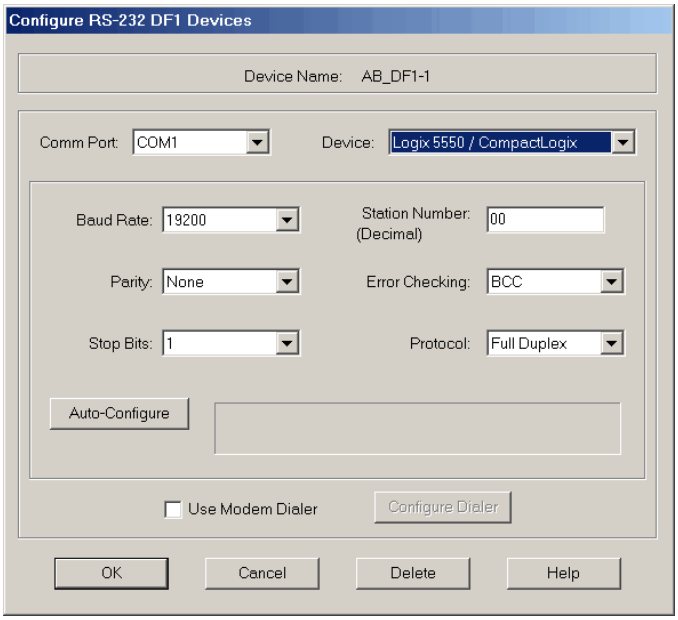
3. Click Add New.

   The Add New RSLinx Driver dialog box appears.



4. Type the driver name and click OK.

5. Specify the serial port settings.
   a. From the Comm Port dropdown menu, choose the serial port on the workstation to which the cable is connected.
   b. From the Device dropdown menu, choose Logix 5550/ CompactLogix.
   c. Click Auto-Configure.



6. If the auto configuration is successful, click OK.

   If the auto configuration is not successful, verify that the correct Comm Port was selected.

7. Click Close.

Upgrade Controller Firmware

You can choose to upgrade the controller firmware by using one of these tools:

- ControlFLASH™ software that is packaged with the Studio 5000® environment
- AutoFlash feature of the Logix Designer application

To upgrade your controller firmware, complete the tasks that are listed in this table.

✓	Task	Page
	Determine Required Controller Firmware	49
	Obtain Controller Firmware	50
	Use ControlFLASH Software to Update Firmware	50
	Use AutoFlash to Update Firmware	55

Determine Required Controller Firmware

IMPORTANT The controller must be in Remote Program or Program mode and all major recoverable faults must be cleared to accept upgrades.

Use Table 6 to determine what firmware revision is required for your controller.

Table 6 - Firmware Required for Controllers

Controller	Series	Use this firmware revision
1756-L61	A	12.*x* or later
	B	13.40 or later
1756-L62	A	12.*x* or later
	B	13.40 or later
1756-L63	A	• If not using a CompactFlash card, 10.*x* or later • If using a CompactFlash card, 11.*x* or later
	B	13.40 or later
1756-L63XT	B	13.40 or later
1756-L64	B	16 or later
1756-L65	B	17 or later
1756-L71	A	20 or later
1756-L72	A	19 or later
1756-L72EROM	A	19 or later
1756-L73	A	19 or later
1756-L73XT	A	19 or later
1756-L73EROM	A	19 or later
1756-L74	A	19 or later
1756-L75	A	19 or later

Obtain Controller Firmware

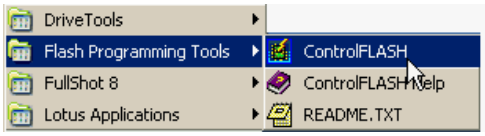
Controller firmware is packaged with the Studio 5000 environment. In addition, controller firmware is also available for download from the Rockwell Automation Technical Support website at https://www.rockwellautomation.com/support/.

Use ControlFLASH Software to Update Firmware

To upgrade your controller firmware with ControlFLASH software, complete these steps.

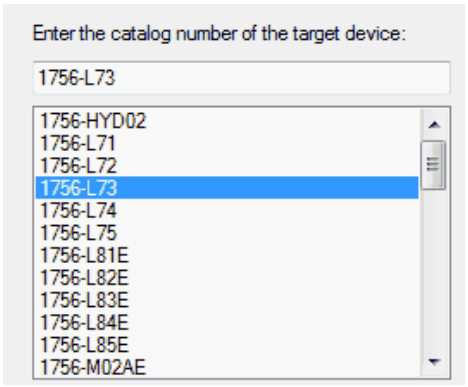
IMPORTANT If the SD card is locked and the Load Image option of the store project is set to On Power Up, the controller firmware is not updated as a result of these steps. The previously stored firmware and project are loaded instead.

1. Verify that the network connection is made and the network driver has been configured in RSLinx software.
2. Start ControlFLASH software and click Next to begin the upgrade process.

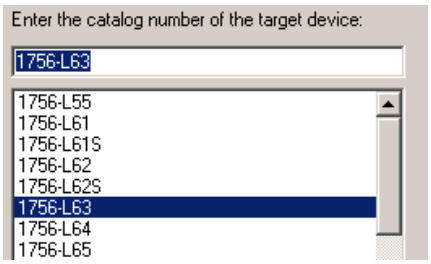


3. Select the catalog number of your controller and click Next.

1756-L7*x* Controllers

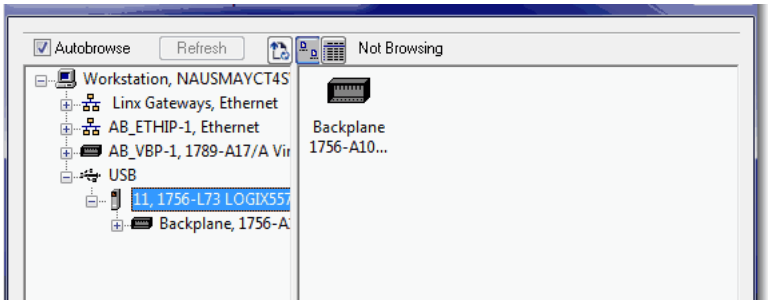


1756-L6*x* Controllers

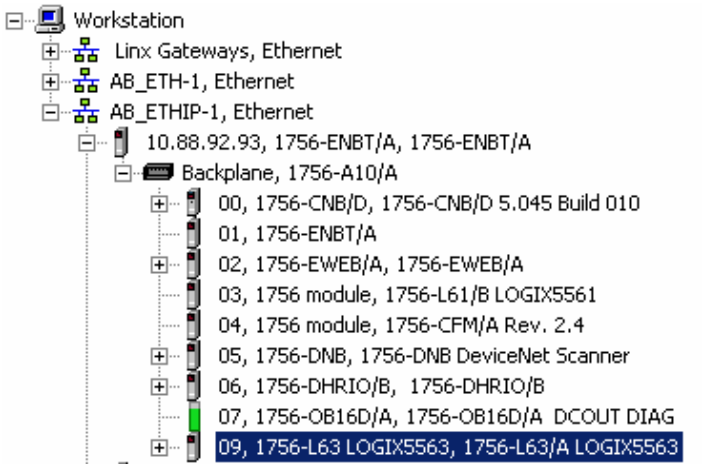


4. Expand the network driver to locate your controller.

1756-L7*x* Controller with USB Network Driver



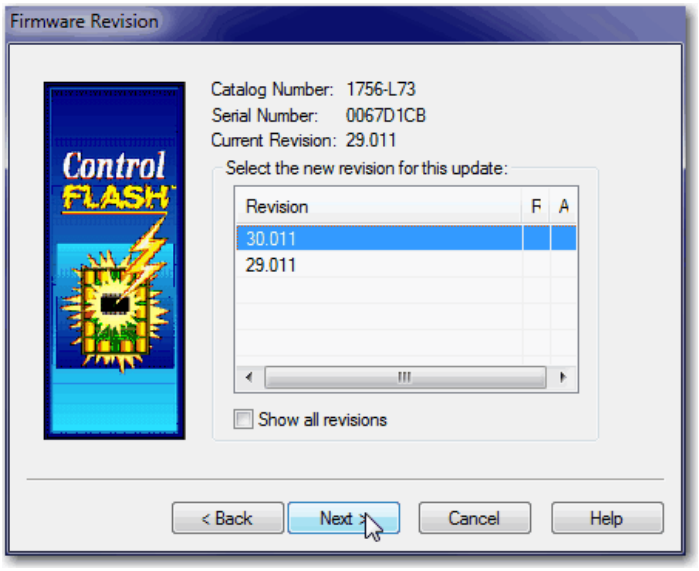
1756-L6*x* Controller with Ethernet Network Driver



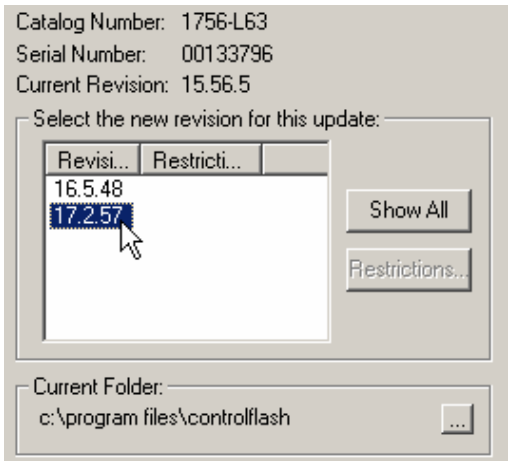
5. Select the controller and click Next.

6. Select the desired firmware revision and click Next.

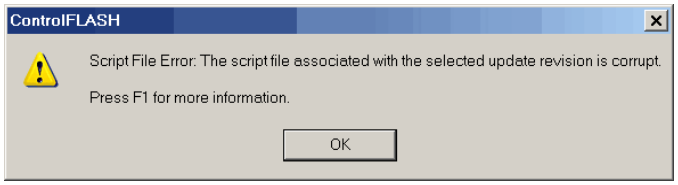
1756-L7*x* Controller Upgrade



1756-L6*x* Controller Upgrade



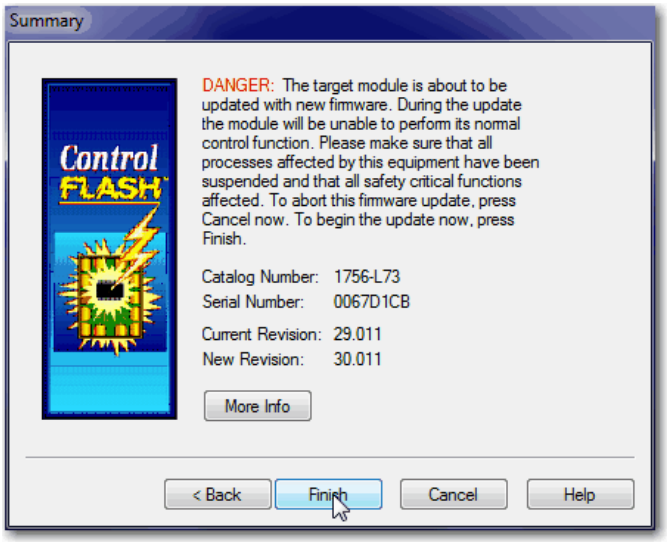
TIP If you are using a 1756-L7*x* controller and experience a Script File Error after selecting the firmware revision number (see the following example), there is likely an anomaly with your firmware files.



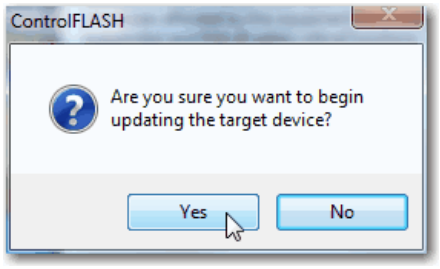
To recover, perform the following:

- Go to https://www.rockwellautomation.com/support/ and download the firmware revision you are trying to upgrade. Replace the firmware revision that you have previously installed with that posted on the Technical Support website.
- If the replacement firmware revision does not resolve the anomaly, contact Rockwell Automation Technical Support.

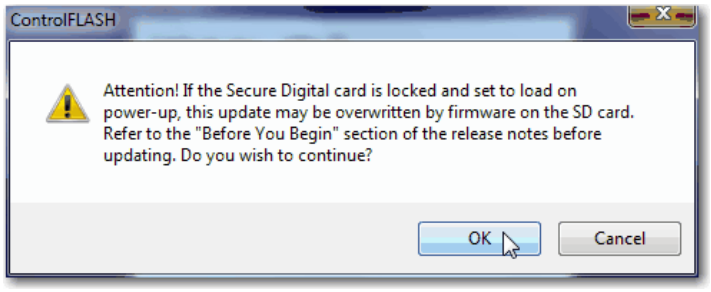
7. Click Finish.



8. When a confirmation dialog box appears, click Yes.



Before the firmware update begins, this dialog box appears. Take the required action for your application. In this example, the upgrade continues when you click OK.



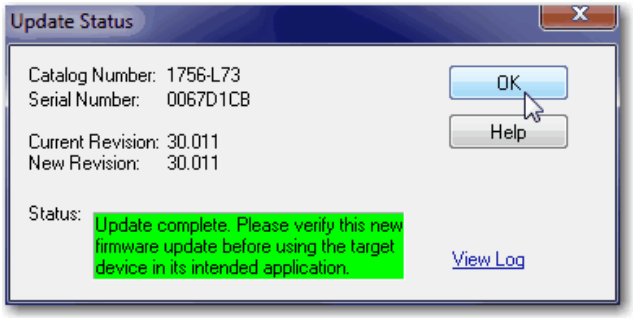
A progress dialog box indicates the progress of the firmware update. The 1756-L7*x* controllers show progress in updates and blocks. The 1756-L6x controllers show progress only in blocks.

WARNING: Let the firmware update fully complete before cycling power or otherwise interrupting the upgrade.

TIP If the ControlFLASH upgrade of the controller is interrupted, the controllers revert to boot firmware that is firmware revision 1.*xxx*.

When the upgrade is complete, the Update Status dialog box indicates that the upgrade is complete.

9. Click OK.



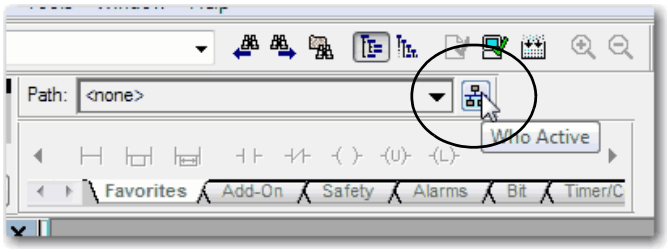
10. Close ControlFLASH software.

Use AutoFlash to Update Firmware

To upgrade your controller firmware with the AutoFlash feature, complete these steps.

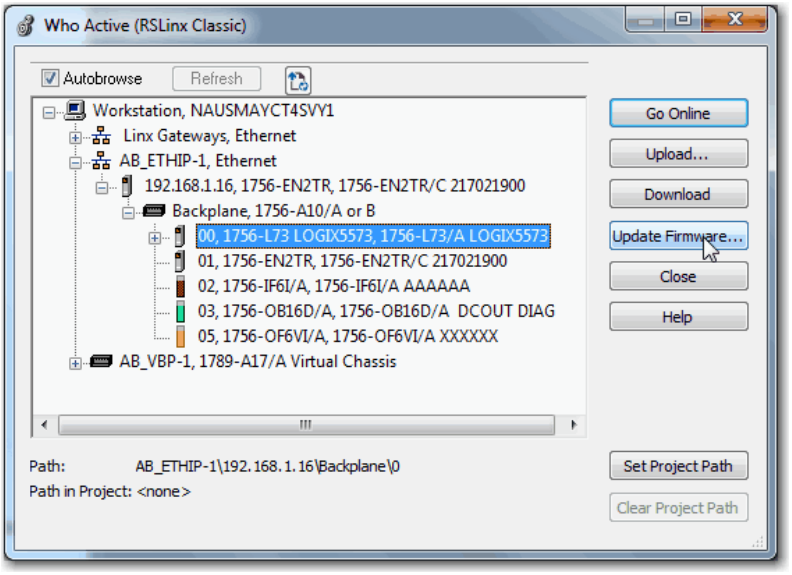
IMPORTANT If the SD card is locked and the Load Image option of the stored project is set to On Power Up, the controller firmware is not updated as a result of these steps. The previously stored firmware and project are loaded instead.

1. Verify the following:
   - The network connection is made.
   - The network driver has been configured in RSLinx Classic software.
   - The controller is in Remote Program or Program mode and all major recoverable faults are cleared.
2. Use the Logix Designer application to create a controller project.
3. On the Path bar, click Who Active.

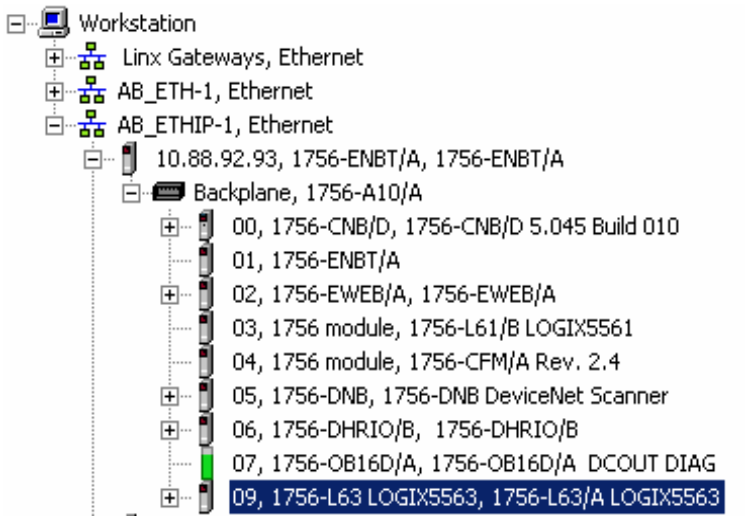


4. Select your controller and click Update Firmware.

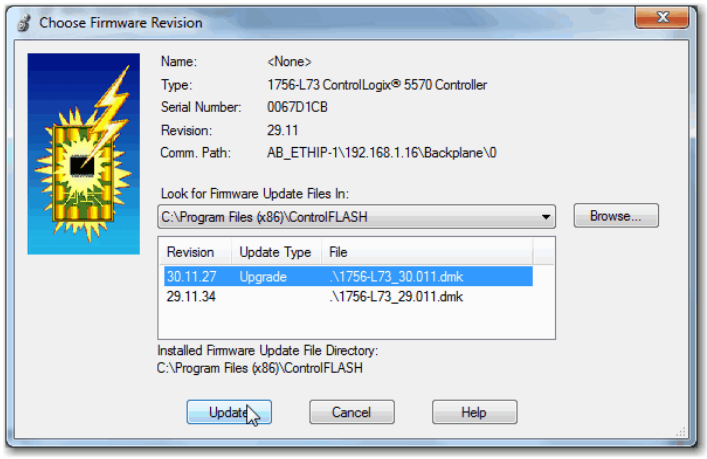
1756-L7*x* Controller with USB Driver



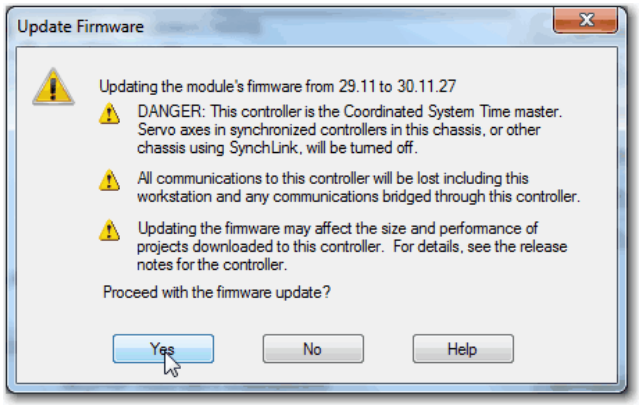
1756-L6*x* Controller with Ethernet Driver



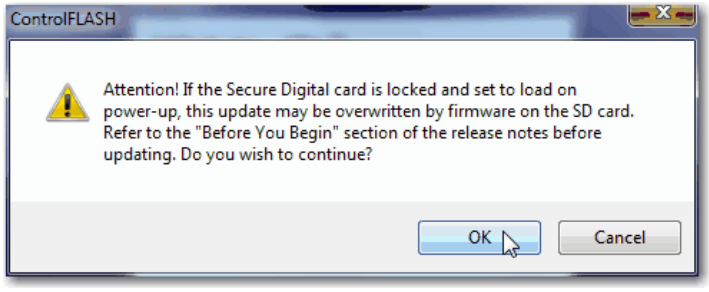
5. Select the firmware revision to upgrade to and click Update.



6. On the Update Firmware dialog box, click Yes.



7. On the ControlFLASH dialog box, click OK.



A progress dialog box indicates the progress of the firmware update. The 1756-L7*x* controllers show progress in updates and blocks. The 1756-L6x controllers show progress only in blocks.

WARNING: Let the firmware update fully complete before cycling power or otherwise interrupting the upgrade.

TIP If the upgrade of the controller is interrupted, the controllers revert to firmware revision 1.*xxx*.

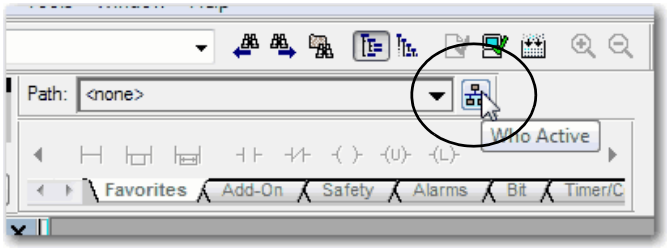
When the upgrade is complete, the Update Status dialog box indicates that the upgrade is complete.

Set the Communication Path

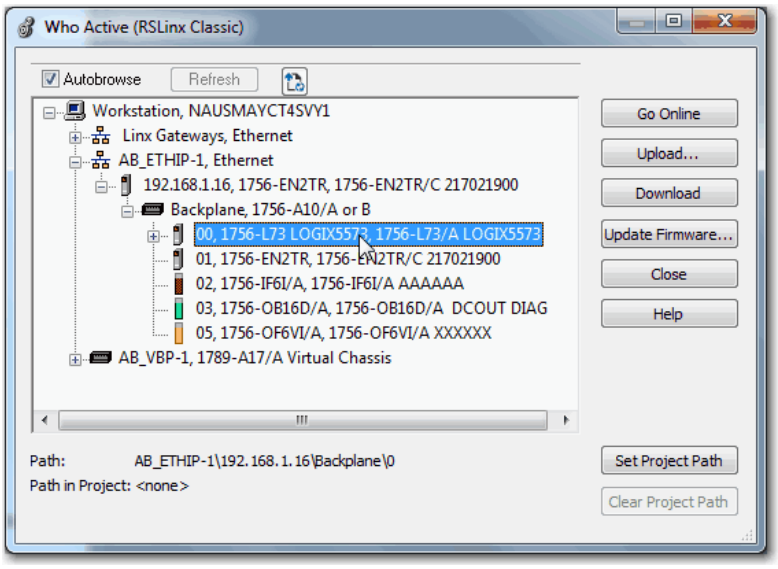
To go online with the controller, you must specify a communication path in the Logix Designer application. You specify the communication path after you create a controller program.

Complete these steps to specify the communication path after you have created your program.

1. Click Who Active.



2. Expand the communication path and select the controller.

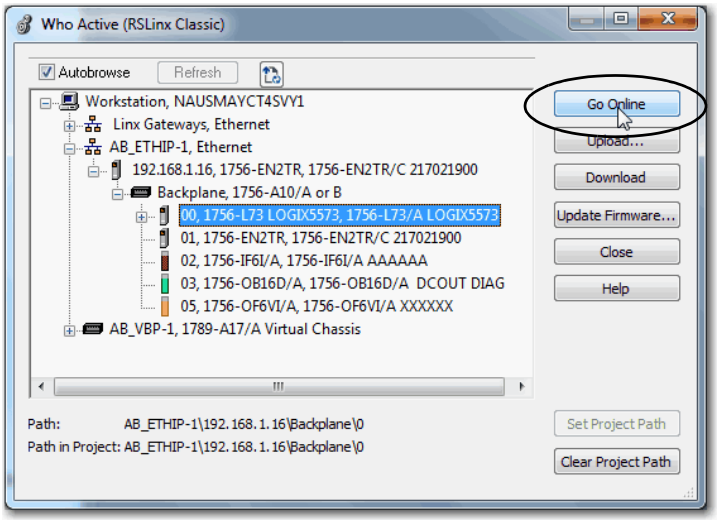


3. Click Set Project Path.

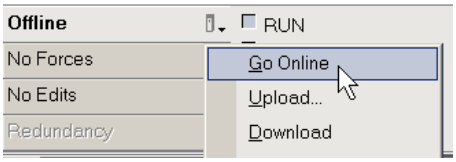
Go Online with the Controller

Use one of these methods to go online with the controller:

- After setting the communication path, click Go Online in the Who Active dialog box.



- From the Controller Status menu, choose Go Online.



Download to the Controller

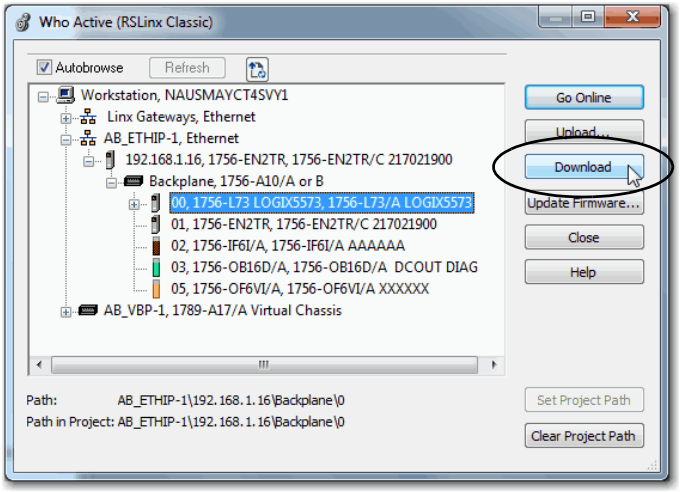
When you download a project to the controller, it moves the project from the Logix Designer application onto the controller. You can download a project in two ways:

- Use the Who Active Dialog Box to Download on page 60
- Use the Controller Status Menu to Download on page 61

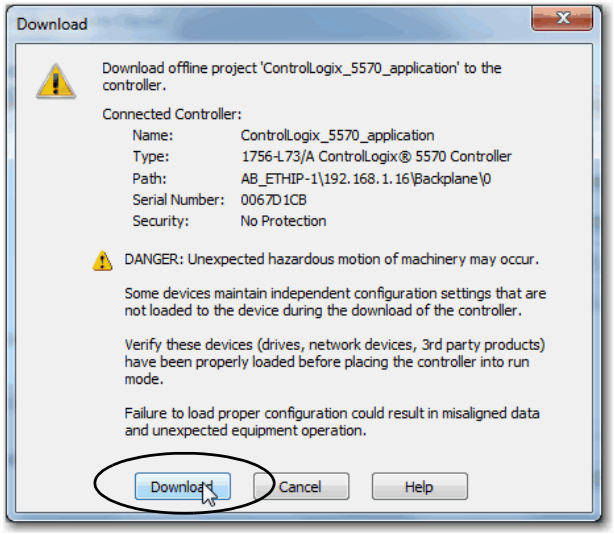
Use the Who Active Dialog Box to Download

You can use the features of the Who Active dialog box to download to your controller after you have set the communication path. Complete these steps to download to the controller.

1. After setting the communication path, click Download in the Who Active dialog box.



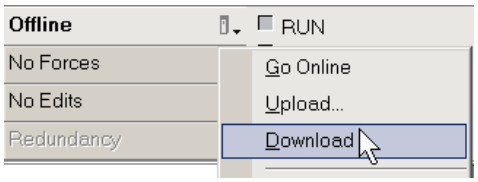
2. Read the warnings on the Download dialog box and click Download.



Use the Controller Status Menu to Download

After you set a communication path in the Logix Designer application, you can use the Controller Status menu to download to the controller. To download, from the Controller Status menu, choose Download.

Figure 4 - Download Via the Controller Status Menu



TIP After the download completes on a 1756-L7*x* controller, the project name is indicated on the scrolling status display.

Upload from the Controller

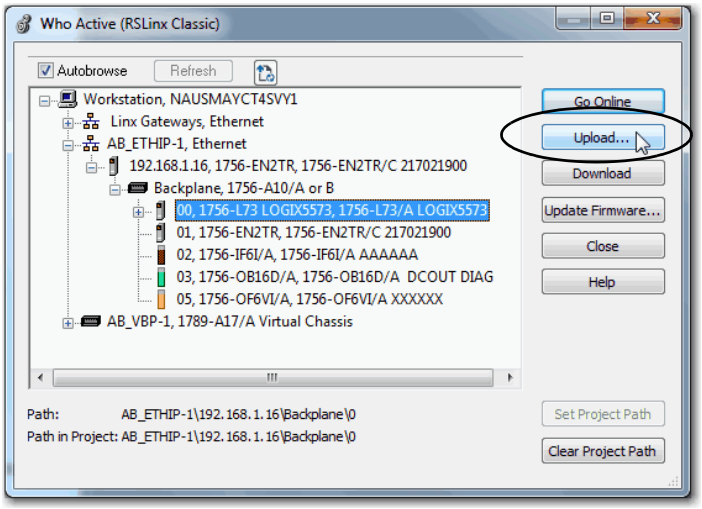
When you upload a project to the controller, it copies the project from the controller to the Logix Designer application. To upload a project, use one of these methods:

- Use the Who Active Dialog Box to Upload, page 61
- Use the Controller Status Menu to Upload, page 62

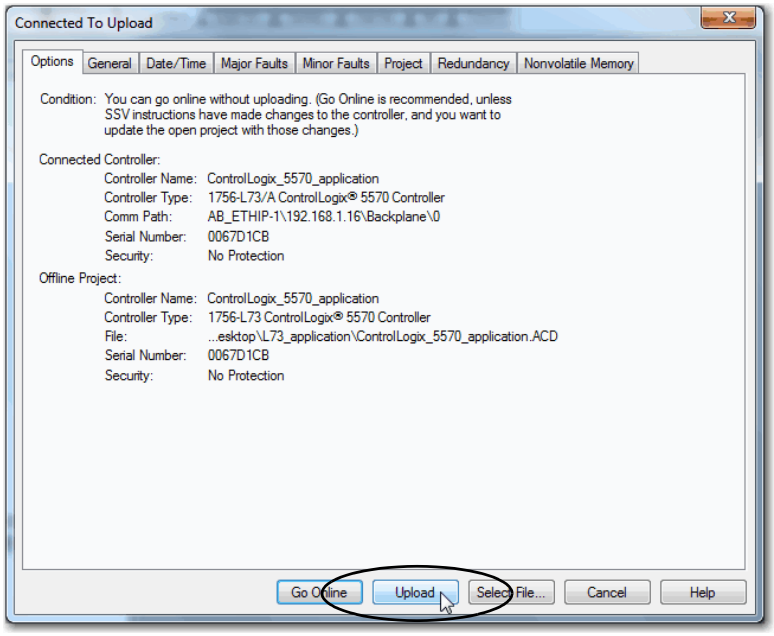
Use the Who Active Dialog Box to Upload

You can use the features of the Who Active dialog box to upload from your controller after you have set the communication path. Complete these steps to upload from the controller.

1. After setting the communication path, click Upload in the Who Active dialog box.



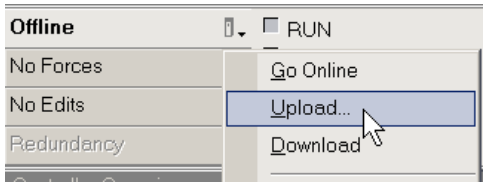
2. Click Upload after verifying the project that you are uploading in the Connected to Upload dialog box.



Use the Controller Status Menu to Upload

After you have set a communication path in the project, you can use the Controller Status menu to upload from the controller. To upload, from the Controller Status menu, choose Upload.

Figure 5 - Upload Via the Controller Status Menu



Choose the Controller Operation Mode

Use Table 7 as a reference when determining your controller Operation mode.

Table 7 - Controller Operation Modes and Meanings

If you want to	Select one of these modes				
	Run	Remote			Program
		Run	Test	Program	
Turn outputs to the state commanded by the logic of the project	X	X			
Turn outputs to their configured state for Program mode			X	X	X
Execute (scan) tasks	X	X	X		
Change the mode of the controller via the Logix Designer application		X	X	X	
Download a project		X	X	X	X
Schedule a ControlNet® network				X	X
While online, edit the project		X	X	X	X
Send messages	X	X	X		
Send and receive data in response to a message from another controller	X	X	X	X	X
Produce and consume tags	X	X	X	X	X

Use the Mode Switch to Change the Operation Mode

Use the mode switch to change the operation mode. The controller mode switch provides a mechanical means to enhance controller and control system security. You must physically move the mode switch on the controller to change its operating mode from RUN, to REM, or to PROG. When the mode switch on the controller is set to RUN mode, features like online editing, program downloads, and firmware updates are prohibited. See Table 7 for a complete list of prohibited features.

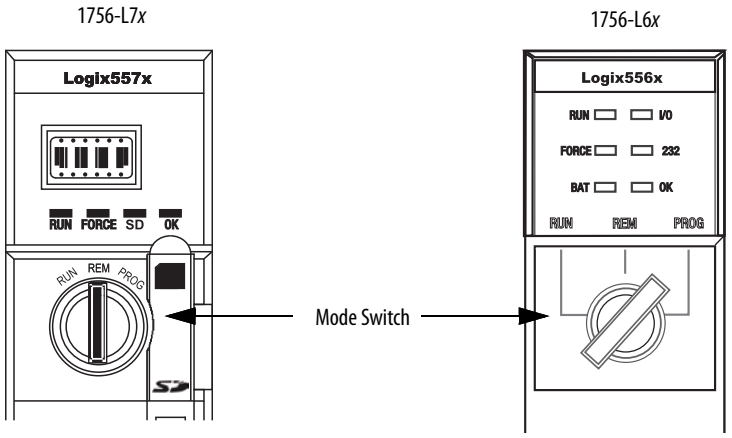
The physical mode switch can complement other authorization and authentication methods that similarly control user-access to the controller, such as the following:

- Logix CPU Security tool
- FactoryTalk® Security service

IMPORTANT During runtime, we recommend that you place the controller mode switch in RUN mode and remove the key (if applicable) from the switch. This can help discourage unauthorized access to the controller or potential tampering with the program of the controller, configuration, or device firmware. Place the mode switch in REM or PROG mode during controller commissioning and maintenance and whenever temporary access is necessary to change the program, configuration, or firmware of the product.

The mode switch on the front of the controller can be used to change the controller to one of these modes:

- Run (RUN)
- Remote (REM)
- Program (PROG)



Mode Switch Position	Available Controller Modes	ATTENTION:
RUN	**Run mode**—The controller is actively controlling the process/machine. Projects cannot be edited in the Logix Designer application when in Run mode.	Run mode is used only when all conditions are safe.
REM	**Remote Run mode**—This mode is identical to Run mode except you can edit the project online.	You are able to modify a project file online in Remote Run mode. Be sure to control outputs with care to avoid injury to personnel and damage to equipment.
	Remote Program mode—This mode is identical to Program mode.	
	Remote Test mode—The controller mode during which code is executing. I/O is not controlled, and limited editing operations are available. Output modules are commanded to their Program mode state (on, off, or hold).	Outputs are commanded to their Program mode state, which can cause a dangerous situation.
	Note: The mode of the controller can be changed from within the Logix Designer application.	
PROG	**Program mode**—The controller mode during which programming language is not executing. I/O is not controlled, and limited editing operations are available. Output modules are commanded to their Program mode state (On, Off, or Hold). In this position, controller modes cannot be changed through the Logix Designer application.	Do not use Program mode as an emergency stop (E-stop). Program mode is not a safety device. Outputs are commanded to their Program mode state, which can cause a dangerous situation.

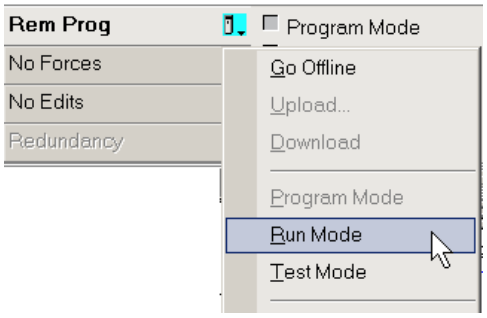
Use the Logix Designer Application to Change the Operation Mode

Dependent on the mode of the controller you specify by using the mode switch, you can change the Operation mode of the controller in the Logix Designer application.

After you are online with the controller and the controller mode switch is set to Remote (REM or the center position), you can use the Controller Status menu in the upper-left corner of the application window to specify these operation modes:

- Remote Program
- Remote Run
- Remote Test

Figure 6 - Operation Mode



TIP For this example, the controller mode switch is set to Remote mode. If your controller mode switch is set to Run or Program modes, the menu options change.

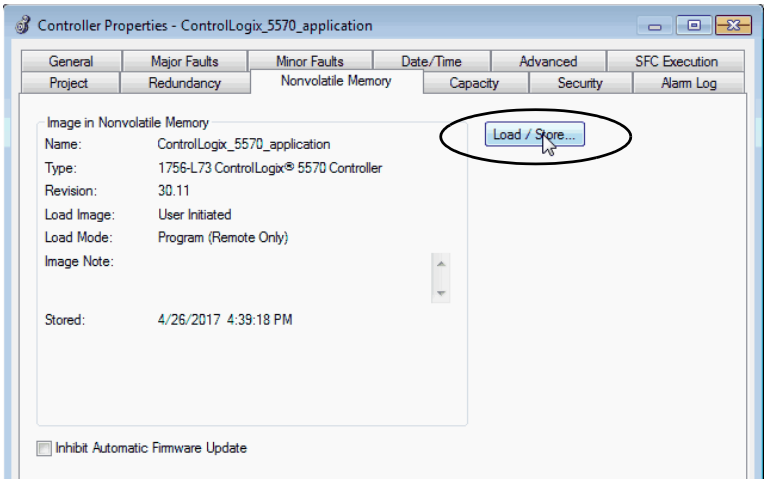
Load or Store to the Memory Card

The memory card that is compatible with your ControlLogix controller is used to load or store the contents of user memory for the controller.

Store to the Memory Card

After you are online with the controller and have changed the controller to Program or Remote Program mode, complete these steps to store a project to the memory card.

1. Open the Controller Properties dialog box and click the Nonvolatile Memory tab.
2. Click Load/Store.



TIP If Load/Store is dimmed (unavailable), verify the following:

- You have specified the correct communication path and are online with the controller in Program mode.
- The memory card is installed.
- With the 1756-L7*x* controllers, if the SD card is locked, Store is dimmed (unavailable) and the locked status is indicated in the bottom-left corner of the Nonvolatile memory/Load Store dialog box. See step 4.

If the memory card is not installed, a message in the lower-left corner of the Nonvolatile Memory tab indicates the missing card as shown here.

3. Change the Load Image, Load Mode, and Automatic Firmware Update properties according to your application requirements.

   The following table describes the Load Image options that you can choose for the project.

IMPORTANT If the SD card is locked and the Load Image option of the project is set to On Power Up, the controller firmware is not updated as a result of a firmware update. The previously stored firmware and project are loaded instead.

If you want the image (project) to load when	Then choose
Power to the controller is applied or cycled	On Power Up
The controller has lost the project and power has been cycled or applied	On Corrupt Memory
Initiated via the Logix Designer application	User Initiated

The following table describes the Load Mode options that you can choose for the project.

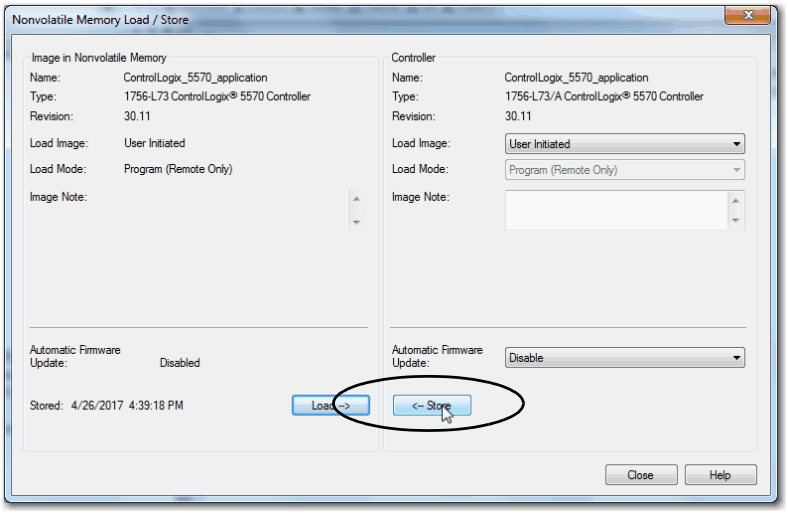
If you want the controller to go to this mode after loading	Then choose
Program	Program (remote only)
Run	Run (remote only)

The following table describes the Automatic Firmware Update options that you can choose for the project. The Automatic Firmware Update property is also referred to as the Firmware Supervisor feature.

If you want to	Then choose
Enable automatic firmware updates so that I/O devices in the configuration tree of the controller that are configured to use Exact Match Keying are updated as required	Enable and Store Files to Image(1)
Disable automatic firmware updates and remove any I/O firmware files that are stored with the image	Disable and Delete Files from Image
Disable automatic firmware updates when there are no firmware files are stored with the image	Disable

(1) The devices that are used with this option must support the revision of firmware being updated to.

4. Click Store.



5. If a confirmation dialog box appears, click Yes.

The project is saved to the memory card as indicated by the controller status indicators.

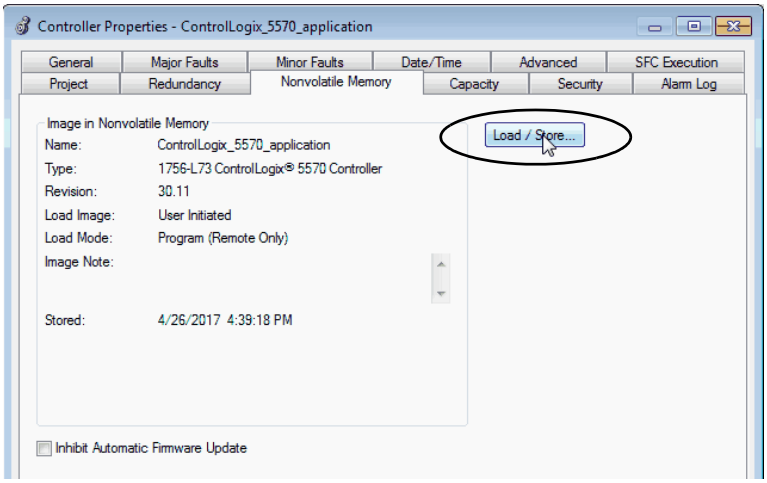
With these controllers	These indications show the store status
1756-L6*x*	While the store is **in progress**, the following occurs: • OK indicator on the controller is steady red • A dialog box in the Logix Designer application indicates that the store is in progress When the store is **complete**, the following occurs: • The OK indicator on the controller is momentarily red, then steady green
1756-L7*x*	While the store is **in progress**, the following occurs: • OK indicator is flashing green • SD indicator is flashing green • SAVE is shown on the status display • A dialog box in the Logix Designer application indicates that the store is in progress When the store is **complete**, the following occurs: • The OK indicator on the controller is momentarily red, then steady green • The SD indicator on the controller is Off

IMPORTANT Allow the store to complete without interruption. If you interrupt the store, data corruption or loss can occur.

Load from the Memory Card

After you have set the communication path, are online with the controller, and have changed the controller to Program mode, complete these steps to load a project to the controller from the memory card.

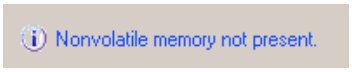
1. Open the Controller Properties and click the Nonvolatile Memory tab.
2. Click Load/Store.



TIP If Load/Store is dimmed (unavailable), verify the following:

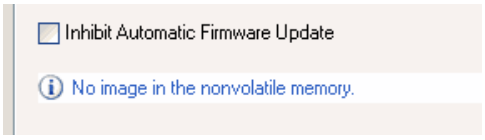
- You have specified the correct communication path and are online with the controller.
- The memory card is installed.

If the memory card is not installed, a message in the lower-left corner of the Nonvolatile Memory tab indicates the missing card as shown here.



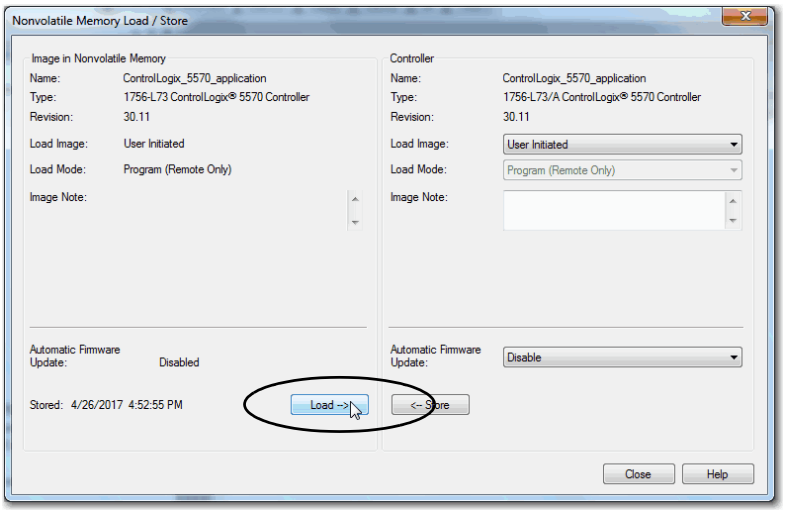
3. Verify that the image in nonvolatile memory (that is, the project on the memory card) is the project that you want to load.

TIP If no project is stored on the memory card, a message in the lower-left corner of the Nonvolatile Memory tab indicates that an image (or project) is not available as shown here.



TIP For information to change the project that is available to load from nonvolatile memory, see the Logix 5000® Controllers Nonvolatile Memory Programming Manual, publication 1756-PM017.

4. Click Load.



5. If a confirmation dialog box appears, click Yes.

   The project is loaded to the controller as indicated by the controller status indicators.

With these controllers	These indications show the store status
1756-L6*x*	While the **load is in progress**, the following occurs: • OK indicator on the controller is flashing green • A dialog box in the Logix Designer application indicates that the store is in progress When the **load is complete**, the following occurs: • The OK indicator on the controller is momentarily red, then steady green
1756-L7*x*	While the **load is in progress**, the following occurs: • OK indicator is steady red • SD indicator is flashing green • LOAD is shown on the status display • UPDT can be shown on the status display if the firmware is also updating with the load • A dialog box in the Logix Designer application indicates that the store is in progress When the **load is complete**, the following occurs: • The OK indicator on the controller is momentarily red, then steady green • The SD indicator on the controller is Off

IMPORTANT Allow the load to complete without interruption. If you interrupt the load, data corruption or loss can occur.

Other Memory Card Tasks

Other tasks that you can complete by using the memory cards of the controller include the following:

- Change the image that is loaded from the card
- Check for a load that was completed
- Clear an image from the memory card
- Store an empty image
- Change load parameters
- Read/write application data to the card

For more information to complete any of these tasks, see the Logix 5000 Controllers Memory Card Programming Manual, publication 1756-PM017.

Use ControlLogix Energy Storage Modules (ESMs)

You can use the ControlLogix ESMs to execute one of the following tasks:

- Provide power to 1756-L7*x* controllers to save the program to the onboard nonvolatile storage (NVS) memory of the controller after power is removed from the chassis or the controller is removed from a powered chassis.

  IMPORTANT When you are using an ESM to save the program to onboard NVS memory, you are **not** saving the program to the SD card installed in the controller.

- Clear the program from the onboard NVS memory of the 1756-L7x controller. For more information, see Clear the Program from Onboard NVS Memory.

This table describes the energy storage modules (ESM).

Cat. No.	Description
1756-ESMCAP	Capacitor-based ESM The 1756-L7*x* controllers come with this ESM installed.
1756-ESMNSE	Capacitor-based ESM without WallClockTime back-up power Use this ESM if your application requires that the ESM depletes its residual stored energy to 40 mJ or less before transporting it into or out of your application. Additionally, you can use this ESM with only a 1756-L73 (8 MB) or smaller memory-sized controller.
1756-ESMNRM	Secure capacitor-based ESM (nonremovable) This ESM provides your application an enhanced degree of security by blocking physical access to the USB connector and the SD card.

Save the Program to On-board NVS Memory

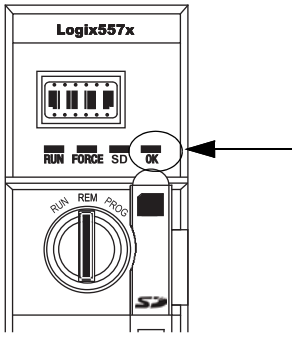
Follow these steps to save the program to NVS memory when the controller loses power.

1. Remove power from the controller.

   You can remove power in one of two ways:
   - Turn power off to the chassis while the controller is installed in the chassis.
   - Remove the controller from a powered chassis.

   Immediately after the controller is no longer powered, the program starts saving while the OK status indicator is green (this green is a dimmer green than normal operation), then turns red after program save is complete. Once the ESM stops operating, it turns off.

   This graphic shows the OK status indicator on the controller.



2. Leave the ESM on the controller until the OK status indicator is Off.

Clear the Program from Onboard NVS Memory

If your application lets you, follow these steps to clear the program from the onboard NVS memory of the 1756-L7x controller.

1. Remove the ESM from the controller.
2. Remove power from the controller.

   You can remove power in one of the following two ways:
   - Turn power off to the chassis while the controller is installed in the chassis.
   - Remove the controller from a powered chassis.
3. Reinstall the ESM into the controller.
4. Restore power to the controller in one of these two ways:
   - If the controller is installed in the chassis, turn power back onto the chassis.
   - If the controller is not installed into the chassis, reinstall the controller into the chassis and turn power back onto the chassis.

Estimate the ESM Support of the WallClockTime

The ESM provides support for the maintenance of the WallClockTime of the controller when power is not applied. Use this table to estimate the hold-up time of the ESM based on the temperature of the controller and installed ESM.

	Hold-up Time (in days)		
Temperature	**1756-ESMCAP**	**1756-ESMNRM**	**1756-ESMNSE**
20 °C (68 °F)	12	12	0
40 °C (104 °F)	10	10	0
60 °C (140 °F)	7	7	0

IMPORTANT Any action that causes the 1756-L7*x* controller to reset (hard or soft), without an ESM installed, results in the WallClockTime of the controller being reset to the factory default of 01/01/1998.

To check the status of the ESM, see General Status Messages on page 174.

Maintain the Battery (Only 1756-L6*x* Controllers)

This section explains how to monitor and maintain the lithium batteries that the ControlLogix controllers support.

Table 8 - 1756-L6*x* Controllers and Compatible Batteries

Cat. No.	Series	Compatible Battery
1756-L61 1756-L62 1756-L63	A	1756-BA1 **or** 1756-BATA **or** 1756-BATM
1756-L61 1756-L62 1756-L63 1756-L64 1756-L65	B	1756-BA2
1756-L63XT	B	

For further information, see the Additional Resources section in the preface.

Check the Battery Status

When the battery is approximately 95% discharged, these low-battery warnings are indicated:

- The BAT is steady red.
- A minor fault (type 10, code 10) is logged.

IMPORTANT To help prevent possible battery leakage, even if the BAT status indicator is off, replace a battery according to this schedule.

If the temperature 2.54 cm (1 in.) below the chassis is	Replace the battery within
-25…35 °C (-13…95 °F)	No replacement required
36…40 °C (96.8…104 °F)	3 years
41…45 °C (105.8…113 °F)	2 years
46…50 °C (114.8…122 °F)	16 months
51…55 °C (123.8…131 °F)	11 months
56…70 °C (132.8…158 °F)	8 months

1756-BA1 or 1756-BATA Battery Life

To estimate how long a 1756-BA1 or 1756-BATA battery can support controller memory on 1756-L6*x*, series A controllers, perform this procedure.

1. Determine the temperature 2.54 cm (1 in.) below the chassis.
2. Determine the weekly percentage of time that the controller is turned on.

EXAMPLE If a controller is Off at one of these times:

- 8 hr/day during a 5-day work week
- All day Saturday and Sunday

Then the controller is off 52% of the time:

- Total hours per week = 7 x 24 = 168 hrs
- Total off hours per week = (5 days x 8 hr/day) + Saturday + Sunday = 88 hrs
- Percentage off time = 88/168 = 52%

3. Determine the estimated worst-case battery life before and after the BAT status indicator turns on.
4. For each year of battery life, decrease the time before the BAT status indicator turns on by the percentage that is shown in the table.

   Do not decrease the time after the BAT status indicator turns on.

IMPORTANT If the BAT status indicator turns on when you apply power to the controller, the remaining battery life can be less than Table 9 indicates. Some of the battery life can be used up while the controller is off and unable to turn on the BAT status indicator.

Table 9 - Worst-case Estimates of 1756-BA1 Battery Life

Temperature	Battery Life Before BAT Status Indicator Turns On			Battery Life After BAT Status Indicator Turns On and Power is Off
	Power Off 100%	Power Off 50%	Yearly Decrease	
60 °C (140 °F)	22 days	43 days	23%	6 hrs
25 °C (77 °F)	21 days	42 days	17%	28 hrs
0 °C (32 °F)	14 days	28 days	17%	2.5 days

Table 10 - Worst-case Estimates of 1756-BATA Battery Life

Temperature	Battery Life Before BAT Status Indicator Turns On			Battery Life After BAT Status Indicator Turns On and Power is Off
	Power Off 100%	Power Off 50%	Yearly Decrease	
60 °C (140 °F)	98 days	204 days	11%	104 days
25 °C (77 °F)	146 days	268 days	5%	157 days
0 °C (32 °F)	105 days	222 days	6%	113 days

1756-BATM Battery Module and Battery Life

Use the 1756-BATM battery module with any 1756-L6*x*/A controller. The battery module is highly recommended for higher-memory controllers.

IMPORTANT If your project is not stored in nonvolatile memory, the use of the battery module is highly recommended.

When the 1756-BATA battery within the 1756-BATM module is approximately 50% discharged, these low-battery warnings are indicated:

- The BAT is steady red.
- A minor fault (type 10, code 10) is logged.

Estimate 1756-BA2 Battery Life

The 1756-BA2 batteries are for use in 1756-L6*x*/B controllers. Use Table 11 to estimate how much time can elapse before the battery becomes low.

Table 11 - Worst-case Estimates of 1756-BA2 Life according to Temperatures and Power Cycles

Temperature 2.54 cm (1 in.) Below the Chassis, max	Power Cycles	Battery Life Before the BAT Status Indicator Turns Red				
		Project Size				
		1 MB	2 MB	4 MB	8 MB	16 MB
-25…35 °C (-13…95 °F)	3 per day	3 years	3 years	26 months	20 months	10 months
	2 per day or less	3 years	3 years	3 years	31 months	16 months
41…45 °C (105.8…113 °F)	3 per day	2 years	2 years	2 years	20 months	10 months
	2 per day or less	2 years	2 years	2 years	2 years	16 months
46…50 °C (105.8…113 °F)	3 per day or less	16 months	16 months	16 months	16 months	10 months
51…55 °C (123.8…131 °F)	3 per day or less	11 months	11 months	11 months	11 months	10 months
56…70 °C (132.8…158 °F)	3 per day or less	8 months	8 months	8 months	8 months	8 months

Estimate 1756-BA2 Battery Life After Warnings

Use this table to estimate the battery life after the low-battery warnings are indicated. Use these times even if the controller does not have power because there is a small power-drain on the battery.

IMPORTANT When you power up the controller, see if there is a low-battery warning. If you get a low-battery warning for the first time, you have less battery life than this table shows. While powered down, the controller still drains the battery but it cannot give the low-battery warning.

Temperature 2.54 cm (1 in.) Below the Chassis, max	Power Cycles	Battery Life After the BAT Status Indicator Turns Red (worst case)				
		Project Size				
		1 MB	2 MB	4 MB	8 MB	16 MB
0…20 °C (32…68 °F)	3 per day	26 weeks	18 weeks	12 weeks	9 weeks	5 weeks
	1 per day	26 weeks	26 weeks	26 weeks	22 weeks	13 weeks
	1 per month	26 weeks	26 weeks	26 weeks	26 weeks	26 weeks
21…40 °C (69.8…104 °F)	3 per day	18 weeks	14 weeks	10 weeks	8 weeks	5 weeks
	1 per day	24 weeks	21 weeks	18 weeks	16 weeks	11 weeks
	1 per month	26 weeks	26 weeks	26 weeks	26 weeks	26 weeks
41…45 °C (105.8…113 °F)	3 per day	12 weeks	10 weeks	7 weeks	6 weeks	4 weeks
	1 per day	15 weeks	14 weeks	12 weeks	11 weeks	8 weeks
	1 per month	17 weeks	17 weeks	17 weeks	17 weeks	16 weeks
46…50 °C (105.8…113 °F)	3 per day	10 weeks	8 weeks	6 weeks	6 weeks	3 weeks
	1 per day	12 weeks	11 weeks	10 weeks	9 weeks	7 weeks
	1 per month	12 weeks	12 weeks	12 weeks	12 weeks	12 weeks
51…55 °C (123.8…131 °F)	3 per day	7 weeks	6 weeks	5 weeks	4 weeks	3 weeks
	1 per day	8 weeks	8 weeks	7 weeks	7 weeks	5 weeks
	1 per month	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks
56…60 °C (132.8…140 °F)	3 per day	5 weeks	5 weeks	4 weeks	4 weeks	2 weeks
	1 per day	6 weeks	6 weeks	5 weeks	5 weeks	4 weeks
	1 per month	6 weeks	6 weeks	6 weeks	6 weeks	6 weeks

EXAMPLE Under these conditions, the battery lasts at least 20 months before the BAT status indicator turns red:

- The maximum temperature 2.54 cm (1 in.) below the chassis = 45 °C (113 °F).
- You cycle power to the controller three times per day.
- The controller contains an 8 MB project.

Battery Storage and Disposal

Follow these general rules to store your batteries:

- Store batteries in a cool, dry environment. We recommend 25 °C (77 °F) with 40…60% relative humidity.
- You can store batteries for up to 30 days in temperatures from -45…85 °C (-49…185 °F), such as during transportation.
- To avoid leakage or other hazards, do not store batteries above 60 °C (140 °F) for more than 30 days.

This product contains a sealed lithium battery that must be replaced during the life of the product.

At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.

The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

ControlLogix System and Controllers

ControlLogix System

The ControlLogix® system is chassis-based and provides the option to configure a control system that uses sequential, process, motion, drive control, and communication and I/O capabilities.

Configuration Options

This section describes some of the many system configuration options that are available with ControlLogix controllers.

Standalone Controller and I/O

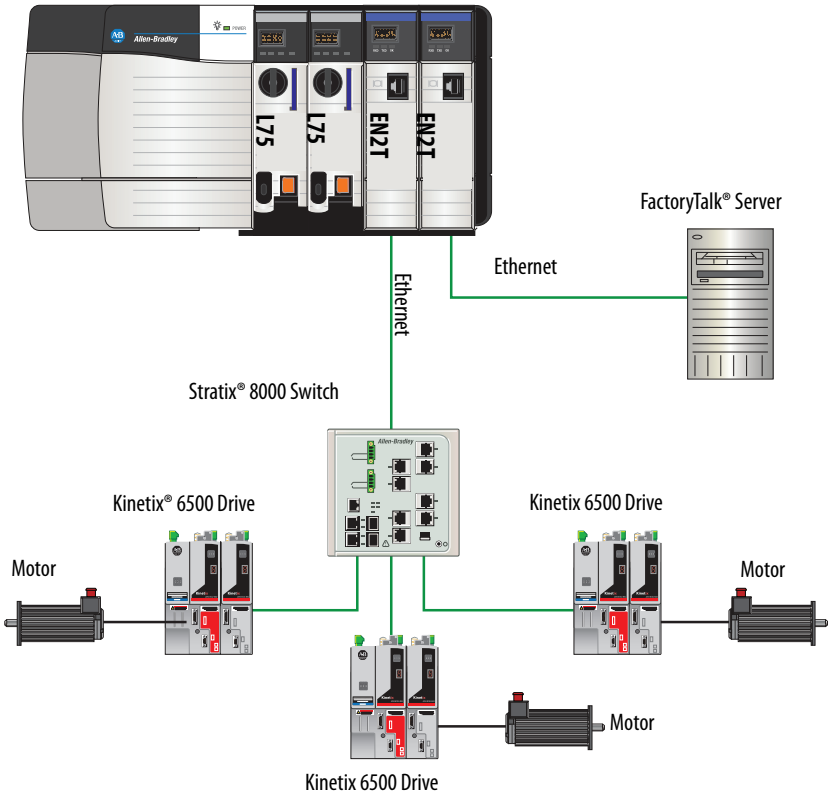
One of the simplest ControlLogix configurations is a standalone controller with I/O assembled in one chassis.

Figure 7 - Standalone Controller and I/O5

Multiple Controllers in One Chassis

For some applications, multiple controllers can be used in one ControlLogix chassis. For example, for better performance, multiple controllers can be used in motion applications.

Figure 8 - Multiple Controllers in One Chassis

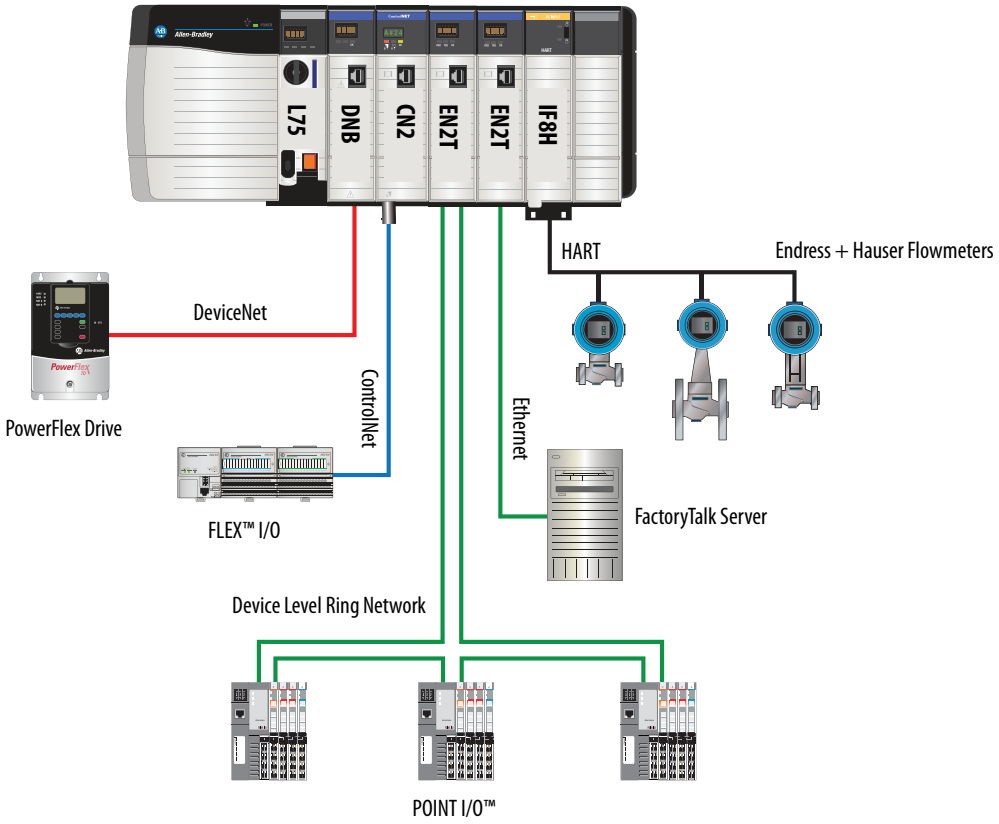


Multiple Devices Connected Via Multiple Networks

For some applications, various devices can be connected to the ControlLogix chassis via multiple communication networks. For example, a system can be connected to the following:

- Distributed I/O via an Ethernet network
- A PowerFlex® drive connected via a DeviceNet® network
- Flowmeters that are connected via a HART connection

Figure 9 - Multiple Devices Connected Via Multiple Networks



Design a ControlLogix System

When you design a ControlLogix system, there are several system components to consider for your application. Some of these components include the following:

- I/O devices
- Motion control and drive requirements
- Communication modules
- Controllers
- Chassis
- Power supplies
- Studio 5000® environment

For more information to design and select components for your ControlLogix system, see the ControlLogix Selection Guide, publication 1756-SG001.

See the Additional Resources section in the preface for more information if you are designing your ControlLogix System for any of the following applications:

- Motion with Integrated Motion on the EtherNet/IP™ network
- Motion with the use of a coordinate system
- Motion with Sercos or analog motion
- Enhanced redundancy
- Standard redundancy
- SIL 2
- SIL 2 fault-tolerant I/O with Studio 5000 subroutines
- SIL 2 fault-tolerant I/O with Studio 5000 Add-On Instructions

ControlLogix Controller Features

The ControlLogix controllers are part of the Logix 5000® family of controllers that are offered by Rockwell Automation. The sections that follow describe the differentiating features of the ControlLogix controllers.

System, Communication, and Programming Features

Table 12 lists the system, communication, and programming features available with ControlLogix controllers.

Table 12 - ControlLogix Controller Features

Feature	1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65	1756-L71, 1756-L72, 1756-L73, 1756-L74, 1756-L75	1756-L72EROM, 1756-L73EROM
Controller tasks	• 32 tasks • 100 programs/task • Event tasks: all event triggers	• 32 tasks • 1000 programs/task starting in Logix Designer application version 24 and later • 100 programs/task starting in Logix Designer application version 15 • 32 programs/task prior to Logix Designer application version 15 • Event tasks: all event triggers	
Communication ports	1 port - RS-232 serial	1 port - USB, 2.0 full-speed, Type B	
Communication options	• EtherNet/IP • ControlNet® • DeviceNet • Data Highway Plus™ • Remote I/O • SynchLink™ • Third-party process and device networks		EtherNet/IP
Serial port communication	• ASCII • DF1 full/half-duplex • DF1 radio modem • DH-485 • Modbus via logic	N/A	
Controller connections supported, max	250	500	
Network connections, per network module	• 128 ControlNet (1756-CN2/B) • 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB) • 256 EtherNet/IP; 128 TCP (1756-EN2*x*) • 128 EtherNet/IP; 64 TCP (1756-ENBT)		256 EtherNet/IP; 128 TCP (1756-EN2*x*)
Controller redundancy	Full support except for motion applications		
Integrated motion	• Integrated Motion on the EtherNet/IP network • Sercos interface • Analog options: – Encoder input – LDT input – SSI input		
Programming languages	• Relay ladder • Structured text • Function block • Sequential function chart (SFC)		

Memory Options

The ControlLogix controller is available in different combinations of user memory. Use Table 13 to determine which controller meets your memory requirements.

Table 13 - ControlLogix Controller Memory Options

Controller	Memory for Data and Logic	I/O	Back-up Memory
1756-L61	2 MB	478 KB	CompactFlash card(1)
1756-L62	4 MB		
1756-L63, 1756-L63XT	8 MB		
1756-L64	16 MB		
1756-L65	32 MB		
1756-L71	2 MB	0.98 MB (1006 KB)	SD card
1756-L72	4 MB		
1756-L73, 1756-L73XT	8 MB		
1756-L74	16 MB		
1756-L75	32 MB		
1756-L72EROM	4 MB		
1756-L73EROM	8 MB		

(1) These nonvolatile memory cards are optional and do not come with the controller.

IMPORTANT The 1756-L7*x* controllers ship with an SD card installed. We recommend that you leave the SD card installed, so if a fault occurs, diagnostic data is automatically written to the card and Rockwell Automation can use the data to troubleshoot the anomaly.

IMPORTANT We recommend that you use the SD cards available from Rockwell Automation (catalog numbers 1784-SD1 or 1784-SD2).

While other SD cards can be used with the controller, Rockwell Automation has not tested the use of those cards with the controller. If you use an SD card other than those cards that are available from Rockwell Automation, you can experience data corruption or loss.

Also, SD cards that are not provided by Rockwell Automation can have different industrial, environmental, and certification ratings as those cards that are available from Rockwell Automation and can have difficulty with survival in the same industrial environments as the industrially rated versions available from Rockwell Automation.

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device that is defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared.

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The following Electronic Keying options are available.

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics: • Same catalog number • Same or higher Major Revision • Minor Revision as follows: – If the Major Revision is the same, the Minor Revision must be the same or higher. – If the Major Revision is higher, the Minor Revision can be any number.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **ATTENTION**: Be cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. **We strongly recommend that you do not use Disable Keying.** If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken.

If an I/O connection to a device is interrupted, the result can be a loss of data.

More Information

For more detailed information on Electronic Keying, see Electronic Keying in the Logix 5000 Control Systems Application Technique, publication LOGIX-AT001.

Notes:

Communication Networks

Networks Available

Several communication networks are available for use with ControlLogix® systems. Table 14 describes typical network applications that are used with ControlLogix systems and lists the networks available to support such applications.

Table 14 - Applications and Supported Networks

Application Type	Supported Networks
Integrated Motion	EtherNet/IP™
Integrated Motion on the EtherNet/IP network for time synchronization	EtherNet/IP
Control of distributed I/O	• ControlNet® • DeviceNet® • EtherNet/IP • Foundation Fieldbus • HART • Universal remote I/O
Produce/consume data between controllers	• ControlNet • EtherNet/IP
Messaging to and from other devices, including access to the controller via the Studio 5000 Logix Designer® application	• ControlNet • DeviceNet (only to devices) • Data Highway Plus™ (DH+™) • DH-485 • EtherNet/IP • Serial

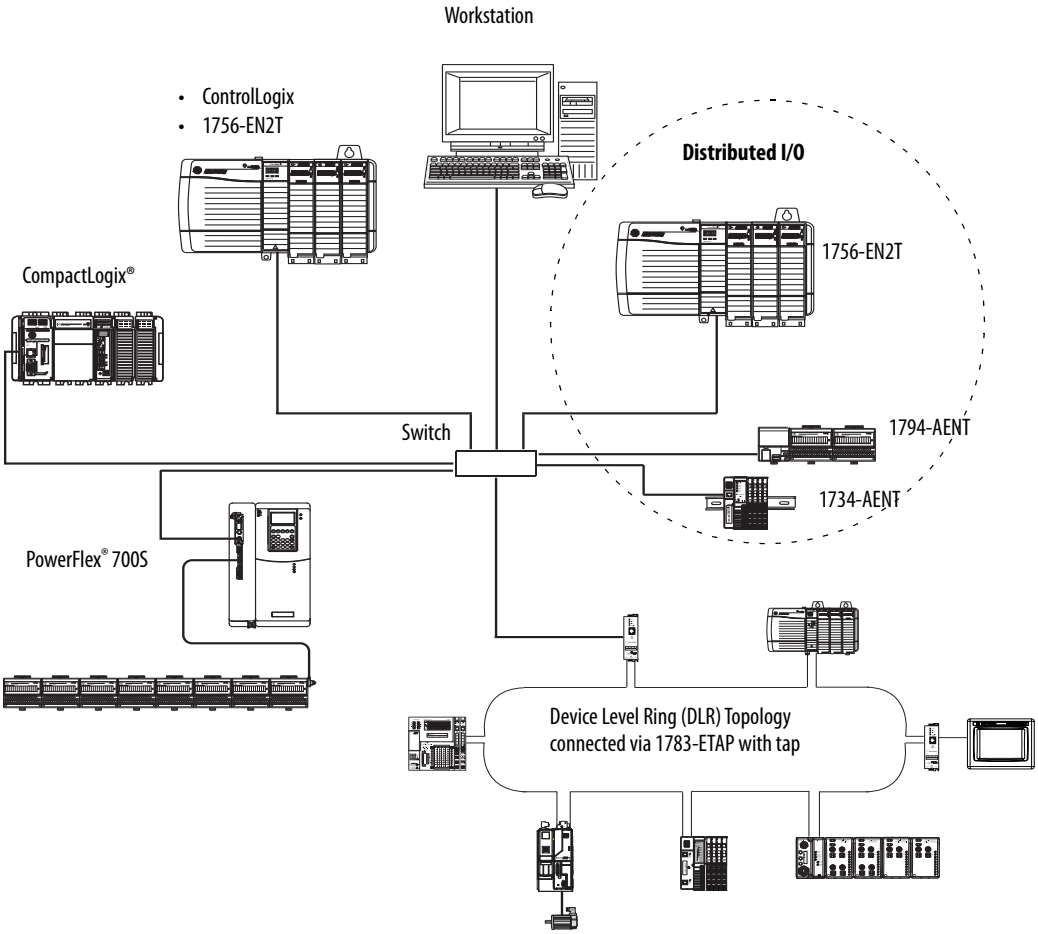
For more information about network design for your system, see the Ethernet Design Considerations Reference Manual, publication ENET-RM002.

EtherNet/IP Network Communication

The EtherNet/IP network offers a full suite of control, configuration, and data collection services by layering the Common Industrial Protocol (CIP™) over the standard internet protocols, such as TCP/IP and UDP. This combination of well-accepted standards provides the capability that is required to support information data exchange and control applications.

The EtherNet/IP network uses commercially available Ethernet components and physical media, providing you with a cost-effective plant-floor solution.

Figure 10 - EtherNet/IP Network Example



For more information about using EtherNet/IP modules, see the EtherNet/IP Modules in Logix 5000 Control Systems User Manual, publication ENET-UM001.

ControlLogix EtherNet/IP Module Features

The ControlLogix EtherNet/IP communication modules provide these features:

- Support for messaging, produced/consumed tags, HMI, and distributed I/O
- The ability to encapsulate messages within the standard TCP/UDP/IP protocol
- A common application layer with ControlNet and DeviceNet networks
- Network connections via an RJ45 cable
- Support half/full duplex 10 MB or 100 MB operation
- Support standard switches

ControlLogix EtherNet/IP Communication Modules

For EtherNet/IP network communication in a ControlLogix system, you have a number of modules to choose from. Table 15 lists their primary features.

Table 15 - EtherNet/IP Communication Modules and Capabilities

Module	Is used to
1756-ENBT	• Connect controllers to I/O modules (requires an adapter for distributed I/O). • Communicate with other EtherNet/IP devices (messages). • Serve as a pathway to share data between Logix 5000® controllers (produce/consume). • Bridge EtherNet/IP nodes to route messages to devices on other networks.
1756-EN2T	• Perform the same functions as a 1756-ENBT module, with twice the capacity for more demanding applications. • Provide a temporary configuration connection via the USB port. • Configure IP addresses quickly by using rotary switches. • Supports as many as 8 integrated motion on the EtherNet/IP network axes
1756-EN2F	• Perform the same functions as a 1756-EN2T module. • Connect fiber media by an LC fiber connector on the module.
1756-EN2TR	• Perform the same functions as a 1756-EN2T module. • Support communication on a ring topology for a Device Level Ring (DLR) single-fault tolerant ring network.
1756-EN2TRXT	• Perform the same functions as a 1756-EN2T module. • Support communication on a ring topology for a Device Level Ring (DLR) single-fault tolerant ring network. • Operate in extreme environments with -25…+70 °C (-13…+158 °F) temperatures.
1756-EN3TR	• Perform the same functions as the 1756-EN2TR module. • Extended Integrated Motion on EtherNet/IP network. • Support of up to 128 motion axes.
1756-EN2TSC	• Perform the same functions as a 1756-ENBT module, with twice the capacity for more demanding applications. • Provide a temporary configuration connection via the USB port. • Configure IP addresses quickly by using rotary switches.
1756-EN2TXT	• Perform the same functions as a 1756-EN2T module. • Operate in extreme environments with -25…+70 °C (-13…+158 °F) temperatures.
1756-EWEB	• Provide customizable webpages for external access to controller information. • Provide remote access via an internet browser to tags in a local ControlLogix controller. • Communicate with other EtherNet/IP devices (messages). • Bridge EtherNet/IP nodes to route messages to devices on other networks. • Support Ethernet devices that are not EtherNet/IP-based with a socket interface. This module does not provide support for I/O or produced/consumed tags.

Software for EtherNet/IP Networks

Table 16 lists software that is used with the EtherNet/IP networks and modules

Table 16 - Software for Use with EtherNet/IP Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define EtherNet/IP communication.	Required
RSLinx® Classic or FactoryTalk® Linx	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	Required
BOOTP/DHCP Utility	Assign IP addresses to devices on an EtherNet/IP network.	Optional
RSNetWorx™ for EtherNet/IP™	• Configure EtherNet/IP devices by IP addresses and/or host names. • Provide bandwidth status.	

Connections Over an EtherNet/IP Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communication between devices as compared to unconnected messages.

All EtherNet/IP connections are unscheduled. The requested packet interval (RPI) for I/O control or the program, such as an MSG instruction triggers an unscheduled connection. Unscheduled messaging lets you send and receive data when needed.

Double Data Rate (DDR) Backplane Communication

DDR communication can be achieved with the 1756-L7*x* controller. The following communication modules support DDR when used with the 1756-L7*x* controller. Some modules require a minimum series:

- 1756-EN2T/C
- 1756-EN2TR/B
- 1756-EN2TF/B
- 1756-EN2TXT/C
- 1756-RM/B

DDR communication is achieved most efficiently when all modules in the communication path are DDR modules, or, in other words, as one conversation (connection) only between DDR modules.

DDR communication is achievable in a chassis with a mix of DDR and non-DDR modules. The DDR communication occurs between the modules that support it. If non-DDR modules are also in the chassis, communication between those modules is at the non-DDR rate.

For example, you can have a chassis with two 1756-L7*x* controllers in slots 0 and 1 communicating with each other by using DDR, and two 1756-L6*x* controllers in slots 2 and 3 communicating by using non-DDR.

When multicast communication is used within a chassis to multiple modules, the transmission rate is limited to the slowest module—or at the non-DDR rate.

For example, if a 1756-L7*x* controller is producing a tag to a 1756-L7*x* controller **and** a 1756-L6*x* controller on the same multicast connection, it must use the non-DDR rate.

ControlNet Network Communication

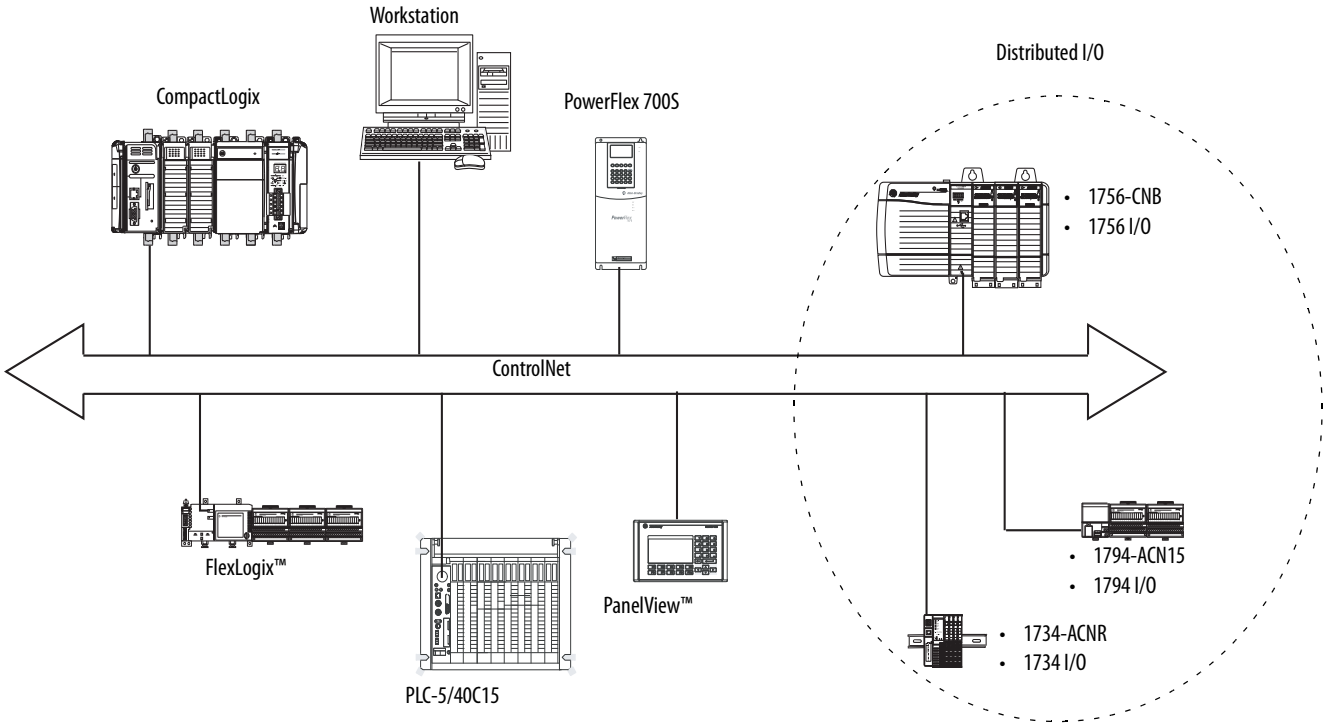
The ControlNet network is a real-time control network that provides high-speed transport of time-critical I/O and interlocking data and messaging data. This includes the upload and download of program and configuration data on one physical-media link. The highly efficient data transfer capability of the ControlNet network significantly enhances I/O performance and peer-to-peer communication in any system or application.

The ControlNet network is highly deterministic and repeatable and is unaffected when devices are connected or disconnected from the network. This quality results in dependable, synchronized, and coordinated real-time performance.

The ControlNet network often functions as the following:

- A substitute/replacement for the remote I/O (RIO) network because the ControlNet network adeptly handles large numbers of I/O points
- A backbone for multiple distributed DeviceNet networks
- A peer interlocking network

Figure 11 - ControlNet Network Overview



In this example, these actions occur via the ControlNet network:

- The controllers produce and consume tags.
- The controllers initiate MSG instructions that do the following:
  - Send and receive data.
  - Configure devices.
- The workstation is used to do the following:
  - Configure the ControlNet devices and the ControlNet network.
  - Download and upload projects from the controllers.

For more information about using ControlNet modules, see ControlNet Modules in Logix 5000 Control Systems User Manual, publication CNET-UM001.

ControlLogix ControlNet Module Features

The ControlNet communication modules provide these features:

- Support for messaging, produced/consumed tags, and distributed I/O
- Use a common application layer with DeviceNet and EtherNet/IP networks
- Requires no routing tables
- Support the use of coax and fiber repeaters for isolation and increased distance
- Support redundant media (only 1756-CNBR, 1756-CN2R, and 1756-CN2RXT modules)

ControlLogix ControlNet Modules

Table 17 lists the available ControlLogix ControlNet modules and their primary features.

Table 17 - ControlNet Modules and Capabilities

Module	Is used to
1756-CNB	• Control I/O modules. • Communicate with other ControlNet devices (messages). • Share data with other Logix 5000 controllers (produce/consume). • Bridge ControlNet links to route messages to devices on other networks.
1756-CNBR	• Perform the same functions as a 1756-CNB module. • Support redundant ControlNet media.
1756-CN2	• Perform the same functions as a 1756-CNB module. • Provide twice the capacity for more demanding applications.
1756-CN2R	• Perform the same functions as a 1756-CN2 module. • Support redundant ControlNet media.
1756-CN2RXT	• Perform same functions as a 1756-CN2R module. • Operate in extreme environments with -25…+70 °C (-13…+158 °F) temperatures.

Software for ControlNet Networks

Table 18 lists software that is used with the ControlNet networks and modules.

Table 18 - Software for Use with ControlNet Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define ControlNet communication.	Required
RSNetWorx™ for ControlNet™	• Configure ControlNet devices. • Schedule a network.	
RSLinx® Classic or Enterprise	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	

Connections Over a ControlNet Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide communication between devices as compared to unconnected messages.

Table 19 - ControlNet Connections

Connection	Definition
Scheduled (unique to a ControlNet network)	A scheduled connection is unique to ControlNet communication. A scheduled connection lets you send and receive data repeatedly at a predetermined interval, which is the requested packet interval (RPI). For example, a connection to an I/O module is a scheduled connection because you repeatedly receive data from the module at a specified interval. Other scheduled connections include connections to the following: • Communication devices • Produced/consumed tags On a ControlNet network, you must use RSNetWorx for ControlNet software to enable all scheduled connections and establish a network update time (NUT). A scheduled connection reserves network bandwidth specifically to handle the connection.
Unscheduled	An unscheduled connection is a message transfer between devices that the requested packet interval (RPI) or the program, such as an MSG instruction, triggers. Unscheduled messaging allows you to send and receive data when you must: Unscheduled connections use the remainder of network bandwidth after scheduled connections are allocated.

ControlNet Module Connections

The 1756-CNB and 1756-CNBR communication modules support 64 CIP connections over a ControlNet network. However, for optimal performance, configure a maximum of 48 connections for each module.

The 1756-CN2, 1756-CN2R, and 1756-CN2RXT communication modules support 128 connections over a ControlNet network, all of which can be configured without risk of performance degradation.

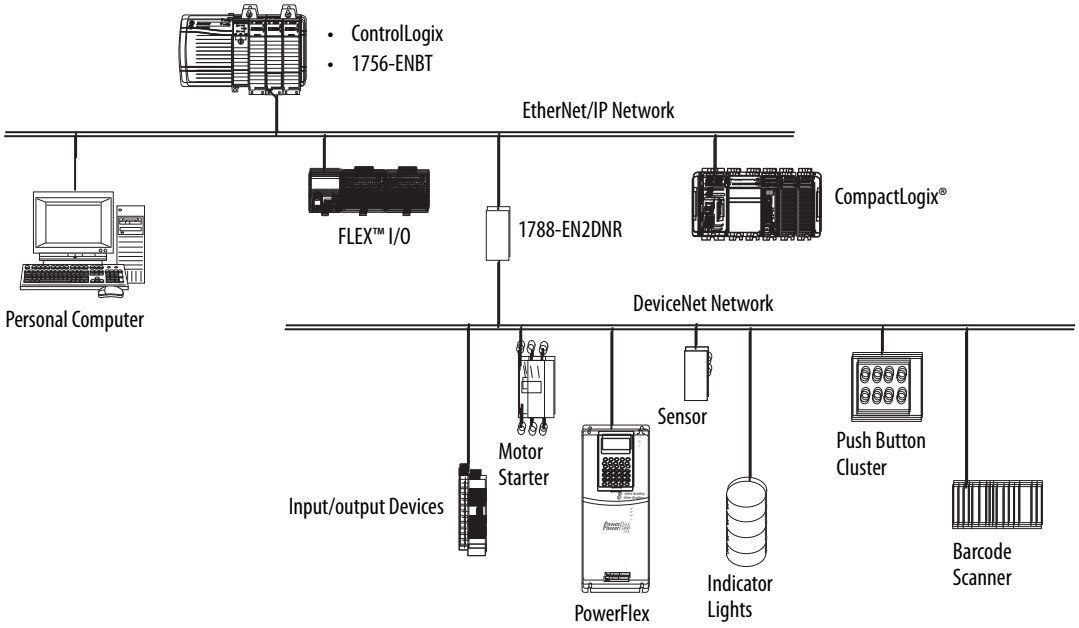
DeviceNet Network Communication

The DeviceNet network uses the Common Industrial Protocol (CIP) to provide the control, configuration, and data collection capabilities for industrial devices. The DeviceNet network uses the proven Controller Area Network (CAN) technology, which lowers installation costs and decreases installation time and costly downtime.

A DeviceNet network provides access to the intelligence present in your devices by letting you connect devices directly to plant-floor controllers without having to hard-wire each device into an I/O module.

With a ControlLogix system, DeviceNet communication requires the use of a 1756-DNB DeviceNet communication module.

Figure 12 - ControlLogix DeviceNet Network Overview



In this example, the ControlLogix controller is connected to the DeviceNet network and devices via the 1788-EN2DNR linking device.

For more information about using DeviceNet modules and devices, see DeviceNet Modules in Logix 5000 Control Systems User Manual, publication DNET-UM004.

ControlLogix DeviceNet Module Features

The DeviceNet communication module provides these features:

- Supports messaging to devices (not controller to controller)
- Shares a common application layer with ControlNet and EtherNet/IP networks
- Offers diagnostics for improved data collection and fault detection
- Requires less wiring than standard, hard-wired systems

ControlLogix DeviceNet Bridge and Linking Devices

Table 20 lists the available ControlLogix DeviceNet bridge and linking devices that can be used with the DeviceNet network.

Table 20 - DeviceNet Communication Modules and Capabilities

Module/Device	Is used to
1756-DNB	• Control I/O modules. • Communicate with other DeviceNet devices (via messages).
1788-EN2DNR	Link an EtherNet/IP network to a DeviceNet network.
1788-CN2DN	Link a ControlNet network to a DeviceNet network.

Software for DeviceNet Networks

Table 21 lists software that is used with the DeviceNet networks and modules.

Table 21 - Software for Use with DeviceNet Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define DeviceNet communication.	Required
RSNetWorx™ for DeviceNet™	• Configure DeviceNet devices. • Define the scan list for those devices.	
RSLinx Classic or Enterprise	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	

Connections Over DeviceNet Networks

The ControlLogix controller requires two connections for each 1756-DNB module. One connection is for module status and configuration. The other connection is a rack-optimized connection for the device data.

ControlLogix DeviceNet Module Memory

The 1756-DNB module has fixed sections of memory for the input and output data of the DeviceNet devices on the network. Each device on your network requires some input or output memory of the scanner. Some devices send and receive data, so they need input and output memory. The 1756-DNB module supports up to add the following:

- 124 DINTs of input data
- 123 DINTs of output data

Data Highway Plus (DH+) Network Communication

For DH+ network communication, you have two module options for use in the ControlLogix chassis. Table 22 lists the DH+ modules and capabilities.

Table 22 - DH+ Modules and Capabilities

RIO Module	Is used to
1756-DHRIO	• Function as a remote I/O (RIO) scanner. • Support 32 logical rack connections or 16 block transfer connections per channel. • Establish connections between controllers and I/O adapters. • Distribute control so that each controller has its own I/O.
1756-DHRIOXT	• Function as a remote I/O (RIO) scanner. • Support 32 logical rack connections or 16 block transfer connections per channel. • Establish connections between controllers and I/O adapters. • Distribute control so that each controller has its own I/O. • Operate in extreme environments with -25…70 °C (-13…158 °F) temperatures.

For DH+ network communication, use a 1756-DHRIO or 1756-DHRIOXT module in the ControlLogix chassis to exchange information between these controllers:

- PLC and SLC™ controllers
- ControlLogix controllers and PLC or SLC controllers
- ControlLogix controllers

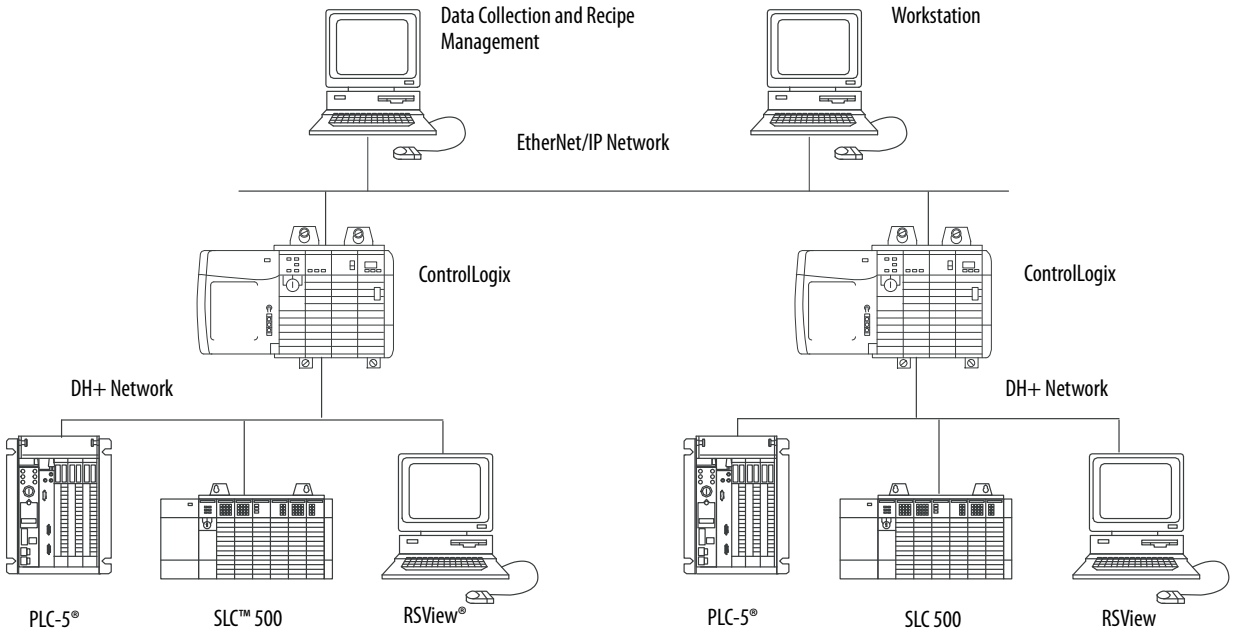
The DH+ network also provides the following:

- Data exchange between controllers
- Plant-wide data sharing
- Cellular level data sharing

You can connect a maximum of 32 stations to one DH+ link:

- Channel A supports 57.6 Kbps, 115.2 Kbps, and 230.4 Kbps.
- Channel B supports 57.6 Kbps and 115.2 Kbps.

Figure 13 - ControlLogix DH+ Network Communication Example



Communicate Over a DH+ Network

For the controller to communicate to a workstation or other device over a DH+ network, use RSLinx Classic software to do the following:

- Specify a unique link ID for each ControlLogix backplane and additional network in the communication path.
- Configure the routing table for the 1756-DHRIO or 1756-DHRIOXT module.

The 1756-DHRIO or 1756-DHRIOXT module can route a message through up to four communication networks and three chassis. This limit applies only to the routing of a message and not to the total number of networks or chassis in a system.

For more information to configure and use a DH+ network via the 1756-DHRIO or 1756-DHRIOXT module, see the Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514.

Universal Remote I/O (RIO) Communication

For universal remote I/O communication, you have two module options for use in the ControlLogix chassis. Table 23 lists the RIO modules and capabilities.

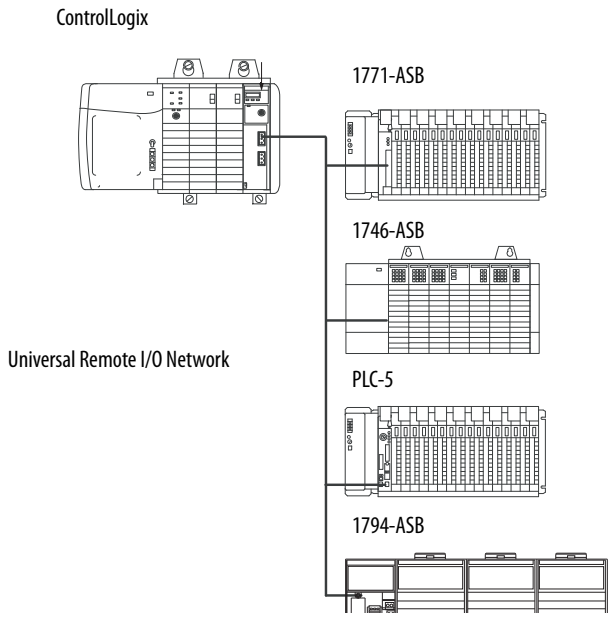
Table 23 - RIO Modules and Capabilities

RIO Module	Is used to
1756-RIO	• Function as an RIO scanner and adapter. • Support connections to 32 racks in any combination of rack size or block transfers. • Update data to the ControlLogix controller by using scheduled connections.
1756-DHRIO	• Function as an RIO scanner. • Support 32 logical rack connections or 16 block transfer connections per channel. • Establish connections between controllers and I/O adapters. • Distribute control so that each controller has its own I/O.
1756-DHRIOXT	• Function as an RIO scanner. • Support 32 logical rack connections or 16 block transfer connections per channel. • Establish connections between controllers and I/O adapters. • Distribute control so that each controller has its own I/O. • Operate in extreme environments with -25…70 °C (-13…158 °F) temperatures.

When a channel on the 1756-DHRIO or 1756-DHRIOXT module is configured for remote I/O, the module acts as a scanner for a universal remote I/O network. The controller communicates to the module to send and receive the I/O data on the universal remote I/O network.

The 1756-RIO module can act as a scanner or adapter on a remote I/O network. The 1756-RIO module transfers digital, block transfer, analog, and specialty data without message instructions.

Figure 14 - ControlLogix Universal Remote I/O Communication Example



Communicate over a Universal Remote I/O Network

For the controller to control I/O over a universal remote I/O network, you must complete these tasks.

1. Configure the remote I/O adapter.
2. Lay out the remote I/O network cable.
3. Connect the remote I/O network cable.
4. Configure the scanner channel.

For more information to configure a remote I/O network with the 1756-RIO, 1756-DHRIO, or 1756-DHRIOXT modules, see these publications:

- Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514
- ControlLogix Remote I/O Communication Module User Manual, publication 1756-UM534

As you design your remote I/O network, remember the following:

- All devices that are connected to a remote I/O network must communicate by using the same communication rate. These rates are available for remote I/O:
  - 57.6 Kbps
  - 115.2 Kbps
  - 230.4 Kbps
- You must assign unique partial and full racks to each channel used in Remote I/O Scanner mode.

  Both channels of a 1756-DHRIO or 1756-DHRIOXT module cannot scan the same partial or full rack address. Both module channels can communicate to 00...37 octal or 40...77 octal, but each channel can communicate only with one address at a time in whichever of these two ranges it falls.

Foundation Fieldbus Communication

Foundation Fieldbus is an open interoperable fieldbus that is designed for process control instrumentation. The fieldbus devices that are described in Table 24 can be connected to the ControlLogix controller via another network as shown in the following example.

Table 24 - Fieldbus Devices and Capabilities

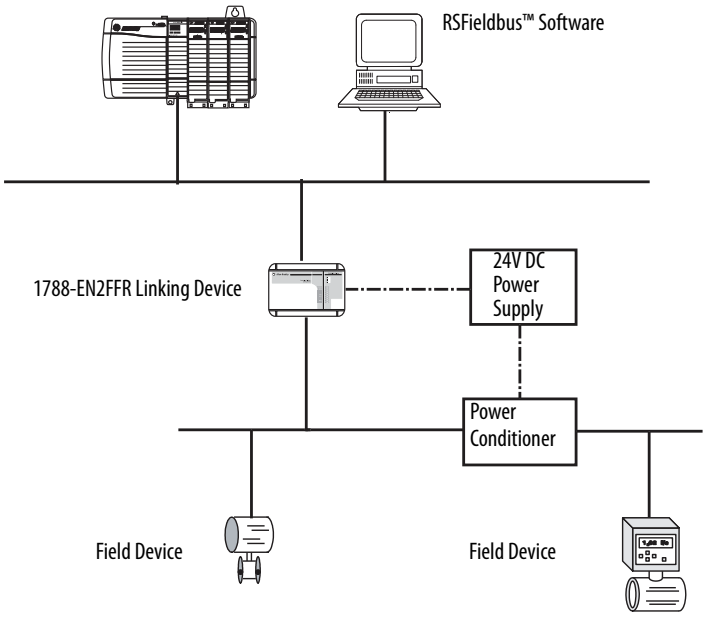
Fieldbus Device	Is used to
1788-EN2FFR	• Bridge an EtherNet/IP network to Foundation Fieldbus. • Connect via a low-speed serial (H1) and high-speed Ethernet (HSE) network connections. • Access devices directly via an OPC server.
1788-CN2FFR	• Connect via low-speed serial (H1) connections. • Bridge a ControlNet network to a Foundation Fieldbus. • Support redundant ControlNet media.

Foundation Fieldbus distributes and executes control in the device. The Foundation Fieldbus linking device does the following:

- Bridges from an EtherNet/IP network to an H1 connection
- Accepts HSE or EtherNet/IP messages and converts them to the H1 protocol

Figure 15 - Foundation Fieldbus Example

- ControlLogix
- 1756-ENBT



For more information about using the Foundation Fieldbus devices available from Rockwell Automation, see these publications:

- EtherNet/IP and ControlNet to FOUNDATION Fieldbus Linking Device User Manual, publication 1788-UM057
- FOUNDATION Fieldbus Design Considerations Reference Manual, publication PROCES-RM005

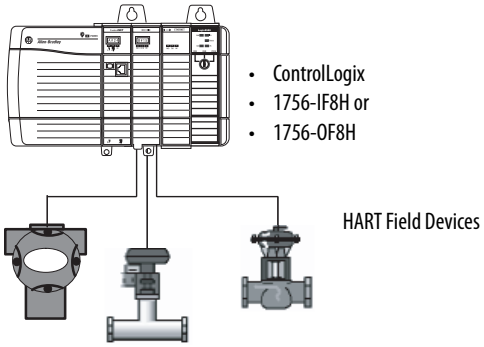
HART Communication

HART (Highway Addressable Remote Transducer) is an open protocol that is designed for process control instrumentation.

Device	Is used to
1756 analog HART I/O modules:	• Act as HART master to allow communication with HART field devices. • Interface directly with field devices (through built-in HART modems), which eliminates the need for external hardware and more wiring. • Provide access to more field device data, including voltage and current measurements. • Directly connect asset management software to HART devices. • Support differential wiring for environments where improved noise immunity is needed (input modules).
ProSoft interface MVI56-HART	• Acquire data or control application with slow update requirements, such as a tank farm. • Does not require external hardware to access HART signal. • Does not provide a direct connection to asset management software.

The HART protocol combines digital signals with analog signals to ready the digital signal for the Process Variable (PV). The HART protocol also provides diagnostic data from the transmitter.

Figure 16 - HART Protocol Example



For more information about using the HART I/O modules, see the ControlLogix HART Analog I/O Modules User Manual, publication 1756-UM533.

For more information about the ProSoft HART interface, see the ProSoft Technologies website at http://www.prosoft-technology.com.

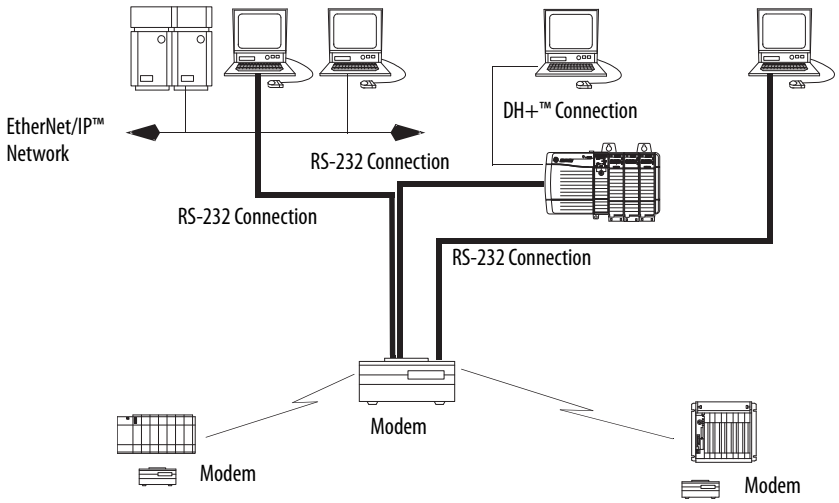
Serial Communication on ControlLogix 5560 Controllers

ControlLogix 5560 Controller Serial Port

ControlLogix® 5560 controllers have a built-in RS-232 port that can be used in various serial-based applications. The potential serial communication applications include the following:

- DF1 modes (including broadcast message support)
- DF1 radio modem
- ASCII device communication

Figure 17 - ControlLogix DF1 Device Communication Example



ControlLogix Chassis Serial Communication Options

You can use the serial port of the ControlLogix controller or use ProSoft modules in the ControlLogix to achieve serial communication. Options specific to the ControlLogix controller serial port are described in this chapter.

For more information about ProSoft modules that can be used to establish serial communication, see the ProSoft Technology website or go to http://www.prosoft-technology.com and browse available products.

Communication with Serial Devices

When configuring the controller for serial communication, you first specify a Serial Port mode (System or User), then a protocol.

Figure 18 - Serial Port Mode in the Controller Properties

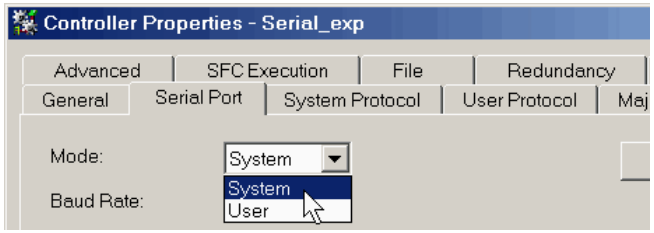


Table 25 describes the serial communication protocols for use with each mode.

Table 25 - Serial Port Modes, Protocols, and Uses

Mode	Protocol	Is used to	Page
System	DF1 Master	Control polling and message transmission between the master and slave nodes.	104
	DF1 Point to Point	• Communicate between the controller and one other DF1-protocol-compatible device. • Program the controller via the serial port.	104
	DF1 Radio Modem	• Communication with SLC™ 500 and MicroLogix™ 1500 controllers. • This protocol supports master/slave and store/forward configurations.	105
	DF1 Slave	Configure the controller as a slave station in a master/slave serial communication network.	108
	DH-485	Communication with other DH-485 devices via a multi-master and token-passing network that enables programming and peer-to-peer messaging.	108
User	ASCII	• Communicate with ASCII devices. • Use ASCII instructions to read and write data from and to an ASCII device.	109

DF1 Master Protocol

The master/slave network includes one controller that is configured as the master node and up to 254 slave nodes. Link slave nodes by using modems or line drivers.

A master/slave network can have node numbers from 0...254. Each node must have a unique node address. Also, at least two nodes, one master and one slave, must exist to define your link as a network.

DF1 Point to Point Protocol

The DF1 Point to Point protocol is used when connecting from the controller to one DF1 device. DF1 Point to Point protocol is the default System mode protocol. Default parameters are listed in Table 26.

Table 26 - Default DF1 Point to Point Parameters

Parameter	Value
Baud Rate	19,200
Data Bits	8
Parity	None
Stop Bits	1

Table 26 - Default DF1 Point to Point Parameters

Parameter	Value
Control Line	No Handshake
RTS send Delay	0
RTS Off Delay	0

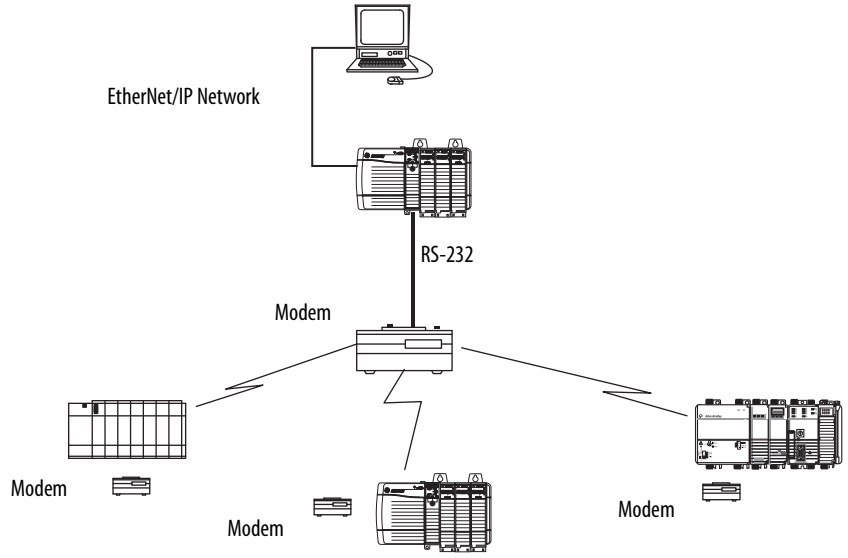
DF1 Radio Modem Protocol

Your ControlLogix controller includes a driver that lets it communicate over the DF1 Radio Modem protocol. The DF1 radio modem driver implements a protocol, optimized for use with radio modem networks, that is a hybrid between DF1 full-duplex protocol and DF1 half-duplex protocol, and therefore is not compatible with these protocols.

IMPORTANT The DF1 radio modem driver is used only among devices that support and are configured for the DF1 Radio Modem protocol.

Additionally, there are some radio modem network configurations that do not work with the DF1 radio modem driver. In these configurations, continue to use DF1 half-duplex protocol.

Figure 19 - DF1 Radio Modem Network Example



Like DF1 full-duplex protocol, the DF1 radio modem lets any node initiate to any other node at any time (that is, if the radio modem network supports full-duplex data-port buffering and radio-transmission collision avoidance). Like DF1 half-duplex protocol, a node ignores any packets received that have a destination address other than its own, except for broadcast packets and passthru packets.

Unlike DF1 full-duplex or DF1 half-duplex protocols, the DF1 radio modem protocol excludes ACKs, NAKs, ENQs, or poll packets. The CRC checksum verifies Data integrity.

DF1 Radio Modem Advantages

The primary advantage of using the DF1 radio modem protocol for radio modem networks is in transmission efficiency. Each read/write transaction (command and reply) requires only one transmission by the initiator (to send the command) and one transmission by the responder (to return the reply). This efficiency minimizes the number of times the radios must key-up to transmit, which maximizes radio life and minimizes radio power consumption.

In contrast, DF1 half-duplex protocol requires five transmissions for the DF1 master to complete a read/write transaction with a DF1 slave—three by the master and two by the slave.

The DF1 radio modem driver can be used in a pseudo master/slave mode with any radio modems, as long as the designated master node is the only node that initiates MSG instructions, and as long as only one MSG instruction is triggered at a time.

For modern serial radio modems that support full-duplex data port buffering and radio transmission collision avoidance, the DF1 radio modem driver can be used to configure a masterless peer-to-peer radio network, where any node can initiate communication to any other node at any time, as long as the nodes are within radio range so that they receive transmissions from each other.

DF1 Radio Modem Limitations

These considerations must be made if you can implement the new DF1 radio modem driver in your radio modem network:

- If the devices on the network are ControlLogix controllers, you must configure them with the DF1 radio modem driver via RSLogix 5000® software, version 17.01.02 or later or Logix Designer application, version 21.00.00 or later. If not, then make sure that the nodes can support the DF1 radio modem protocol.

- If each node receives the radio transmissions of each other node, being within radio transmission/reception range and on a common receiving frequency (via a Simplex radio mode or via one, common, full-duplex repeater) the radio modems must handle full-duplex data port buffering and radio transmission collision avoidance.

  If so, you can take full advantage of the peer-to-peer message initiation capability in each node (for example, the ladder logic in any node can trigger an MSG instruction to any other node at any time).

  If not all modems can handle full-duplex data port buffering and radio transmission collision avoidance, you can use the DF1 radio modem driver. Use the DF1 radio modem driver only if you limit MSG instruction initiation to one master node who transmits to each other node.

- If not all nodes receive the radio transmission of each other node, you can use the DF1 radio modem driver. Use the DF1 radio modem driver only if you limit MSG instruction initiation to the node connected to the master radio modem who transmits to each other radio modem in the network.

- You can take advantage of the ControlLogix controller channel-to-channel passthru to program the other nodes via RSLinx® Classic and Logix Designer applications that run on a personal computer that is connected to a local ControlLogix controller via DH-485, DH+™, or Ethernet network.

DF1 Radio Modem Protocol Parameters

Use Table 27 as a reference when setting the parameters for the use of the DF1 Radio Modem Protocol.

Table 27 - DF1 Radio Protocol Parameters

Parameter	Description
Station Address	Specifies the node address of the controller on the serial network. Select a number 1…254 decimal, inclusive. To optimize network performance, assign node addresses in sequential order. Initiators, such as personal computers, are assigned the lowest address numbers to minimize the time that is required to initialize the network.
Error Detection	Click one of the radio buttons to specify the error detection scheme that is used for all messages. • BCC - the processor sends and accepts messages that end with a BCC byte. • CRC - the processor sends and accepts messages with a 2-byte CRC.
Enable Store and Forward	Check 'Enable Store and Forward' if you want to enable the store and forward functionality. When enabled, the destination address of any received message is compared to the Store and Forward tag table. If there is a match, the message is then forwarded (rebroadcasted) out the port. From the Store and Forward Tag dropdown menu, choose an integer (INT[16]) tag. Each bit is a station address. If this controller reads a message that is destined for a station that has its bit set in this table, it forwards the message.

DF1 Slave Protocol

With the DF1 slave protocol, a controller uses DF1 half-duplex protocol. One node is designated as the master and it controls who has access to the link. The other nodes are slave stations and must wait for permission from the master before transmitting.

Make these considerations when using the DF1 Slave protocol:

- If multiple slave stations are used on the network, link slave stations by using modems or line drivers to the master.
- If you are using one slave station on the network, you do not need a modem to connect the slave station to the master.
- Control parameters can be configured without handshaking.
- 2...255 nodes can be connected to one link.

DH-485 Protocol

The controller can send and receive messages to and from other controllers on a DH-485 network. The DH-485 connection supports remote programming and monitoring via the Logix Designer application. However, excessive traffic over a DH-485 connection can adversely affect overall controller performance and lead to timeouts and decreased performance of the configuration.

You can also use a 1756-DH485 module to connect the ControlLogix chassis to a DH-485 network with multiple controllers. For more information, see the ControlLogix DH-485 Communication Module User Manual, publication 1756-UM532.

IMPORTANT Use Logix 5000® controllers on DH-485 networks only when you want to add controllers to an existing DH-485 network.

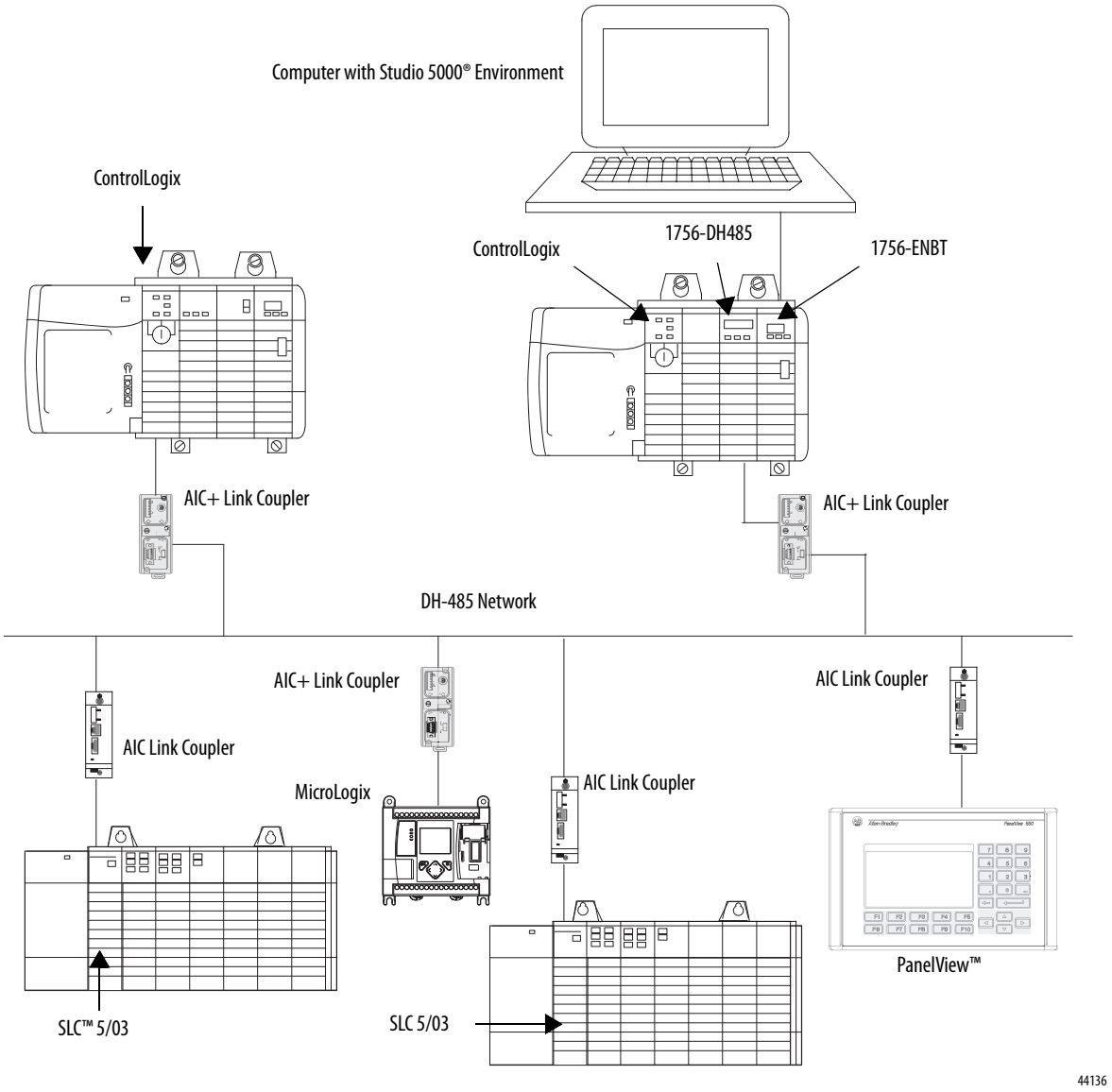
For new applications with Logix 5000 controllers, we recommend that you use networks in the NetLinx open architecture.

The DH-485 protocol uses RS-485 half-duplex as its physical interface. RS-485 is a definition of electrical characteristics, not a protocol. You can configure the RS-232 port of the ControlLogix controller to act as a DH-485 interface.

To connect the controller to the DH-485 network, you must use these components:

- A 1761-NET-AIC converter (two controllers can be connected to one converter)
- An RS-232 cable (catalog number 1756-CP3 or 1747-CP3) for each controller to connect to the converter

Figure 20 - DH-485 Network Communication Overview



IMPORTANT A DH-485 network consists of multiple cable segments. Limit the total length of the segments to 1219 m (4000 ft).

ASCII Protocol

When you configure the serial port for User mode and the ASCII protocol, you can use it to do the following:

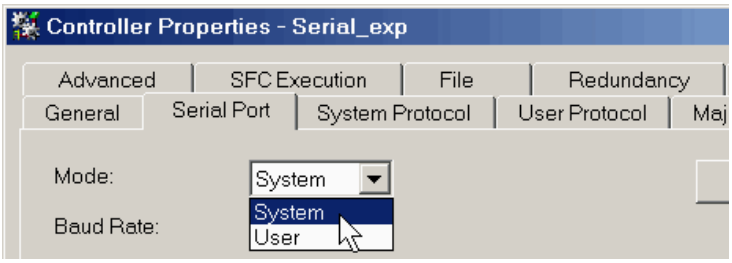
- Read ASCII characters from a weigh scale module or barcode reader.
- Send and receive messages from an ASCII-triggered device, such as a MessageView™ terminal.

After you configure the controller for use with the ASCII protocol, program the controller by using the ASCII instructions. Reference the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003, for information about the ASCII instructions.

Configure the ControlLogix 5560 Controller for Serial Communication

Complete these steps to configure your 1756-L6*x* controller for serial communication after creating a controller project in the Logix Designer application.

1. Open the Controller Properties and click the Serial Port tab.

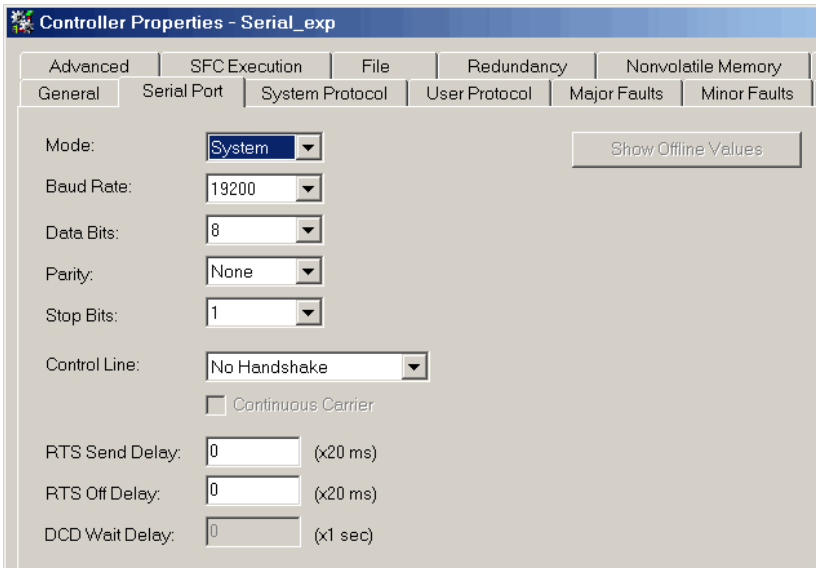


2. From the Mode dropdown menu, choose the mode that corresponds to your intended protocol.

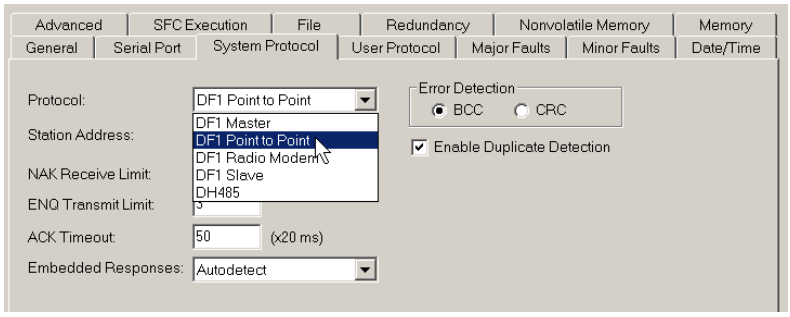
   Use this table as a reference.

For this protocol	Choose this mode
DF1 Master	System
DF1 Point to Point	
DF1 Radio Modem	
DF1 Slave	
DH-485	
ASCII	User

3. Specify the remaining properties in the Serial Port tab according to your communication preferences.

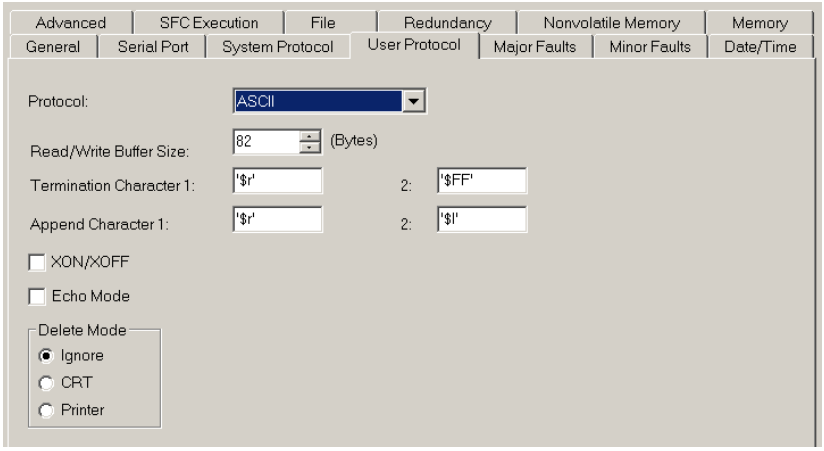


4. If you are using the System mode protocols, click the System Protocol tab and specify the protocol parameters.
   a. From the Protocol dropdown, choose the protocol that you need.



   b. Specify the parameters for the protocol.

5. If you are using the User mode protocol (ASCII), click the User Protocol tab and specify the ASCII parameters.



After you have configured the controller for ASCII protocol communication, reference the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003, for the available ASCII instructions.

Broadcast Messages Over a Serial Port

You can broadcast messages over a serial port connection from a master controller to its slave controllers by using several communication protocols. These protocols include the following:

- DF1 Master
- DF1 Radio Modem
- DF1 Slave

Use the 'message' tag to broadcast over a serial port. Because messages are sent to receiving controllers, only the 'write' type messages can be used for broadcasting.

The broadcast feature can be configured by using ladder logic or structured text. The broadcast feature can also be set by modifying the path value of a message tag in the tag editor.

To configure and program the controller to broadcast messages via the serial port, complete these procedures:

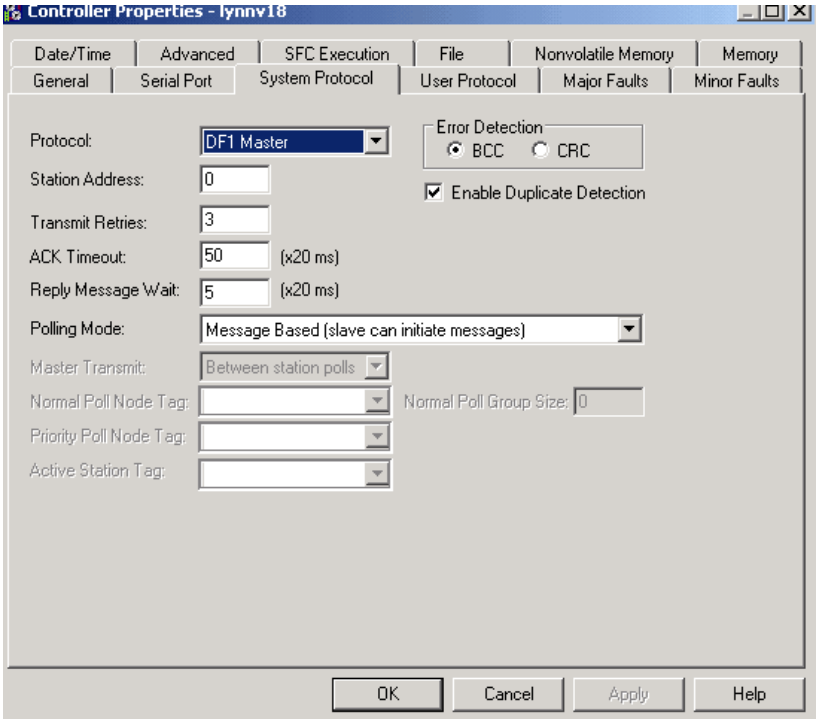
- Configure Controller Serial Port Properties on page 113
- Program the Message Instruction on page 114

For these procedure examples, ladder logic programming is used.

Configure Controller Serial Port Properties

First, set the System Protocol by following these steps.

1. In the Controller Organizer, right-click the controller and choose Properties.
2. In the Controller Properties dialog box, from the System Protocol tab, choose the settings for the controller and click OK.



Use this table when specifying settings for the protocols listed.

Field	DF-1 Master Protocol	DF-1 Slave Protocol	DF-1 Radio Modem Protocol
Station Address	Controller station address number	Controller station address number	Controller station address number
Transmit Retries	3	3	N/A
ACK Timeout	50	N/A	N/A
Slave Poll Timeout	N/A	3000	N/A
Reply Message Wait	5	N/A	N/A
Polling Mode	Message: polls the slave by using the message instruction Slave: initiates messages for slave-to-slave broadcast Standard: schedules polling for the slave	N/A	N/A
EOT Suppression	N/A	Disable	N/A
Error Detection	BCC	BCC	BCC
Duplicate Detection	Enabled	Enabled	N/A
Enable Store and Forward	N/A	N/A	Choose enable if you want to use the store and forward tag. The last bit of the INT[16] Enable Store and Forward array must be 'enabled.' For example, say that you create an INT[16] tag named EnableSandF. Then EnableSandF[15].15 must be set to 1 for broadcast to work on a radio modem.

Program the Message Instruction

Add and configure the message instruction according to the protocol you are using. For more information to specify the configuration details, see the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

IMPORTANT When using structured text, broadcast over a serial port is set by typing MSG(aMsg) and right-clicking an MSG to display the Message Configuration dialog box.

Modbus Support

To use ControlLogix controllers with the Modbus protocol, establish a serial port connection and execute a ladder-logic routine.

Two controller projects specific to the Modbus network are available as sample programs within the Logix Designer application:

- ModbusMaster.ACD
- ModbusSlave.ACD

For information about using these sample programs, see the Using Logix 5000 Controllers as Masters or Slaves on Modbus Application Solution, publication CIG-AP129.

Manage Controller Communication

Connection Overview

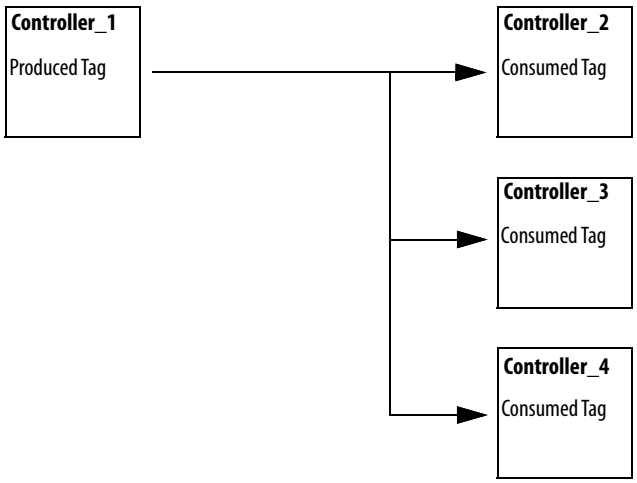
A Logix 5000® system uses a connection to establish a communication link between two devices. The types of connections include the following:

- Controller-to-local I/O modules or local communication modules
- Controller-to-remote I/O or remote communication modules
- Controller-to-remote I/O (rack-optimized) modules
- Produced and consumed tags
- Messages
- Controller access via the Studio 5000 Logix Designer® application
- Controller access via RSLinx® Classic or FactoryTalk® Linx applications for HMI or other applications

Produce and Consume (Interlock) Data

ControlLogix® controllers let you produce (transmit) and consume (receive) system-shared tags.

Figure 21 - Illustration of Produced and Consumed Tags



The system-shared tags are explained in Table 28.

Table 28 - Produced and Consumed Tag Definitions

Tag	Definition
Produced tag	A tag that a controller makes available for use by other controllers. Multiple controllers can simultaneously consume (receive) the data. A produced tag sends its data to one or more consumed tags (consumers) without using logic.
Consumed tag	A tag that receives the data of a produced tag. The data type of the consumed tag must match the data type (including any array dimensions) of the produced tag. The RPI of the consumed tag determines the period at which the data updates.

For two controllers to share produced or consumed tags, the controllers must be attached to the same network. You cannot bridge produced and consumed tags over two networks.

Produced and consumed tags use connections of the controller and the communication modules being used. For a ControlNet® network, produced and consumed tags use scheduled connections.

Connection Requirements of a Produced or Consumed Tag

Produced and consumed tags each require connections. As you increase the number of controllers that can consume a produced tag, you reduce the number of connections the controller has available for other operations, like communication and I/O.

IMPORTANT If a consumed-tag connection fails, the other tags being consumed from that remote controller stop receiving new data.

Each produced or consumed tag uses the number of connections that are listed in Table 29. Adding status information to a produced/consumed tag does not affect the number of connections used.

Table 29 - Produced and Consumed Tag Connections

This Type of Tag	Uses This Many Connections	Of This Module
Produced tag	*number_of_configuredconsumers* + 1	Controller
Consumed tag	1	
Produced or consumed tag	1	Communication

EXAMPLE Calculations of connections for produced or consumed tags:

- A ControlLogix controller producing 4 tags for 1 controller uses 8 connections.

Each tag uses 2 connections (1 consumer + 1 = 2).

2 connections per tag x 4 tags = 8 connections.

- Consuming 4 tags from a controller uses 4 connections (1 connection per tag x 4 tags = 4 connections).

The number of available connections limits the number of tags that can be produced or consumed. If the controller uses its connections for I/O and communication devices, no connections are left for produced and consumed tags.

Table 30 - ControlLogix Modules and Available Connections

Module Type	Cat. No.	Available Connections
Controller	1756-L7*x*	500
	1756-L6*x*	250
EtherNet/IP™	• 1756-EN2F • 1756-EN2T • 1756-EN2TXT • 1756-EN2TR	256
	• 1756-ENBT • 1756-EWEB	128
ControlNet	• 1756-CN2 • 1756-CN2R • 1756-CN2RXT	128
	• 1756-CNB • 1756-CNBR	64

For more information about produced/consumed tags, see the Logix 5000 Controllers Produced and Consumed Tags Programming Manual, publication 1756-PM011.

Send and Receive Messages

Messages transfer data to other devices, such as other controllers or operator interfaces. The MSG instruction is a ladder logic output instruction that asynchronously reads or writes a block of data to or from another module over the backplane or a network. The size of the instruction depends on the data types and message command that you program.

Messages use connection resources to send or receive data. Messages can leave the connection open (cache) or closed when the message is done transmitting.

Each message uses one connection out of the controller, regardless of how many devices are in the message path. To conserve connections, configure one message to read from or write to multiple devices.

Table 31 - Message Types

Message Type	Communication Method	Connected Message	Message Can Be Cached
CIP™ data table read or write	N/A	Configurable	Yes
PLC-2®, PLC-3®, PLC-5®, or SLC™ (all types)	CIP	No	No
	CIP with Source ID	No	No
	DH+™	Yes	Yes
CIP generic	N/A	Optional (1)	Yes(2)
Block-transfer read or write	N/A	Yes	Yes

(1) You can connect CIP generic messages. However, for most applications we recommend that you leave CIP generic messages unconnected.

(2) Consider caching only if the target module requires a connection.

For more information about using messages, see these publications:

- Logix 5000 Controllers Messages, publication 1756-PM012
- Logix 5000 Controllers General Instructions, publication 1756-RM003

Determine Whether to Cache Message Connections

When you configure an MSG instruction, you can choose whether to cache the connection. Use Table 32 to determine options for caching connections.

Table 32 - Options for Caching Connections

If the message executes	Then
Repeatedly	Cache the connection. This keeps the connection open and optimizes execution time. Opening a connection each time the message executes increases execution time.
Infrequently	Do not cache the connection. This closes the connection upon completion of the message, which frees up that connection for other uses.

TIP Cached connections transfer data faster than uncached connections. The controller supports only 32 cached messages.

Calculate Connection Use

The total connection requirements of a ControlLogix system include local and remote connections.

Local Connections

Local connections refer to connections used to communicate between modules that are housed in the same ControlLogix chassis (that is, the local modules). Use Table 33 to calculate the number of local connections that are based on the configuration of your local chassis.

Table 33 - Local Chassis Connections

Local Connection To	Device Quantity	Connections per Device	Total Connections
Local I/O module (a direct connection)		1	
1756-M16SE, 1756-M08SE, or 1756-M02AE servo module		3	
• 1756-CN2, 1756-CN2R, 1756-CN2RXT ControlNet communication module • 1756-CNB, 1756-CNBR ControlNet communication module		0	
• 1756-EN2F, 1756-EN2T, 1756-EN2TXT, or 1756-EN2TR EtherNet/IP communication module • 1756-ENBT EtherNet/IP communication module		0	
1756-EWEB EtherNet/IP web server module		0	
1756-DNB DeviceNet® communication module		2	
1756-RIO remote I/O communication module (Connection count depends on module configuration and can be as many as 10 per module.)		1	
1756-DHRIO DH+/universal remote I/O communication module Each adapter that is associated with the module		1 1	
1756-DHRIOXT DH+/universal remote I/O communication module Each adapter that is associated with the module		1 1	
1756-DH-485 DH-485 communication module		1	
		Total	

Remote Connections

Use remote connections when the communication module is in a chassis that is remote from the controller. The number of connections a communication module supports determines how many remote connections the controller can access through that module.

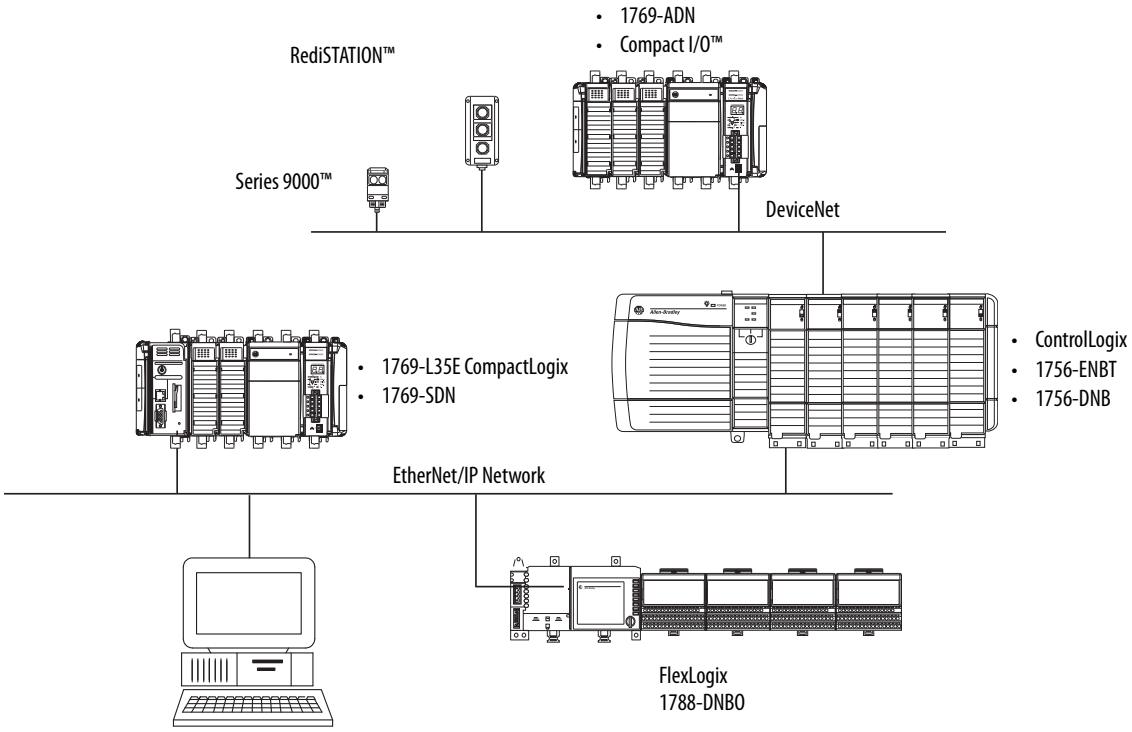
Table 34 - Remote Connections

Remote Connection Type	Device Quantity	Connections per Device	Total Connections
Remote ControlNet communication module I/O configured as direct connection (none) I/O configured as rack-optimized connection		 0 1	
Remote I/O module over a ControlNet network (direct connection)		1	
Remote EtherNet/IP communication module I/O configured as direct connection (none) I/O configured as rack-optimized connection		 0 1	
Remote I/O module over a EtherNet/IP network (direct connection)		1	
Remote device over a DeviceNet network (accounted for in rack-optimized connection for local 1756-DNB)		 0	
DeviceNet module in a remote chassis		2	
Other remote communication adapter		1	
Produced tag Each consumer		1 1	
Consumed tag		1	
Message (see Table 31 for message types) Connected Unconnected		 1 0	
Block transfer message		1	
		Total	

Connections Example

In this example system, the 1756 ControlLogix controller does the following:

- Controls local digital I/O modules in the same chassis
- Controls remote I/O devices on a DeviceNet network
- Sends and receives messages to and from a CompactLogix® controller on an EtherNet/IP network
- Produces one tag that the 1794 FlexLogix™ controller consumes
- Is programmed via the Logix Designer application



The ControlLogix controller in this example uses these connections.

Table 35 - Connections Example Calculation

Connection Type	Device Quantity	Connections per Device	Total Connections
Controller to local I/O modules	4	1	4
Controller to 1756-ENBT module	1	0	0
Controller to 1756-DNB module	1	2	2
Controller to Logix Designer application	1	1	1
Message to CompactLogix controller	2	1	2
Produced tag Consumed by FlexLogix controller	1 1	1 1	1 1
		Total	11

Notes:

I/O Modules

Selecting ControlLogix I/O Modules

Rockwell Automation offers several ControlLogix® I/O modules for use in ControlLogix systems. When you select your I/O modules, remember the following:

- A wide variety of digital, analog, and specialty I/O modules are available from Rockwell Automation. Some features of these I/O modules include the following:
  - Field-side diagnostics
  - Electronic fusing
  - Individually isolated inputs/outputs
- Removable terminal blocks (RTBs) or 1492 wiring systems are required for use with I/O modules.
- 1492 PanelConnect™ modules and cables can be used to connect input modules to sensors.

For more information about ControlLogix I/O module features, specifications, and wiring options, see the ControlLogix System Selection Guide, publication 1756-SG001.

Local I/O Modules

The ControlLogix chassis that you choose affects how many local I/O modules you can use. Several ControlLogix chassis sizes are available to suit your configuration requirements. You can fill the slots of your chassis with any combination of controllers, communication modules, and I/O modules.

Table 36 lists the available ControlLogix and ControlLogix-XT™ chassis and the number of slots available with each.

Table 36 - ControlLogix and ControlLogix-XT™ Chassis and Slots

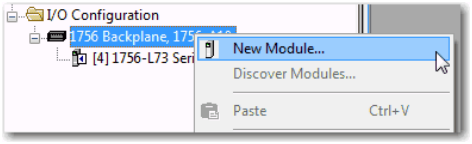
Chassis	Slots
1756-A4	4
1756-A4LXT	
1756-A5XT	5
1756-A7	7
1756-A7LXT	
1756-A7XT	
1756-A10	10
1756-A10XT	
1756-A13	13
1756-A17	17

If you have empty slots in your chassis, use the 1756-N2 or 1756-N2XT slot-filler module.

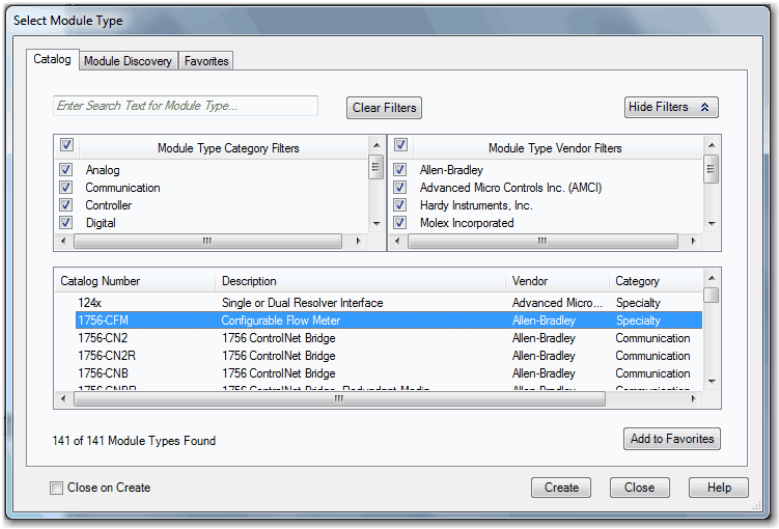
Add Local I/O to the I/O Configuration

If you are adding local I/O, add the I/O module to the backplane with the controller. To add an I/O module to the local chassis, complete these steps.

1. Right-click the backplane and choose New Module.



2. Select the I/O module that you want to add and click OK.



3. Specify the configuration properties according to the module and network configuration you are using.

   See the Additional Resources section in the preface for more information if you are designing your ControlLogix System for any of the following modules:

   - Analog I/O
   - Configurable flowmeter
   - Digital I/O
   - HART analog I/O
   - High-speed analog I/O
   - High-speed counter
   - Low-speed counter
   - Programmable limit switch

Remote I/O Modules

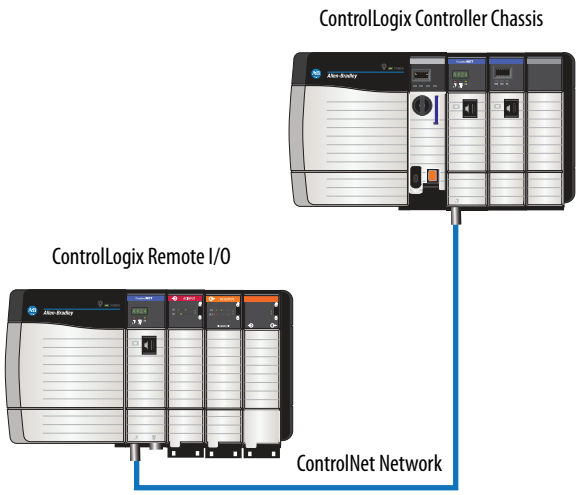
Remote I/O refers to I/O that is not in the local chassis and is connected to the controller via a communication network.

The ControlLogix controller supports the use of remote I/O via these networks:

- EtherNet/IP™
- ControlNet®
- DeviceNet®
- Universal remote I/O

For more information about the network configurations that can be used to connect remote I/O, see Communication Networks on page 87.

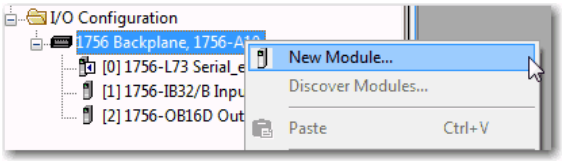
Figure 22 - ControlLogix Controller and Remote I/O Example

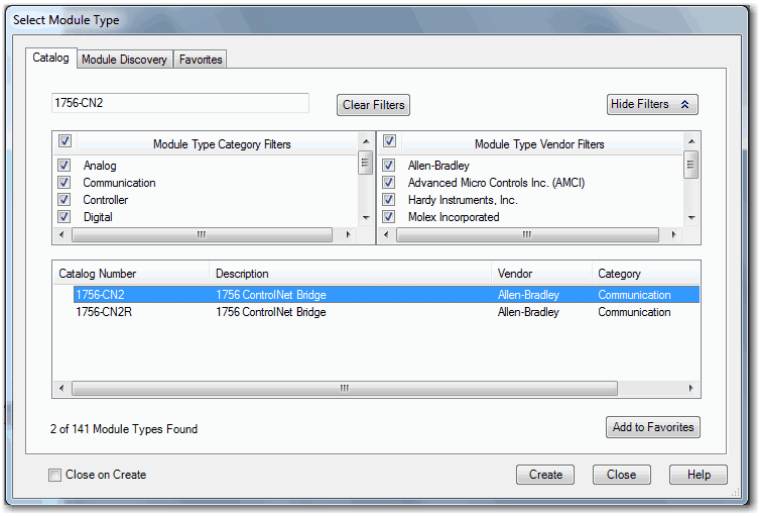


Add Remote I/O to the I/O Configuration

If you are adding remote I/O, add the I/O modules to the backplane of the remote communication module that is connected to the controller. To add a remote I/O to the I/O Configuration folder in the Logix Designer application, complete these steps.

1. Add a communication module to the backplane that contains the controller.

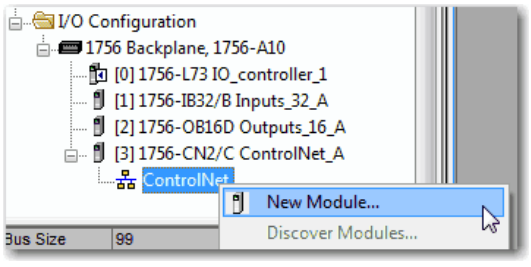




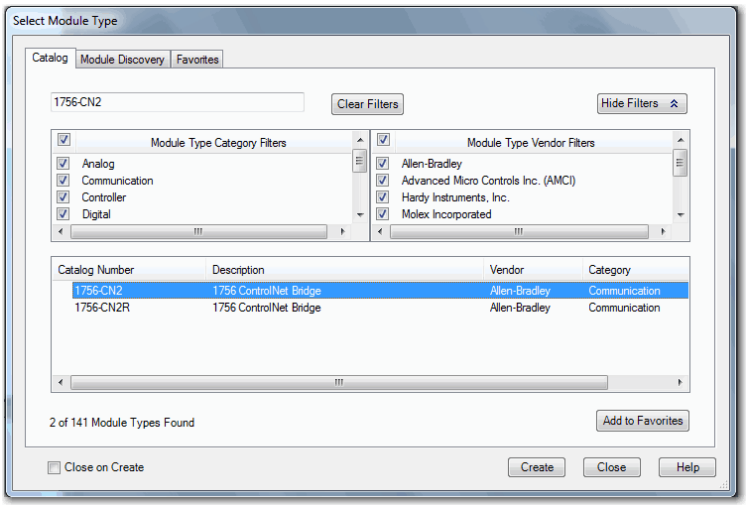
2. Specify the communication module properties according to your network configuration.

   For more information about the communication module and network properties, see the Additional Resources section in the preface.

3. Right-click the communication network and choose New Module.

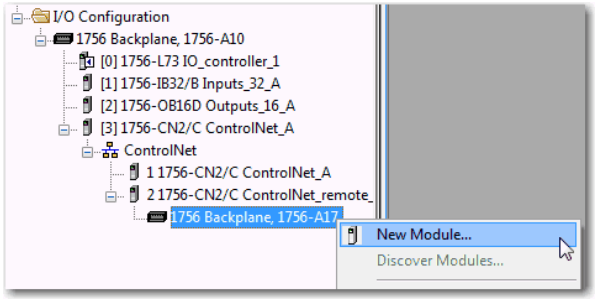


4. Add the remote communication module that you are using.

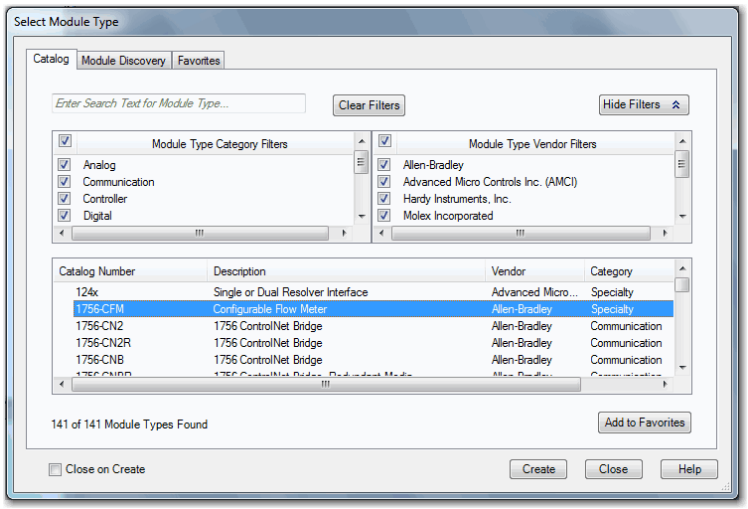


5. Specify the chassis and connection properties according to your network configuration.

6. Right-click the backplane of the newly added communication module and choose New Module.



7. Select the I/O module that you want to add and click OK.

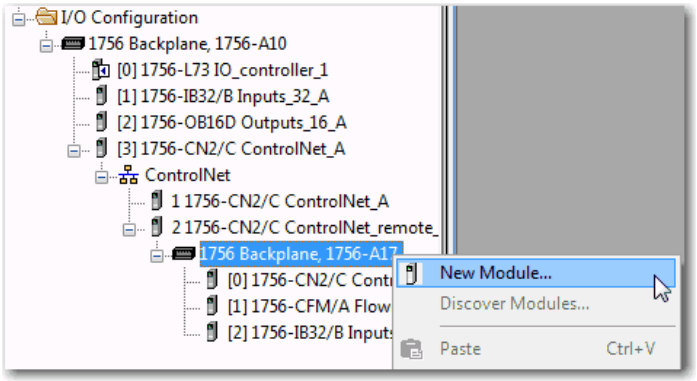


8. Specify the Module Properties according to your module and application.

   See the Additional Resources section in the preface for more information about the module configuration properties for any of the following modules:

   - Analog I/O
   - Configurable flowmeter
   - Digital I/O
   - HART analog I/O
   - High-speed analog I/O
   - High-speed counter
   - Low-speed counter
   - Programmable limit switch

9. Add any other I/O modules that you are using in the remote chassis.



10. Complete steps 1...9 until your remote I/O network and I/O modules are configured.

Distributed I/O

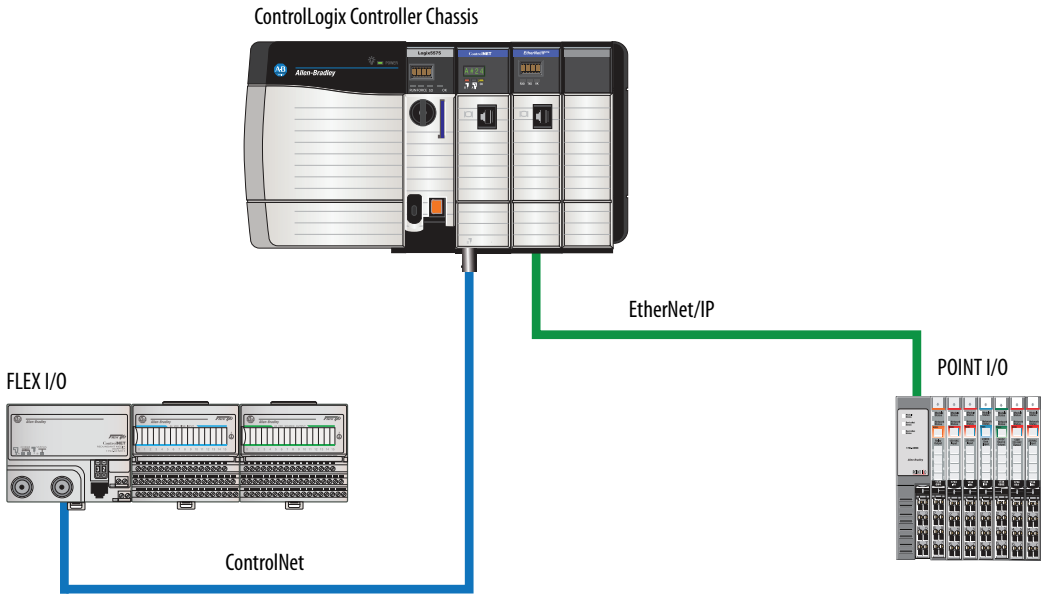
Distributed I/O refers to I/O that is remote from the controller and is not designed for use with a specific controller. Examples of distributed I/O that can be used with Logix 5000® controllers include the following:

- 1794 FLEX™ I/O modules
- 1734 POINT I/O™ modules
- 1797 FLEX Ex™ I/O modules
- 1738 ArmorPOINT® I/O modules
- 1732 ArmorBlock® I/O modules
- 1753 GuardPLC™ Safety I/O modules
- 1790 CompactBlock™ LDX I/O modules
- 1791 CompactBlock Guard Safety I/O modules
- 1791 CompactBlock I/O modules
- 1732DS ArmorBlock Guard Safety I/O modules
- 1792 ArmorBlock MaXum™ I/O modules

Distributed I/O is connected to the ControlLogix controller via a communication network. The ControlLogix controller supports the use of distributed I/O via these networks:

- EtherNet/IP
- ControlNet
- DeviceNet

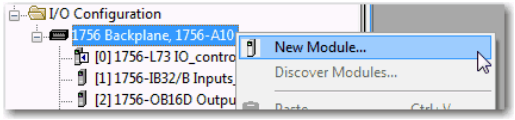
Figure 23 - ControlLogix System with Distributed I/O Example

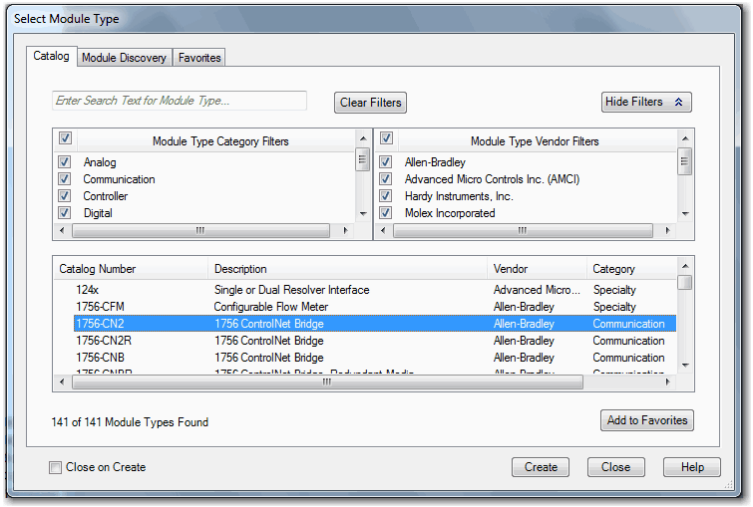


Add Distributed I/O to the I/O Configuration

If you are adding distributed I/O, add the I/O modules to the communication adapter of the I/O. To add distributed I/O to the I/O Configuration folder for the ControlLogix controller, complete these steps.

1. Add a communication module to the backplane that contains the controller.

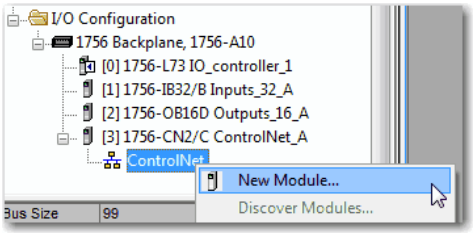




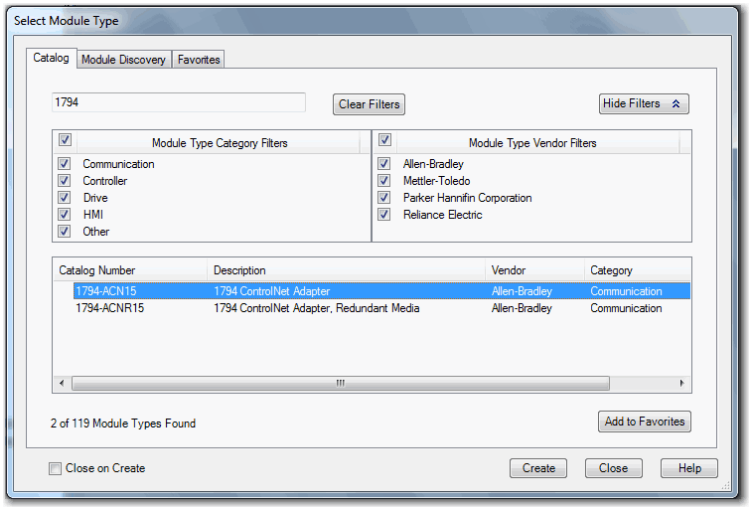
2. Specify the communication module properties according to your network configuration.

   For more information about the communication module and network properties, see the Additional Resources section in the preface.

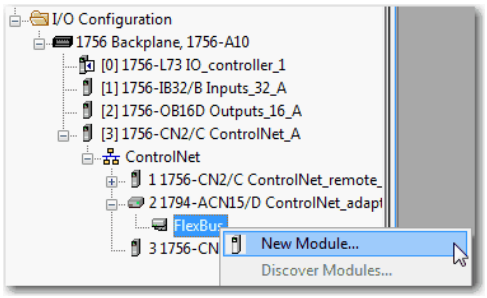
3. Right-click the communication network and choose New Module.



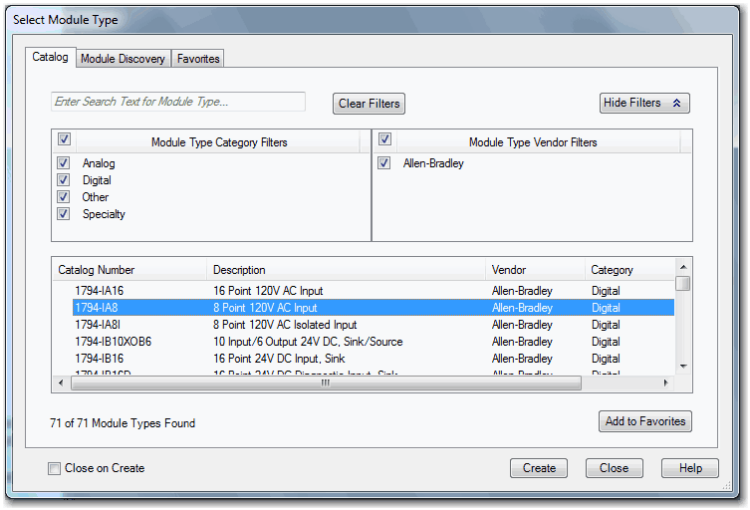
4. Add the communication adapter for the distributed I/O platform that you are using.



5. Specify the module and connection properties according to your network configuration.
6. Right-click the bus of the newly added communication adapter and choose New Module.



7. Select the I/O module that you want to add and click OK.



8. Specify the Module Properties according to your module and application.

   For more information about the module configuration properties, see the user manual for the I/O module you are adding.

9. Add any other I/O modules that you are using in this bus.
10. Complete steps 1...9 until your remote I/O network and distributed I/O modules are configured.

Reconfigure an I/O Module

If an I/O module supports reconfiguration, you can reconfigure the module via the following:

- The Module Properties dialog box in the I/O Configuration folder
- An MSG instruction in program logic

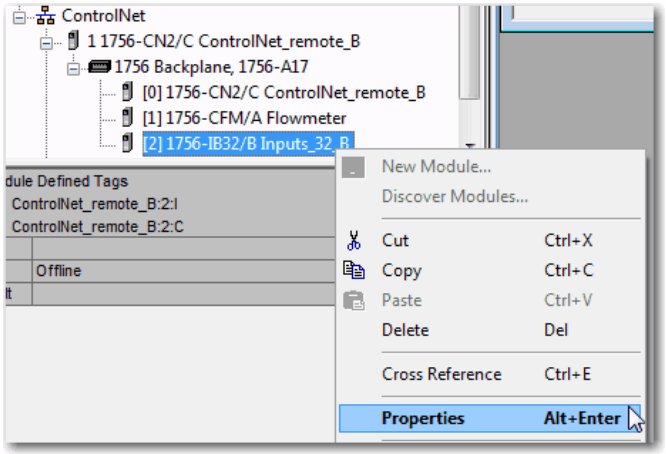
IMPORTANT Use care when changing the configuration of an I/O module. You can inadvertently cause the I/O module to operate incorrectly.

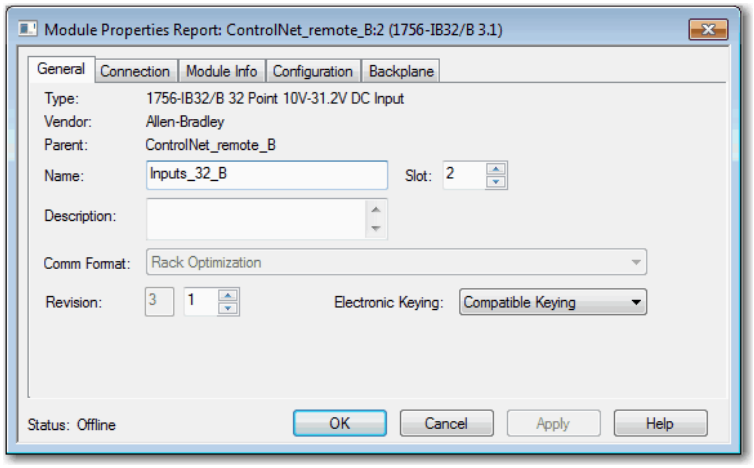
Use an MSG instruction of type Module Reconfigure to send new configuration information to an I/O module. During the reconfiguration, consider the following:

- Input modules continue to send input data to the controller
- Output modules continue to control their output devices

Reconfigure an I/O Module Via the Module Properties

To reconfigure an I/O module by using the module properties, right-click the module in the I/O Configuration tree and choose Properties. Then, edit the properties that you must change and click Apply.





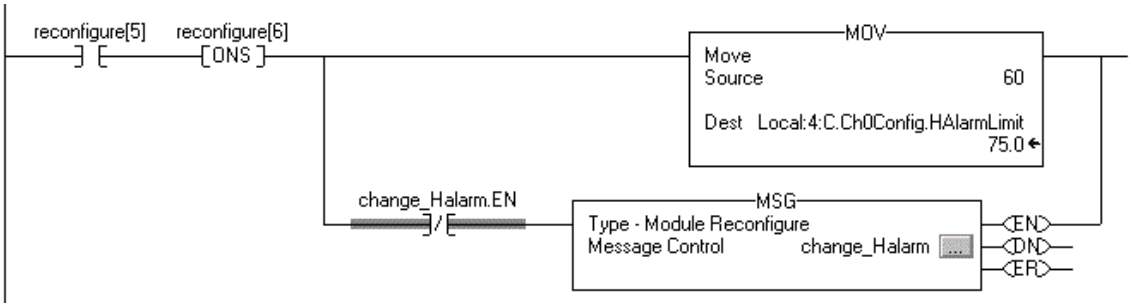
Reconfigure an I/O Module Via a Message Instruction

To reconfigure an I/O module via a message instruction, use this procedure.

1. Set the required member of the configuration tag of the module to the new value.
2. Send a Module Reconfigure message to the module.

EXAMPLE Reconfigure an I/O module

When reconfigure[5] is on, the MOV instruction sets the high alarm to 60 for the local module in slot 4. The Module Reconfigure message then sends the new alarm value to the module. The ONS instruction does not allow the rung to send multiple messages to the module while the reconfigure[5] is on.



For more information about using message instructions, see the Logix 5000 Controllers General Instruction Reference Manual, publication 1756-RM003.

Add to the I/O Configuration While Online

With RSLogix 5000 software, version 15.02.00 or later, and Logix Designer application, version 21.00.00 or later, you can add I/O and other devices to the controller configuration while you are online and in Run mode.

The modules and devices you can add while online depends on the version of the software you are using. Later versions have more modules and devices that can be added while online.

You can add these modules and devices to the local or remote chassis via the unscheduled portion of a ControlNet network or via an EtherNet/IP network.

Modules and Devices That Can Be Added While Online

These modules and devices **can be added** to the ControlLogix controller I/O configuration while online as of RSLogix 5000® software, version 19.01.00 or later and Logix Designer application, version 21.00.00 or later.

- 1756 controllers
- 1756 ControlNet modules
- 1756 DeviceNet bridges
- 1756 EtherNet/IP modules
- 1756 I/O and specialty modules
- 1756-DHRIO
- 1756-DHRIOXT

IMPORTANT These ControlLogix modules **cannot** be added while online:

- Motion modules (1756-M02AE, 1756-HYD02, 1756-M02AS, 1756-M03SE, 1756-M08SE, 1756-M08SEG, 1756-M16SE)
- 1756-RIO
- 1756-SYNCH
- 1756-56AMXN

Online Additions - ControlNet Considerations

ControlNet considerations that must be made depend upon the ControlLogix ControlNet modules you are using.

1756-CNB and 1756-CNBR Modules

When you add I/O to the ControlNet network via the 1756-CNB or 1756-CNBR modules while online, these considerations must be made:

- Digital I/O modules can be added as rack-optimized connections if the parent module is configured with rack-optimized connections.

  TIP While you can add a new digital I/O module to an existing rack-optimized connection, you cannot add rack-optimized connections while online.

- Digital I/O modules can also be added as direct connections.
- Analog I/O modules can be added only as direct connections.
- Disable the Change of State (COS) feature on digital input modules because it can cause inputs to be sent more quickly than the RPI.

- If you plan to add large amounts of I/O to the ControlNet network, dedicate one ControlNet network for I/O. For the dedicated ControlNet network, verify that there is little or none of the following:
  - HMI traffic
  - MSG traffic
  - Programming workstations
- Requested Packet Intervals (RPIs) faster than 25 ms for unscheduled modules can overload the 1756-CNB or 1756-CNBR communication module. To avoid the overload, make these considerations:
  - Use a NUT of 10 ms or more.
  - Keep the SMAX and UMAX values as small as possible.
- If the module has a Real Time Sample (RTS), disable it or set it to a rate that is greater than the RPI.
- You can add I/O modules until you reach these limits:
  - 75% of CPU utilization of the 1756-CNB or 1756-CNBR communication module
  - Plan for a CPU-use increase of 1...4% of the 1756-CNB or 1756-CNBR module for each I/O module you add, depending on the RPI.
  - 48 connections on the 1756-CNB or 1756-CNBR communication module
  - Less than 400,000 unscheduled bytes per second are displayed in RSNetWorx™ for ControlNet™ software after the network has been scheduled.

1756-CN2, 1756-CN2R, 1756-CN2RXT Modules

The use of 1756-CN2/B, 1756-CN2R/B, and 1756-CN2RXT modules provides increased capacity for adding I/O while online compared to 1756-CNB or 1756-CNBR modules. With this increased capacity, you can easily add I/O and increase ControlNet connections that are used with less impact on the overall system.

Table 37 demonstrates the performance factors of the 1756-CN2/B, 1756-CN2R/B, and 1756-CN2RXT modules when adding I/O online.

Table 37 - 1756-CN2, 1756-CN2R, and 1756-CN2RXT Performance Example(1)

No. of Direct Analog I/O Connections Added Online	RPI = 2 ms		RPI = 4 ms		RPI = 10 ms		RPI = 20 ms		RPI = 50 ms		RPI = 100 ms	
	CPU %(2)	Avg. API(3)	CPU %(2)	Avg. API(3)	CPU %(2)	Avg. API(3)	CPU %(2)	Avg. API(3)	CPU %(2)	Avg. API(3)	CPU %(2)	Avg. API(3)
0	1.50%	N/A	1.50%	N/A	1.50%	N/A	1.50%	N/A	1.50%	N/A	1.50%	N/A
1	4.80%	2.0	3.70%	4.0	2.50%	10.0	2.30%	20.0	1.90%	50.0	1.70%	100.0
2	7.00%	2.0	5.00%	4.0	3.30%	10.0	2.70%	20.0	2.10%	50.0	1.90%	100.0
3	9.00%	2.0	6.10%	4.0	3.80%	10.0	3.00%	20.0	2.20%	50.0	2.00%	100.0
4	11.20%	2.2	7.40%	4.0	4.40%	10.0	3.40%	20.0	2.40%	50.0	2.10%	100.0
5	11.50%	3.3	8.70%	4.0	5.00%	10.0	3.70%	20.0	2.60%	50.0	2.20%	100.0
6	12.80%	3.3	9.70%	4.0	5.50%	10.0	4.00%	20.0	2.70%	50.0	2.30%	100.0
7	13.80%	3.4	10.80%	4.0	5.90%	10.0	4.30%	20.0	2.90%	50.0	2.30%	100.0
8	15.10%	3.4	11.90%	4.0	6.40%	10.0	4.50%	20.0	3.00%	50.0	2.50%	100.0
9	15.00%	3.3	13.20%	4.0	7.00%	10.0	4.80%	20.0	3.20%	50.0	2.60%	100.0
10	15.60%	3.6	13.20%	4.0	7.50%	10.0	5.20%	20.0	3.40%	50.0	2.70%	100.0
11	16.40%	3.8	13.50%	4.0	8.20%	10.0	5.50%	20.0	3.50%	50.0	2.70%	100.0
12	17.00%	3.8	14.00%	4.0	8.80%	10.0	5.80%	20.0	3.70%	50.0	2.80%	100.0
13	17.80%	3.7	14.60%	4.0	9.30%	10.0	6.10%	20.0	3.80%	50.0	2.90%	100.0
14	18.50%	3.7	15.20%	4.0	9.90%	10.0	6.40%	20.0	4.00%	50.0	2.90%	100.0
15	19.40%	3.9	15.80%	4.0	10.50%	10.0	6.70%	20.0	4.10%	50.0	3.00%	100.0

(1) Example assumes that adequate unscheduled bandwidth is available.
(2) Approximate use of the central processing unit (CPU) of the module in percent.
(3) The average Actual Packet Interval with 2000 samples (shown in ms).

Because of the increased performance that is provided by the 1756-CN2, 1756-CN2R, and 1756-CN2RXT modules, many of the considerations that must be made with the 1756-CNB and 1756-CNBR modules are not applicable. With the 1756-CN2, 1756-CN2R, and 1756-CN2RXT modules, you can add I/O while online as long as you use reasonable RPI settings and remain within the CPU limitations of the ControlNet module.

When adding to the I/O Configuration with 1756-CN2, 1756-CN2R, and 1756-CN2RXT modules, make these considerations:

- Digital I/O modules can be added as rack-optimized connections if the parent module is configured with rack-optimized connections.

  TIP While you can add a new digital I/O module to an existing rack-optimized connection, you cannot add rack-optimized connections while online.

- Digital I/O modules can also be added as direct connections.
- Analog I/O modules can be added only as direct connections.
- Disable the Change of State (COS) feature on digital input modules because it can cause inputs to be sent more quickly than the RPI.

- If you plan to add large amounts of I/O to the ControlNet network, dedicate one ControlNet network for I/O. For the dedicated ControlNet network, verify that there is little or none of the following:
  - HMI traffic
  - MSG traffic
  - Programming workstations
- If the module has a Real Time Sample (RTS), disable it or set it to a rate that is greater than the RPI.
- You can add I/O modules until you reach these limits:
  - 80% of CPU utilization of the 1756-CN2, 1756-CN2R, or 1756-CN2RXT communication module.
  - Less than 400,000 unscheduled bytes per second are displayed in RSNetWorx for ControlNet software after the network has been scheduled.

Online Additions—EtherNet/IP Considerations

When you add I/O modules to the EtherNet/IP network, make these considerations:

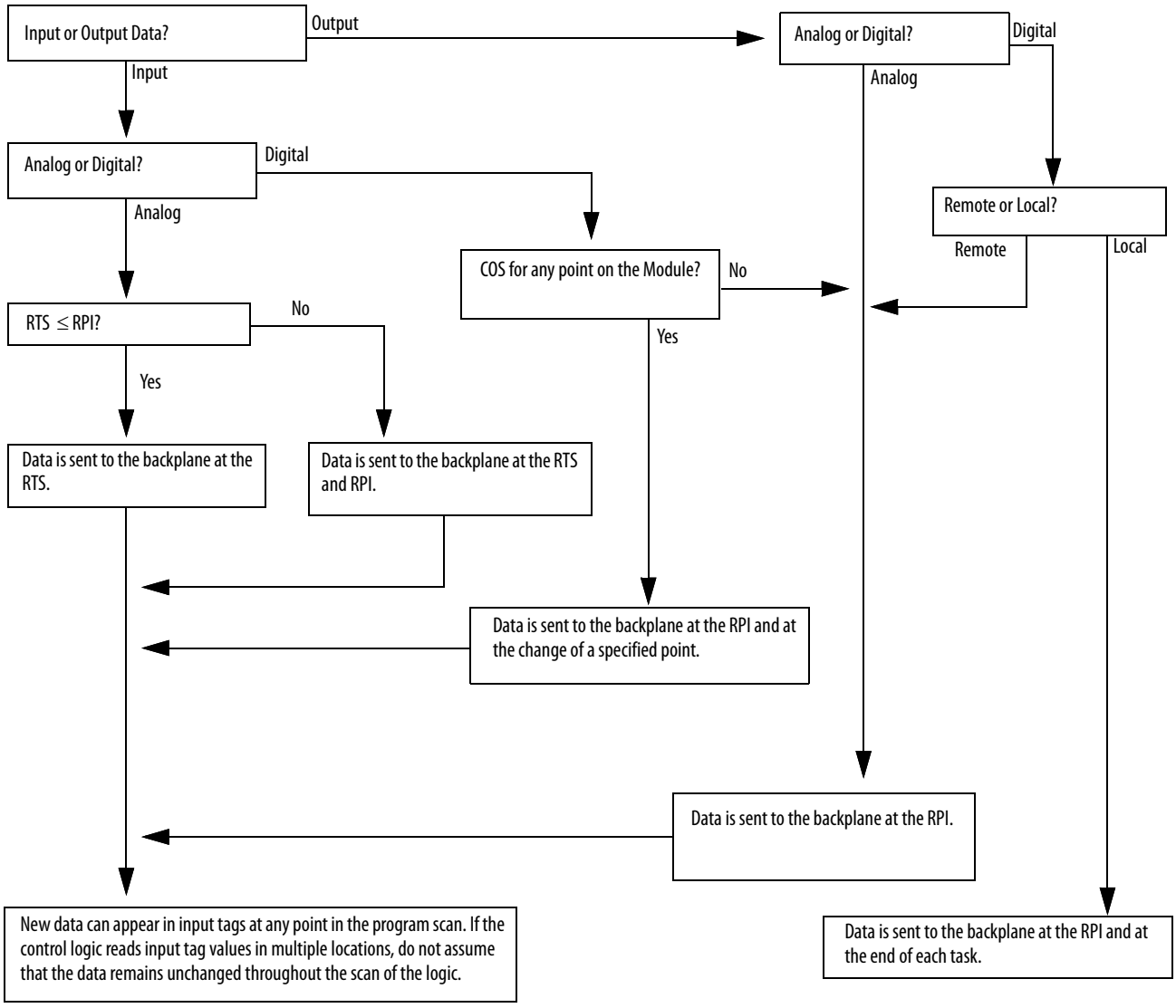
- The EtherNet/IP I/O modules that you add can be added as these connection types:
  - Rack-optimized connections, including new and existing connections
  - Direct connections
- You can add I/O modules until you reach the limits of the communication connections of the module.

  For EtherNet/IP module limitations, see the EtherNet/IP Modules in Logix 5000 Control Systems User Manual, publication ENET-UM001.

Determine When Data Is Updated

ControlLogix controllers update date asynchronously with the execution of logic. Use this flowchart to determine when a producer, such as a controller, input module, or bridge, sends data.

Figure 24 - Data Update Flowchart



- Over a ControlNet network, remote data is sent at the actual packet interval.
- Over an EtherNet/IP network, remote data is sent close to the RPI.

Notes:

Develop Motion Applications

Motion Control Options

ControlLogix® controllers support digital, analog, and Integrated Motion interfaces:

- Digital drive interfaces include EtherNet/IP™ connected drives and Sercos interface connected drives.
- Analog drives support ±10V analog output and can interface with various feedback device types including quadrature encoder, SSI, and LVDT feedback.
- Integrated Motion on an EtherNet/IP network supports Kinetix® 350, Kinetix 5500, Kinetix 6500, and PowerFlex® 755 drives.

Motion Overview

The configuration process varies, depending on your application and your drive selection. The following are general steps to configure a motion application.

1. Create a controller project.
2. Select the type of drive.

Drive Type	Requirements
CIP Sync™	• EtherNet/IP communication module • Digital drive with an EtherNet/IP connection
Sercos interface	Select a Sercos interface module: • 1756-M03SE • 1756-M08SE • 1756-M16SE
Analog interface	Select an analog interface module: • 1756-HYD02 • 1756-M02AE • 1756-M02AS

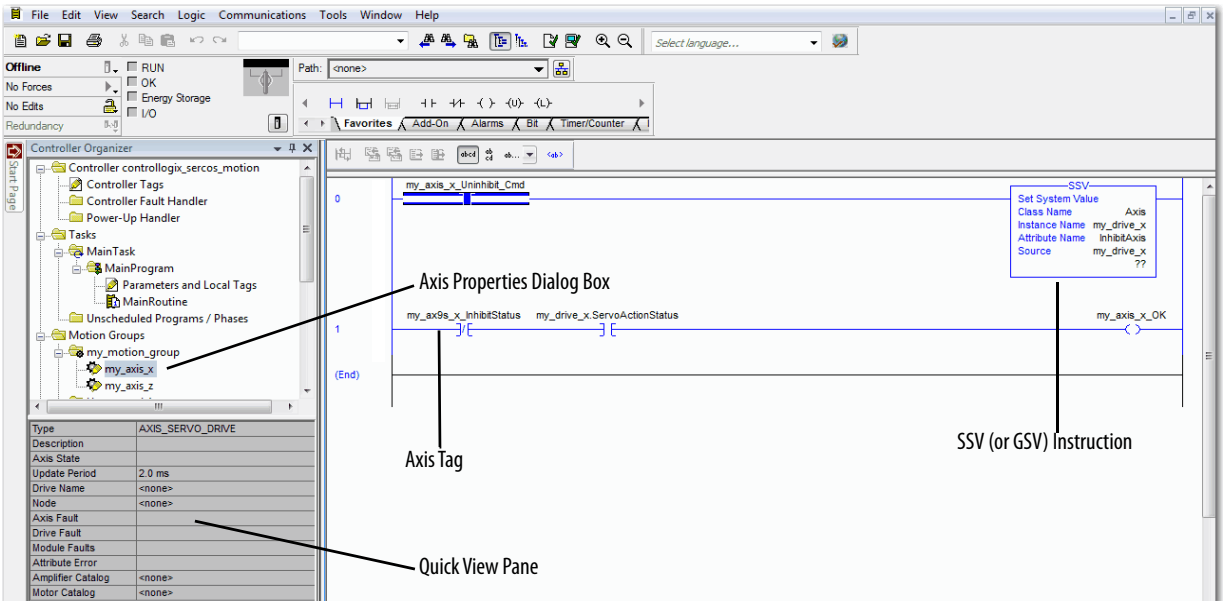
3. Create axis tags as needed.
4. Configure the drive.
5. Create axes as needed.

Obtain Axis Information

You can obtain axis information by using these methods:

- Double-click the axis to open the Axis Properties dialog box.
- Use a Get System Value (GSV) or Set System Value (SSV) instruction to read or change the configuration at runtime.
- View the Quick View pane to see the state and faults of an axis.
- Use an axis tag for status and faults.

Figure 25 - Obtain Axis Information

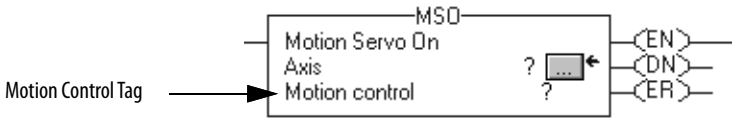


Program Motion Control

The controller provides a set of motion control instructions for your axes:

- The controller uses these instructions just like the rest of the Logix 5000® instructions.
- Each motion instruction works on one or more axes.
- Each motion instruction needs a motion control tag. The tag uses a MOTION_INSTRUCTION data type and stores the information status of the instruction.
- You can program by using motion control instructions in these programming languages:
  - Ladder Diagram (LD)
  - Structured Text (ST)
  - Sequential Function Chart (SFC)

Figure 26 - Motion Control Instruction



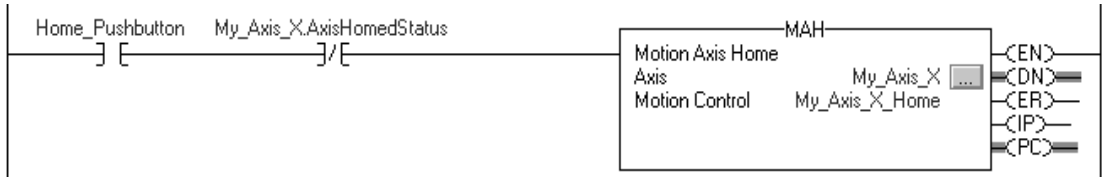
ATTENTION: Use the tag for the motion control operation of motion instruction only once. Unintended operation of the control variables can happen if you reuse of the same motion control tag in other instructions.

Example

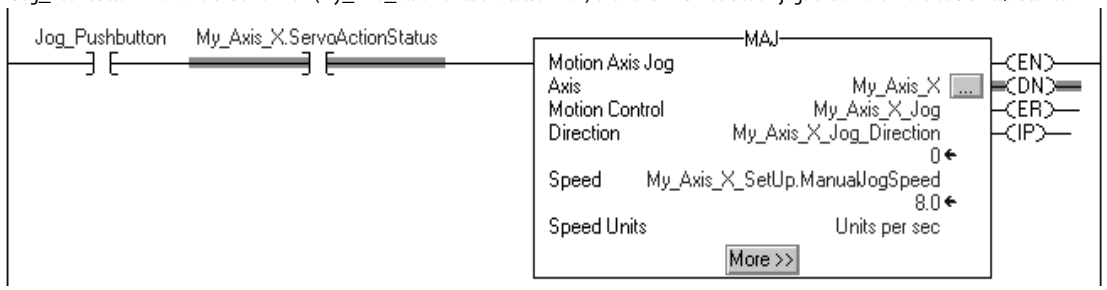
In this example, a simple ladder diagram that homes, jogs, and moves an axis.

If Initialize_Pushbutton = on and the axis = off (My_Axis_X.ServoActionStatus = off) then the MSO instruction turns on the axis.

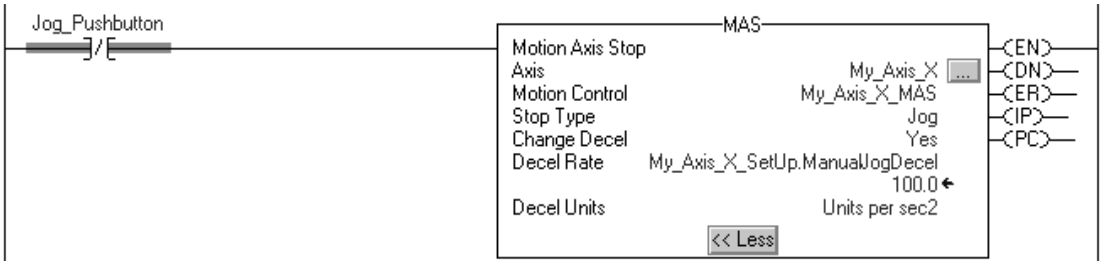
If Home_Pushbutton = on and the axis hasn't been homed (My_Axis_X.AxisHomedStatus = off) then the MAH instruction homes the axis.



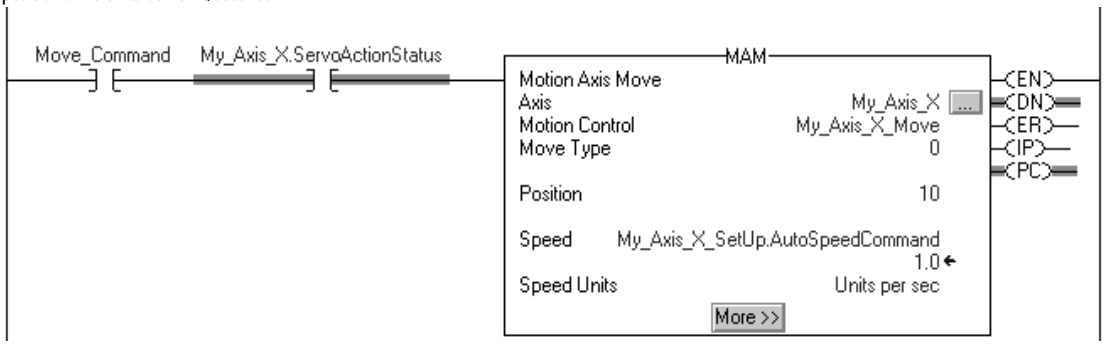
If Jog_Pushbutton = on and the axis = on (My_Axis_X.ServoActionStatus = on) then the MAJ instruction jogs the axis forward at 8 units/second.



If Jog_Pushbutton = off then the MAS instruction stops the axis at 100 units/.second^2. Make sure that Change Decel is Yes. Otherwise, the axis decelerates at its maximum speed.



If Move_Command = on and the axis = on (My_Axis_X.ServoActionStatus = on) then the MAM instruction moves the axis. The axis moves to the position of 10 units at 1 unit/second.



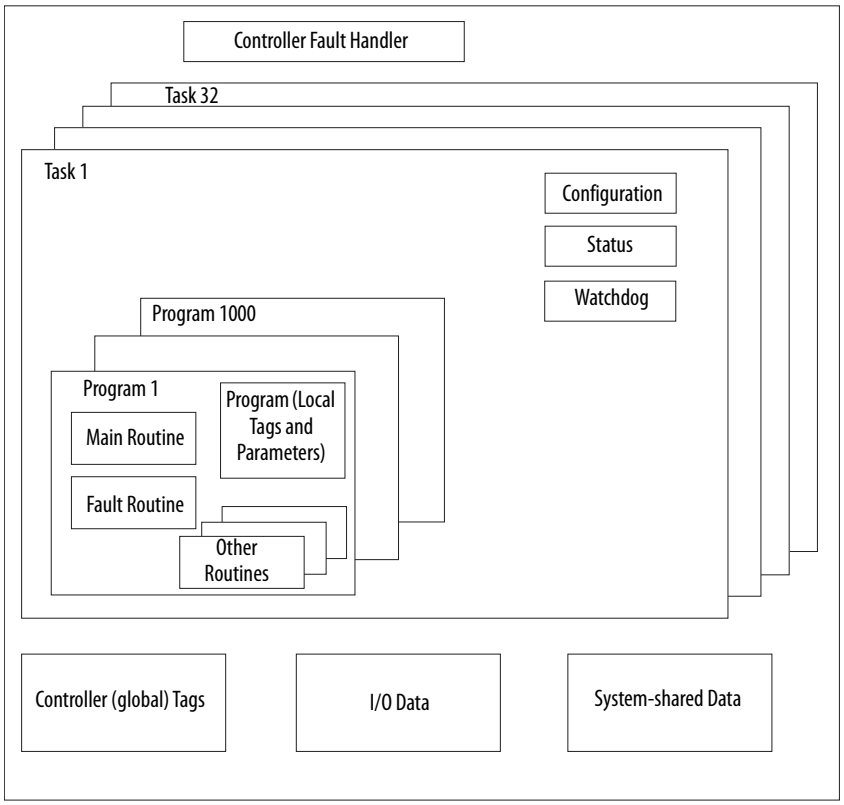
Develop Applications

Elements of a Control Application

A control application is composed of several elements that require planning for efficient application execution. Application elements include the following:

- Tasks
- Programs
- Routines
- Parameters and Local Tags

Figure 27 - Elements of a Control Program



Tasks

A Logix 5000® controller lets you use multiple tasks to schedule and prioritize the execution of your programs based on criteria. This multitasking allocates the processing time of the controller among the operations in your application:

- The controller executes only one task at a time.
- One task can interrupt the execution of another and take control.

- In any given task, multiple programs can be used. However, only one program executes at a time.
- You can display tasks in the Controller or Logical Organizer views, as necessary.

Figure 28 - Task Within a Control Application

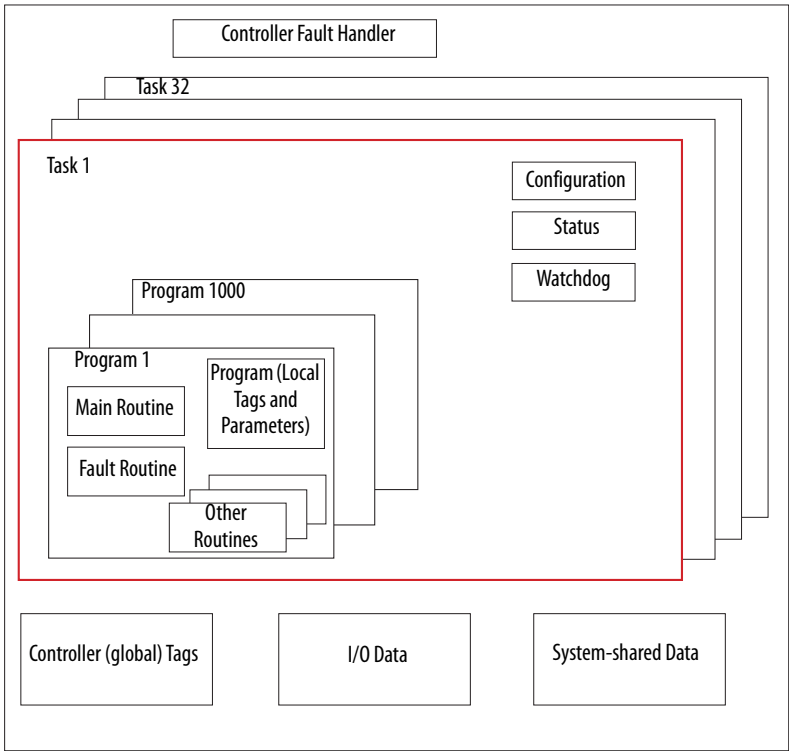
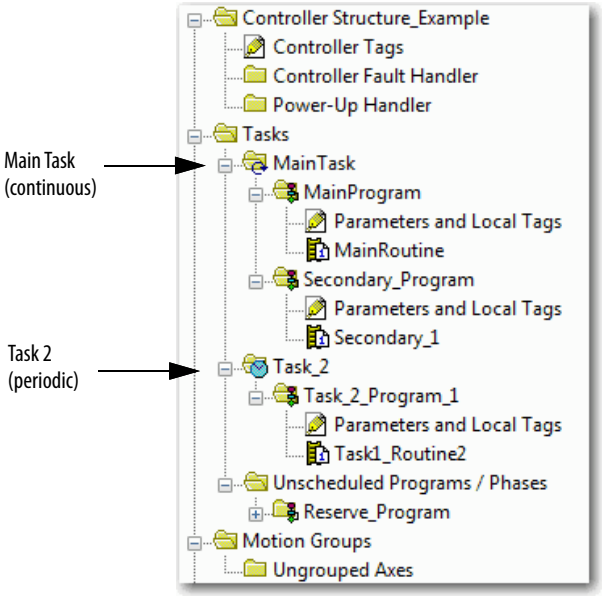
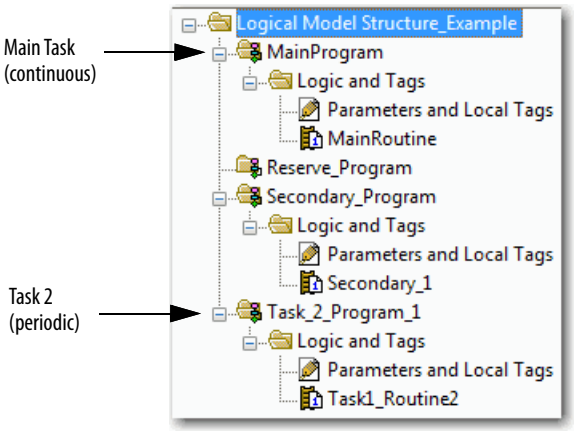


Figure 29 - Tasks

Controller Organizer



Logical Organizer



A task provides scheduling and priority information for a set of one or more programs. Configure tasks as continuous, periodic, or event by using the Task Properties dialog box.

Figure 30 - Configuring the Task Type

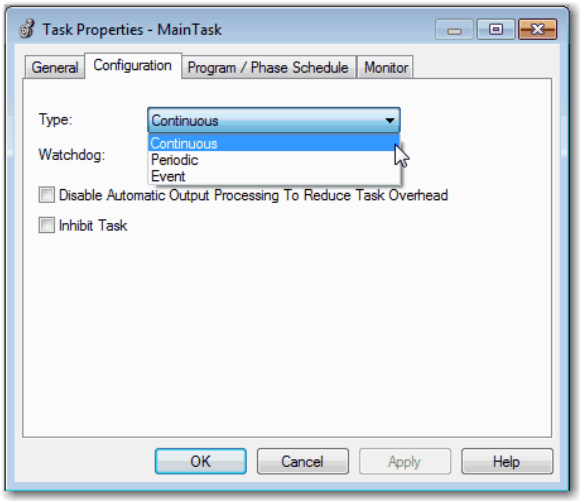


Table 38 explains the types of tasks that you can configure.

Table 38 - Task Types and Execution Frequency

Task Type	Task Execution	Description
Continuous	Constant	The continuous task runs in the background. Any CPU time that is not allocated to other operations (such as motion, communication, and other tasks) is used to execute the programs in the continuous task. • The continuous task runs constantly. When the continuous task completes a full scan, it restarts immediately. • A project does not require a continuous task. If used, there can be only one continuous task.
Periodic	• At a set interval, such as each 100 ms • Multiple times within the scan of your other logic	A periodic task performs a function at an interval. • Whenever the time for the periodic task expires, the task interrupts any lower priority tasks, executes once, and returns control to where the previous task left off. • You can configure the time period from 0.1…2,000,000.00 ms. The default is 10 ms. It is also controller and configuration dependent. • The performance of a periodic task depends on the type of Logix 5000 controller and on the logic in the task.
Event	Immediately when an event occurs	An event task performs a function only when an event (trigger) occurs. The trigger for the event task can be the following: • Module input data change of state • A consumed tag trigger • An EVENT instruction • An axis trigger • A motion event trigger

The ControlLogix® controller supports up to 32 tasks, only one of which can be continuous.

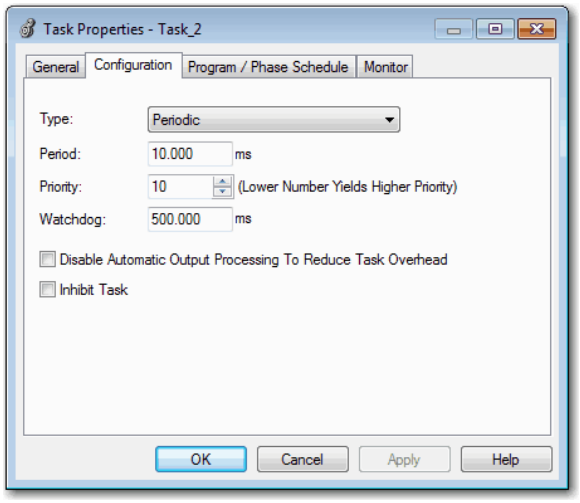
A task can have up to 1000 programs, starting with the Logix Designer application, version 24.00.00 and later, each with its own executable routines and program-scoped tags. Once a task is triggered (activated), the programs that are assigned to the task execute in the order in which they are grouped. Programs can appear only once in the Controller Organizer and multiple tasks cannot share them.

Task Priority

Each task in the controller has a priority level. The operating system uses the priority level to determine which task to execute when multiple tasks are triggered. A higher priority task interrupts any lower priority task. The continuous task has the lowest priority and a periodic or event task interrupts it.

You can configure periodic and event tasks to execute from the lowest priority of 15 up to the highest priority of 1. Configure the task priority by using the Task Properties dialog box.

Figure 31 - Configure Task Priority



Programs

The controller operating system is a preemptive multitasking system that is in compliance with IEC 1131-3. This system provides the following:

- Programs to group data and logic
- Routines to encapsulate executable code that is written in one programming language

Each program contains the following:

- Local Tags
- Parameters
- A main executable routine
- Other routines
- An optional fault routine

Figure 32 - Program Within a Control Application

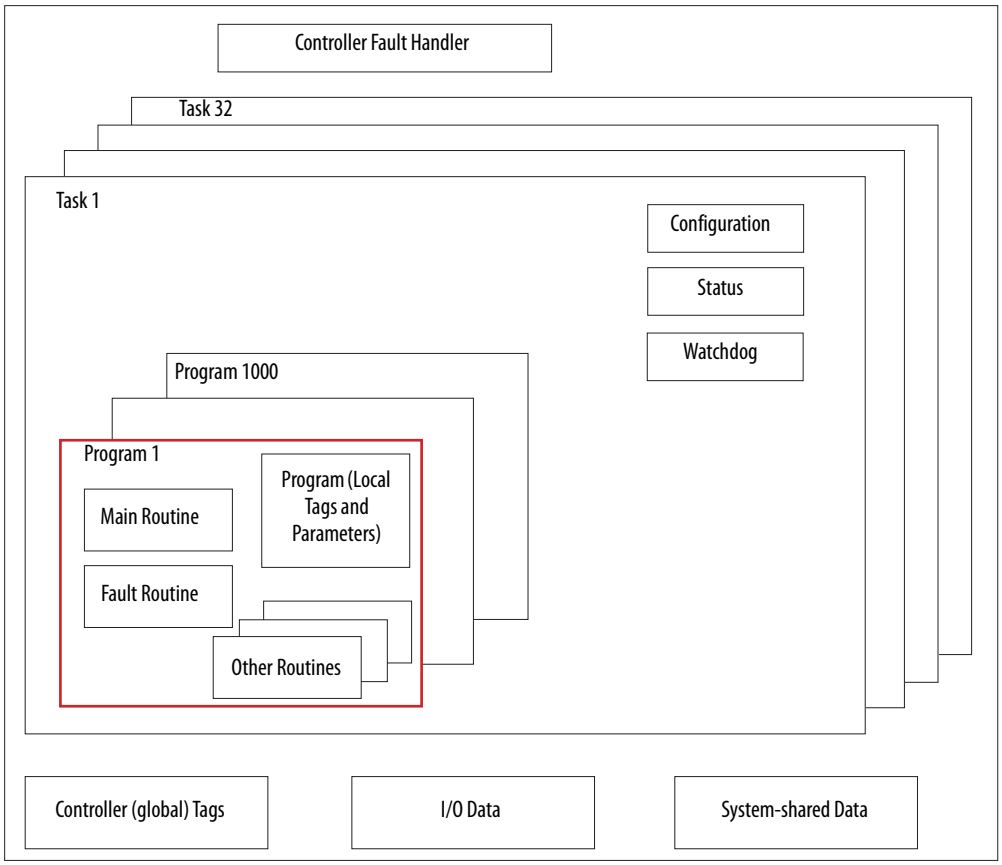
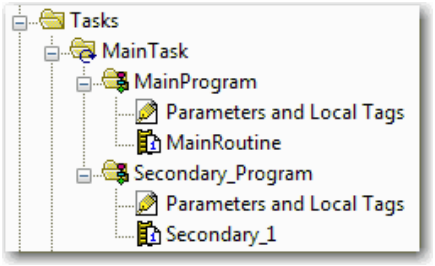
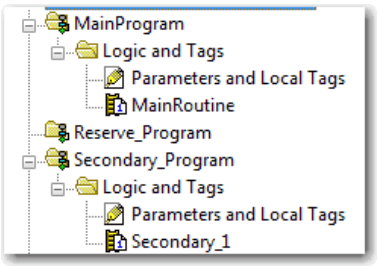


Figure 33 - Programs

Controller Organizer



Logical Organizer



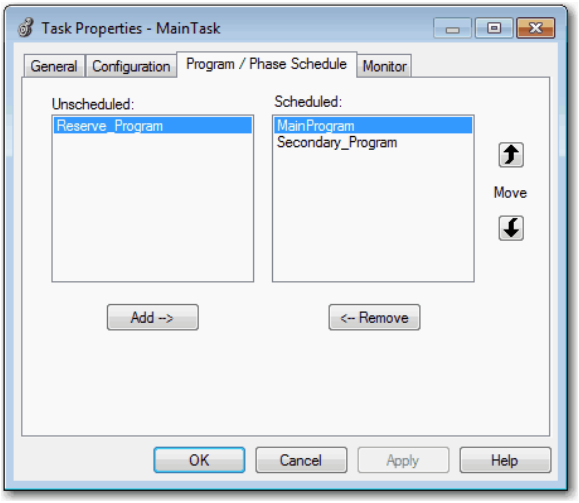
Scheduled and Unscheduled Programs

The scheduled programs within a task execute to completion from first to last. Programs that are not attached to any task show up as unscheduled programs.

Unscheduled programs within a task are downloaded to the controller with the entire project. The controller verifies unscheduled programs but does not execute them.

You must schedule a program within a task before the controller can scan the program. To schedule an unscheduled program, use the Program/ Phase Schedule tab of the Task Properties dialog box.

Figure 34 - Scheduling an Unscheduled Program



Routines

A routine is a set of logic instructions in one programming language, such as Ladder Diagram (ladder logic). Routines provide the executable code for the project in a controller. A routine is similar to a program file or subroutine in a PLC or SLC™ processor.

Each program has a main routine. The main is the first routine to execute when the controller triggers the associated task and calls the associated program. Use logic, such as the Jump to Subroutine (JSR) instruction, to call other routines.

You can also specify an optional program fault routine. The controller executes this routine if it encounters an instruction-execution fault within any of the routines in the associated program.

Figure 35 - Routines in a Control Application

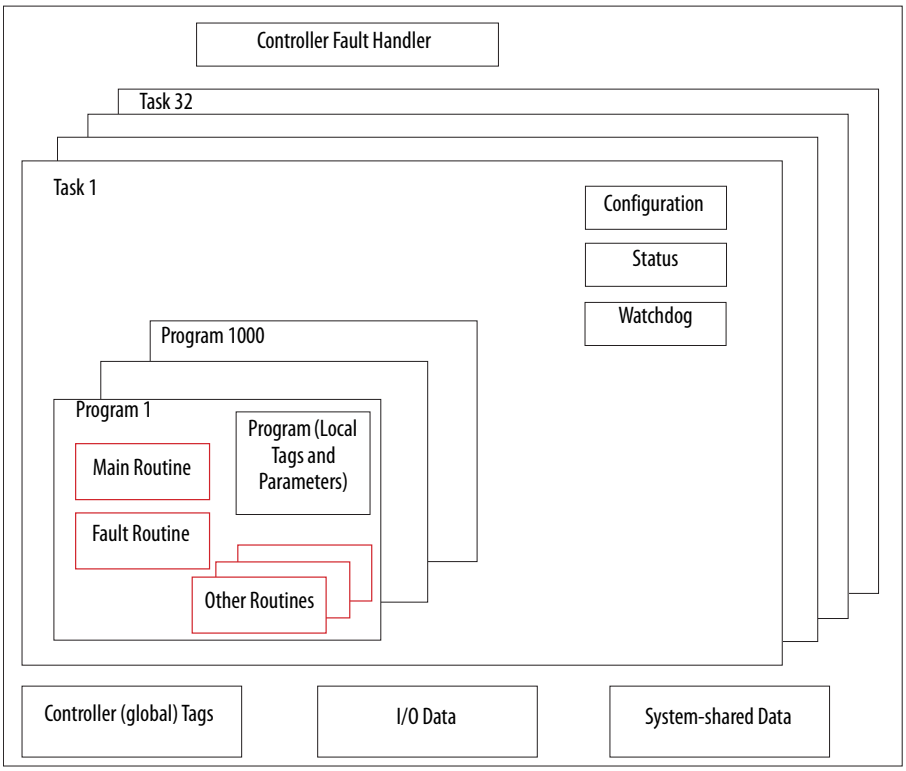
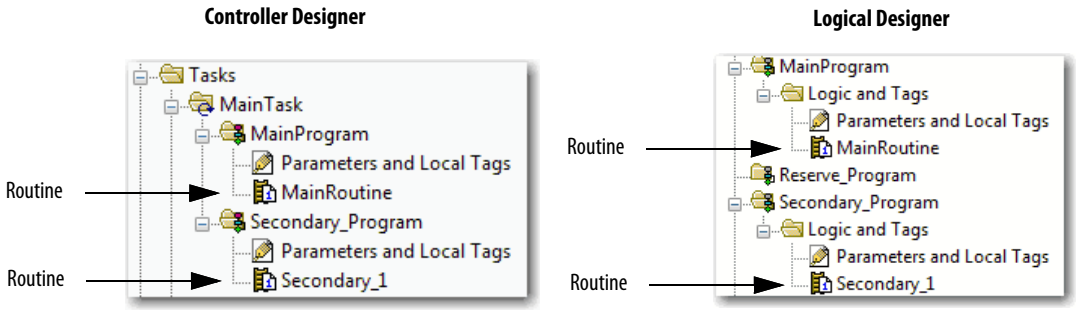


Figure 36 - Routines



Parameters and Local Tags

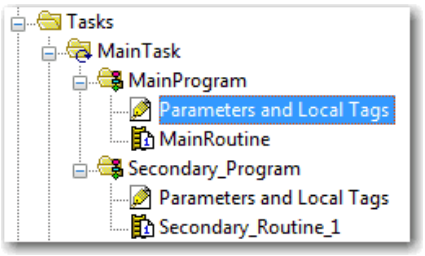
With a Logix 5000 controller, you use a tag (alphanumeric name) to address data (variables). In Logix 5000 controllers, there is no fixed, numeric format. The tag name identifies the data and lets you do the following:

- Organize your data to mirror your machinery.
- Document your application as you develop it.

This example shows data tags that are created within the scope of the Main Program of the controller.

Figure 37 - Tags Example

Controller Organizer —Main Program Parameters and Local Tags



Program Tags Window—Main Program Parameters and Local Tags

Analog I/O Device

Integer Value
Storage Bit
Counter
Timer
Digital I/O Device

Scope: MainProgram Show: All Tags Enter Name Filter...

Name	Usage	Alias For	Base Tag	Data Type	Description	External Access	Constant	Style
north_tank_mix	Local			BOOL		Read/Write		Decimal
north_tank_pr...	Local			REAL		Read/Write		Float
north_tank_temp	Local			REAL		Read/Write		Float
one_shots	Local			DINT		Read/Write		Decimal
recipe	Local			TANK		Read/Write		
recipe_number	Local			DINT		Read/Write		Decimal
replace_bit	Local			BOOL		Read/Write		Decimal
running_hours	Local			COUNTER		Read/Write		
running_secon...	Local			TIMER		Read/Write		
start	Local			BOOL		Read/Write		Decimal
stop	Local			BOOL		Read/Write		Decimal

There are several guidelines for creating and configuring parameters and local tags for optimal task and program execution. For more information, see the Logix 5000 Controllers and I/O Tag Data Programming Manual, publication 1756-PM004.

Extended Properties

The Extended Properties feature lets you define more information, such as limits, engineering units, or state identifiers, for various components within your controller project.

Component	Extended Properties
Tag	In the tag editor, add extended properties to a tag.
User-defined data type	In the data type editor, add extended properties to data types.
Add-On Instructions	In the properties that are associated with the Add-On Instruction definition, add extended properties to Add-On Instructions.

Pass-through behavior is the ability to assign extended properties at a higher level of a structure or Add-On Instruction and have that extended property automatically available for all members. Pass-through behavior is available for descriptions, state identifiers, and engineering units and you can configure it. Configure pass-through behavior on the Project tab of the Controller Properties dialog box. If you choose not to show pass-through properties, only extended properties that have been configured for a given component are displayed.

Pass-through behavior is **not** available for limits. When an instance of a tag is created, if limits are associated with the data type, the instance is copied.

You must know which tags have limits that are associated with them as there is no indication in the tag browser that extended properties are defined for a tag. If, however, you try to use extended properties that have not been defined for a tag, the editors show a visual indication and the routine does not verify.

Access Extended Properties in Logic

You can access limits that are defined on tags by using the .@Min and .@Max syntax:

- You cannot write to extended properties values in logic.
- To use extended tag properties in an Add-On Instruction, you must pass them in as input operands to the Add-On Instruction.
- Alias tags that have extended properties cannot access the extended properties in logic.
- Limits can be configured for input and output parameters in Add-On Instructions. However, limits cannot be defined on an InOut parameter of an Add-On Instruction.
- Limits cannot be accessed inside Add-On Instruction logic. Limits are only for use by HMI applications.

If an array tag is using indirect addressing to access limits in logic, the following conditions apply:

- If the array tag has limits that are configured, the extended properties are applied to any array element that does not explicitly have that particular extended property configured. For example, if the array tag MyArray has Max configured to 100, any element of the array that does not have Max configured inherits the value of 100 when being used in logic. However, it is not visible to you that the value inherited from MyArray is configured in the tag properties.

- At least one array element must have a limit that is configured for indirectly referenced array logic to verify. For example, if MyArray[x].@Max is being used in logic, at least one array element of MyArray[] must have Max extended property configured if MyArray has not configured Max.

- Under the following circumstances a data type default value is used:

  – Array is accessed programmatically with indirect reference.
  – Array tag does not have the extended property configured.
  – A member of an array does not have the extended property configured.

  For example, for an array of SINT type, when max limit is called in logic for a member, the value 127 is used.

If an array element is directly accessed, the element has to have the extended property defined. If not, verification fails.

Programming Languages

The ControlLogix controller supports these programming languages: online and offline.

Table 39 - ControlLogix Controller Programming Languages

Language	Is best used in programs with
Relay ladder	Continuous or parallel execution of multiple operations (not sequenced)
	Boolean or bit-based operations
	Complex logical operations
	Message and communication processing
	Machine interlocking
	Operations that service or maintenance personnel have to interpret to troubleshoot the machine or process
Function block diagram	Continuous process and drive control
	Loop control
	Calculations in circuit flow
Sequential function chart (SFC)	High-level management of multiple operations
	Repetitive sequence of operations
	Batch process
	Motion control using structured text
	State machine operations
Structured text	Complex mathematical operations
	Specialized array or table loop processing
	ASCII string handling or protocol processing

For information about programming in these languages, see the Logix 5000 Controllers Common Procedures Programming Manual, publication 1756-PM001.

Add-On Instructions

With RSLogix 5000® software, version 16.03.00 or later, and Logix Designer application, version 21.00.00 or later, you can design and configure sets of commonly used instructions to increase project consistency. Similar to the built-in instructions that are contained in Logix 5000 controllers, these instructions you create are called Add-On Instructions. Add-On Instructions reuse common control algorithms. With them, you can do the following:

- Ease maintenance by animating logic for one instance.
- Help protect intellectual property with locking instructions.
- Reduce documentation development time.

You can use Add-On Instructions across multiple projects. You can define your instructions, obtain them from somebody else, or copy them from another project.

Table 40 explains some of the capabilities and advantages of use Add-On Instructions.

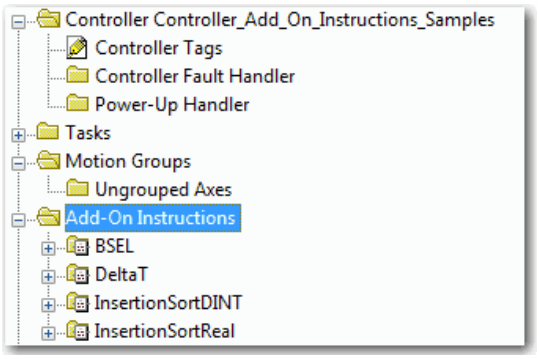
Table 40 - Add-On Instruction Capabilities

Capability	Description
Save Time	With Add-On Instructions, you can combine your most commonly used logic into sets of reusable instructions. You save time when you create instructions for your projects and share them with others. Add-On Instructions increase project consistency because commonly used algorithms all work in the same manner, regardless of who implements the project.
Use Standard Editors	You create Add-On Instructions by using one of three programming editors: • Relay Ladder • Function Block Diagram • Structured Text
Export Add-On Instructions	You can export Add-On Instructions to other projects and copy and paste them from one project to another. Give each instruction a unique name so that you don't accidentally overwrite another instruction of the same name.
Use Context Views	Context views let you visualize the logic of an instruction for instant, simplified online troubleshooting of your Add-On Instructions. Each instruction contains a revision, a change history, and an auto-generated help page.
Create Custom Help	When you create an instruction, you enter information for the description fields. This information becomes custom Help.
Apply Source Protection	As the creator of Add-On Instructions, you can limit users of your instructions to read-only access, or you can bar access to the internal logic or local parameters that are used by the instructions. This source protection lets you stop unwanted changes to your instructions and helps protect your intellectual property.

Once defined in a project, Add-On Instructions behave similarly to the built-in instructions in Logix 5000 controllers. They appear on the instruction tool bar for easy access along with internal instructions.

Figure 38 - Add-On Instructions

Controller Organizer



Instruction Toolbar

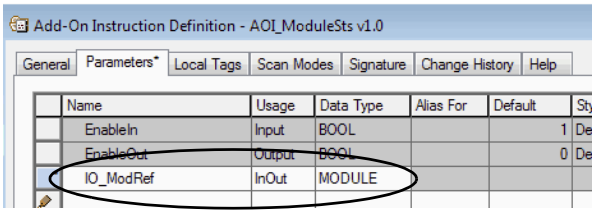
Access the Module Object

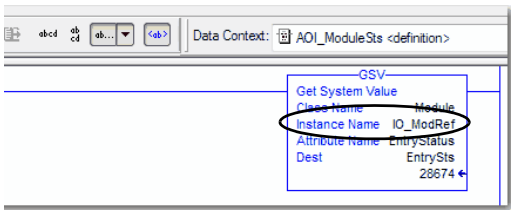
The MODULE object provides status information about a module. To select a particular module object, set the Object Name operand of the GSV/SSV instruction to the module name. The specified module must be present in the I/O Configuration section of the controller organizer and must have a device name.

Create the Add-On Instruction

With Logix Designer application, version 24.00.00 and later, you can access a MODULE object directly from an Add-On Instruction. Previously, you could access the MODULE object data but not from within an Add-On Instruction.

You must create a Module Reference parameter when you define the Add-On Instruction to access the MODULE object data. A Module Reference parameter is an InOut parameter of the MODULE data type that points to the MODULE Object of a hardware module. You can use module reference parameters in both Add-On Instruction logic and program logic.





For more information on the Module Reference parameter, see the Logix 5000 Controllers Add-On Instructions Programming Manual, publication 1756-PM010 and the Logix Designer application online help.

The MODULE object uses the following attributes to provide status information:

- EntryStatus
- FaultCode
- FaultInfo
- FWSupervisorStatus
- ForceStatus
- Instance
- LEDStatus
- Mode
- Path

The Path attribute is available with Logix Designer application, version 24.00.00 and later. This attribute provides a communication path to the module.

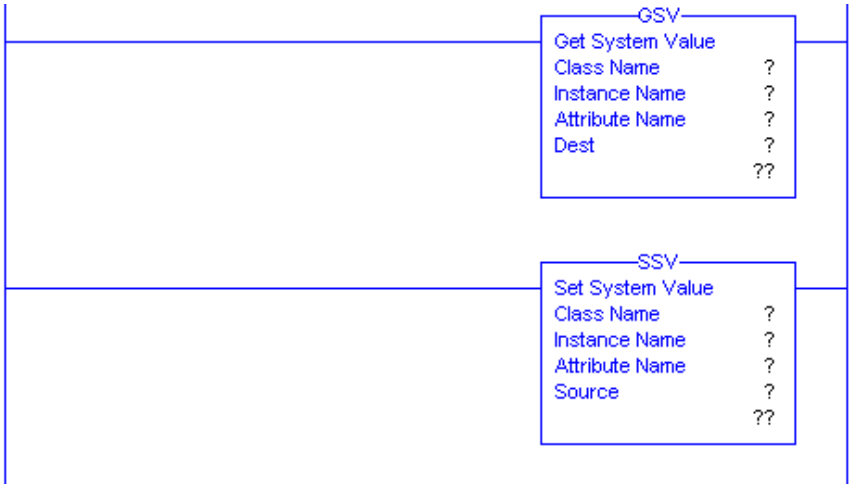
For more information on the attributes available in the MODULE object, see the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

Monitoring Controller Status

The ControlLogix controller uses Get System Value (GSV) and Set System Value (SSV) instructions to get and set (change) controller data. The controller stores system data in objects. There is no status file, as in the PLC-5® processor.

The GSV instruction retrieves the specified information and places it in the destination. The SSV instruction sets the specified attribute with data from the source. Both instructions are available from the Input/Output tab of the Instruction toolbar.

Figure 39 - GSV and SSV Instructions for Monitoring and Setting Attributes



When you add a GSV/SSV instruction to the program, the object classes, object names, and attribute names for the instruction are shown. For the GSV instruction, you can get values for the available attributes. For the SSV instruction, only the attributes you can set are shown.

Some object types appear repeatedly, so you have to specify the object name. For example, there can be several tasks in your application. Each task has its own Task object that you access by the task name.

There are several objects and attributes that you can use the GSV and SSV instructions to monitor and set the system. For more information about GSV instructions, SSV instructions, objects, and attributes see the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

Monitoring I/O Connections

If communication with a device in the I/O configuration of the controller does not occur in an application-specific period, the communication times out and the controller produces warnings.

The minimum timeout period that, once expired without communication, causes a timeout is 100 ms. The timeout period can be greater, depending on the RPI of the application. For example, if your application uses the default RPI = 20 ms, the timeout period is 160 ms.

For more information on how to determine the time for your application, search the Rockwell Automation® Knowledgebase for answer ID 38535. The document is available at https://www.rockwellautomation.com/knowledgebase.

When a timeout does occur, the controller produces these warnings;

- An I/O fault status code is indicated on the status display of the 1756-L7*x* controller.
- The I/O status indicator on the front of the 1756-L6x controller flashes green.
- A ⚠ shows over the I/O configuration folder and over the devices that have timed out.
- A module fault code is produced, which you can access via the following:
  - The Module Properties dialog box
  - A GSV instruction

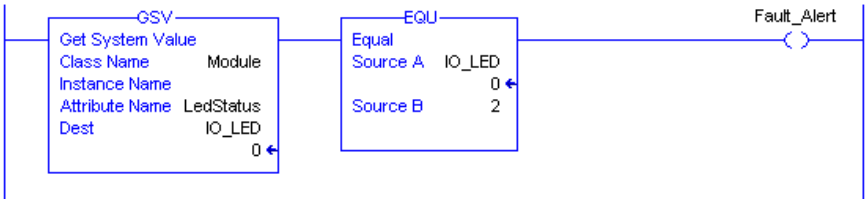
For more information about I/O faults, see the Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

Determine If I/O Communication Has Timed Out

This example can be used with the 1756-L7*x* or 1756-L6*x* controllers:

- The GSV instruction gets the status of the I/O status indicator (via the LEDStatus attribute of the Module object) and stores it in the IO_LED tag.
- IO_LED is a DINT tag that stores the status of the I/O status indicator or status display on the front of the controller.
- If IO_LED equals 2, then at least one I/O connection has been lost and the Fault_Alert is set.

Figure 40 - GSV Used to Identify I/O Timeout



For more information about attributes available with the Module object, see the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

Determine If I/O Communication to a Specific I/O Module Has Timed Out

If communication times out with a device (module) in the I/O configuration of the controller, the controller produces a fault code and fault information for the module. You can use GSV instructions to get fault code and information via the FaultCode and FaultInfo attributes of the Module object.

For more information about attributes available with the Module object, see the Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

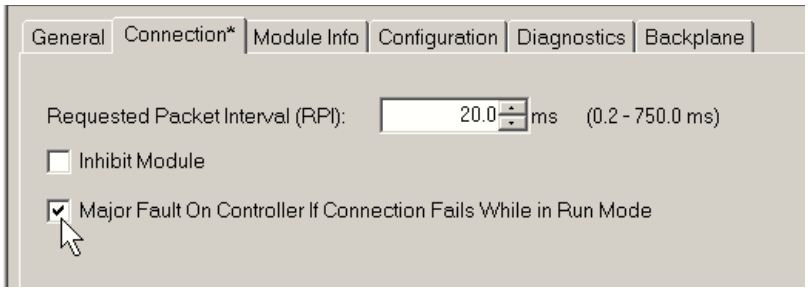
Interrupt the Execution of Logic and Execute the Fault Handler

Dependent on your application, you can want an I/O connection error to cause the Controller Fault Handler to execute. To do so, set the module property that causes a major fault to result from an I/O connection error. The major fault causes the execution of the Controller Fault Handler.

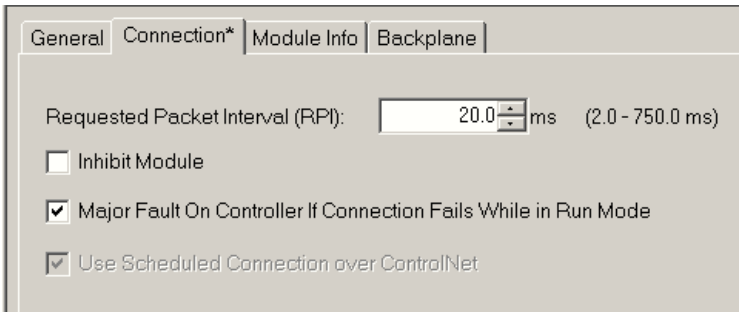
First, develop a routine in the Controller Fault Handler that can respond to I/O connection faults. Then, in the Module Properties dialog box of the I/O module or parent communication module, check Major Fault On Controller If Connection Fails While in Run Mode.

Figure 41 - I/O Connection Fault Causes Major Fault

I/O Module Properties



Parent Communication Module Properties



For more information about programming the Controller Fault Handler, see the Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

System Overhead Time Slice

The controller communicates with other devices at a specified rate (scheduled) or when processing time is available to service the communication.

The system overhead time slice specifies the percentage of time a controller devotes to service communication. If you have a continuous task, the system overhead time slice that is entered on the Advanced tab of the Controller Properties dialog box specifies the continuous task/service communication ratio. However, if there is no continuous task, the overhead time slice has no effect.

Table 41 shows the ratio between the continuous task and service communication at various system overhead time slices for RSLogix 5000 software, version 16.03.00 or later, and the Logix Designer application, version 21.00.00 or later.

Table 41 - Ratio between Continuous Task and Service Communication

Time Slice	Continuous Task Duration	Service Communication Duration
10%	9 ms	1 ms
20%	4 ms	1 ms
25%	3 ms	1 ms
33%	2 ms	1 ms
50%	1 ms	1 ms
66%	1 ms	2 ms
75%	1 ms	3 ms
80%	1 ms	4 ms
90%	1 ms	9 ms

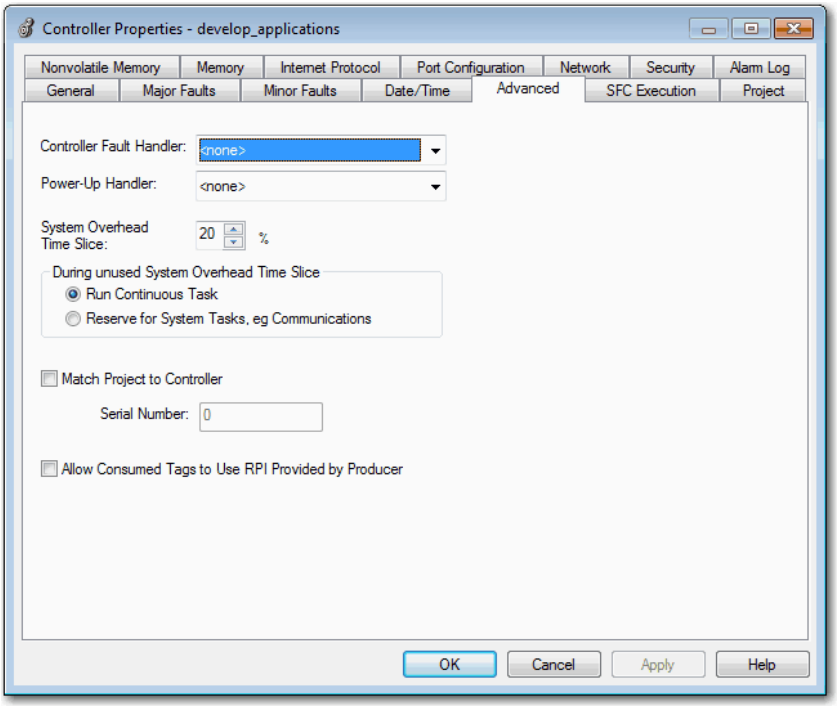
As shown in the table, if the system overhead time slice is less than or equal to 50%, the duration stays fixed at 1 ms. The same applies for 66% and higher, except there are multiple 1 ms intervals. For example, at 66% there are two 1 ms intervals of consecutive time and at 90%, there are nine 1 ms intervals of consecutive time.

Configure the System Overhead Time Slice

To configure the system overhead time slice, perform this procedure.

1. In the Controller Organizer, right-click the controller and choose Properties.

   The Controller Properties dialog box appears.

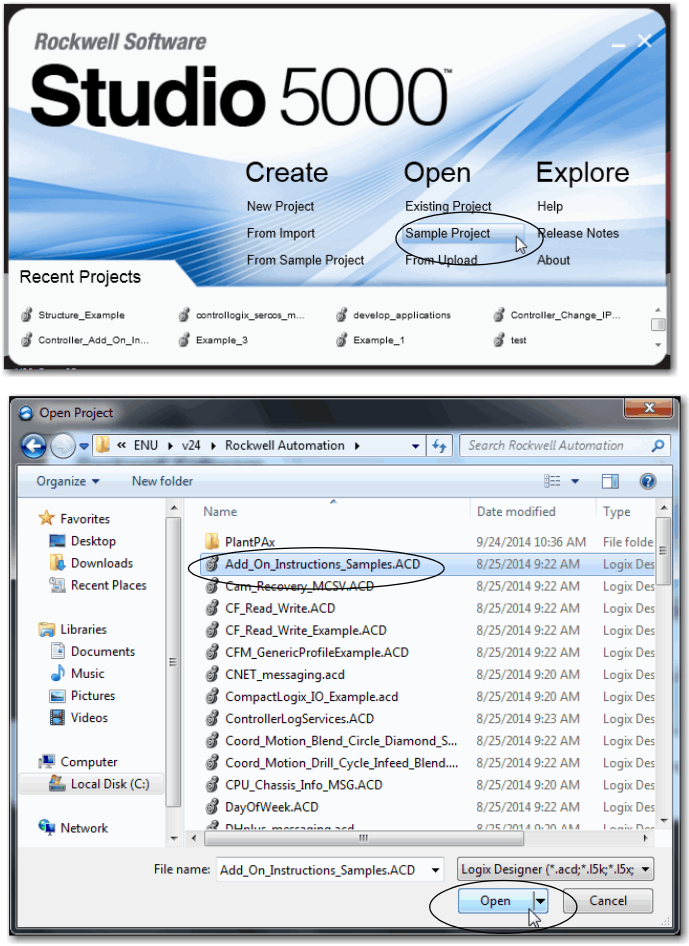


2. Click the Advanced tab.
3. Enter a numeric value in the System Overhead Time Slice box.
4. Use Run Continuous Task (default) or Reserve for System Tasks.
   - The Run Continue Task radio button is used when there is no communication or background tasks to process; controller immediately returns to the continuous task.
   - The Reserve for System Task radio button allocates the entire 1 ms of the system overhead time slice whether the controller has communication or background tasks to perform before returning back to the continuous task. This option lets you simulate a communication load on the controller during design and programming before HMIs, controller to controller messaging, and so forth, are configured.
5. Click OK.

Sample Controller Projects

The Studio 5000 Logix Designer® application includes sample projects that you can copy and modify to fit your application. To access the sample projects, choose Open Sample Project in the Studio 5000® interface and navigate to Samples > ENU > v24 > Rockwell Automation.

Figure 42 - Opening Sample Projects



Using the PhaseManager Tool

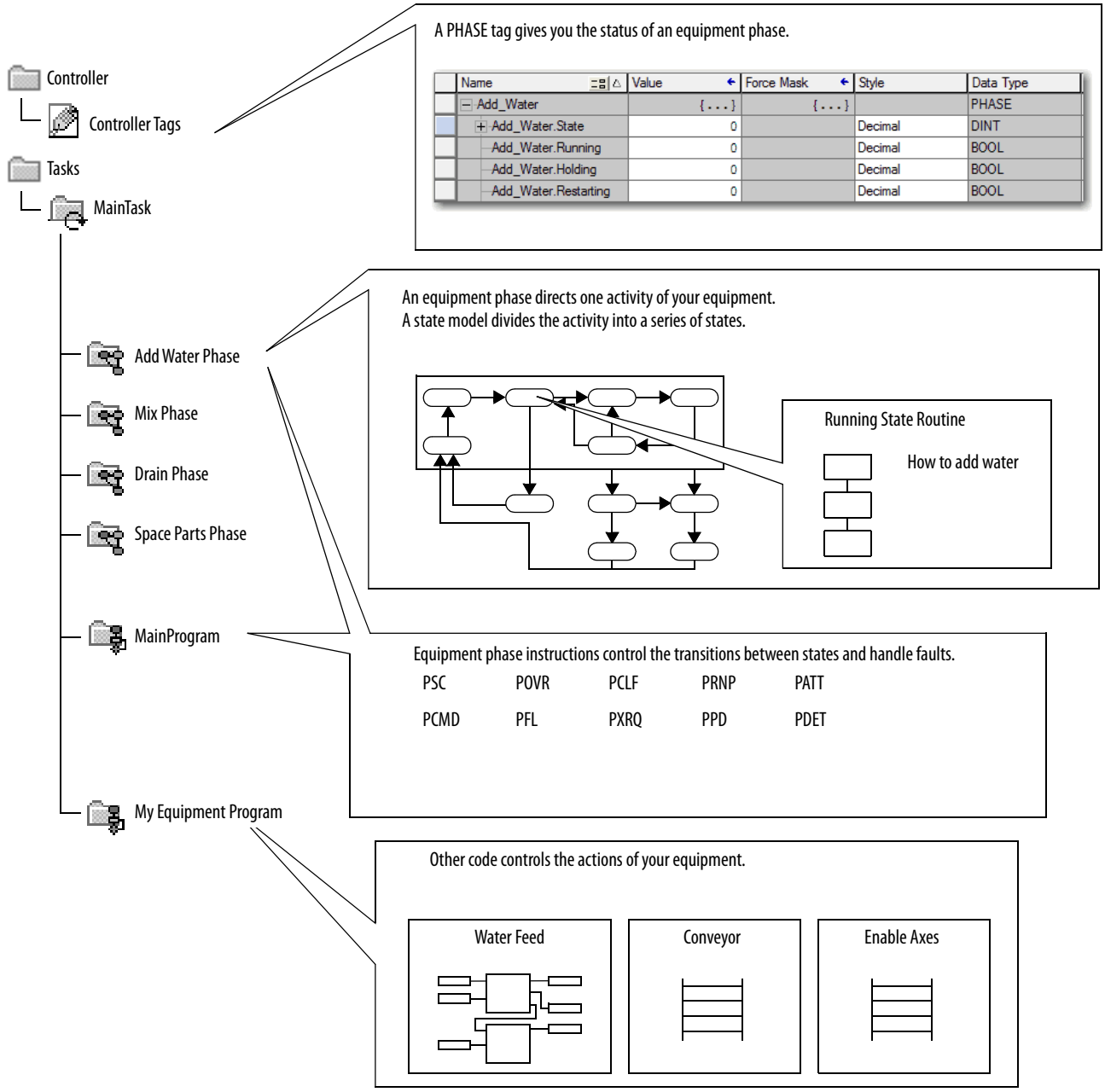
PhaseManager Overview

The PhaseManager™ tool lets you add equipment phases to your controller. An equipment phase helps you lay out your code in sections that are easier to write, find, follow, and change.

Table 42 - PhaseManager Terminology

Term	Description
Equipment phase	• As with a program, an equipment phase is run in a task and is given a set of routines and tags. • Unlike a program, an equipment phase runs by a state model and lets you do one activity.
State model	• A state model divides the operating cycle of your equipment into a series of states. Each state is an instance in the operation of the equipment, the actions, or conditions of the equipment at a given time. • The state model of an equipment phase resembles that of the S88 and Pack*ML* state models.
State machine	An equipment phase includes an embedded state machine that does the following: • Calls the routine that is associated with an active state • Manages the transitions between states with minimal coding • Makes sure that the equipment goes from state to state along an allowable path
PHASE tag	When you add an equipment phase, the application creates a tag for the equipment phase. The tag uses the PHASE data type.

Figure 43 - PhaseManager Overview



Minimum System Requirements

To develop PhaseManager programs, you need the following:

- A ControlLogix® controller at firmware revision 16 or later
- A communication path to the controller
- RSLogix 5000® software, version 16.03.00 or later or Logix Designer application, version 21.00.00 or later

To enable PhaseManager support, you need the Full or Professional edition of the software, or the software with PhaseManager software (catalog number 9324-RLDPMENE).

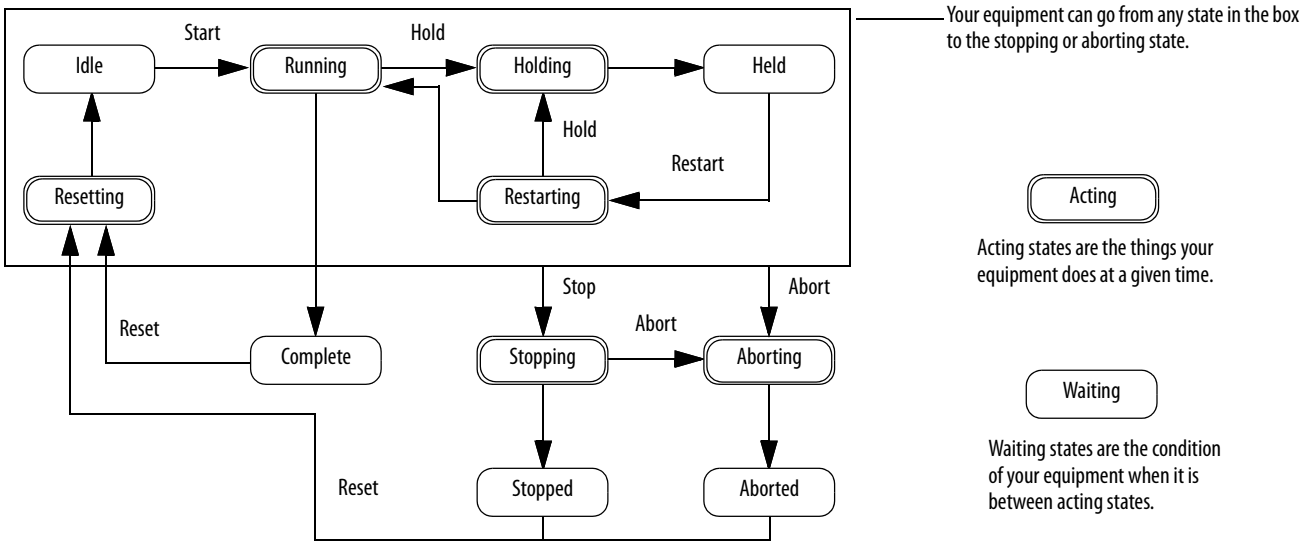
State Model Overview

A state model defines what your equipment does under different conditions, and how the states relate to each other. Each state can be described as an Acting state or Waiting state.

Table 43 - States in PhaseManager Software

State	Description
Acting	Does something or several things for a certain time or until certain conditions are met. An acting state runs once or repeatedly.
Waiting	Shows that certain conditions are met and the equipment is waiting for the signal to go to the next state.

Figure 44 - PhaseManager State Transitions



With a state model, you define the behavior of your equipment during Acting states.

Table 44 - Acting States in the PhaseManager State Model

State	Question to Ask
Resetting	How does the equipment get ready to run?
Running	What does the equipment do to make the product?
Holding	How does the equipment temporarily stop making product without making scrap?
Restarting	How does the equipment resume production after holding?
Stopping	What happens during a normal shutdown?
Aborting	How does the equipment shut down if a fault or failure occurs?

How Equipment Changes States

The arrows of the state model show the states through which your equipment progresses:

- Each arrow is called a transition.
- A state model lets the equipment make only certain transitions. This restriction standardizes the behavior of the equipment so that other equipment using the same model behaves the same way.

Figure 45 - PhaseManager Transition Commands

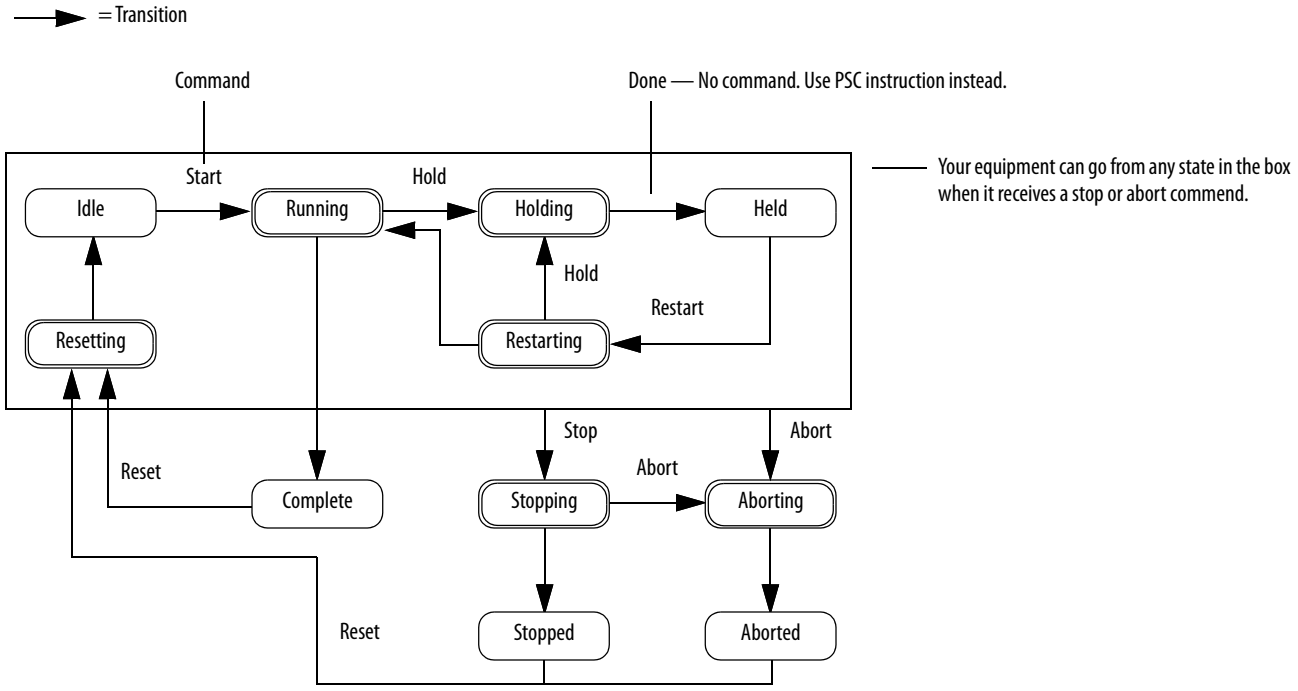


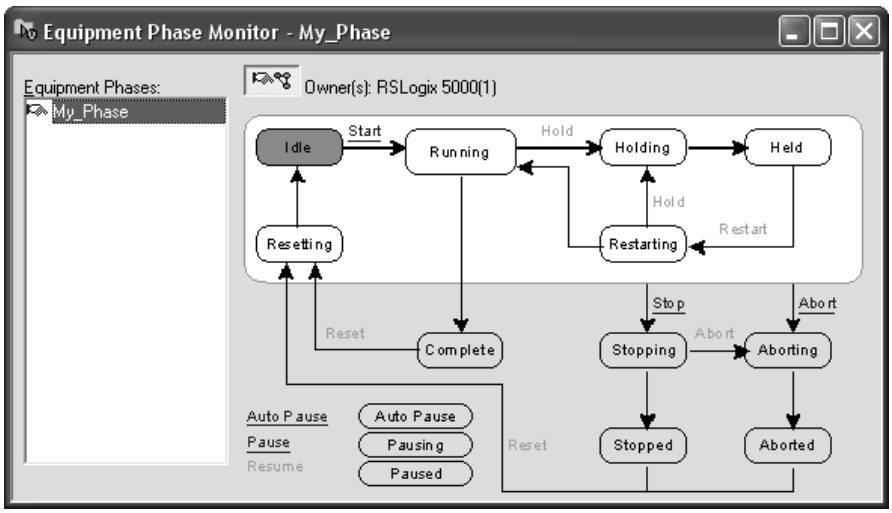
Table 45 - PhaseManager Transitions

Type of Transition	Description		
Command	A command tells the equipment to do something. For example, the operator pushes the start button to begin production and the stop button to halt production. The PhaseManager tool uses these commands:		
	Reset	Stop	Restart
	Start	Hold	Abort
Done	Equipment goes to a waiting state when it is finished with what it is doing. You do not give the equipment a command. Instead, you configure your code to signal when the phase state is finished.		
Fault	A fault tells you that something out of the ordinary has happened. You configure your code to look for faults and act if it finds any. If you want to shut down your equipment as quickly as possible when it detects a fault, configure your code to look for that fault and give the abort command if it finds it.		

Manually Change States

You can manually change an equipment phase. To change a PhaseManager state, perform this procedure.

1. Open the Equipment Phase Monitor.
2. Take ownership of the equipment phase by clicking Owners and clicking Yes.
3. Click the command that initiates the state you need (for example, Start or Reset).
4. After you have finished manually changing the state, click Owners to release your ownership.



PhaseManager Tool versus Other State Models

Table 46 compares PhaseManager state models to other state models.

Table 46 - PhaseManager Tool and Other State Models

PhaseManager Tool	S88	Pack*ML*
Resetting…Idle	Idle	Starting…Ready
Running…Complete	Running…Complete	Producing
Subroutines or breakpoints	Pausing…Paused	Standby
Holding…Held	Holding…Held	Holding…Held
Restarting	Restarting	None
Stopping…Stopped	Stopping…Stopped	Stopping…Stopped
Aborting…Aborted	Aborting…Aborted	Aborting…Aborted

Equipment Phase Instructions

The controller supports several equipment-phase relay ladder and structured text instructions.

Table 47 - Instructions for Use with PhaseManager Tool

Instruction	Instruction Function
PSC	Signal a phase that the state routine is complete and to go ahead to the next state.
PCMD	Change the state or substate of a phase.
PFL	Signal a failure for a phase.
PCLF	Clear the failure code of a phase.
PXRQ	Initiate communication with FactoryTalk® Batch software.
PRNP	Clear the NewInputParameters bit of a phase.
PPD	Configure breakpoints within the logic of a phase.
PATT	Take ownership of a phase to **one** of the following: • Stop another program or FactoryTalk Batch software from commanding a phase. • Make sure another program or FactoryTalk Batch software does not own a phase.
PDET	Relinquish ownership of a phase.
POVR	Override a command.

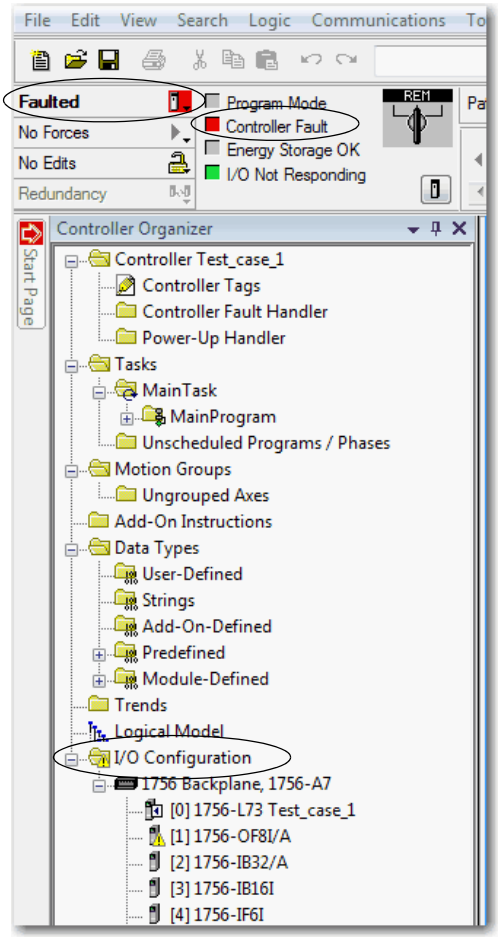
For more information about instructions for use with equipment phases, see the PhaseManager User Manual, publication LOGIX-UM001.

Troubleshoot the Module

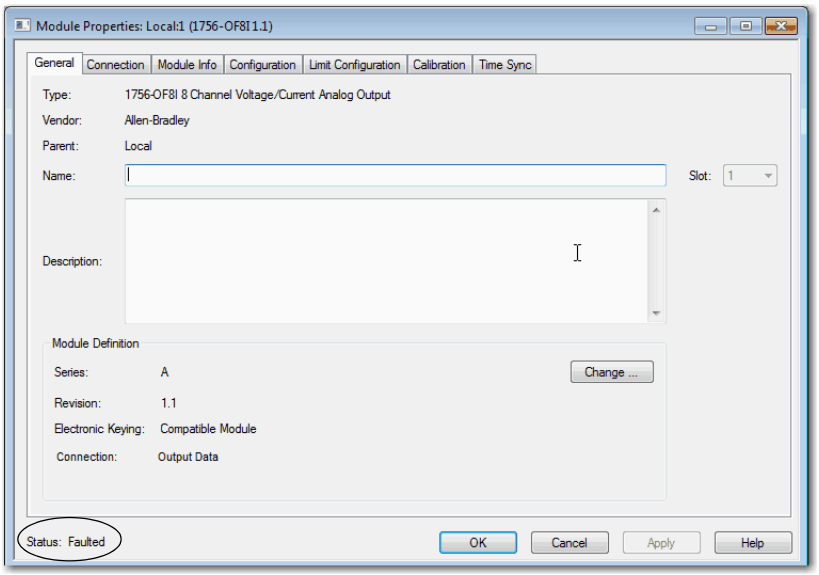
Troubleshoot in the Logix Designer Application

The Studio 5000 Logix Designer® application indicates fault conditions in the following ways:

- **Warning signal** on the main screen next to the module - This occurs when the connection to the module is broken. The controller state also indicates Faulted and the Controller fault is illuminated in red.



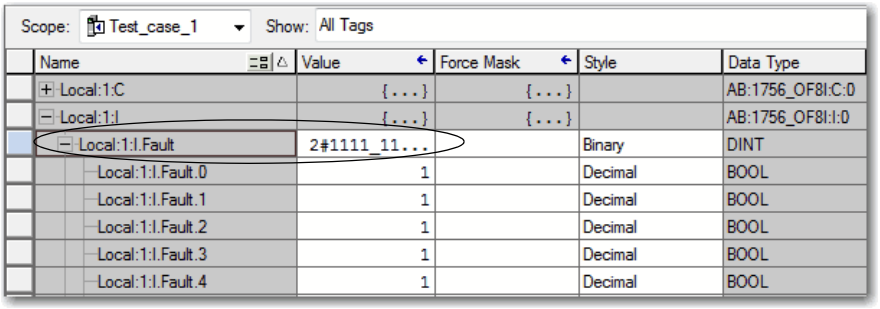
- Message in the **status line** of a screen.



On the Module Info tab, in the Status section, the Major and Minor Faults are listed along with the Internal State of the module.

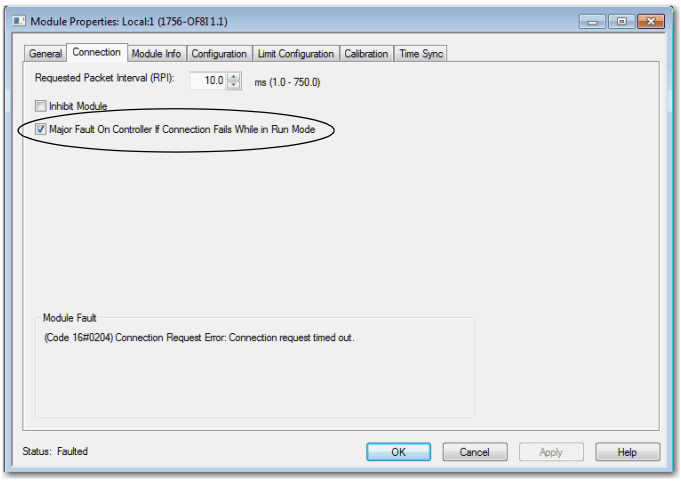
Notification in the Tag Editor - General module faults are also reported in the Tag Editor. Diagnostic faults are reported only in the tag editor.

The Value field indicates a fault with the number 1.

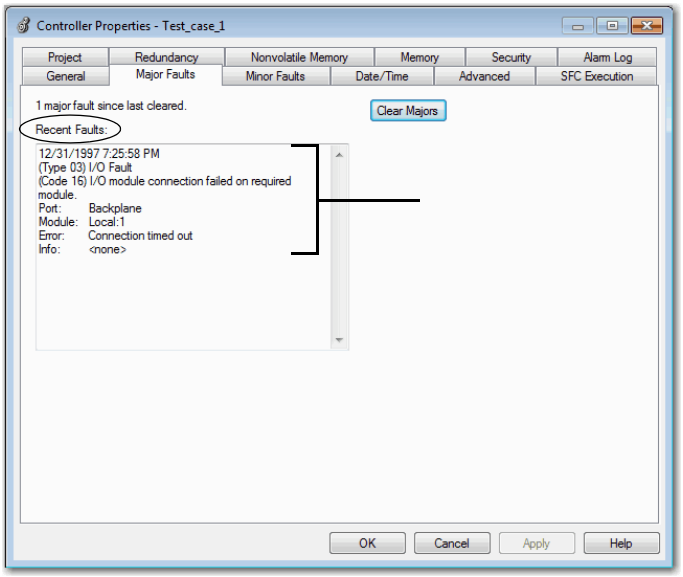


Fault Type Determination

To display recent fault information in the Major Faults tab of the Module Properties screen, you must check the Major Fault on Controller option in the Connection tab.



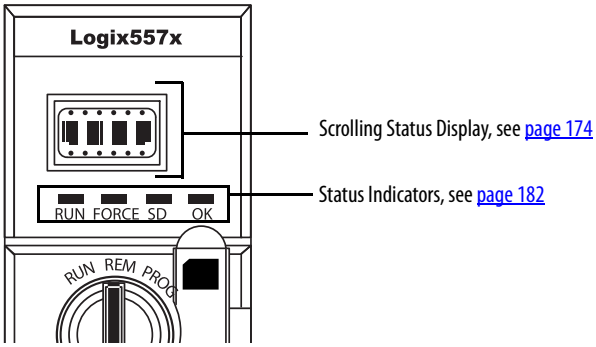
When you are monitoring the configuration properties of a module in the Logix Designer application and receive a Communication fault message, the Major Faults tab indicates the type of fault under Recent Faults.



ControlLogix 5570 Controller Status Display and Indicators

ControlLogix® 5570 controllers have four status indicators and one four-character scrolling status display.

Figure 46 - 1756-L7*x* Status Display and Indicators



ControlLogix 5570 Controller Status Display

The ControlLogix 5570 controller status display scrolls messages that provide information about the firmware revision, ESM status, project status, and major faults of the controller.

General Status Messages

The messages that are described in Table 48 are typically indicated upon powerup, powerdown, and while the controller is running to show the status of the controller and the ESM.

Table 48 - General Status Messages

Message	Interpretation
No message is indicated	The controller is Off. Check the OK indicator to determine if the controller is powered and determine the state of the controller.
TEST	The controller is conducting power-up tests.
PASS	Power-up tests have been successfully completed.
SAVE	A project is being saved to the SD card. You can also view the SD Indicator (see page 183) for more status information. Allow the save to complete before: • removing the SD card. • disconnecting power.
LOAD	A project is being loaded from the SD card at controller powerup. You can also view the SD Indicator (see page 183) for more status information. Allow the load to complete before doing the following: • Removing the SD card • Disconnecting power • Removing the ESM module
UPDT	A firmware update is being conducted from the SD card upon powerup. You can also view the SD Indicator (see page 183) for more status information. If you do not want the firmware to update upon powerup, change the Load Image property of the controller.
CHRG	The capacitor-based ESM is being charged.
1756-L7*x*/*X*	The controller catalog number and series.

Table 48 - General Status Messages (Continued)

Message	Interpretation
Rev *XX.xxx*	The major and minor revision of the firmware of the controller.
No Project	No project is loaded on the controller. To load a project, do one of the following: • Use the Logix Designer application to download the project to the controller • Use an SD card to load a project to the controller
Project Name	The name of the project that is currently loaded on the controller.
BUSY	The I/O modules that are associated with the controller are not yet fully powered. Allow time for powerup and I/O module self-testing.
Corrupt Certificate Received	The security certificate that is associated with the firmware is corrupted. Go to https://www.rockwellautomation.com/support/ and download the firmware revision you are trying to upgrade to. Replace the firmware revision that you have previously installed with that posted on the Technical Support website.
Corrupt Image Received	The firmware file is corrupted. Go to https://www.rockwellautomation.com/support/ and download the firmware revision you are trying to upgrade to. Replace the firmware revision that you have previously installed with that posted on the Technical Support website.
ESM Not Present	An ESM is not present and the controller cannot save the application at powerdown. Insert a compatible ESM, and, if using a capacitor-based ESM, do not remove power until the ESM is charged.
ESM Incompatible	The ESM is incompatible with the memory size of the controller. Replace the incompatible ESM with a compatible ESM.
ESM Hardware Failure	A failure with the ESM has occurred and the controller is incapable of saving of the program in the event of a powerdown. Replace the ESM before removing power to the controller so the controller program is saved.
ESM Energy Low	The capacitor-based ESM does not have sufficient energy to enable the controller to save the program in the event of a powerdown. Replace the ESM.
ESM Charging	The capacitor-based ESM is charging. Do not remove power until charging is complete.
Flash in Progress	A firmware update initiated via ControlFLASH™ or AutoFlash utilities is in progress. Allow the firmware update to complete without interruption.
Firmware Installation Required	The controller is using boot firmware (that is revision 1.*xxx*) and requires a firmware update. Upgrade controller firmware.
SD Card Locked	An SD card that is locked is installed.
SD Card Unprotected	The controller SD card has become unprotected and is available for remote read/write operations.

Fault Messages

If the controller displays a fault, these messages can be indicated on the status display.

Table 49 - Fault Messages

Message	Interpretation
Major Fault T*XX*:C*XX message*	A major fault of Type *XX* and Code *XX* has been detected. For example, if the status display indicates Major Fault T04:C42 Invalid JMP Target, a JMP instruction is programmed to jump to an invalid LBL instruction. For details about major recoverable faults, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.
I/O Fault Local:*X #XXXX message*	An I/O fault has occurred on a module in the local chassis. The slot number and fault code are indicated along with a brief description. For example, I/O Fault Local:3 #0107 Connection Not Found indicates that a connection to the local I/O module in slot three is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix 5000 Controllers Major, Minor, and I/O FaultsLogix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.
I/O Fault *ModuleName #XXXX message*	An I/O fault has occurred on a module in a remote chassis. The name of the faulted module is indicated with the fault code and a brief description of the fault. For example, I/O Fault My_Module #0107 Connection Not Found indicates that a connection to the module named My_Module is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.
I/O Fault *ModuleParent:X #XXXX message*	An I/O fault has occurred on a module in a remote chassis. The parent name of the module is indicated because no module name is configured in the I/O Configuration tree of the Logix Designer application. In addition, the fault code is indicated with a brief description of the fault. For example, I/O Fault My_CNet:3 #0107 Connection Not Found indicates that a connection to a module in slot 3 of the chassis with the communication module named My_CNet is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.
X I/O Faults	I/O faults are present and *X* = the number of I/O faults present. If there are multiple I/O faults, the controller indicates that the first fault reported. As each I/O fault is resolved, the number of faults indicated decreases and the I/O Fault message indicates the next fault reported. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

Major Fault Messages

The Major Fault T*XX*:C*XX message* on the controller status display indicates major faults. Table 50 lists fault types, codes, and the associated messages as they are shown on the status display.

For detailed descriptions and suggested recovery methods for major faults, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

Table 50 - Major Fault Status Messages

Type	Code	Message
1	1	Run Mode Powerup
1	60	Nonrecoverable
1	61	Nonrecoverable – Diagnostics Saved on CF Card
1	62	Nonrecoverable – Diagnostics and Program Saved on SD card
3	16	I/O Connection Failure
3	20	Chassis Failure
3	21	
3	23	Connection Failure
4	16	Unknown Instruction
4	20	Invalid Array Subscript
4	21	Control Structure LEN or POS < 0
4	31	Invalid JSR Parameter
4	34	Timer Failure
4	42	Invalid JMP Target
4	82	SFC Jump Back Failure
4	83	Value Out of Range
4	84	Stack Overflow
4	89	Invalid Target Step
4	90	Invalid Instruction
4	91	Invalid Context
4	92	Invalid Action
4	990	User-defined
4	991	
4	992	
4	993	
4	994	
4	995	
4	996	
4	997	
4	998	
4	999	

Table 50 - Major Fault Status Messages (Continued)

Type	Code	Message
6	1	Task Watchdog Expired
7	40	Save Failure
7	41	Bad Restore Type
7	42	Bad Restore Revision
7	43	Bad Restore Checksum
7	44	Failed to Restore Processor Memory
8	1	Keyswitch Change Ignored
11	1	Positive Overtravel Limit Exceeded
11	2	Negative Overtravel Limit Exceeded
11	3	Position Error Tolerance Exceeded
11	4	Encoder Channel Connection Fault
11	5	Encoder Noise Event Detected
11	6	Sercos Drive Fault
11	7	Synchronous Connection Fault
11	8	Servo Module Fault
11	9	Asynchronous Connection Fault
11	10	Motor Fault
11	11	Motor Thermal Fault
11	12	Drive Thermal Fault
11	13	Sercos Communications Fault
11	14	Inactive Drive Enable Input Detected
11	15	Drive Phase Loss Detected
11	16	DriveGuard® Fault
11	32	Motion Task Overlap Fault
11	33	CST Reference Loss Detected
12	32	Disqualified Secondary Controller Cycle Power
12	33	Unpartnered Controller Identified in New Primary Chassis
12	34	Keyswitch Positions of Primary and Secondary Controllers Mismatched
14	1	Safety Task Watchdog Expired
14	2	Error In Routine of Safety Task
14	3	Safety Partner Missing
14	4	Safety Partner Unavailable
14	5	Safety Partner Hardware Incompatible
14	6	Safety Partner Firmware Incompatible
14	7	Safety Task Inoperable
14	8	Coordinated System Time (CST) Not Found
14	9	Safety Partner Nonrecoverable Controller Fault
18	1	CIP Motion Initialization Fault
18	2	CIP Motion Initialization Fault Mfg

Table 50 - Major Fault Status Messages (Continued)

Type	Code	Message
18	3	CIP Motion Axis Fault
18	4	CIP Motion Axis Fault Mfg
18	5	CIP Motion Fault
18	6	CIP™ Module Fault
18	7	Motion Group Fault
18	8	CIP Motion Configuration Fault
18	9	CIP Motion APR Fault
18	10	CIP Motion APR Fault Mfg
18	128	CIP Motion Guard Fault

I/O Fault Codes

The controller indicates I/O faults on the status display in one of these formats:

- I/O Fault Local:*X #XXXX message*
- I/O Fault *ModuleName #XXXX message*
- I/O Fault *ModuleParent*:*X #XXXX message*

The first part of the format is used to indicate the location of the module with a fault. How the location is indicated depends on your I/O configuration and the properties of the module that are specified in Logix Designer application.

The latter part of the format, #XXXX message, can be used to diagnose the type of I/O fault and potential corrective actions. For details about each I/O fault code, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

Table 51 - I/O Fault Messages

Code	Message
#0001	Connection Failure
#0002	Insufficient Resource
#0003	Invalid Value
#0004	IOI Syntax
#0005	Destination Unknown
#0006	Partial Data Transferred
#0007	Connection Lost
#0008	Service Unsupported
#0009	Invalid Attribute Value
#000A	Attribute List Error
#000B	State Already Exists
#000C	Object Mode Conflict

Table 51 - I/O Fault Messages (Continued)

Code	Message
#000D	Object Already Exists
#000E	Attribute Not Settable
#000F	Permission Denied
#0010	Device State Conflict
#0011	Reply Too Large
#0012	Fragment Primitive
#0013	Insufficient Command Data
#0014	Attribute Not Supported
#0015	Data Too Large
#0100	Connection In Use
#0103	Transport Not Supported
#0106	Ownership Conflict
#0107	Connection Not Found
#0108	Invalid Connection Type
#0109	Invalid Connection Size
#0110	Module Not Configured
#0111	RPI Out of Range
#0113	Out of Connections
#0114	Wrong Module
#0115	Wrong Device Type
#0116	Wrong Revision
#0117	Invalid Connection Point
#0118	Invalid Configuration Format
#0119	Module Not Owned
#011A	Out of Connection Resources
#0203	Connection Timeout
#0204	Unconnected Message Timeout
#0205	Invalid Parameter
#0206	Message Too Large
#0301	No Buffer Memory
#0302	Bandwidth Not Available
#0303	No Bridge Available
#0304	ControlNet® Schedule Error
#0305	Signature Mismatch
#0306	CCM Not Available
#0311	Invalid Port
#0312	Invalid Link Address
#0315	Invalid Segment Type
#0317	Connection Not Scheduled

Table 51 - I/O Fault Messages (Continued)

Code	Message
#0318	Invalid Link Address
#0319	No Secondary Resources Available
#031E	No Available Resources
#031F	No Available Resources
#0800	Network Link Offline
#0801	Incompatible Multicast RPI
#0814	Data Type Mismatch
#FD01	Bad Backplane EEPROM
#FD02	No Error Code
#FD03	Missing Required Connection
#FD04	No CST Master
#FD05	Axis or GRP Not Assigned
#FD06	Sercos Transition Fault
#FD07	Sercos Init Ring Fault
#FD08	Sercos Comm Fault
#FD09	Sercos Init Node Fault
#FD0A	Axis Attribute Reject
#FD1F	Safety I/O
#FD20	No Safety Task
#FE01	Invalid Connection Type
#FE02	Invalid Update Rate
#FE03	Invalid Input Connection
#FE04	Invalid Input Data Pointer
#FE05	Invalid Input Data Size
#FE06	Invalid Input Force Pointer
#FE07	Invalid Output Connection
#FE08	Invalid Output Data Pointer
#FE09	Invalid Output Data Size
#FE0A	Invalid Output Force Pointer
#FE0B	Invalid Symbol String
#FE0C	Invalid Scheduled Personal Computer Instance
#FE0D	Invalid Symbol Instance
#FE0E	Module Firmware Updating
#FE0F	Invalid Firmware File Revision
#FE10	Firmware File Not Found
#FE11	Firmware File Invalid
#FE12	Automatic Firmware Update Failed
#FE13	Update Failed - Active Connection
#FE14	Searching Firmware File

Table 51 - I/O Fault Messages (Continued)

Code	Message
#FE22	Invalid Connection Type
#FE23	Invalid Unicast Allowed
#FF00	No Connection Instance
#FF01	Path Too Long
#FF04	Invalid State
#FF08	Invalid Path
#FF0B	Invalid Config
#FF0E	No Connection Allowed

ControlLogix 5570 Controller Status Indicators

The status indicators are below the status display on the controller. They indicate the state of the controller as described in these tables.

RUN Indicator

Use the mode switch on the front of the controller or use the Controller Status menu in the Logix Designer application to change the controller mode that is shown by the RUN indicator.

Table 52 - RUN Indicator

State	Description
Off	The controller is in Program or Test mode.
Steady green	The controller is in Run mode.

FORCE Indicator

The Force indicator shows if I/O forces are enabled on the controller.

Table 53 - FORCE Indicator

State	Description
Off	No tags contain I/O force values.
Steady yellow	I/O forces are active (enabled) though I/O force values and can be configured. **Use caution if you install (add) a force. If you install (add) a force, it immediately takes effect.**
Flashing yellow	One or more input or output addresses have been forced to an On or Off state, but the forces have not been enabled. **Use caution if you enable I/O forces. If you enable I/O forces, all existing I/O forces also take effect.**

SD Indicator

The SD indicator shows if the SD card is in use.

Table 54 - SD Indicator

State	Description
Off	No activity is occurring with the SD card.
Flashing green	The controller is reading from or writing to the SD card. Do not remove the SD card while the controller is reading or writing.
Steady green	
Flashing red	The SD card does not have a valid file system.
Steady red	The controller does not recognize the SD card.

OK Indicator

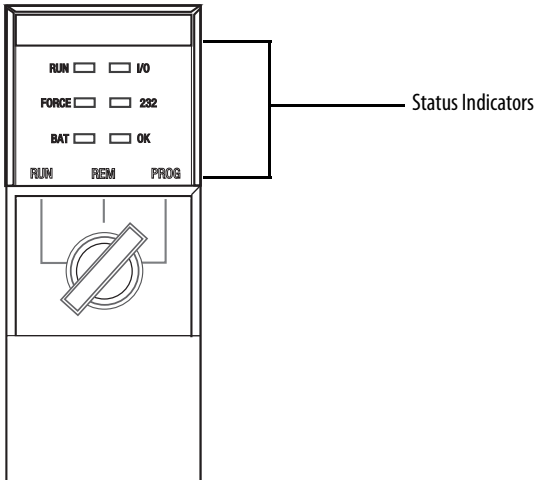
The OK indicator shows the state of the controller.

Table 55 - OK Indicator

State	Description
Off	No power is applied to the controller.
Flashing red	Either of the following is true: • It is a new controller, out of the box, and it requires a firmware update. If a update firmware update is required, the status display indicates Firmware Installation Required. To update firmware, see Upgrade Controller Firmware on page 48. • It is a previously used or in-use controller and a major fault has occurred. For details about major recoverable and nonrecoverable faults, see the Logix 5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.
Steady red	One of the following is true: • The controller is completing power-up diagnostics. • The charge of the capacitor in the ESM is being discharged upon powerdown. • The controller is powered, but is inoperable. • The controller is loading a project to nonvolatile memory.
Steady green	The controller is operating normally.

ControlLogix 5560 Status Indicators

ControlLogix 5560 controllers have status indicators on the front of the controller that show the state of the controller.



RUN Indicator

Use the mode switch on the front of the controller or use the Controller Status menu in the Logix Designer application to change the controller mode that is shown by the RUN indicator.

Table 56 - RUN Indicator

State	Description
Off	The controller is in Program or Test mode.
Steady green	The controller is in Run mode.

I/O Indicator

The I/O indicator shows the status of I/O modules in the project of the controller.

Table 57 - I/O Indicator

State	Description
Off	Either of the following is true: • There are no devices are in the I/O configuration of the controller. If needed, add the required devices to the I/O configuration of the controller. • The controller does not contain a project (controller memory is empty). If prepared, download the project to the controller.
Steady green	The controller is communicating with the devices in its I/O configuration.
Flashing green	One or more devices in the I/O configuration of the controller are not responding. For more information, go online with the Logix Designer application to check the I/O configuration of the controller.
Flashing red	A chassis fault exists. Troubleshoot the chassis and replace it if necessary.

FORCE Indicator

The FORCE indicator shows if I/O forces are active or enabled.

Table 58 - FORCE Indicator

State	Description
Off	Either of the following is true: • No tags contain I/O force values. • I/O forces are inactive (disabled).
Steady yellow	I/O forces are active (enabled) though I/O force values and can be configured. **Use caution if you install (add) a force. If you install (add) a force, it immediately takes effect.**
Flashing yellow	One or more input or output addresses have been forced to an On or Off state, but the forces have not been enabled. **Use caution if you enable I/O forces. If you enable I/O forces, all existing I/O forces also take effect.**

RS-232 Indicator

The RS-232 indicator shows if the serial port is in use.

Table 59 - RS-232 Status Indicator

State	Description
Off	There is no serial connection activity.
Flashing green	There is serial connection activity.

BAT Indicator

The BAT indicator shows the charge of the battery and if the program is being saved.

Table 60 - BAT Indicator

State	Controller Series	Description
Off	N/A	The controller is able to support memory.
Steady green	A	The series A controllers do not use this state.
	B	The series B controller is conducting a save of the program to internal-nonvolatile memory during a controller power down.
Steady red	N/A	Either of the following is true: • A battery is not installed. • The battery is 95% discharged and requires replacement. If the indicator is steady red before a power down, the indicator remains red while the controller is completing a program save to internal-nonvolatile memory.

OK Indicator

The OK indicator shows the state of the controller.

Table 61 - OK Indicator

State	Description
Off	No power is applied to the controller.
Flashing red	Either of the following is true: • It is a new controller, out of the box, and it requires a firmware update. • It is a previously used or in-use controller and a major fault has occurred. • The controller is experiencing a nonrecoverable, major fault.
Steady red	• A nonrecoverable major fault occurred and the program was cleared from memory. • The controller is powered up, in diagnostics mode. • The controller is powered, but inoperable.
Steady green	The controller is operating normally.
Flashing green	The controller is storing or loading a project to or from nonvolatile memory. If using a CompactFlash card, leave the card in the controller until the OK status indicator turns steady green.

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Technical Data

Original Instructions

ControlLogix I/O Modules Specifications

Bulletin 1756

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The ControlLogix® Architecture provides a wide range of input and output modules to span many applications, from high-speed digital to process control. The ControlLogix architecture uses Producer/Consumer technology, which allows input information and output status to be shared among multiple ControlLogix controllers.

Bulletin 1756 ControlLogix® chassis-based modules provide a full range of digital, diagnostic digital, analog, motion control, specialty I/O, and compute modules to meet your application needs.

ControlLogix I/O Module Accessories

Chassis and Power Supply

1756 ControlLogix I/O modules must be mounted in a ControlLogix chassis and each chassis requires a power supply. For more information about the 1756 Chassis and Power Supply options available for your system, see page 239.

Standard I/O Module Wiring

1756 ControlLogix standard I/O modules require either a Removable Terminal Block (RTB) or a 1492 interface module (IFM) to connect all field-side wiring. RTBs and IFMs are not included with the I/O modules. They must be ordered separately. For more information about the RTBs and IFMs available for your system, see page 239 and page 240.

Safety I/O Module Wiring

1756 ControlLogix safety I/O modules require either a specific Removable Terminal Block (RTB) or 1492 interface module (IFM) to connect all field-side wiring.

- 1756-IB16S and 1756-IB16SK (1756 ControlLogix 16-point Sinking Safety Input Modules) have been agency certified using only the ControlLogix RTBs (1756-TBCHS or 1756-TBS6HS).
- 1756-OBV8S and 1756-OBV8SK (ControlLogix 8-point Safety Bipolar/Sourcing Output Modules) have been agency certified using only the ControlLogix RTBs (1756-TBNHS and 1756-TBSHS).
- For information about the IFM module wiring systems that have been tested for use with 1756 Safety I/O modules, see Knowledgebase Technote, *1492 IFM Modules, Cables and Wiring Diagrams for 1756-IB16S, 1756-OBV8S Safety I/O Modules*.

RTBs and IFMs are not included with the I/O modules. They must be ordered separately. For more information about the RTBs and IFMs available for your system, see page 239 and page 240.

Any application that requires agency certification of the ControlLogix system by using other wiring termination methods may require application-specific approval by the certifying agency.

Available 1756 I/O Modules

Certain I/O module catalog numbers contain characters at the **end** of the catalog number that indicate additional features.

Character	I/O Type	Description
D	Diagnostic	These modules provide diagnostic features to the point level.
E	Electronic fusing	These modules have internal electronic fusing to help prevent too much current from flowing through the module.
I	Individually isolated	These modules have individually isolated inputs or outputs.
K	Conformal coated	These modules have conformal coating that adds a layer of protection when exposed to harsh, corrosive environments.
H	HART interface	These modules send and receive digital information across analog wires between smart devices and control or monitoring systems data using HART (Highway Addressable Remote Transducer) protocol.
S	Scheduled or Safety	These modules offer time-scheduled output control or ensure that ControlLogix control systems operate safely.
SOE	Sequence of Events	These modules offer sub-millisecond time-stamping on a per point basis.

Available 1756 I/O Modules

Module Type	Input Module Catalog Number	Page	Output Module Catalog Number	Page
AC Digital I/O Modules	1756-IA8D	5	1756-OA8	23
	1756-IA16, 1756-IA16K	8	1756-OA8D	26
	1756-IA16I, 1756-IA16IK	11	1756-OA8E	29
	1756-IA32, 1756-IA32K	14	1756-OA16, 1756-OA16K	32
	1756-IM16I, 1756-IM16IK	17	1756-OA16I, 1756-OA16IK	36
	1756-IN16	20	1756-ON8	39
DC Digital I/O Modules	1756-IB16, 1756-IB16K	43	1756-OB8	79
	1756-IB16D, 1756-IB16DK	46	1756-OB8EI	82
	1756-IB16I, 1756-IB16IK	49	1756-OB16D, 1756-OB16DK	85
	1756-IB16IF, 1756-IB16IFK	52	1756-OB16E, 1756-OB16EK	88
	1756-IB16ISOE, 1756-IB16ISOEK	55	1756-OB16I	92
	1756-IB32, 1756-IB32K	58	1756-OB16IEF, 1756-OB16IEFK	95
	1756-IC16	61	1756-OB16IEFS	99
	1756-IG16	64	1756-OB16IS	103
	1756-IH16I	67	1756-OB32, 1756-OB32K	106
	1756-IH16ISOE	70	1756-OC8	109
	1756-IV16, 1756-IV16K	73	1756-OG16	112
	1756-IV32, 1756-IV32K	76	1756-OH8I	115
			1756-OV16E	118
			1756-OV32E	122
Safety I/O Modules	1756-IB16S, 1756-IB16SK	125	1756-OBV8S, 1756-OBV8SK	132
Contact I/O Modules			1756-OX8I	141
			1756-OW16I	144
Analog I/O Modules	1756-IF4FXOF2F, 1756-IF4FXOF2FK	147	1756-OF4, 1756-OF4K	181
	1756-IF8, 1756-IF8K	151	1756-OF8, 1756-OF8K	185
	1756-IF8I, 1756-IF8IK	156	1756-OF8I, 1756-OF8IK	189
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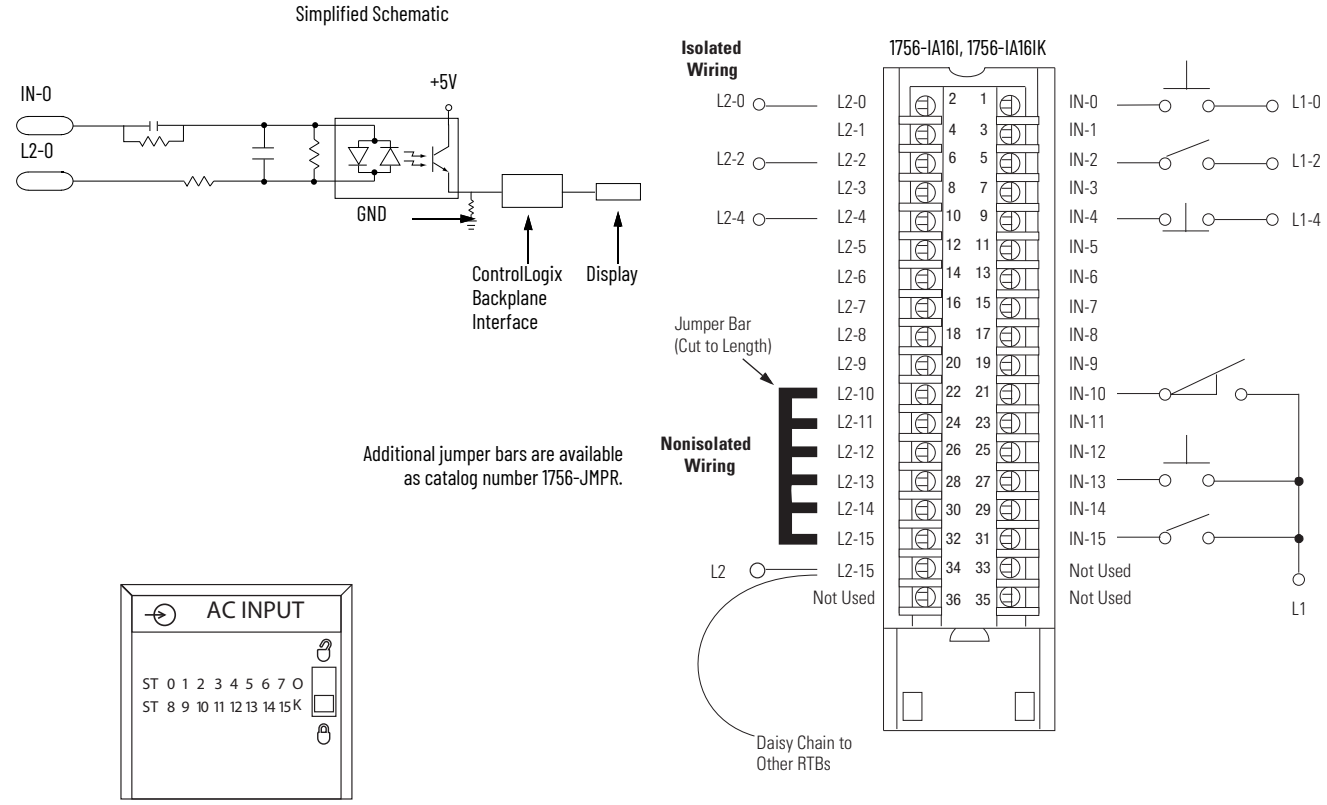
HART I/O Modules	1756-IF8H, 1756-IF8HK	193	1756-OF8H, 1756-OF8HK	205
	1756-IF8IH, 1756-IF8IHK	196	1756-OF8IH, 1756-OF8IHK	208
	1756-IF16H, 1756-IF16HK	199		
	1756-IF16IH, 1756-IF16IHK	202		
Compute Modules	1756-CMEE1Y1	211		
	1756-CMS1B1, 1756-CMS1C1, 1756-CMS1D1, 1756-CMS1H1, 1756-CMS1B4	213		
Specialty I/O Modules	1756-CFM	215	1756-LSC8XIB8I, 1756-LSC8XIB8IK	229
	1756-CMS1B4, 1756-HIST2G	221	1756-PLS	233
	1756-HSC	223		

1756-IA16I, 1756-IA16IK

ControlLogix 120V AC isolated input module



Technical Specifications

Attribute	1756-IA16I, 1756-IA16IK
Inputs	16 individually isolated
Voltage category	120V AC 50/60 Hz
Operating voltage range[1]	79...132V AC, 47...63 Hz
Input voltage, nom	120V AC 50/60 Hz
Input delay time (screw to backplane) Off to On On to Off	 Hardware delay: 10 ms max + filter time User-selectable filter time: 1 ms or 2 ms Hardware delay: 8 ms max + filter time User-selectable filter time: 9 ms or 18 ms
Current draw @ 5.1V	125 mA
Current draw @ 24V	3 mA
Total backplane power	0.71 W
Power dissipation, max	4.9 W @ 60 °C (140 °F)
Thermal dissipation	16.71 BTU/hr
Off-state voltage, max	20V
Off-state current, max	2.5 mA
On-state current, min	5 mA @ 79V AC, 47...63 Hz
On-state current, max	15 mA @ 132V AC, 47...63 Hz
Inrush current, max	250 mA
Input impedance, max	8.8 kΩ @ 132V AC, 60 Hz
Cyclic update time	200 µs...750 ms
Change of state	Software configurable

Technical Specifications (Continued)

Attribute	1756-IA16I, 1756-IA16IK
Time stamp of inputs	±200 µs
Isolation voltage	125V (continuous), basic insulation type, inputs-to-backplane, and input-to-input
Module keying	Electronic, software configurable
Removable terminal block housing	1756-TBCH 1756-TBS6H
RTB keying	User-defined mechanical
Slot width	1
Wire category[2]	1 - on signal ports
Enclosure type	None (open-style)
North American temperature code	T4A

(1) UL certification for 120V 50/60 Hz nominal. Rockwell Automation specified to 74...132V, 47...63 Hz.
(2) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications

Attribute	1756-IA16I, 1756-IA16IK
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0...60 °C (32...140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)
Relative humidity IEC 60068-2-30 (Test dB, Unpackaged Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	IEC 61000-6-4
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on signal ports
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports
Conducted RF immunity IEC 61000-4-6	10V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz
Oscillatory surge withstand IEEE C37.90.1	3 kV

Certifications

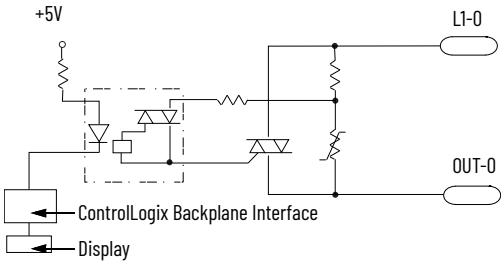
Certification (when product is marked)[1]	1756-IA16I, 1756-IA16IK
cULus	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions European Union 2014/35/EU LVD Directive, compliant with: EN 61131-2; Programmable Controllers (Clause 11)
RCM	Australian Radiocommunications Act, compliant with: EN 61000-6-4; Industrial Emissions
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements

(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

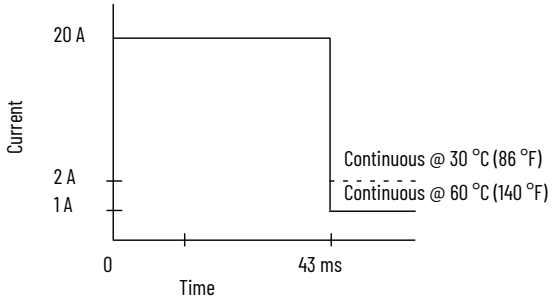
1756-OA16I, 1756-OA16IK

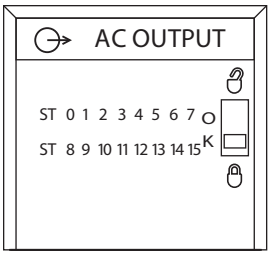
ControlLogix 120/240V AC isolated output module

Simplified Schematic

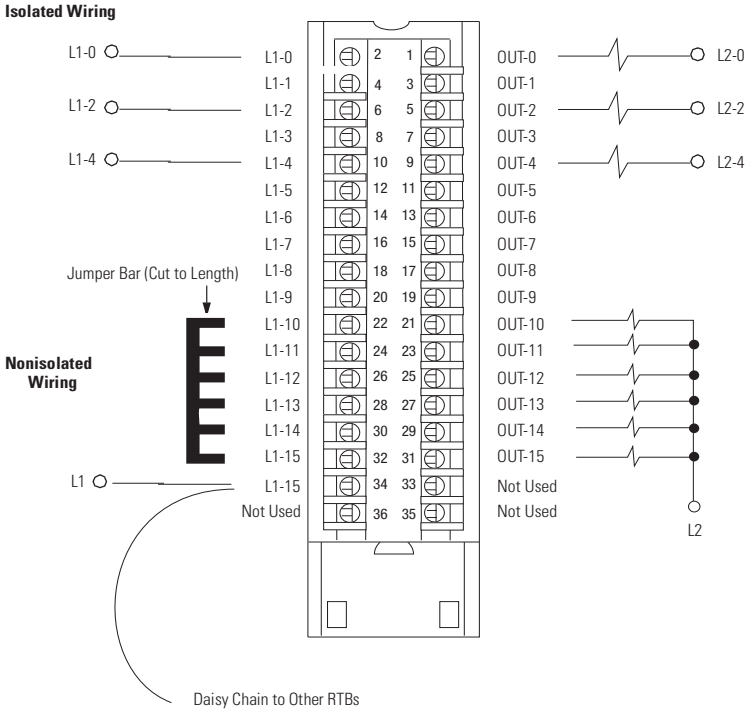


Surge Current Chart





1756-OA16I, 1756-OA16IK



Additional jumper bars are available as catalog number 1756-JMPR.

Technical Specifications

Attribute	1756-OA16I, 1756-OA16IK
Outputs	16 individually isolated
Pilot duty	Yes
Voltage category	120/240V AC 50/60 Hz
Operating voltage range[1]	74...265V AC 47...63 Hz
Output delay time Off to On	9.3 ms @ 60 Hz 11 ms @ 50 Hz
On to Off	9.3 ms @ 60 Hz 11 ms @ 50 Hz
Current draw @ 5.1V	300 mA
Current draw @ 24V	2.5 mA
Total backplane power	1.59 W
Power dissipation, max	5.5 W @ 60 °C (140 °F)
Thermal dissipation	18.76 BTU/hr
Off-state leakage current, max	3 mA per point
On-state voltage drop, max	1.5V peak @ 2 A 6V peak @ load current < 50 mA
Current per point, max	2 A @ 30 °C (86 °F) linear derating 1 A @ 60 °C (140 °F) linear derating

Technical Specifications (Continued)

Attribute	1756-OA16I, 1756-OA16IK
Current per module, max	5 A @ 30 °C (86 °F) linear derating 4 A @ 60 °C (140 °F) linear derating
Surge current per point	20 A for 43 ms per point, repeatable every 2 s @ 60 °C (140 °F)
Load current, min	10 mA per point
Commutating voltage	4V/µs for loads > 50 mA 0.2V/µs for loads < 50 mA(2)
Scheduled outputs	Synchronization within 16.7 s max, reference to the Coordinated System Time
States in Fault mode per point	Hold last state, On or Off (Off is default)
States in Program mode per point	Hold last state, On or Off (Off is default)
Isolation voltage	250V (continuous), basic insulation type, outputs-to-backplane, and output-to-output
Inhibit voltage, max	Zero crossing 60V peak
Module keying	Electronic, software configurable
Fusing	Not protected. A fused IFM is recommended to help protect outputs
Removable terminal block	1756-TBCH 1756-TBS6H
RTB keying	User-defined mechanical
Slot width	1
Wire category	1(3)
Enclosure type	None (open style)
North American temperature code	T4A

(1) UL certification for 120/240V 50/60 Hz nominal. Rockwell Automation specified to 74…265V, 47…63 Hz.
(2) The commutating dv/dt of the output voltage (OUTPUT to L2) should not exceed 0.2V/µs for loads under 50 mA. The commutating dv/dt rating of the module for loads 50…500 mA (OUTPUT to L2) is 4V/µs maximum. If the commutating dv/dt rating of the TRIAC is exceeded, the TRIAC could latch on. If the commutating dv/dt rating is exceeded in the 10…50 mA range, a resistor can be added AC across the output and L2. The purpose of this resistor is to increase the total output current to 50 mA (I=V/R). At 50 mA and above, the module has a higher commutating dv/dt rating. When adding a resistor for the output to L2, be sure it is rated for the power that it dissipates (P=(V**2)/R). If the commutating dv/dt rating is exceeded in the 50…500 mA range, the L1 AC waveform could be at fault. Be sure that the waveform is a good sinusoid, void of any anomalies such as distorted, or flattened sections.
(3) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications

Attribute	1756-OA16I, 1756-OA16IK
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…+85 °C (-40…+185 °F)
Relative humidity IEC 60068-2-30 (Test dB, Unpackaged Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	IEC 61000-6-4
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000…2700 MHz
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on signal ports

Environmental Specifications (Continued)

Attribute	1756-OA16I, 1756-OA16IK
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports
Conducted RF immunity IEC 61000-4-6	10V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz
Oscillatory surge withstand IEEE C37.90.1	3 kV

Certifications

Certification (when product is marked)(1)	1756-OA16I, 1756-OA16IK
cULus	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2014/35/EU LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)
RCM	Australian Radiocommunications Act, compliant with: EN 61000-6-4; Industrial Emissions
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements

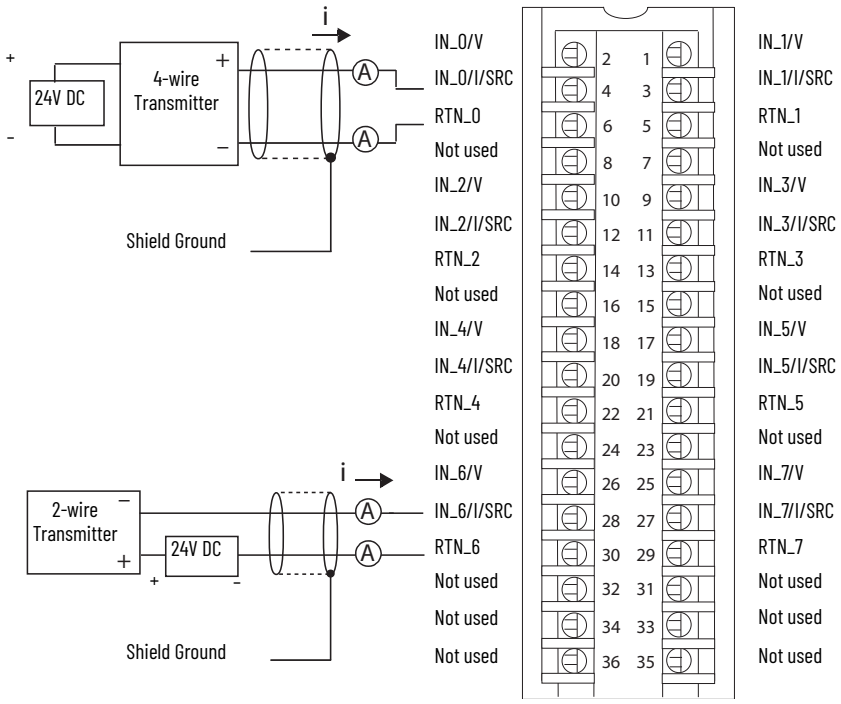
(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

1756-IF8I, 1756-IF8IK

ControlLogix isolated voltage/current analog input module

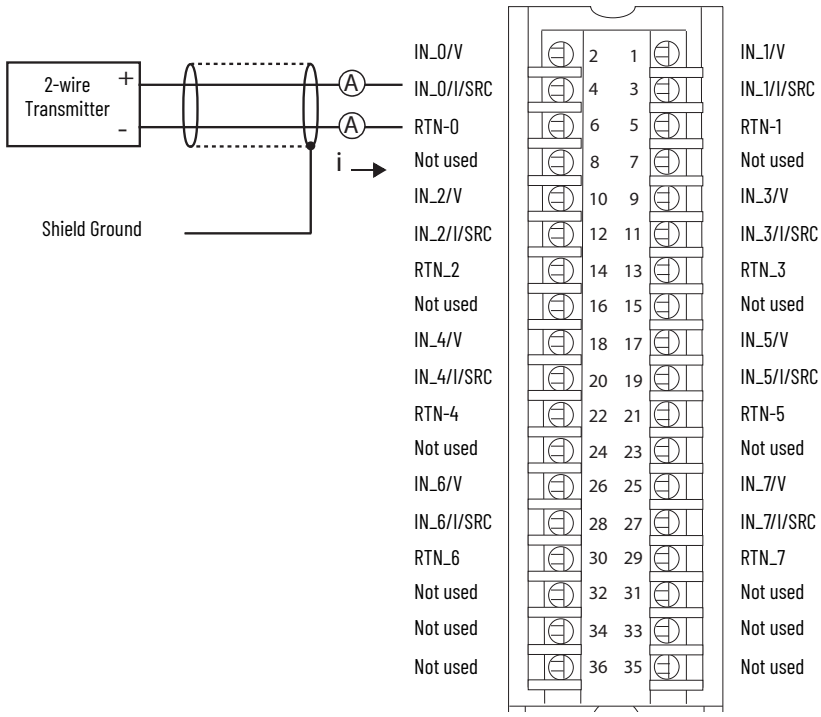
1756-IF8I, 1756-IF8IK Module Wiring Diagram -Current Mode with External Loop Power

IMPORTANT: Remember the following:
- In this wiring diagram, an external, user-provided power supply provides 24V DC loop power.
- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.
- Place additional loop devices, for example, strip chart recorders, at either 'A' location in the current loop.



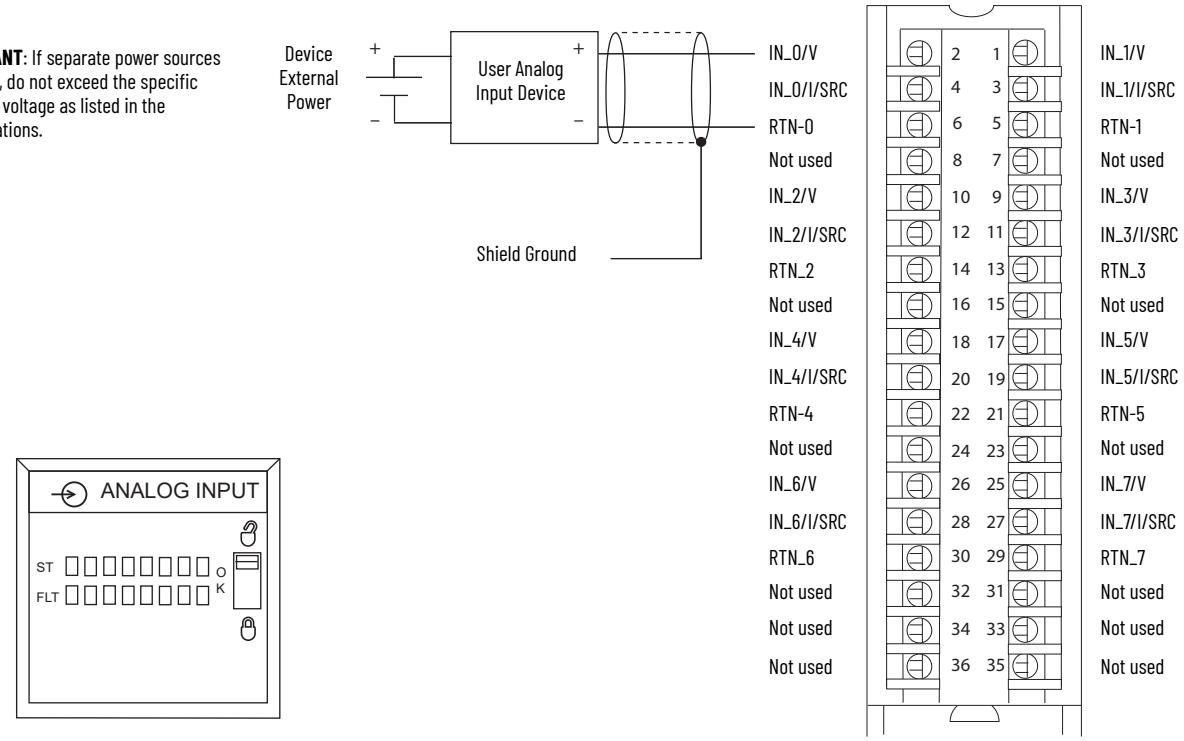
1756-IF8I, 1756-IF8IK Module Wiring Diagram -Current Mode with Internal Loop Power

IMPORTANT: Remember the following:
- In this wiring diagram, the module provides 24V DC loop power.
- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.
- Place additional loop devices, for example, strip chart recorders, at either 'A' location in the current loop.



1756-IF8I, 1756-IF8IK Module Wiring Diagram - Voltage Mode

IMPORTANT: If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.



Technical Specifications

Attribute	1756-IF8I, 1756-IF8IK
Inputs	Eight isolated channels - Any combination of Voltage or Current mode
Voltage and current ratings	Backplane: 5.1V DC 200 mA, 24V DC 400 mA Input Voltage: -10V to +10V, 0V to 10V, 0V to 5V Input Current: 0...20 mA Output Current: 0...20 mA
Input ranges	-10...10V 0...10V 0...5V 0...20 mA
Resolution	24-bit ±10.5V (1.49 µV/count) 0...10.5V (1.49 µV/count) 0...5.25V (1.49 µV/count) 0...21 mA (2.99 nA/count)
Current draw @ 5.1V	200 mA
Current draw @ 24V	Voltage/Non-sourcing Current mode: 150 mA Sourcing Current mode: 400 mA (In Sourcing Current mode, the channel provides loop power.)
Total backplane power	Voltage/Non-sourcing Current mode: 4.6 W Sourcing Current mode: 10.6 W
Power dissipation	Voltage mode: 4.6 W (15.7 BTU/hr) Non-sourcing Current mode: 5.1 W (17.4 BTU/hr) Sourcing Current mode: 7.3 W (24.9 BTU/hr)
Thermal dissipation	Voltage mode: 15.7 BTU/hr Non-sourcing Current mode: 17.4 BTU/hr Sourcing Current mode: 24.9 BTU/hr
Input impedance, approx	Voltage mode: 1 G Ω (powered); 7500 Ω (unpowered) Current mode: 125 Ω
Sourcing voltage, min	20V DC
Sourcing voltage, max	36V DC (open circuit)
Sourcing current, max	Current Limited < 45 mA (IN_x/I/SRC to RTN_x)

Technical Specifications (Continued)

Attribute	1756-IF8I, 1756-IF8IK
Open circuit detection time	5 s
Overvoltage protection, max	±30V DC
Normal mode noise rejection	80 dB @ 60 Hz(1)
Common mode noise rejection	120 dB @ 50/60 Hz
Channel bandwidth	Notch filter configuration dependent See publication 1756-UM540 for possible values.
Settling time	Notch filter configuration dependent See publication 1756-UM540 for possible values.
Calibrated accuracy 25 °C (77 °F)	0.05%
Module error over full temperature range	0.1%
Module input scan time, min	1 ms
Onboard data alarming	Yes
Scaling to engineering units	Yes
Real-time channel sampling	Yes - Rate set by Requested Packet Interval rate
Data format	IEEE 32-bit floating point
Module conversion method	Sigma-Delta
Isolation voltage	250V (continuous), reinforced insulation type, inputs to backplane 250V (continuous), basic insulation type, input to input Compliant and tested according to IEC/UL 61010-1
Module keying	Electronic, software configurable
Removable terminal block	1756-TBCH 1756-TBS6H
RTB keying	User-defined mechanical
Slot width	1
Wire size	1756-TBCH Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Double wire connection: 0.33…1.3 mm^2 (22…16 AWG) solid or stranded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. 1756-TBS6H Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max.
Wire category	2 on signal ports(2)
Enclosure type	None (open-style)
Temperature code	T4

(1) Notch filter dependent.
(2) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications

Attribute	1756-IF8I, 1756-IF8IK
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0...60 °C (32...140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)
Relative humidity IEC 60068-2-30 (Test dB, Unpackaged Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	IEC 61000-6-4
ESD immunity IEC 61000-4-2	Series B ±8 kV contact discharges ±8 kV air discharges Series A 6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	Series B 20V/m with 1 kHz sine wave 80% AM from 80...1000 MHz 10V/m with 1 kHz sine wave 80% AM from 1000...2000 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...6000 MHz Series A 10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	Series B ±4 kV at 5 kHz and 100 kHz on shielded signal ports Series A ±4 kV at 5 kHz on shielded signal ports
Surge transient immunity IEC 61000-4-5	±2 kV line-earth (CM) on shielded signal ports
Conducted RF immunity IEC 61000-4-6	Series B 20V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz Series A 10V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz

Certifications

Certification (when product is marked)[1]	1756-IF8I, 1756-IF8IK
cULus	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2014/35/EU LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)
RCM	Australian Radiocommunications Act, compliant with: • EN 61000-6-4; Industrial Emissions
Ex	European Union 2014/34/EU ATEX Directive, compliant with: • EN IEC 60079-0 Edition 7; General Requirements • EN IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • UL 22 ATEX 2772X
IECEx	IECEx System, compliant with: • IEC 60079-0 Edition 7; General Requirements • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • IECEx UL 22.0039X
UKex	In conformity with the following UKex Statutory Instruments and their amendments: • Schedule 1 of the UKEX Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2499X Zone 2 classification according to UKEX Regulation 2016 No. 1107
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements
CCC	CCC 2020122309111830, 2020122309111998, 2020122309113868 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products

(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

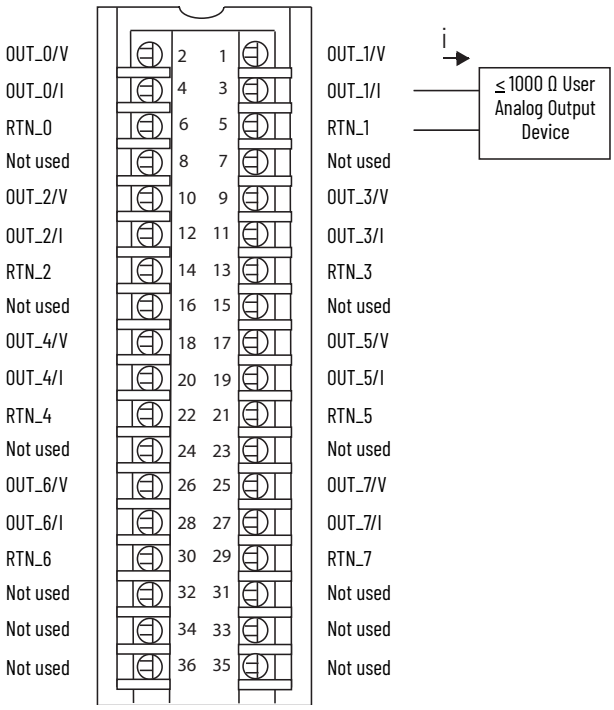
1756-OF8I, 1756-OF8IK

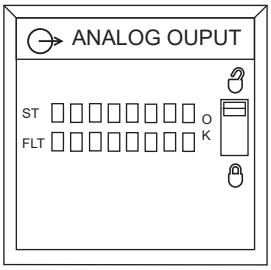
ControlLogix isolated voltage/current output analog module.

1756-OF8I, 1756-OF8IK Module Wiring Diagram - Current Mode

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.
- Place additional devices anywhere in the loop.

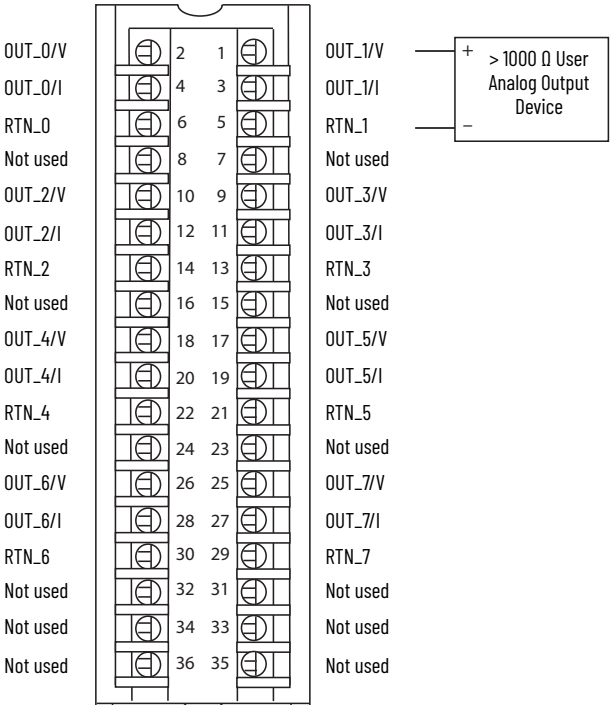




1756-OF8I, 1756-OF8IK Module Wiring Diagram - Voltage Mode

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.
- Place additional devices anywhere in the loop.



Technical Specifications

Attribute	1756-OF8I, 1756-OF8IK
Outputs	Eight isolated channels - Any combination of voltage or current mode
Output range	-10...10V 0...10V 0...5V 0...20 mA
Resolution	16-bit ±10.5V (0.32 mV/count) 0...10.5V (0.16 mV/count) 0...5.25V (0.08 mV/count) 0...21 mA (0.32 µA/count)
Current draw @ 5.1V	200 mA
Current draw @ 24V	Voltage or Current mode with 250 Ω loads = 220 mA Current mode with 500 Ω loads = 275 mA Current mode with 750 Ω loads = 340 mA Current mode with 1000 Ω loads = 385 mA
Total backplane power	Voltage mode = 6.3 W Current mode with 250 Ω loads = 6.3 W Current mode with 500 Ω loads = 7.6 W Current mode with 750 Ω loads = 9.2 W Current mode with 1000 Ω loads = 10.2 W
Power dissipation	Voltage mode: 5.4 W (18.4 BTU/hr) Current mode with 250 Ω loads: 5.4 W (18.4 BTU/hr) Current mode with 500 Ω loads: 5.8 W (19.8 BTU/hr) Current mode with 750 Ω loads: 6.5 W (22.2 BTU/hr) Current mode with 1000 Ω loads: 6.7 W (22.9 BTU/hr)
Thermal dissipation	Voltage mode = 18.4 BTU/hr Current mode with 250 Ω loads = 18.4 BTU/hr Current mode with 500 Ω loads = 19.8 BTU/hr Current mode with 750 Ω loads = 22.2 BTU/hr Current mode with 1000 Ω loads = 22.9 BTU/hr
Output impedance	46 Ω (Current output)
Open circuit detection	Current output = Yes
Short circuit detection	Voltage output = Yes
Overvoltage protection	±30V DC (voltage/current)
Drive capability	Current output = 0...1000 Ω Voltage output = >1000 Ω
Settling time	< 2 ms to 95% of final value with Resistive loads
Calibrated accuracy @ 25 °C (77 °F)	0.05%
Module error over full temperature range	0.1%
Module scan time, min	1 ms
Data format	IEEE 32-bit floating point
Module conversion method	R-Ladder DAC, monotonicity with no missing codes
Isolation voltage	250V (continuous), reinforced insulation type, outputs to backplane 250V (continuous), basic insulation type, output to output Compliant and tested according to IEC/UL 61010-1
Module keying	Electronic, software configurable
Removable terminal block	1756-TBCH 1756-TBS6H
RTB keying	User-defined mechanical
Slot width	1
Wire size	1756-TBCH Single wire connection: 0.33...2.1 mm^2 (22...14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than one conductor on any single terminal. Double wire connection: 0.33...1.3 mm^2 (22...16 AWG) solid or stranded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than two conductors on any single terminal. 1756-TBS6H Single wire connection: 0.33...2.1 mm^2 (22...14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than one conductor on any single terminal.

Technical Specifications (Continued)

Attribute	1756-OF8I, 1756-OF8IK
Wire category[1]	2 - on signal ports
Enclosure type	None (open-style)
Temperature code	T4

(1) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications

Attribute	1756-OF8I, 1756-OF8IK
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0...60 °C (32...140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40...+85 °C (-40...+185 °F)
Relative humidity IEC 60068-2-30 (Test dB, Unpackaged Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	IEC 61000-6-4
ESD immunity IEC 61000-4-2	Series B ±8 kV contact discharges ±8 kV air discharges Series A 6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	Series B 20V/m with 1 kHz sine wave 80% AM from 80...1000 MHz 10V/m with 1 kHz sine wave 80% AM from 1000...2000 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...6000 MHz Series A 10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	Series B ±4 kV at 5 kHz and 100 kHz on shielded signal ports Series A ±4 kV at 5 kHz on shielded signal ports
Surge transient immunity IEC 61000-4-5	±2 kV line-earth (CM) on shielded signal ports
Conducted RF immunity IEC 61000-4-6	Series B 20V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz Series A 10V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz

Certifications

Certification (when product is marked)[1]	1756-OF8I, 1756-OF8IK
cULus	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2014/35/EU LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)
RCM	Australian Radiocommunications Act, compliant with: EN 61000-6-4; Industrial Emissions
Ex	European Union 2014/34/EU ATEX Directive, compliant with: • EN IEC 60079-0 Edition 7; General Requirements • EN IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • UL 22 ATEX 2772X
IECEx	IECEx System, compliant with: • IEC 60079-0 Edition 7; General Requirements • IEC 60079-7; Potentially Explosive Atmospheres, Protection "e" • II 3 G Ex ec IIC T4 Gc • IECEx UL 22.0039X
UKex	In conformity with the following UKex Statutory Instruments and their amendments: • Schedule 1 of the UKEX Regulation 2016 No. 1107 • Equipment protection by increased safety "e", reference certificate number UL22UKEX2499X Zone 2 classification according to UKEX Regulation 2016 No. 1107
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation
UKCA	In conformity with the following UK Statutory Instruments and their amendments: • 2016 No. 1091, Electromagnetic Compatibility Regulations • 2016 No. 1101, Electrical Equipment (Safety) Regulations • 2016 No. 1107, Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations • 2012 No. 3032, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
Morocco	In conformity with the following regulations: • Arrêté ministériel n° 6404-15 du 1 er muharram 1437 (15 octobre 2015) Équipements électriques destinés à être utilisés sous certaines limites de tension • Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) Compatibilité électromagnétique des équipements
CCC	CCC 2020122309111830, 2020122309111998, 2020122309113868 CNCA-C23-01 强制性产品认证实施规则 防爆电气 CNCA-C23-01 CCC Implementation Rule Explosion-Proof Electrical Products

(1) See the Product Certification link at rok.auto/certifications for Declarations of Conformity, Certificates, and other certification details.

Chassis and Power Supply

1756 ControlLogix® I/O modules must be mounted in a ControlLogix chassis. Modules can be mounted in any chassis slot. Each chassis requires a power supply.

Product	Cat. No.
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17
Power supply, standard	1756-PA72/C, 1756-PA75/B, 1756-PB72/C, 1756-PB75/B, 1756-PC75/B, 1756-PH75/B
Power supply, redundant	1756-PA75R, 1756-PB75R, 1756-PSCA2 1756-CPR2 cable

- For more information on chassis specifications, see ControlLogix Chassis Specifications Technical Data, publication 1756-TD006.
- For more power supply specifications, see ControlLogix Power Supply Specifications Technical Data, publication 1756-TD005.
- For more information on how to choose the right power supply for your application, the Integrated Architecture® Builder (IAB) software from Rockwell Automation provides advanced selection assistance and a graphical interface for designing systems.

1756 Removable Terminal Blocks

Removable terminal blocks (RTBs) provide a flexible interconnection between your plant wiring and 1756 ControlLogix I/O modules. The RTB plugs into the front of the I/O module. The type of module determines which RTB you need. You can choose screw-clamp or spring-clamp RTBs.

RTBs are not shipped with I/O modules. You must order them separately. The standard housing on the front of the wiring arm is not deep enough for 2.5 mm^2 (14 AWG) wiring. So, if you plan to use 2.5 mm^2 (14 AWG) wiring, order the extended housing.

ATTENTION: If separate power sources are used, do not exceed the specified isolation voltage. See the specifications for each individual module on the preceding pages.

WARNING: Do not use the 1756-TBNHS, 1756-TBSHS, 1756-TBCHS, 1756-TBS6HS safety RTBs, and the 1756-TBES Extended-depth terminal block housing, on non-safety I/O modules.

RTB Specifications

Attribute	1756-TBCH, 1756-TBCHS	1756-TBNH, 1756-TBNHS	1756-TBSH, 1756-TBSHS	1756-TBS6H, 1756-TBS6HS	1756-TBE, 1756-TBES
Description	36-pin cage-clamp removable terminal block with standard housing	20-position NEMA screw-clamp removable block	20-pin spring-clamp removable terminal block with standard housing	36-pin spring-clamp removable terminal block with standard housing	Extended depth terminal block housing
Screw torque	0.5 N•m (4.4 lb•in)	1.36 N•m (12 lb•in)	–	–	–
Wire size[1]	Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than one conductor on any single terminal. Double wire connection: 0.33…1.3 mm^2 (22…16 AWG) solid or stranded copper wire rated at 105 °C (221 °F), or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than two conductors on any single terminal.		Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire, rated at 105 °C (221 °F) or greater, 1.2 mm (3/64 in.) insulation max. Do not wire more than one conductor on any single terminal.		–
Screwdriver width	3.2 mm (1/8 in.)	8 mm (5/16 in.) Max	–	–	–

(1) Maximum wire size requires extended housing, catalog number 1756-TBE.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
ControlLogix System User Manual, publication 1756-UM001	Describes how to use a ControlLogix system
ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543	Describes how to use a ControlLogix 5580 or GuardLogix® 5580 Controller
ControlLogix Digital I/O Modules User Manual, publication 1756-UM058	Describes how to use ControlLogix digital I/O modules
ControlLogix Analog I/O Modules User Manual, publication 1756-UM009	Describes how to use ControlLogix analog I/O modules
1756 ControlLogix Digital Safety I/O Modules User Manual, publication 1756-UM013	Describes how to use ControlLogix digital safety I/O modules
ControlLogix HART Analog I/O Modules User Manual, publication 1756-UM533	Describes how to use ControlLogix HART Analog I/O modules
ControlLogix Configurable Flowmeter Module User Manual, publication 1756-UM010	Describes how to use a ControlLogix Configurable Flowmeter module
ControlLogix High-speed Counter Module User Manual, publication 1756-UM007	Describes how to use a ControlLogix High-speed counter module
ControlLogix Programmable Limit Switch Module User Manual, publication 1756-UM002	Describes how to use a ControlLogix Programmable Limit Switch module
ControlLogix Compute Modules User Manual, publication 1756-UM003	Describes how to use ControlLogix Compute modules
FactoryTalk Analytics LogixAI Quick Start, publication 1756-QS002	Describes how to configure the FactoryTalk® Analytics™ LogixAI module
FactoryTalk Historian Machine Edition Series C Configuration Guide, publication 1756-UM019	Describes how to configure and use the FactoryTalk® Historian ME Series C module
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

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Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

ControlLogix High Resolution Analog I/O Modules

Catalog Numbers 1756-IF8I, 1756-IF8IK, 1756-IRT8I, 1756-IRT8IK, 1756-OF8I, 1756-OF8IK, 1756-IR12, 1756-IR12K, 1756-IT16, 1756-IT16K

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ControlLogix® analog I/O modules are interface modules that convert analog signals to digital values for inputs and convert digital values to analog signals for outputs. Controllers can then use these signals for control purposes.

Summary of Changes

These updated installation instructions include new and revised content as shown in this table.

Description	Page
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ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.
Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。
安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。
如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。
ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.
El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.
ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.
É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.
Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.
ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.
Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.
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ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.
Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.
Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.
ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.
Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.
Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.
주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .
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본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .
ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.
Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.
Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.
DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.
Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.
Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.
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如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。
POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se museji vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.
Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.
Pokud se toto zařízení používá způsobem neodpovidajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.
UWAGA: Przed instalacją , konfiguracją , użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiają ce instalację, konfigurację i procedury użytkowania tego urzą dzenia. Użytkownicy mają obowią zek zapoznać się z instrukcjami dotyczą cymi instalacji oraz oprzewodowania, jak również z obowią zują cymi kodeksami, prawem i normami.
Działania obejmują ce instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowią zują cym kodeksem postępowania.
Jeśli urzą dzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urzą dzenie może zostać ograniczone.
OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.
Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.
Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.
LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bedient of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.
Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.
Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

ATTENTION: Before installing, configuring, operating, or maintaining this product, read this document and the documents that are listed in the additional resources section for installing, configuring, or operating equipment. Be familiar with installation and wiring instructions and requirements of all applicable codes, laws, and standards.
This equipment is certified for use only within the surrounding air temperature range of 0…60 °C (32…140 °F). The equipment must not be used outside of this range.
Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance must be carried out by suitably trained personnel in accordance with applicable code of practice.
If this equipment is used in a manner that is not specified by the manufacturer, the protection that is provided by the equipment can be impaired.
If there is malfunction or damage, make no attempt at repair. Return the module to the manufacturer for repair. Do not dismantle the module.
Use only a soft dry anti-static cloth to wipe down equipment. Do not use any cleaning agents.

IMPORTANT Any illustrations, charts, sample programs, and layout examples that are shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements that are associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use based on the examples that are shown in this publication.

Environment and Enclosure

ATTENTION: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in EN/IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.
This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.
This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to help prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to help prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.
In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosures.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Removal and Insertion Under Power (RIUP)

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Electrical Safety Considerations

ATTENTION: If multiple power sources are used, do not exceed the specified isolation voltage.
When using the 1756-TBCH terminal block, do not wire more than two 0.33…1.3 mm^2 (22…16 AWG) conductors on any single terminal.
Use only the same size wires with no intermixing of solid and stranded wire types.
When using the 1756-TBS6H terminal block, do not wire more than one conductor on any single terminal.
The 1756-IR12 and 1756-IT16 modules are classified Measurement Category II per IEC 61010-2-30.

Removable Terminal Blocks (RTB)

WARNING: When you connect or disconnect the removable terminal block (RTB) with field-side power applied, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.

Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.

WARNING: EXPLOSION HAZARD

- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Substitution of components may impair suitability for Class I, Division 2.
- If this product contains batteries, they must be changed only in an area known to be nonhazardous.

Informations sur l'utilisation de cet équipement en environnements dangereux.

Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

AVERTISSMENT: RISQUE D'EXPLOSION

- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement.
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit.
- La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2.
- S'assurer que l'environnement est classé non dangereux avant de changer les piles.

UK and European Hazardous Location Approval

The following applies to products marked Ex , II 3 G. Such modules:

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection is <Ex ec IIC T4 Gc> Equipment protection by increased safety “e”.
- Equipment protection by increased safety “e”, reference certificate number UL 22 ATEX 2772X and UL22UKEX2499X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

IEC Hazardous Location Approval

The following applies to products with IECEx certification. Such modules:

- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection is <Ex ec IIC T4 Gc>.
- IECEx certificate number IECEx UL 22.0039X.

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 140% of the peak rated voltage when applied in Zone 2 environments.
- The instructions in the user manual shall be observed.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Installation Requirements

Before you install the module, you must complete the following steps.

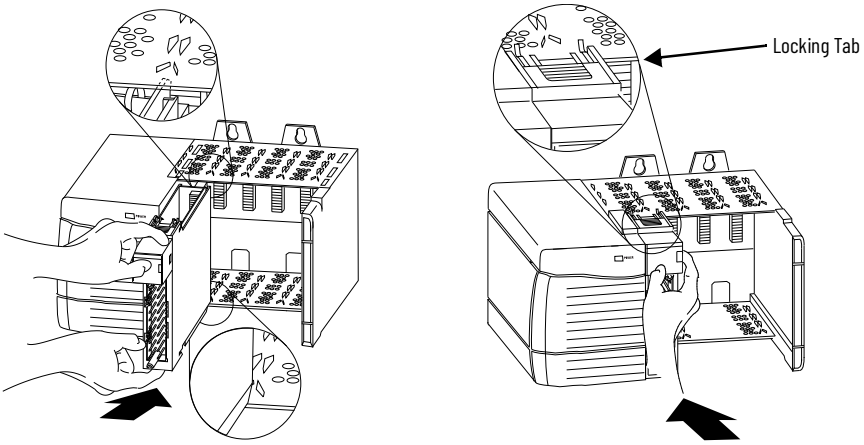
1. Install a 1756 ControlLogix chassis.
2. Install a 1756 ControlLogix power supply.

Install the Module

You can install or remove a module while chassis power is applied.

ATTENTION: The module is designed to support removal and insertion under power (RIUP). However, when you remove or insert a removable terminal block (RTB) with field-side power applied, unintended machine motion or loss of process control can occur. Exercise extreme caution when using this feature.

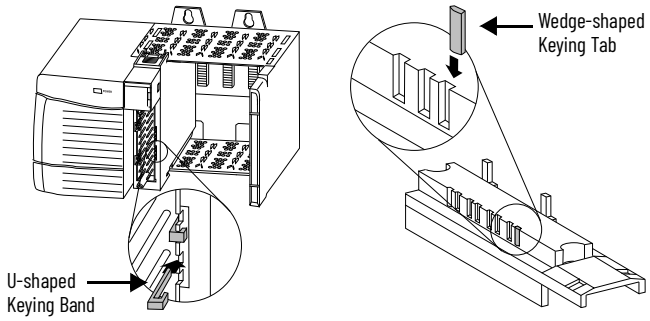
Slide the module into the slot in the chassis until the locking tabs click.



Key the Removable Terminal Block

Key the RTB to help prevent inadvertently connecting the incorrect RTB to your module.

1. Push the U-shaped band onto the module until it snaps into place.
2. Insert wedge-shaped tabs into positions on the RTB that correspond to unkeyed module positions on the module until they stop.



Connect Wiring

Connect wiring to the module with an RTB or a Bulletin 1492 pre-wired analog interface module (AIFM). This publication describes how to wire the module with an RTB. If you are using an AIFM to connect wiring, see the documentation for that product.

IMPORTANT For RTB wiring on the following modules, we recommend that you use Belden 8761 shielded copper cable:

- 1756-IR12, 1756-IR12K
- 1756-IF8I, 1756-IF8IK
- 1756-OF8I, 1756-OF8IK

For terminations with RTD functionality on the following modules, we recommend that you use Belden 9533 or 83503 cable:

- 1756-IRT8I, 1756-IRT8IK
- 1756-IR12, 1756-IR12K

For terminations with thermocouple functionality on the following modules, we recommend that you use shielded thermocouple cable:

- 1756-IRT8I, 1756-IRT8IK
- 1756-IT16, 1756-IT16K

ATTENTION: The ControlLogix system has been agency certified using only the ControlLogix RTBs (1756-TBCH, 1756-TBNH, 1756-TBSH, and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system when using other wiring termination methods can require application-specific approval by the certifying agency.

WARNING: If you connect or disconnect wiring while the field-side power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Connect the Grounded End of the Cable

Before wiring the RTB, you must connect the ground wiring.

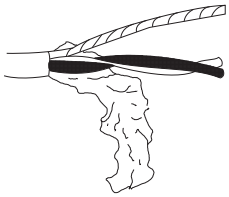
IMPORTANT We recommend that you ground the following ControlLogix analog modules at the field-side:

- 1756-IR12, 1756-IR12K
- 1756-IT16, 1756-IT16K
- 1756-OF8I, 1756-OF8IK
- 1756-IRT8I, 1756-IRT8IK
- 1756-IF8I, 1756-IF8IK on points that use the current/voltage functionality

If you cannot ground the modules at field-side, ground them at an earth ground on the chassis.
We recommend that you always **ground the 1756-IF8I, 1756-IF8IK module at an earth ground on the chassis** when you use the **current sourcing functionality.**

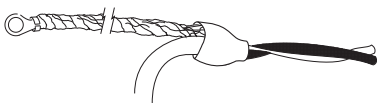
1. Remove a length of cable jacket from the Belden cable.

2. Pull the foil shield and bare drain wire from the insulated wire.



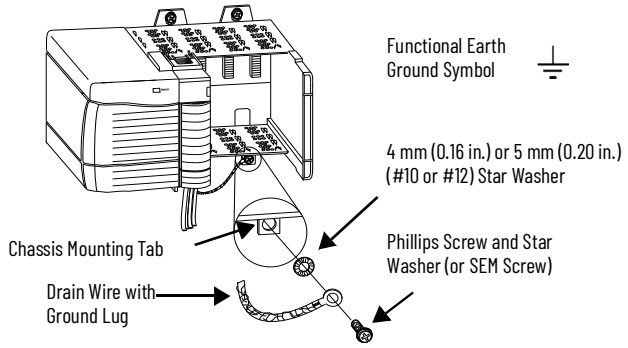
3. Twist the foil shield and drain wire together to form one strand.

4. Attach a ground lug and apply heat shrink tubing to the exit area.



5. Connect the drain wire to a chassis mounting tab.

6. Use any chassis mounting tab that is designated as a functional signal ground. The functional earth ground symbol appears near the tab.



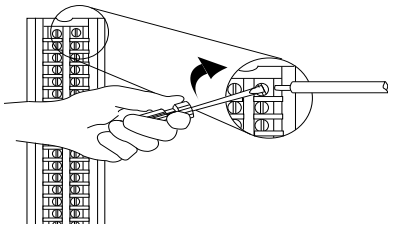
7. When the drain wire is grounded, connect the insulated wires to the field-side.

Connect the Ungrounded End of the Cable

1. Cut the foil shield and drain wire back to the cable casing and apply shrink wrap.
2. Connect the insulated wires to the RTB.

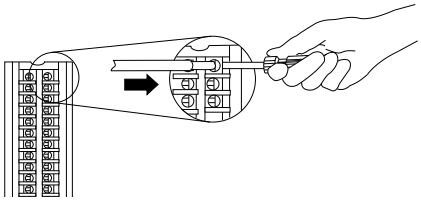
Cage Clamp-style RTB - Catalog Number 1756-TBCH

1. Insert the wire into the terminal.
2. Turn the screw clockwise to close the terminal on the wire.



Spring Clamp - Catalog Number 1756-TBS6H

1. Insert the screwdriver into the outer hole of the RTB.
2. Insert the wire into the open terminal and remove the screwdriver.



Recommendations for Wiring Your RTB

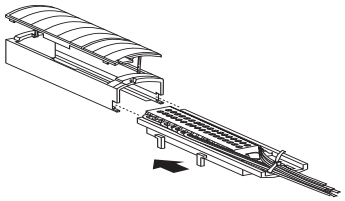
We recommend that you follow these guidelines when wiring your RTB:

- Begin wiring the RTB at the bottom terminals and move up.
- Use a tie to secure the wires in the strain relief (bottom) area of the RTB.
- Order and use an extended-depth housing (catalog number 1756-TBE) for applications that require heavy gauge wiring.

Assemble the RTB and the Housing

Removable housing covers the wired RTB to protect wiring connections when the RTB is seated on the module.

1. Align the grooves at the bottom of each side of the housing with the side edges of the RTB.
2. Slide the RTB into the housing until it snaps into place.



IMPORTANT If additional wire routing space is required for your application, use the extended-depth housing, catalog number 1756-TBE.

Install the Removable Terminal Block

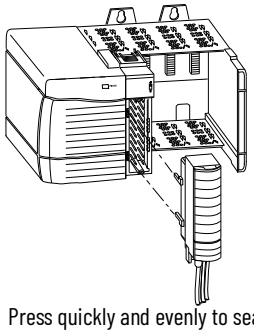
WARNING: When you connect or disconnect the removable terminal block (RTB) with field side power applied, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Before installing the RTB, verify the following:

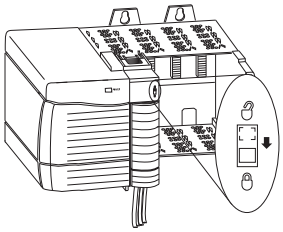
- Field-side wiring of the RTB is complete.
- The RTB housing is snapped into place on the RTB.
- The RTB housing door is closed.
- The locking tab at the top of the module is unlocked.

Follow these steps to install the RTB onto the module to connect the wiring.

1. Align the top, bottom, and left side guides of the RTB with the guides on the module.



2. Press quickly and evenly to seat the RTB on the module until the latches snap into place.
3. Slide the locking tab down to lock the RTB onto the module.



Removable Terminal Block (RTB) Ratings

Cat. No.	Torque and Wire Size (where applicable)
1756-TBCH	0.5 N•m (4.4 lb•in) Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Double wire connection: 0.33…1.3 mm^2 (22…16 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Do not wire more than two 0.33…1.3 mm^2 (22…16 AWG) conductors on any single terminal. Use only the same size wires with no intermixing of solid and stranded wire types.
1756-TBS6H	0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Do not wire multiple conductors on any single terminal.

Module Specifications

Series B Modules

Attribute	1756-IF8I, 1756-IF8IK	1756-IRT8I, 1756-IRT8IK	1756-OF8I, 1756-OF8IK	1756-IR12, 1756-IR12K	1756-IT16, 1756-IT16K
Voltage and Current Ratings	Backplane: 5.1V DC, 200 mA; 24V DC, 400 mA Input Voltage: -10...+10V, 0...10V, 0...5V Input Current: 0...20 mA Output Current: 0...20 mA	Backplane: 5.1V DC, 210 mA; 24V DC, 150 mA Input: 1...4000 Ohms, +/-100 mV, Thermocouple; B,C,E,J,K,R,S,T,N,D,L	Backplane: 5.1V DC, 200 mA; 24V DC, 385 mA Output Voltage: -10...+10V, 0...10V, 0...5V Output Current: 0...20 mA	Backplane: 5.1V DC, 210 mA; 24V DC, 70 mA Input: 1...4000 Ohms	Backplane: 5.1V DC, 210 mA; 24V DC, 80 mA Analog inputs: +/- 100 mV max 5 VA/Thermocouples B,C,E,J,K,R,S,T,N,D,L
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C < Ta ≤ 60 °C (32 °F ≤ Ta ≤ 140 °F)				
Temperature, surrounding air, max	60 °C (140 °F)				
Corrosive Atmosphere[1] ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX[2] per IEC 60721-3-3:2019, Chemically Active Substances				
Enclosure Type Rating	None (open-style)				
Isolation Voltage	250V (continuous), Reinforced Insulation Type, inputs to backplane 250V (continuous), Basic Insulation Type, input to input Type tested at 3000V AC for 60 s, inputs to backplane Type tested at 1500V AC for 60 s, input to input		250V (continuous), Reinforced Insulation Type, outputs to backplane 250V (continuous), Basic Insulation Type, output to output Type tested at 3000V AC for 60 s, outputs to backplane Type tested at 1500V AC for 60 s, output to output	250V (continuous), Reinforced Insulation Type, inputs to backplane No isolation between individual inputs Type tested at 3000V AC for 60 s	
NA Temp Code	T4	T4A	T4	T4A	T4A
ATEX Temp Code	T4	T4	T4	T4	T4
IECEx Temp Code	T4	T4	T4	T4	T4

(1) Only applicable to modules that end with a 'K' or 'XT'.
(2) Up to 9.6 microns per year, corrosion rate of copper.

Series A Modules

Attribute	1756-IF8I, 1756-IF8IK	1756-IRT8I, 1756-IRT8IK	1756-OF8I, 1756-OF8IK	1756-IR12, 1756-IR12K	1756-IT16, 1756-IT16K
Voltage and Current Ratings	Backplane: 5.1V DC, 200 mA; 24V DC, 400 mA Input Voltage: -10...+10V, 0...10V, 0...5V Input Current: 0...20 mA Output Current: 0...20 mA	Backplane: 5.1V DC, 200 mA; 24V DC, 150 mA Input: 1...4000 Ohms, +/-100 mV, Thermocouple; B,C,E,J,K,R,S,T,N,D,L	Backplane: 5.1V DC, 200 mA; 24V DC, 385 mA Output Voltage: -10...+10V, 0...10V, 0...5V Output Current: 0...20 mA	Backplane: 5.1V DC, 200 mA; 24V DC, 70 mA Input: 1...4000 Ohms	Backplane: 5.1V DC, 200 mA; 24V DC, 80 mA Analog inputs: +/- 100 mV max 5 VA/Thermocouples B,C,E,J,K,R,S,T,N,D,L
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C < Ta ≤ 60 °C (32 °F ≤ Ta ≤ 140 °F)				
Temperature, surrounding air, max	60 °C (140 °F)				
Corrosive Atmosphere[1] ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants—Gases Severity Level CX[2] per IEC 60721-3-3:2019, Chemically Active Substances				
Enclosure Type Rating	None (open-style)				
Isolation Voltage	250V (continuous), Reinforced Insulation Type, inputs to backplane 250V (continuous), Basic Insulation Type, input to input Type tested at 2300V AC for 60 s, inputs to backplane Type tested at 1500V AC for 60 s, input to input		250V (continuous), Reinforced Insulation Type, outputs to backplane 250V (continuous), Basic Insulation Type, output to output Type tested at 2300V AC for 60 s, outputs to backplane Type tested at 1500V AC for 60 s, output to output	250V (continuous), Reinforced Insulation Type, inputs to backplane No isolation between individual inputs Type tested at 1800V AC for 60 s	
NA Temp Code	T4	T4A	T4	T4A	T4A
ATEX Temp Code	T4	T4	T4	T4	T4
IECEx Temp Code	T4	T4	T4	T4	T4

(1) Only applicable to modules that end with a 'K' or 'XT'.
(2) Up to 9.6 microns per year, corrosion rate of copper.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002	Provides specification information for the isolated analog I/O modules.
ControlLogix Isolated Analog I/O Modules User Manual, 1756-UM540	Provides detailed information on installation and use of the isolated analog I/O modules.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Describes how to install a ControlLogix power supply.
ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620	Describes how to install redundant ControlLogix power supplies.
ControlLogix Chassis Installation Instructions, publication 1756-IN621	Describes how to install a ControlLogix chassis.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at https://www.rockwellautomation.com/literature/.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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High Resolution Analog I/O Modules

Catalog Numbers 1756-IF8I, 1756-IF8IK, 1756-IRT8I, 1756-IRT8IK, 1756-OF8I,1756-OF8IK, 1756-IR12, 1756-IR12K, 1756-IT16, 1756-IT16K

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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About This Publication

This manual describes how to install, configure, and troubleshoot ControlLogix® analog I/O modules.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Updated current draw @ 5.1V DC for 756-IRT8I, 1756-IRT8IK, 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K Series B modules	183

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix I/O Specifications, publication 1756-TD002	Provides specifications for ControlLogix analog and digital I/O modules and the accessories that can be used with each.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Provides information about how to install a wide range of ControlLogix power supplies.
ControlLogix Chassis Installation Instructions, publication 1756-IN621	Provides information about how to install a wide range of ControlLogix chassis.
Migrating 6-Channel 1756 Analog Modules to 8-Channel 1756 Analog Modules, publication 1756-RM011	Provides information about how to migrate the 1756 Isolated Analog I/O 6-channel modules to the 8-channel modules.
ControlLogix Digital I/O Modules User Manual, publication 1756-UM058	Provides information about how to install, configure, and troubleshoot ControlLogix digital I/O modules.
ControlLogix High Resolution Analog I/O Modules Installation Instructions, publication 1756-IN056	Provides information about how to install and wire ControlLogix high resolution analog I/O modules.
ControlLogix System User Manual, publication 1756 UM001	Describes how to install, configure, program, and operate a ControlLogix system.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP™ devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Notes:

Analog I/O Module Operation in the ControlLogix System

ControlLogix® controllers use analog I/O modules to control devices in a ControlLogix control system. The modules are installed in a ControlLogix chassis and use a removable terminal block (RTB) or a Bulletin 1492 interface module[1] cable to connect to field-side wiring.

The modules use the Producer/Consumer network communication model. This communication is an intelligent data exchange between modules and other system devices in which each module produces data without first being polled.

Before You Begin

Before you install and use your module, complete the following tasks:

- Install and ground a 1756 ControlLogix chassis and power supply[2]. You can use a standard power supply or a redundant power supply.

  For more information on how to install the 1756 ControlLogix chassis and power supplies, see Additional Resources on page 7.
- Verify that you have an RTB or IFM and its components.

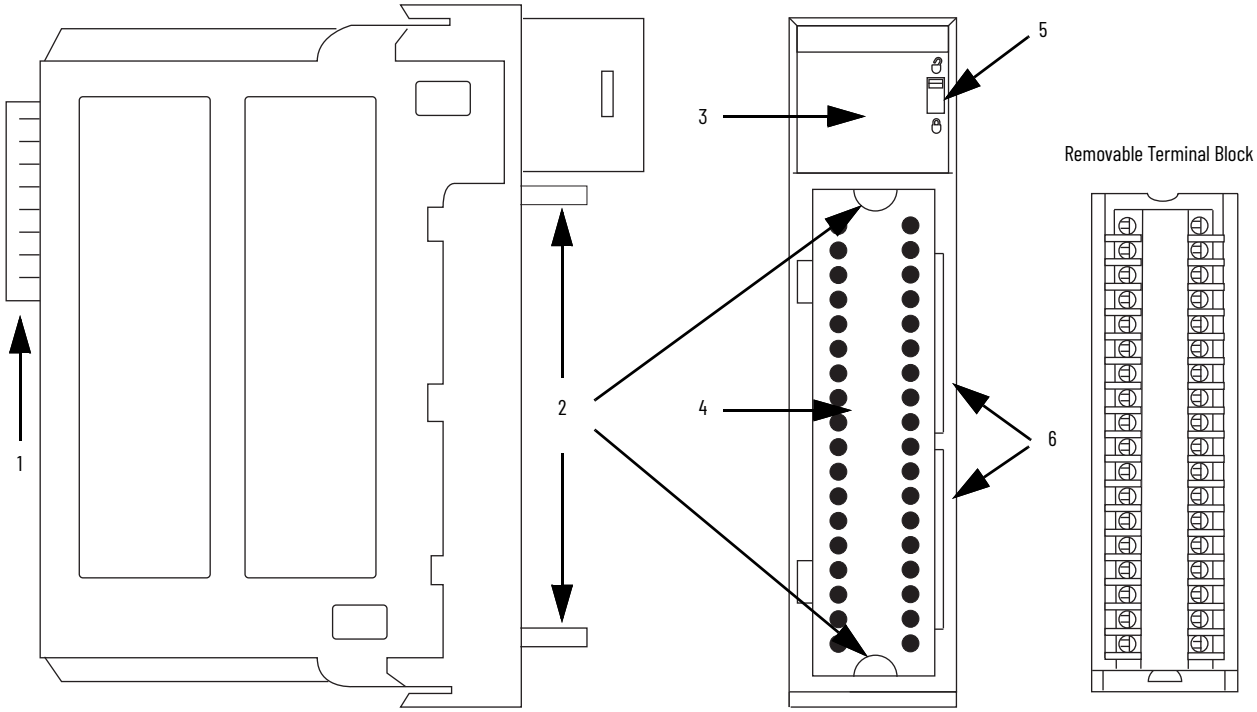
IMPORTANT RTBs and IFMs are not included with your module purchase.

Table 1 - Types of ControlLogix Isolated Analog I/O Modules

Cat. No.	Description	RTB Used	Page
1756-IF8I	8-point general-purpose isolated analog current/voltage input module	36-pin (1756-TBCH or 1756-TBS6H)	35
1756-IF8IK	8-point general-purpose isolated analog current/voltage input module with conformal coating		
1756-IRT8I	8-point isolated combined temperature and mV sensing input module		53
1756-IRT8IK	8-point isolated combined temperature and mV sensing input module with conformal coating		
1756-OF8I	8-point general-purpose isolated analog current/voltage output module		81
1756-OF8IK	8-point general-purpose isolated analog current/voltage output module with conformal coating		

(1) The ControlLogix system has been agency certified using only the ControlLogix RTBs (catalog numbers 1756-TBCH, 1756-TBNH, 1756-TBSH and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system using other wiring termination methods can require application specific approval by the certifying agency.
(2) In addition to standard ControlLogix power supplies, ControlLogix Redundant Power Supplies are also available for your application. For more information on these supplies, see the ControlLogix Selection Guide, publication 1756-SG001, or contact your local distributor or Rockwell Automation representative.

Figure 1 - Parts Illustration of the ControlLogix Isolated Analog I/O Module



Item	Description
1	Backplane connector - Interface for the ControlLogix system that connects the module to the backplane.
2	Top and bottom guides - Guides provide assistance in seating the RTB or IFM cable onto the module.
3	Status indicators - Indicators display the status of communication, module health, and input/output (I/O) devices. Indicators help in troubleshooting anomalies.
4	Connector pins - Input/output, power, and grounding connections are made to the module through these pins with the use of an RTB or IFM.
5	Locking tab - The locking tab anchors the RTB or IFM cable on the module, maintaining wiring connections.
6	Slots for keying - Mechanically keys the RTB to prevent inadvertently making the wrong wire connections to your module.

Ownership

Every I/O module in the ControlLogix system must be owned by a ControlLogix controller. This controller performs the following:

- Stores configuration data for every module that it owns.
- Resides in the local or remote chassis in regard to the position of the I/O module.
- Sends the I/O module configuration data to define the behavior of the module and begin operation in the control system.

Each ControlLogix I/O module must continuously maintain communication with its owner to operate normally. Typically, each module in the system has only one owner. Some Input modules can have multiple owners. Output modules, and Input modules that have an Output image like the 1756-IF8I and 1756-IRT8I modules, however, are limited to one owner.

Redundant Ownernership

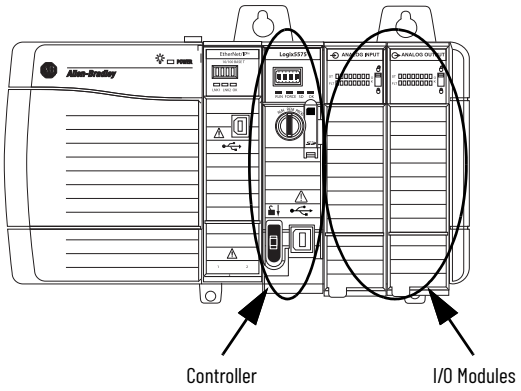
Redundant ownership lets a single controller use redundant network paths to communicate with a single output or lets two separate controllers coordinate to control the output.

See Redundant Ownership on page 89.

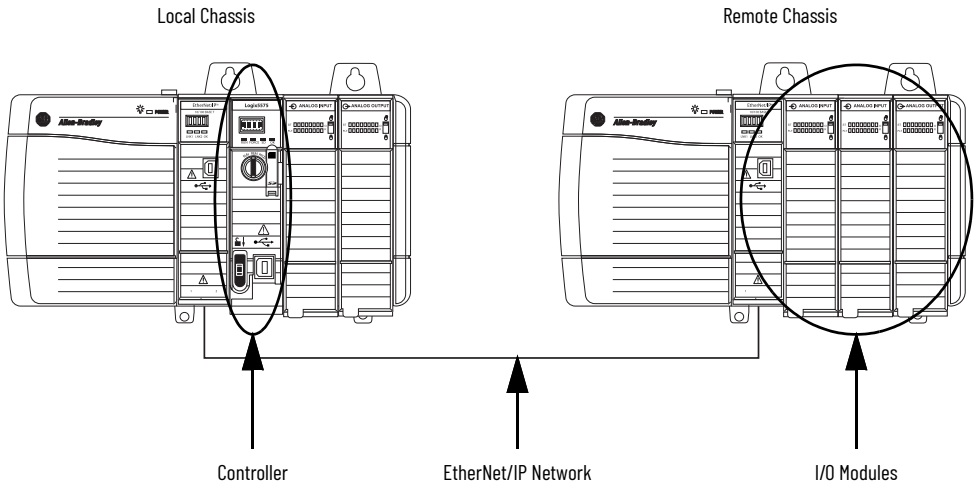
Configure a Module

You use the I/O configuration portion of the Studio 5000 Logix Designer® application to configure each I/O module. An I/O module can reside in either of the following:

- **Local chassis** - The chassis in which the owner-controller resides.



- **Remote chassis** - A chassis that does not contain the module's owner-controller but is connected to the local chassis over the EtherNet/IP™ network or ControlNet™ network.



The Logix Designer application transfers configuration data to the controller during the program download. Then, data is transferred to the I/O modules in the local and remote chassis.

The I/O module can operate immediately after the project download from the owner-controller is complete.

Direct Connections

A direct connection is a real-time data transfer link between the controller and the device that occupies the slot that the configuration references.

IMPORTANT ControlLogix analog I/O modules support only direct connections.

When you download module configuration to a controller, the controller attempts to establish a direct connection to each module referenced by the configuration.

If controller configuration refers to a chassis slot in the system, the controller periodically checks for the presence of a device there. If a device is detected, the controller sends the configuration, and one of the following occurs:

- If the configuration is appropriate to the module detected, a connection is made and operation begins.
- If the configuration is not appropriate to the module detected, the data is rejected and the Logix Designer application indicates that an error occurred.

  The configuration can be inappropriate for any of a number of reasons. For example, the configuration or a module can include a mismatch in electronic keying that prevents normal operation.

The controller maintains and monitors its connection with a module. Any break in the connection, for example, the removal of the module from the chassis while under power, causes a fault.

The Logix Designer application indicates that the fault occurred in the fault status bits associated with the module. The Logix Designer application monitors the fault status bits to annunciate the failures of a module.

Input Module Operation

In traditional I/O systems, controllers periodically poll input modules to obtain their input status.

In the ControlLogix system, the controller does not poll the analog input modules. Instead, the modules broadcast their input data–channel and status data–to their backplane periodically.

Requested Packet Interval (RPI)

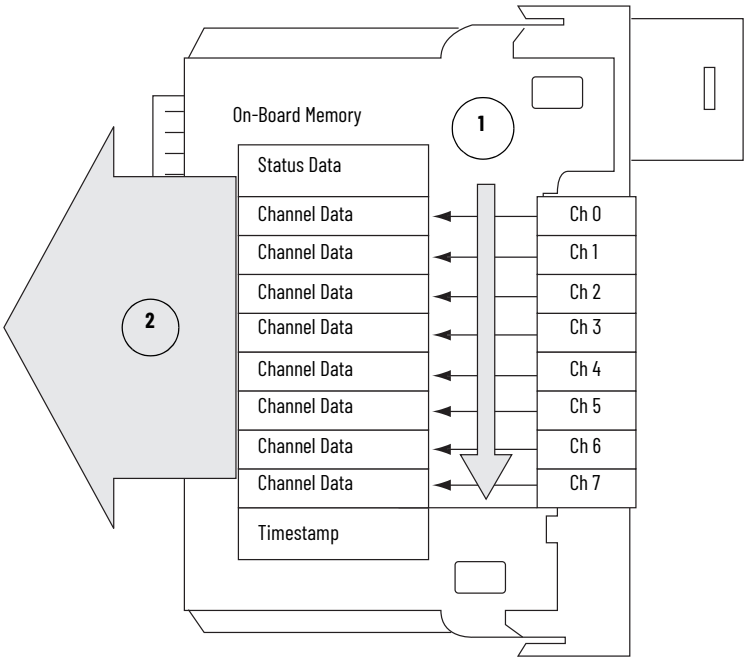
The RPI is a configurable parameter that defines a specific period when the module broadcasts input data to the backplane. Valid RPI values are 1...750 ms. The default value is 100 ms for inputs and 10 ms for outputs.

Set the RPI value at initial module configuration and adjust it as necessary only when the controller is in Program mode.

IMPORTANT	Other ControlLogix analog input modules offer the **Real Time Sample (RTS)** parameter that determines when channel data is scanned and stored on the module's on-board memory until broadcast to the chassis backplane. The input modules described in this user manual **do not offer the RTS parameter**. With these modules, the channel sampling rate is exclusively determined by the RPI value.

At the RPI, the following events occur.

1. The module scans its channels for input data.
2. The module broadcasts the data to its backplane.



The input module broadcasts data to the chassis backplane immediately after the scan:

- When the module resides in the local chassis, the controller receives the data immediately.
- When the module resides in a remote chassis, the time that elapses before the controller receives the data depends on the network configuration that connects the local and remote chassis.

  For more information, see Input Modules in a Remote Chassis.

Input Modules in a Local Chassis

When an input module resides in a local chassis (see Configure a Module on page 11) and after the input module broadcasts data to the chassis backplane, the controller receives it immediately. The analog input module broadcasts data using Multicast as its connection method in a local chassis.

Input Modules in a Remote Chassis

When an input module resides in a remote chassis (see Configure a Module on page 11), it is considered remote input module.

At the RPI, the following events occur.

1. The remote input module scans its channels for input data.
2. The remote input module broadcasts the data to its backplane.
3. The network communication module in the chassis with the I/O module sends the data over the network to the controller.

Broadcast Method

The analog input module broadcasts data by using one of the following connection methods:

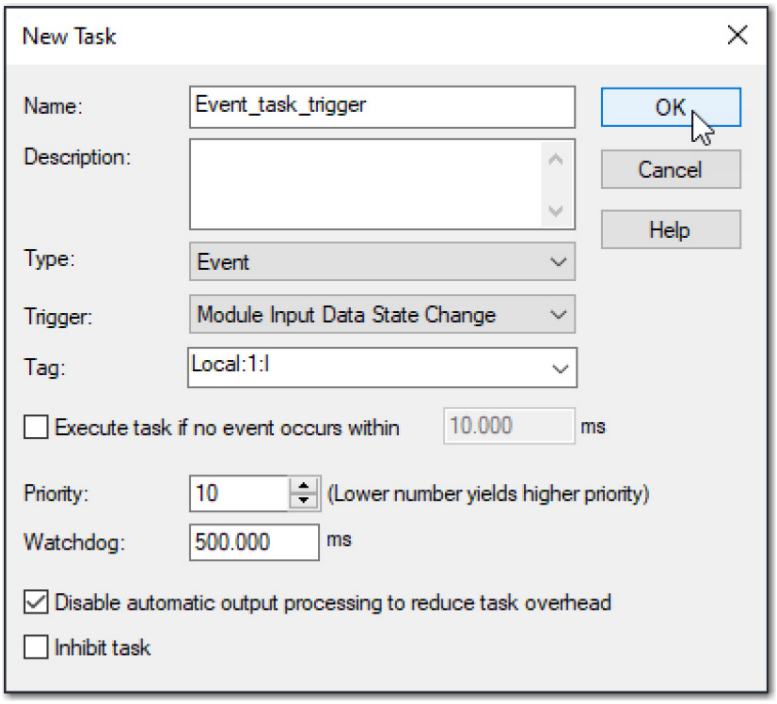
- Multicast - Data is sent to all network devices at once
- Unicast - Data is sent to a specific controller depending on the configuration of the module

For more information on guidelines for specifying RPI rates, see the Logix5000™ Controllers Design Considerations Reference Manual, publication 1756-RM094.

Trigger Event Tasks

ControlLogix analog input modules can trigger an Event task. The Event task causes the controller to execute a section of logic immediately when a triggering event occurs. You can configure the Event task to be triggered if new input data is sent at the RPI.

The following graphic shows an Event task dialog box in Logix Designer application.



Event tasks are useful for synchronizing process variable (PV) samples and proportional integral derivative (PID) calculations.

For more information on Event tasks, see the Logix 5000 Controllers Tasks, Programs, and Routines Programming Manual, publication 1756-PM005.

Output Module Operation

The RPI defines when a controller sends data to the analog output module and when the output module echoes data. The controller sends data to an output module only at the RPI.

When an output module receives new data from the controller, the module multicasts or 'echoes' a data value that corresponds to the signal present at its terminals to the rest of the control system. This feature, called Data Echo, occurs whether the output module resides in the local or remote chassis.

Depending on the value of the RPI, regarding the length of the controller program scan, the output module can receive and 'echo' data multiple times during one program scan.

When the RPI is less than the program scan length, the module's output channels can change values multiple times during one program scan. The controller does not depend on reaching the end of the program to send data.

Output Modules in a Local Chassis

When an output module resides in a local chassis (see Configure a Module on page 11), it receives data almost immediately after the owner-controller sends it. The analog output module broadcasts data using Multicast as its connection method in a local chassis.

Output Modules in a Remote Chassis

When an output module resides in a remote chassis (see Configure a Module on page 11), and is connected to the local chassis via an EtherNet/IP network, the following events occur for the controller to send data to the output module.

1. The controller broadcasts data to its local chassis at one of the following events:
   - RPI value
   - A programmed Immediate Output (IOT) instruction is executed.
     An IOT sends data immediately and resets the RPI timer.
2. The 1756 ControlLogix EtherNet/IP communication module in the local chassis broadcasts the data over the EtherNet/IP network.
3. After receiving the output data, the 1756 ControlLogix EtherNet/IP communication in the remote chassis broadcasts the data to its backplane, that is, the remote chassis.
4. The output module receives the data almost immediately after it is broadcast to the remote chassis backplane.

Broadcast Method

The analog output module broadcasts data by using one of the following connection methods:

- Multicast - Data is sent to all network devices at once
- Unicast - Data is sent to a specific controller depending on the module's configuration

For more information on guidelines for specifying RPI rates, see the Logix 5000 Controllers Design Considerations Reference Manual, publication 1756-RM094.

Listen-only Mode

Any controller in the system can listen to the data from any I/O module, that is, input data or echoed output data, even if the controller does not own the module.

During the I/O configuration process, you can specify a Listen-Only connection. For more information on Connection options when configuring your system, see page 103.

When you choose a Listen-Only connection, the controller and module establish communication without the configuration data being sent by the controller. In this instance, another controller owns the I/O module.

IMPORTANT The Listen-Only controller receives data from the I/O module as long as an owning connection between a controller and I/O module is maintained.

If the connection between all owner-controllers and the module is broken, the module stops sending data and connections to all `Listening controllers' are also broken.

In addition, multicast Listen Only connections require at least one multicast owning connection to be active.

Notes:

Analog I/O Module Features

ControlLogix® analog input modules convert an analog signal to a digital value. The following are example analog signal types to which input modules convert to digital values:

- Volts
- Millivolts
- Milliamps
- Ohms

ControlLogix analog output modules convert a digital value to an analog signal. The following are example analog signal types to which output modules convert digital values:

- Volts
- Milliamps

Common Analog I/O Features

The ControlLogix analog I/O modules have the following features:

- CIP Sync Timestamp of Data
- Rolling Timestamp of Data
- Floating Point Data Format
- Module Quality Reporting
- Calibration
- Fault and Status Reporting
- Configurable Software
- Latching of Alarms
- Module Inhibiting
- Electronic Keying
- Elegant Migration Emulation Mode

CIP Sync Timestamp of Data

The control system uses a 64-bit system clock. The modules support CIP Sync timestamping by using the 1588 protocol passed throughout the system. The 1588 protocol is defined in the IEEE 1588-2002 standard, publication Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.

Each input channel scan or new output application is stamped with a CIP Sync timestamp and one timestamp is returned to the controller for the module with the input data transfer.

You can use this feature for the following:

- To identify the sequence of events in fault conditions or during normal operation.

  It is possible to use the system clock between multiple modules in the same chassis or throughout a system in which a common Time Master is used.
- To measure the change between samples–which correlates closely with the RPI if no samples are missed in the logic–and to detect when a new sample is available for processing via the logic.

You can also use the 1588 Protocol to synchronize sampling for modules across the entire system. By using the Synchronized Sampling feature, described in detail on page 45 and page 67, you can configure multiple modules to coordinate their input samples precisely with each other when using the same RPI.

Synchronized Sampling lets you configure a test stand, for example, and take many measurements simultaneously across many modules, if needed, while still precisely coordinating the sampling. With these modules, the synchronized sampling should coordinate within approximately ± 20 µs.

Rolling Timestamp of Data

The rolling timestamp is a continuously running 16-bit rolling timestamp that counts in milliseconds from 0…32,767 ms; where 1 ms = 1 count.

Rolling Timestamp with Input Modules

The ControlLogix analog input modules described in this user manual scan their inputs at the RPI, update the input data, and update the rolling timestamp value. Other ControlLogix analog input modules scan their inputs at the RTS, not the RPI.

In either case, though, program the controller to use the last two rolling timestamp values to calculate the interval between the receipt of data or the time at which new data is received.

The rolling value is commonly used with instructions such as the PID and PIDE instructions. Every time a rolling timestamp changes, a PID or PIDE instruction is executed. When you configure a PID instruction for use with an input module, set the loop update time equal to the module's RPI value.

Rolling Timestamp with Output Modules

For the 1756-OF8I or 1756-OF8IK module, the rolling timestamp value is updated only when new values are applied to the Digital to Analog Converter (DAC).

Floating Point Data Format

The modules return channel data to the owner-controller in the IEEE 32-bit floating point data format. In your Logix Designer application, the data type is REAL. You can configure the module to scan its channels and return data as quickly as every 1 ms.

The floating point data format lets you change the data representation of the selected channel. Although the full range of the module does not change, you can scale your module to represent I/O data in specific terms for your application.

To scale a channel, select two points that represent signal units, that is, a Low Signal and a High Signal. You also select two points that represent engineering units, that is, Low Engineering and High Engineering.

The Low Signal point equates to the Low Engineering point and the High Signal point matches the High Engineering point.

EXAMPLE A 1756-IF8I or 1756-IF8IK module that is used in current mode maintains 0...21 mA range capability. Your application uses a 4...20 mA transmitter.

- If you want to receive values in **signal units**, configure the module as follows:
  - Low Signal = 4 mA
  - High Signal = 20 mA
  - Low Engineering = 4 EU
  - High Engineering = 20 EU
- If you want to receive values in terms of **Percent of Full Scale**, configure the module as follows:
  - Low Signal = 4 mA
  - High Signal = 20 mA
  - Low Engineering = 0%
  - High Engineering = 100%

By default, module channels that are used in Current mode are scaled such that 4...20 mA equate to 0...100% engineering units. Other module channels scale 1:1 regarding signal units and engineering units by default.

Module Quality Reporting

The modules indicate the quality of channel data returned to the owner-controller. Data quality represents accuracy. There are levels of data quality reported via module input tags.

The following input tags indicate the level of data quality. In the tag names, *x* represents the module channel number:

- *I.Ch[x].Fault* tag - This tag indicates that channel data can be completely inaccurate and cannot be trusted for use in the application. If the tag is set to 1, you cannot trust the data reported. You must troubleshoot the module to correct the cause of the inaccuracy.

  Common causes of inaccurate data include the following:

  - An overrange or underrange condition exists.
  - A wire off detection condition has occurred.
  - A short circuit detection condition has occurred.
- *I.Ch[x].Uncertain* tag - This tag indicates that channel data can be inaccurate but it is not known to what degree of inaccuracy. We recommend that you do not use the data for control.

  If the tag is set to 1, you know that the data can be inaccurate but you must troubleshoot the module to discover what degree of inaccuracy exists.

  Common causes of uncertain data include the following:

  - The channel is actively being calibrated.
  - An invalid sensor offset value exists.
  - The last data sample of the channel failed the CRC check between the module processor and the Analog to Digital Converter (ADC) which results in the most recent valid data sample was used.
  - The channel is not calibrated.

We recommend that you monitor these tags in your program to make sure that the application is operating as expected with accurate channel input data.

Calibration

These modules use precise analog components that maintain their specifications over time. The modules are calibrated at the factory and recalibration is not required.

If desired, you can recalibrate the modules on a channel-by-channel or module-wide basis. For more information, see Calibrated Accuracy on page 30 if you choose to recalibrate the modules in the future.

Fault and Status Reporting

The modules provide fault and status data along with channel data. Faults are indicated via the status indicators on the front of the module and the module tags. Status data is available via the module tags.

- For more information on fault and status reporting via module tags, see the following:
  - 1756-IF8I, 1756-IF8IK fault and status reporting - page 51
  - 1756-IRT8I, 1756-IRT8IK fault and status reporting - page 80
  - 1756-IR12, 1756-IR12K fault and status reporting - page 80
  - 1756-IT16, 1756-IT16K fault and status reporting - page 80
  - 1756-OF8I, 1756-OF8IK fault and status reporting - page 87
- For more information on fault reporting via status indicators, see Chapter 8, Troubleshoot Your Module on page 143

Configurable Software

Use one of the following software applications with your module:

- RSLogix 5000® software, versions 18...20
- Logix Designer application, version 21 or later

IMPORTANT You must install Add-on Profiles (AOP) to use the modules in any Logix Designer application or RSLogix 5000 software project.

This publication describes configuration with Logix Designer application. AOPs are available at:

https://download.rockwellautomation.com/esd/download.aspx?downloadid=addonprofiles

All module feature configuration begins in the I/O configuration portion of the Logix Designer application. In addition, to enable or disable module features, you can use the application to interrogate any module for the following module information:

- Serial number
- Revision information
- Catalog number
- Vendor identification
- Error/fault information
- Diagnostic counters

Latching of Alarms

This feature latches a module alarm in the set position once the alarm is triggered. The alarm remains on, even if the condition that causes it to occur disappears, until the alarm is unlatched.

IMPORTANT You must manually unlatch the alarm. You can unlatch the alarm by using one of the following methods:

- While the project is online, click the Alarm Configuration tab on the Module. Then click Unlatch to unlatch a specific alarm or Unlatch All to unlatch all alarms.
- Change the module output tag for the alarm that you want to unlatch. For example, the *Ch[x].LLAlarmUnlatch* tag to unlatch a Low Low Alarm.

For more information on module tags, see Appendix A, Analog I/O Module Tag Definitions on page 157.

- Use a CIP Generic message.

For more information how to use a CIP Generic message, see Rockwell Automation® Knowledgebase article #63046, How to Reset Latched Status of an Analog Module. You can access the article at: (Login required)

https://rockwellautomation.custhelp.com/

To see where to latch alarms, see page 109.

Module Inhibiting

This feature suspends the connection between an owner-controller and a module. This process can occur in either of the following ways:

- You write configuration for an I/O module but inhibit the module to prevent it from communicating with the owner-controller.

  In this case, the owner does not establish a connection and configuration is not sent to the module until the connection is uninhibited.
- A controller owns a module and has downloaded configuration to it. Data is being exchanged over the connection between the devices.

  In this case, when you inhibit the module and the owner-controller behaves as if the connection to the module does not exist.

IMPORTANT Whenever you inhibit an output module, it enters Program mode and all outputs change to the state configured for the Program mode. For example, if an output module is configured so that the states of the outputs go to zero (0.0) during Program mode, whenever that module is inhibited, the outputs go to zero (0.0).

The following examples are instances where you need to use module inhibiting:

- Multiple controllers own an analog input module. A configuration change is required. You must make the change in the program in all controllers. In this case, complete the following tasks.
  a. Inhibit the module.
  b. Change configuration in all controllers.
  c. Uninhibit the module.
- You want to upgrade the module. We recommend that you complete the following tasks.
  a. Inhibit the module.
  b. Perform the upgrade.
  c. Uninhibit the module.
- The program includes a module that you do not physically possess and you do not want the controller to continually look for a module that does not exist.

  Inhibit the module until it physically resides in the proper slot. To see where to inhibit a module connection, see page 103.

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared.

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The following Electronic Keying options are available.

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics: • Same catalog number • Same or higher Major Revision • Minor Revision as follows: – If the Major Revision is the same, the Minor Revision must be the same or higher. – If the Major Revision is higher, the Minor Revision can be any number.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **ATTENTION**: Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We **strongly recommend** that you **do not use** Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT	Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken. If an I/O connection to a device is interrupted, the result can be a loss of data.

More Information

For more detailed information on Electronic Keying, see Electronic Keying in Logix5000™ Control Systems Application Technique, publication LOGIX-AT001.

Elegant Migration Emulation Mode

The 1756 Isolated Analog I/O modules, which are 6-channel, have a migration path to the 1756 Isolated Analog 8-channel modules. Table 2 shows the relationship between the 6-channel modules and the 8-channel modules.

Table 2 - 1756-Isolated Analog I/O Module Migration Descriptions

Catalog Number	1756 ControlLogix Isolated Analog I/O 6-channel Description	Migration Catalog Number	1756 ControlLogix Isolated Analog I/O 8-channel Description
1756-IF6I	Isolated Analog Input-Current/Voltage 6 Pts (20 Pin)	1756-IF8I, 1756-IF8IK	Analog Input Module, 8 Isolated Points, Current, Current Sourcing and Voltage (36 Pin)
1756-IF6CIS	Isolated Analog In-Current Sourcing 6 Pts (20 Pin)		
1756-IT6I	Isolated Thermocouple/mV Input 6 Pts (20 Pin)	1756-IRT8I, 1756-IRT8IK	RTD / Ohms / Thermocouple / mV Input Module, 8 Individually Configurable Isolated Points (36 Pin)
1756-IT6I2	Enhanced Isolated Thermocouple/mV Input 6 Pts (20 Pin)		
1756-IR6I	Isolated RTD Input 6 Pts (20 Pin)		
1756-OF6VI	Isolated Analog Output - Voltage 6 Pts (20 Pin)	1756-OF8I, 1756-OF8IK	Analog Output Module, 8 Isolated Points, Current and Voltage (36 Pin)
1756-OF6CI	Isolated Analog Output - Current 6 Pts (20 Pin)		

The migration catalog numbers, firmware revision 2.011 and later, can communicate to the controller as if they are 6-channel modules. This Emulation mode lets a 6-channel module application migrate to use the 8-channel module.

This migration means that when a forward open containing configuration data is sent to the 8-channel module, it can accept it and respond as if it were a 6-channel module. After the connection is established, all data (input and/or output) is sent to/from the controller in the same format and tag structures as if it were a 6- channel module. With this method, you can directly replace a 6-channel module with an 8-channel module with no I/O tree modifications or program changes.

When an 8-channel module receives configuration data for a 6-channel module, the 8-channel module takes that information and reformats it to replicate the configuration data of an 8-channel module. The 8-channel module scans the firmware but reformats the input and/or output data to match the 6-channel module.

In general, the 8-channel module is internally behaving as an 8-channel module because most of the firmware has not changed. The difference in 8-

channel module firmware is that in emulation mode, configuration, input, and output data is reformatted to match the appropriate 6-channel module.

All data to/from an 8-channel module is mapped from a 6-channel module format to an 8-channel module format. The controller still sends data in the 1756-IF6I module format but firmware internally moves data to the 1756-IF8I module format.

Figure 2 - 1756-IF6I Module Configuration Example

1756-IF6I module configuration data sent to the 1756-IF8I module.

Name	Value	Style	Data Type
Local:1:C	{...}		AB:1756_AI6_Float:C:0
Local:1:C.Ch0Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.Ch0Config.AlarmDeadband	0.0	Float	REAL
Local:1:C.Ch0Config.AlarmDisable	0	Decimal	BOOL
Local:1:C.Ch0Config.CalBias	0.0	Float	REAL
Local:1:C.Ch0Config.DigitalFilter	0	Decimal	INT
Local:1:C.Ch0Config.HAlarmLimit	10.0	Float	REAL
Local:1:C.Ch0Config.HHAlarmLimit	10.0	Float	REAL
Local:1:C.Ch0Config.HighEngineering	10.0	Float	REAL
Local:1:C.Ch0Config.HighSignal	10.0	Float	REAL
Local:1:C.Ch0Config.LAlarmLimit	-10.0	Float	REAL
Local:1:C.Ch0Config.LLAlarmLimit	-10.0	Float	REAL
Local:1:C.Ch0Config.LowEngineering	-10.0	Float	REAL
Local:1:C.Ch0Config.LowSignal	-10.0	Float	REAL
Local:1:C.Ch0Config.ProcessAlarmLatch	0	Decimal	BOOL
Local:1:C.Ch0Config.RangeTypeNotch	16#0002	Hex	INT
Local:1:C.Ch0Config.RateAlarmLatch	0	Decimal	BOOL
Local:1:C.Ch0Config.RateAlarmLimit	0	Decimal	INT
Local:1:C.Ch0Config.TenOhmOffset	0	Decimal	INT
Local:1:C.Ch1Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.Ch2Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.Ch3Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.Ch4Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.Ch5Config	{...}		AB:1756_AI6_Struct:C:0
Local:1:C.CJDisable	0	Decimal	BOOL
Local:1:C.CJOffset	0.0	Float	REAL
Local:1:C.RealTimeSample	100	Decimal	INT
Local:1:C.RemoteTermination	0	Decimal	BOOL
Local:1:C.TempMode	0	Decimal	BOOL

Internally, the 1756-IF8I module sees the data like the following.

Name	Value	Style	Data Type
Local:1:C	{...}		AB:1756_IF8I:C:0
Local:1:C.Ch	{...}		AB:1756_IF8I_ChStruct:C:0[8]
Local:1:C.Ch[0]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[0].AlarmDeadband	0.0	Float	REAL
Local:1:C.Ch[0].AlarmDisable	0	Decimal	BOOL
Local:1:C.Ch[0].DigitalFilter	0	Decimal	INT
Local:1:C.Ch[0].Disable	0	Decimal	BOOL
Local:1:C.Ch[0].HAlarmLimit	10.0	Float	REAL
Local:1:C.Ch[0].HHAlarmLimit	10.0	Float	REAL
Local:1:C.Ch[0].HighEngineering	10.0	Float	REAL
Local:1:C.Ch[0].HighSignal	10.0	Float	REAL
Local:1:C.Ch[0].InputRange	0	Decimal	SINT
Local:1:C.Ch[0].LAlarmLimit	-10.0	Float	REAL
Local:1:C.Ch[0].LLAlarmLimit	-10.0	Float	REAL
Local:1:C.Ch[0].LowEngineering	-10.0	Float	REAL
Local:1:C.Ch[0].LowSignal	-10.0	Float	REAL
Local:1:C.Ch[0].NotchFilter	2	Decimal	SINT
Local:1:C.Ch[0].ProcessAlarmLatch	0	Decimal	BOOL
Local:1:C.Ch[0].RateAlarmLatch	0	Decimal	BOOL
Local:1:C.Ch[0].RateAlarmLimit	0.0	Float	REAL
Local:1:C.Ch[0].Sourcing	0	Decimal	BOOL
Local:1:C.Ch[0].SynchronizeSampling	0	Decimal	BOOL
Local:1:C.Ch[1]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[2]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[3]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[4]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[5]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[6]	{...}		AB:1756_IF8I_ChStruct:C:0
Local:1:C.Ch[7]	{...}		AB:1756_IF8I_ChStruct:C:0

1756-IF6I Module Configuration Example

The controller still sends data in the 1756-IF6I module format, but firmware internally moves data to the 1756-IF8I format. An 8-channel module still behaves as an 8-channel module, but accepts a 6-channel module format.

For more information, see Migrating from 6 Channel 1756 Analog Modules to 8 Channel 1756 Analog Modules, publication 1756-RM011.

Relationship between Module Resolution and Scaling

The following concepts must be explained with each other:

- Module Resolution
- Scaling

Module Resolution

Resolution is the smallest degree of change that the module is capable of detecting. Module resolution represents a fixed number of counts across the **theoretical operating range** of the module.

- 1756-IF8I, 1756-IF8IK and 1756-IRT8I, 1756-IRT8IK modules support 24-bit resolution.

  The 24 bits represent 16,777,216 counts.
- 1756-OF8I, 1756-OF8IK modules support 16-bit resolution.

  The 16 bits represent 65,536 counts.
- 1756-IR12, 1756-IR12K modules support 24-bit resolution.
- 1756-IT16, 1756-IT16K modules support 24-bit resolution.

Resolution on Input Modules

The theoretical operating range is the full range across which the module can operate. For example, an input module in Current mode has a theoretical operating range = -25.1...25.1 mA. The 24-bit resolution and 16,777,216 counts are available across 50.2 mA, which yields our calculated 2.99 nA/count resolution.

However, when the input module operates in Current mode, it is configured for an input range = 0...20 mA. This range limits the input to a 0...21 mA actual range capability.

The number of counts on a module is fixed. Module actual range capabilities, however, narrow operating ranges from the theoretical and result in supporting fewer counts. Using the example above, the 0...21 mA actual range capability represents 5,815,117 counts, that is, slightly more than 22.5 bits.

Divide the actual range capability by the number of counts in that range to determine the value of each count. The input range that you choose during module configuration determines the value of each count. It does not determine the number of counts in that range. Therefore, module resolution across the usable input operating range is not always 24 bits.

Resolution on Output Module

The module resolution for the output module is always 16 bits, regardless of operating mode and operating range.

Table 3 lists the resolution for each module's input/output range and corresponding range capability.

Table 3 - Module Resolution in Various Configuration Selections

Module	Mode	Available Input/ Output Range[1]	Actual Input/Output Range Capability	Number of Bits Across the Theoretical Operating Range	Number of Bits Across the Actual Range Capability	Resolution (signal per count)
1756-IF8I, 1756-IF8IK	Voltage	-10...10V 0...10V 0...5V	-10.5...10.5V 0...10.5V 0...5.25V	24 bits	23.75 22.75 21.75	1.49 µV/count
	Current	0...20 mA 0...20 mA (sourcing)	0...21 mA 0...21 mA (sourcing)		22.74	2.99 nA/count
1756-IRT8I, 1756-IRT8IK 1756-IT16, 1756-IT16K	Thermocouple	-100...100 mV	-101...101 mV	24 bits	23.98	0.01 µV/count
1756-IRT8I, 1756-IRT8IK 1756-IR12, 1756-IR12K	RTD	1...500 Ω 2...1000 Ω 4...2000 Ω 8...4000 Ω	0...510 Ω 0...1020 Ω 0...2040 Ω 0...4080 Ω		23.98	0.06 mΩ/count 0.12 mΩ/count 0.25 mΩ/count 0.50 mΩ/count
1756-OF8I, 1756-OF8IK	Voltage	-10...10V 0...10V 0...5V	-10.5...10.5V 0...10.5V 0...5.25V	16 bits	16.00	0.32 mV/count 0.16 mV/count 0.08 mV/count
	Current	0...20 mA	0...21 mA		16.00	0.32 µA

(1) These ranges represent the range choices available in the Logix Designer application.

IMPORTANT Because these modules must allow for possible calibration inaccuracies, resolution values represent the available Analog-to-Digital or Digital-to-Analog counts over the specified range.

Additionally, RPI and Notch Filter settings affect module resolution on the 1756-IF8I, 1756-IF8IK and 1756-IRT8I, 1756-IRT81K modules. For more information, see page 38 and page 55, respectively.

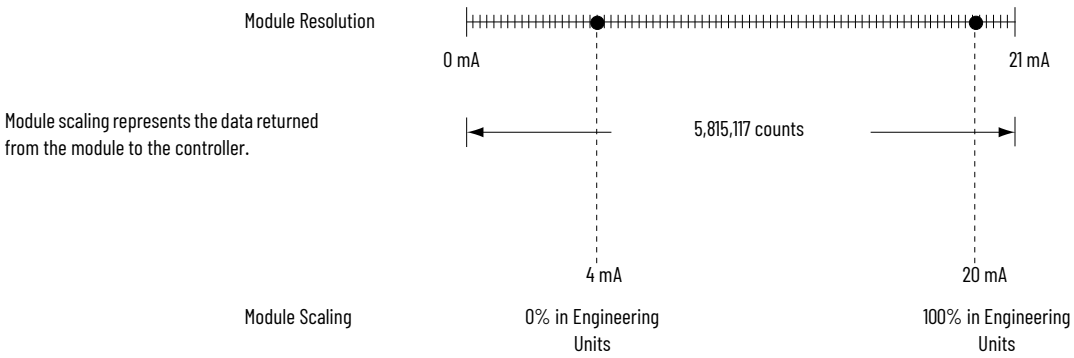
Scaling

When scaling, you choose two points along the module's operating range and apply low and high values to those points.

For example, if you are using the 1756-IF8I module in Current mode, the module supports a 0...21 mA actual range capability. But your application uses a 4...20 mA transmitter. Scaling lets you configure the module to return data to the controller so that a low signal value of 4 mA returns a low engineering value of 0% and a high signal value of 20 mA returns a high engineering value of 100%.

The returned engineering unit's value is indicated in the *I.Ch[x].Data* tag as shown in Table 4.

Figure 3 - Module Resolution Compared to Module Scaling



IMPORTANT	In choosing two points for the low and high value of your application, you do not limit the range of the module. The module's range and its resolution remain constant regardless of how you scale it for your application.

The module can operate with values beyond the 4…20 mA range. If an input signal beyond the low and high signals is present at the module, for example, 0 mA, that data is represented in terms of the engineering units set during scaling.

Table 4 shows example values that can appear based on the example mentioned above.

Table 4 - Current Values Represented in Engineering Units

Current	Engineering Units Value	Value in I.Ch[x].Data Tag
0.0 mA	-25.00%	-25.00
4.0 mA	0.0%	0.00
12.0 mA	50.0%	50.0
20.0 mA	100.0%	100.0
21.0 mA	106.25%	106.25

Calibration

The ControlLogix analog modules are calibrated via the following methods:

- Factory calibration when the modules are built.
- User-executed calibration as described in Chapter 7, Calibrate the ControlLogix Analog I/O Modules on page 117.

  User-executed calibration is optional.
- **1756-IRT8I or 1756-IRT8IK modules only** - Channels that are configured for Thermocouple inputs perform a lead resistance self-calibration when the module power is cycled.

Calibrated Accuracy

The calibrated accuracy specification represents the module's accuracy when its ambient temperature is the same as the temperature at which the module was calibrated.

Table 5 -

Specification	Description
Calibrated accuracy at 25 °C (77 °F)	This specification matches the temperature at which the module was calibrated in the factory during manufacturing.
Module error over full temperature range	This specification represents the error that occurs if the module's ambient temperature changes a total of 60 °C (140 °F), that is, from 0…60 °C (32…140 °F) or 60…0 °C (140…32 °F).

For individual module specifications, see the ControlLogix I/O Module Specifications Technical Data, publication 1756-TD002.

Error Calculated over Hardware Range

The calibration accuracy of a ControlLogix analog I/O module at 25 °C (77 **°F)** is calculated over the full hardware range of the module. It is not dependent on the application's use of the range. The error is the same if you are measuring it across a 10% or 100% portion of a given range.

However, a module's accuracy at 25 °C (77 **°F)** is dependent on the hardware range in which the module operates.

EXAMPLE When the 1756-IRT8I channel uses the Thermocouple (mV) input type, the input range is -100...100 mV, the module error is 0.2 mV when using 0.1% of range accuracy.

These error values are the same whether you use 10% or 100% of the chosen range.

RTD and Thermocouple Error Calculations

When you use a 1756-IRT8I, 1756-IRT8IK, 1756-IR12, 1756-IR12K, 1756-IT16, or 1756-IT16 K module in temperature mode, error calculations are achieved by a two-step process.

1. Calculate the error in ohms or volts.
2. Convert the ohm/volt error to temperature for the specific sensor and at the correct application temperature.

RTD Error

RTD error on a 1756-IRT8I, 1756-IRT8IK, 1756-IR12, or 1756-IR12K module that is used with an RTD input is defined in ohms. The error is calculated across the entire input range selected, not the available range of a sensor used with the module. For example, if the 1...500 Ω input range is used, the module error is calculated across 510 Ω (actual range = 0...510 Ω).

The error in ohms translates to temperature, but that translation varies because the relationship is non-linear. The most effective way to check the module error is to calculate the error in ohms and use that value in a linearization table to check the temperature error.

If the module is calibrated at operating temperature and the operating temperature remains relatively stable, calibration accuracy is better than 0.05% of the full range. This 0.05% value is a worst case value. In other words, with the 1...500 Ω input range that is selected, the worst case module error is 0.255 Ω.

Finally, you must check an RTD linearization table to determine how the temperature error of 0.255 Ω translates.

For example, if the module has a 0.05% (or 0.255 Ω) error and is at a temperature of 0 °C (32 °F), the temperature error is ±0.65 °C (±1.17 °F) when the Platinum 385 sensor type is used. This same error at a temperature of 200 °C (392 °F) translates to a temperature error of ±0.69 °C (±1.26 °F).

Thermocouple Error

Thermocouple error on a 1756-IRT8I, 1756-IRT8IK, 1756-IT16, or 1756-IT16K module at 25 °C (77 °F) indicates the module's accuracy in measuring temperature. This accuracy varies depending on these factors:

- Input range = -100...100 mV.
- Thermocouple sensor type, any of the following:
  - Type B
  - Type C
  - Type D
  - Type E
  - Type J (1756-IT16, 1756IT16K default value)
  - Type K (1756-IRT8I, 1756-IRT8IK default value)
  - Type N
  - Type R
  - Type S
  - Type T
  - Type TXK/XK (L)
- Application temperature, that is, the temperature of the physical location where the thermocouple is being used.

EXAMPLE When a 1756-IRT8I or 1756-IT16 module is used with a thermocouple input type in the following conditions, module error at 25 °C (77 °F) is ±3.74 °C (38.73 °F):

- Connected to a type S thermocouple
- Application temperature of 1200 °C (2192 °F)

In other words, the difference between the temperature the module reports and the actual application temperature can be ±3.74 °C (38.73 °F).

The module can report an application temperature of 1200 °C (2192 °F) in this case when the actual temperature can be in the range from 1196.26...1203.74 °C (2185.268...2198.732 °F).

These calculations used a typical error of 0.02% of full scale range.

Module Error at 25 °C (77 °F)

Table 6 lists the 1756-IRT8I, 1756-IRT8IK module error at 25 °C (77 °F) when using a thermocouple input type.

Table 6 - 1756-IRT8I, 1756-IRT8IK Module Error At 25 °C (77 °F) with Thermocouple Input Type(1)

Application Temperature	Module Error (+/-) at 25 °C (77 °F) When Connected to Thermocouple Types										
	Type B	Type C	Type D	Type TXK/ XK(L)	Type R	Type S	Type E	Type J	Type K	Type N	Type T
-200 °C (-328 °F)	–	–	–	1.65 °C	–	–	1.79 °C	2.06 °C	2.95 °C	4.53 °C	2.86 °C
0 °C (32 °F)	–	3.46 °C	4.59 °C	0.93 °C	8.51 °C	8.33 °C	0.77 °C	0.89 °C	1.14 °C	1.72 °C	1.16 °C
200 °C (392 °F)	–	2.65 °C	2.83 °C	0.71 °C	5.09 °C	5.32 °C	0.61 °C	0.81 °C	1.13 °C	1.36 °C	0.85 °C
400 °C (752 °F)	11.08 °C	2.37 °C	2.36 °C	0.62 °C	4.34 °C	4.70 °C	0.56 °C	0.82 °C	1.07 °C	1.21 °C	0.73 °C
600 °C (1112 °F)	7.56 °C	2.37 °C	2.22 °C	0.56 °C	3.96 °C	4.41 °C	0.56 °C	0.77 °C	1.06 °C	1.16 °C	–
800 °C (1472 °F)	5.89 °C	2.37 °C	2.20 °C	0.51 °C	3.65 °C	4.14 °C	0.57 °C	0.70 °C	1.10 °C	1.15 °C	–
1000 °C (1832 °F)	4.93 °C	2.37 °C	2.25 °C	–	3.40 °C	3.90 °C	0.60 °C	0.76 °C	1.15 °C	1.17 °C	–
1200 °C (2192 °F)	4.35 °C	2.65 °C	2.36 °C	–	3.23 °C	3.74 °C	–	0.79 °C	1.23 °C	1.21 °C	–
1400 °C (2552 °F)	3.99 °C	2.81 °C	2.47 °C	–	3.18 °C	3.71 °C	–	–	1.33 °C	–	–
1600 °C (2912 °F)	3.85 °C	3.00 °C	2.63 °C	–	3.24 °C	3.80 °C	–	–	–	–	–
1800 °C (3272 °F)	3.92 °C	3.46 °C	2.85 °C	–	3.67 °C	4.36 °C	–	–	–	–	–
2000 °C (3632 °F)	–	3.75 °C	3.19 °C	–	–	–	–	–	–	–	–
2200 °C (3992 °F)	–	4.09 °C	3.95 °C	–	–	–	–	–	–	–	–

(1) This table represents +/-.02% typical error while the maximum stated error is +/- 0.05%.

Table 7 lists the 1756-IT16, 1756-IT16K module error at 25 °C (77 °F) when using a thermocouple input type.

Table 7 - 1756-IT16, 1756-IT16K Module Error At 25 °C (77 °F) with Thermocouple Input Type(1)

Application Temperature	Module Error (+/-) at 25 °C (77 °F) When Connected to Thermocouple Types										
	Type B	Type C	Type D	Type TXK/ XK(L)	Type R	Type S	Type E	Type J	Type K	Type N	Type T
-200 °C (-328 °F)	–	–	–	3.30 °C	–	–	3.58 °C	4.12 °C	5.90 °C	9.06 °C	5.72 °C
0 °C (32 °F)	–	6.92 °C	9.18 °C	1.86 °C	17.02 °C	16.66 °C	1.54 °C	1.78 °C	2.28 °C	3.44 °C	2.32 °C
200 °C (392 °F)	–	5.30 °C	5.66 °C	1.42 °C	10.18 °C	10.64 °C	1.22 °C	1.62 °C	2.26 °C	2.72 °C	1.70 °C
400 °C (752 °F)	22.16 °C	4.74 °C	4.72 °C	1.24 °C	8.68 °C	9.40 °C	1.12 °C	1.64 °C	2.14 °C	2.42 °C	1.46 °C
600 °C (1112 °F)	15.12 °C	4.74 °C	4.44 °C	1.12 °C	7.92 °C	8.82 °C	1.12 °C	1.54 °C	2.12 °C	2.32 °C	–
800 °C (1472 °F)	11.78 °C	4.74 °C	4.40 °C	1.02 °C	7.30 °C	8.28 °C	1.14 °C	1.40 °C	2.20 °C	2.30 °C	–
1000 °C (1832 °F)	9.86 °C	4.74 °C	4.50 °C	–	6.80 °C	7.80 °C	1.20 °C	1.52 °C	2.30 °C	2.34 °C	–
1200 °C (2192 °F)	8.70 °C	5.30 °C	4.72 °C	–	6.46 °C	7.48 °C	–	1.58 °C	2.46 °C	2.42 °C	–
1400 °C (2552 °F)	7.98 °C	5.62 °C	4.94 °C	–	6.36 °C	7.42 °C	–	–	2.66 °C	–	–
1600 °C (2912 °F)	7.70 °C	6.00 °C	5.26 °C	–	6.48 °C	7.60 °C	–	–	–	–	–
1800 °C (3272 °F)	7.84 °C	6.92 °C	5.70 °C	–	7.34 °C	8.72 °C	–	–	–	–	–
2000 °C (3632 °F)	–	7.50 °C	6.38 °C	–	–	–	–	–	–	–	–
2200 °C (3992 °F)	–	8.18 °C	7.90 °C	–	–	–	–	–	–	–	–

(1) This table represents +/-.04% typical error while the maximum stated error is +/- 0.10%.

IMPORTANT When calculating total measurement error, module error at 25 °C (77 °F) is only one factor in deriving the total measurement error budget.

Other factors that impact thermocouple measurement error include the following:

- Thermocouple sensor accuracy/error
- Conditions of thermocouple wire, such as wire length
- Cold junction compensation values

Thermocouple Resolution

Thermocouple resolution indicates the degrees that an application temperature must change before the 1756-IRT8I, 1756-IRT8IK module that is connected to a thermocouple module reports a change. Resolution depends on the following factors:

- Thermocouple sensor type, any of the following:
  - Type B
  - Type C
  - Type D
  - Type E
  - Type J
  - Type J (1756-IT16, 1756-IT16K default value)
  - Type K (1756-IRT8I, 1756-IRT8IK default value)
  - Type R
  - Type S
  - Type T
  - Type TXK/XK (L)
- Application temperature, that is, the temperature of the physical location where the thermocouple is being used.

EXAMPLE For example, when a 1756-IRT8I module is used with a thermocouple input type in the following conditions, module resolution is 0.01 °:

- Input channel is connected to a type K thermocouple
- Application temperature is 400 °C (752 °F)

In other words, the application temperature must change by 0.01 ° or greater for the 1756-IRT8I module that is used with a thermocouple input to record a change. If the temperature stays in a range from 399.991...400.009 °C (751.984...752.016 °F), the module continues to report an application temperature of 400 °C (752 °F).

Table 8 lists the 1756-IRT8I, 1756-IRT8IK module resolution when using a thermocouple input type.

Table 8 - 1756-IRT8I, 1756-IRT8IK Module Resolution in Degrees C with Thermocouple Input Type

Application Temperature	Module Resolution (in degrees C) When Connected to This Thermocouple Type										
	Type B	Type C	Type D	Type TXK/XK(L)	Type R	Type S	Type E	Type J	Type K	Type N	Type T
-200 °C (-328 °F)				+/- 0.02 °C			+/- 0.02 °C	+/- 0.02 °C	+/- 0.03 °C	+/- 0.04 °C	+/- 0.03 °C
0 °C (32 °F)		+/- 0.03 °C	+/- 0.05 °C	+/- 0.01 °C	+/- 0.08 °C	+/- 0.08 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.02 °C	+/- 0.01 °C
200 °C (392 °F)		+/- 0.03 °C	+/- 0.03 °C	+/- 0.01 °C	+/- 0.05 °C	+/- 0.05 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C
400 °C (752 °F)	+/- 0.11 °C	+/- 0.02 °C	+/- 0.02 °C	+/- 0.01 °C	+/- 0.04 °C	+/- 0.05 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C
600 °C (1112 °F)	+/- 0.07 °C	+/- 0.02 °C	+/- 0.02 °C	+/- 0.01 °C	+/- 0.04 °C	+/- 0.04 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	
800 °C (1472 °F)	+/- 0.06 °C	+/- 0.02 °C	+/- 0.02 °C	+/- 0.01 °C	+/- 0.04 °C	+/- 0.04 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	
1000 °C (1832 °F)	+/- 0.05 °C	+/- 0.02 °C	+/- 0.02 °C		+/- 0.03 °C	+/- 0.04 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	
1200 °C (2192 °F)	+/- 0.04 °C	+/- 0.03 °C	+/- 0.02 °C		+/- 0.03 °C	+/- 0.04 °C		+/- 0.01 °C	+/- 0.01 °C	+/- 0.01 °C	
1400 °C (2552 °F)	+/- 0.04 °C	+/- 0.03 °C	+/- 0.02 °C		+/- 0.03 °C	+/- 0.04 °C			+/- 0.01 °C		
1600 °C (2912 °F)	+/- 0.04 °C	+/- 0.03 °C	+/- 0.03 °C		+/- 0.03 °C	+/- 0.04 °C					
1800 °C (3272 °F)	+/- 0.04 °C	+/- 0.03 °C	+/- 0.03 °C		+/- 0.04 °C	+/- 0.04 °C					
2000 °C (3632 °F)		+/- 0.04 °C	+/- 0.03 °C								
2200 °C (3992 °F)		+/- 0.04 °C	+/- 0.04 °C								

1756-IF8I, 1756-IF8IK Isolated Analog Input Module

The 1756-IF8I, 1756-IF8IK module has eight isolated channels. Each channel supports connection to the following input types:

- Current
- Voltage

The module provides 24-bit resolution and uses differential inputs. Differential inputs have a greater resistance to the effects of electromagnetic noise and provide improved flexibility regarding cable length when wiring your module.

Module Features

The 1756-IF8I, 1756-IF8IK module has the following features:

- Internal Loop Power Source
- Multiple Input Ranges
- Notch Filter
- Underrange/Overrange Detection
- Digital Filter
- Process Alarms
- Rate Alarm
- Sensor Offset
- Wire Off Detection
- Synchronized Sampling

IMPORTANT Most of the features are software configurable. For more information on how to configure the module, see Chapter 6, Configure ControlLogix Analog I/O Modules on page 99.

Internal Loop Power Source

The module offers a software user-configurable selection for an internal loop power source on each channel. You must use the Current input type and enable Source Loop Current to use an internal power source on the channel.

The source is current limited to ~45 mA and lets the module power a two-wire transmitter directly without the need for an external power supply.

A sourcing overcurrent condition typically occurs due to a short between terminals on the module. With this module, the short is between terminals IN_*x*/I/SRC and RTN_*x* (where *x* is the channel number).

If a sourcing overcurrent condition exists, the 1756-IF8I module sets the input to 24 mA, that is, the equivalent engineering unit value. This value indicates a special error condition beyond the normal overrange value, that is, 21 mA:

- For one second, the overcurrent condition self-corrects if the condition trigger is removed.
- After one second, the condition latches, the channel disables Source Loop Current and continues to send 24 mA with an Overrange indication.

  The following are examples of events that unlatch the condition:

  - Power is cycled to the module.
  - The module is reset.
  - The controller connection to the module is inhibited and then uninhibited.
  - New configuration is sent from the controller.

The transmitter varies the current to the analog input in proportion to the process variable being measured. The inclusion of an internal onboard loop power source saves you the expense of extra power supplies and greatly simplifies the interface wiring to field devices. Each channel on the module provides independent, isolated, current-limited power to its current transmitter.

In addition to supplying loop power to two-wire transmitters, the module can also accommodate current transmitters that are powered by an external supply. The module accommodates two-wire and four-wire transmitters when configured for Current input type and Source Loop Current is disabled.

Power Calculations

The 24V backplane current requirements of the module increase when it operates with a Current input type and Source Loop Current mode enabled.

The module uses the power provided across the ControlLogix® chassis backplane as the source for loop power. Because of the demands that are placed on that supply, take special care when calculating the power requirements for modules in the same chassis as a 1756-IF8I, 1756-IF8IK module.

For example, when used with the 1756-L75 controller and operating in the Sourcing Loop Current mode, you can place only six 1756-IF8I, 1756-IF8IK modules in the chassis before exceeding the wattage capacity of the power supply.

For backplane power specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.

Other Devices in the Wiring Loop

The voltage source on each channel can drive loop impedance of up to approximately 1300 Ω. This lets you include other devices, such as chart recorders and meters, in the current loop.

For more information on wiring the module, see page 76.

Multiple Input Ranges

The module offers multiple input ranges that are dictated by channel configuration choices. The input type selection determines the available ranges.

Input Type	Input Range
Current (mA)	0...20 mA
Voltage (V)	Any of the following: • -10...10V • 0...5V • 0...10V

To see where to select the input range, see page 103.

Notch Filter

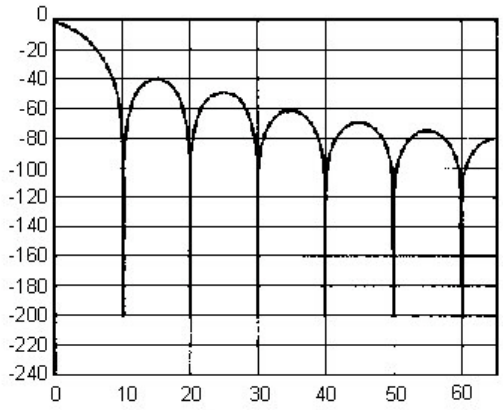
The Notch Filter is a built-in feature of the Analog-to-Digital convertor (ADC) that removes line noise in your application for **each channel**. The removal of line noise is also known as noise immunity.

The Notch Filter attenuates the input signal at the specified frequency. That is, the filter reduces the amplitude of the signal with minimal signal distortion.

Choose a Notch Filter based on what noise frequencies are present in the operating environment for the module and any sampling requirements needed for control. The default Notch Filter setting is 60 Hz.

For example, a Notch Filter is typically set to 60 Hz to filter out 60 Hz AC line noise and its overtones. A 60 Hz Notch Filter setting attenuates frequencies of 60 Hz, 120 Hz, 180 Hz, and so forth.

The following graphic shows 10 Hz Notch Filter selection and how the noise is dissipated over the entire spectrum but especially at the Notch Filter setting and its overtones.



Relationship between Noise Rejection Level and RPI Setting

The 1756-IF8I, 1756-IF8IK module offers two levels of line noise rejection. Each level has a filter associated with it. The module automatically determines which filter is used based on the Notch Filter setting and RPI rate.

A trade-off exists between sampling speed and level of noise rejection:

- The faster sampling speed, ranging from 1 / Notch Filter to 3 / Notch Filter, the less noise rejection. In this case, the module automatically uses a SINC^1 filter.

  The SINC^1 filter offers 34 dB noise rejection at the Notch Filter frequency and its overtones.
- The slower sampling rate, > 3 / Notch Filter, the better noise rejection. In this case, the module automatically uses a SINC^3 filter.

  The SINC^3 filter offers 100 dB noise rejection at the Notch Filter frequency and its overtones.

Notch Filter Setting

The following table lists the available Notch Filter settings, the minimum RPI rate available with that Notch Filter setting, and the corresponding noise response.

1756-IF8I, 1756-IF8IK Notch Filter Settings and the Minimum RPI Rate

Notch Filter Setting	5 Hz	10 Hz	15 Hz	20 Hz	50 Hz	60 Hz (Default)	100 Hz	500 Hz	1000 Hz	5000 Hz
Minimum Sample Time (RPI) - SINC^1 Filter[1]	207.0 ms	103.5 ms	69.1 ms	51.8 ms	20.7 ms	17.3 ms	10.4 ms	2.1 ms	1.1 ms	1.0 ms
Minimum Sample Time (RPI) - SINC^3 Filter[1]	621.0 ms	310.5 ms	207.1 ms	153.4 ms	62.1 ms	51.9 ms	31.2 ms	6.1 ms	3.1 ms	1.0 ms
0...100% Step Response Time[2][3]	600 ms + 1RPI	300 ms + 1RPI	200 ms + 1RPI	150 ms + 1RPI	60 ms + 1RPI	50 ms + 1RPI	30 ms + 1RPI	6 ms + 1 RPI	3 ms + 1RPI[4]	1 ms + 1RPI[4]
-3 dB Frequency[2]	1.3 Hz	2.7 Hz	4.3 Hz	5.1 Hz	13 Hz	15 Hz	26 Hz	128 Hz	258 Hz	1296 Hz
Typical Effective Resolution[2]	21 bits	20 bits	20 bits	20 bits	20 bits	20 bits	19 bits	18 bits	18 bits	17 bits

(1) The minimum RPI value for the module depends on the channel with the lowest Notch Filter setting. For example, if three of the channels on a module use a Notch Filter setting of 20 Hz and one channel uses a Notch Filter setting of 60 Hz, you cannot set the module RPI lower than 50.1 ms.
(2) Using the SINC^3 filter.
(3) Worst case settling time to 100% of step change includes 0...100% step response time plus one RPI sample time.
(4) Value represents module performance in Current mode. For the value when the module is used in Voltage mode, include additional 3 ms settling time due to RC time constant of 7500 Ω voltage input resistor.

For example, if your application requires a Notch Filter setting of 50 Hz, the module's minimum RPI rate is 20.7 ms. In this case, sampling speed is more important than noise rejection. The module automatically uses a SINC^1 filter.

If your application requires a Notch Filter setting of 50 Hz and the greater level of noise rejection provided by a SINC^3 filter, the minimum RPI rate is 62.1 ms. The module automatically uses a SINC^3 filter.

The RPI must be > 1/Notch Filter plus some small scan time for the ADC to sample properly. The SINC^3 filter takes three times as long and thus requires RPI > 3/Notch plus some small scan time. The module rejects combinations which violate that relationship. Table 9 lists the available Notch Filter settings and the RPI values for the two types of filters.

Table 9 - 1756-IF8I, 1756-IF8IK Notch Filter Settings and the RPI Values

Notch Filter	Fastest RPI for a SINC^1 Filter	Fastest RPI for a SINC^3 Filter
5 Hz	207.0 ms	621.0 ms
10 Hz	103.5 ms	310.5 ms
15 Hz	69.1 ms	207.1 ms
20 Hz	51.8 ms	153.4 ms
50 Hz	20.7 ms	62.1 ms
60 Hz (default)	17.3 ms	51.9 ms
100 Hz	10.4 ms	31.2 ms
500 Hz	2.1 ms	6.1 ms
1000 Hz	1.1 ms	3.1 ms
5000 Hz	1.0 ms	1.0 ms

For more information on Notch Filter settings, see page 103.

Underrange/Overrange Detection

This feature detects when the isolated input module is operating beyond limits set by the input range. For example, if you are using the module in the 0...10V input range and the module voltage increases to 11V, the overrange feature detects this condition.

The following table lists the input ranges of the module and the lowest/highest signal available in each range before the module detects an underrange/overrange condition.

Input Type	Range	Underrange Threshold	Overrange Threshold
Current (mA)	0...20 mA	≤ 3.6 mA(1) (2)	≥ 21.00 mA(3)
Voltage (V)	±10.00V	≤ -10.50	≥10.50
	0...10V	≤ 0.00V	≥10.50
	0...5V	≤ 0.00V	≥ 5.25V

(1) Underrange is set at 3.6 mA, but the *I:Ch[x].Data* tag reports values as low as 0.0 mA.
(2) When used with a Current input type, the module has an inherent deadband. Once latched, an Underrange condition continues until the signal is greater than 3.8 mA.
(3) When used with a Current input type, the module has an inherent deadband. Once latched, an Overrange condition continues until the signal is less than 20.75 mA.

IMPORTANT Be aware that the Disable All Alarms feature does not disable the underrange/overrange detection feature. The Disable All Alarms feature disables all alarms on the module.

The underrange/overrange detection feature is not an alarm. It is an indicator that channel data has gone beyond the absolute maximum or minimum, respectively, for the channel's chosen range but does not trigger an alarm.

To disable the underrange/overrange detection feature, you must disable the channel.

To see where to set the Underrange/Overrange detection values, see page 109.

Digital Filter

The digital filter smooths input data noise transients on **each input channel**. This value specifies the time constant for a digital, first-order lag filter on the input. It is specified in units of milliseconds. A value of 0 (zero) disables the filter.

The digital filter equation is a classic, first order lag equation.

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + TA} X_n - Y_{n-1}$$

Y_n = Present output, filtered peak voltage (PV)

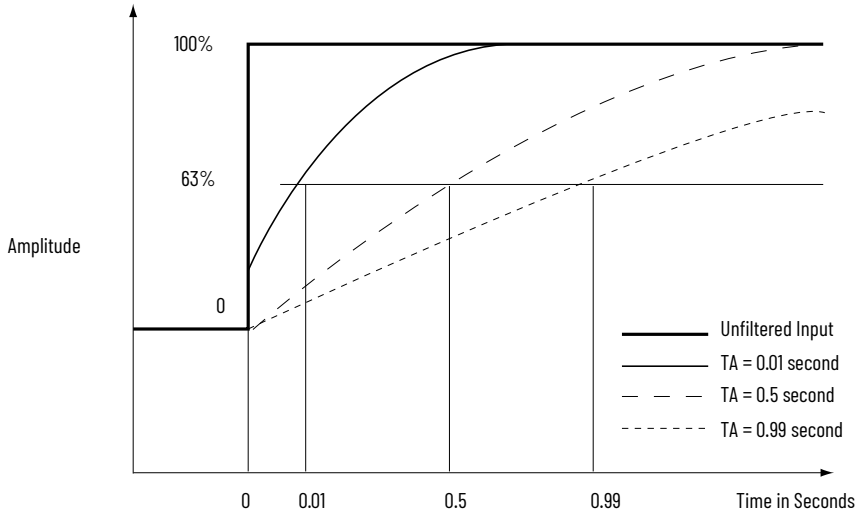
Y_{n-1} = Previous output, filtered PV

Δt = Module channel update time (seconds)

TA = Digital filter time constant (seconds)

X_n = Present input, unfiltered PV

As shown in the following graphic, by using a step input change to illustrate the filter response, you see that 63.2% of the total response is reached when the digital filter time constant elapses. Each additional time constant achieves 63.2% of the remaining response.



To see where to set the Digital Filter, see page 103.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. The limits are set at four, user-configurable, alarm trigger points:

- High high
- High
- Low
- Low low

You can enable or disable Process Alarms individually via the Output tags for each channel. When a module is added to your Logix Designer application project and tags are created, the Alarms are disabled by default.

Each individual Process Alarm enable tag, that is, *O.Ch[x].LLAlarmEn, O.Ch[x].LAlarmEn, O.Ch[x].HAlarmEn and O.Ch[x].HHAlarmEn,* is disabled when the module is created. You must enable the tags in the Output Data to allow the individual alarm to trigger.

If a Process Alarm's enable bit is not set, the corresponding Input Process Alarm never triggers. To see where to set the Process Alarms, see page 109.

You can latch process alarms. The alarm remains on, even if the condition that causes it to occur disappears, until the alarm is unlatched.

IMPORTANT You must manually unlatch the alarm. You can unlatch the alarm, by using one of the following methods:

- While the project is online, click the Alarm Configuration tab on the Module. Then click Unlatch to unlatch a specific alarm or Unlatch All to unlatch all alarms.
- Change the module output tag for the alarm that you want to unlatch. For example, the *Ch[x].LLAlarmUnlatch* tag to unlatch a Low Low Alarm.

For more information on module tags, see Appendix A, Analog I/O Module Tag Definitions on page 157.

- Use a CIP Generic message.

For more information how to use a CIP Generic message, see Rockwell Automation Knowledgebase article #63046, How to Reset Latched Status of an Analog Module. You can access the article at:

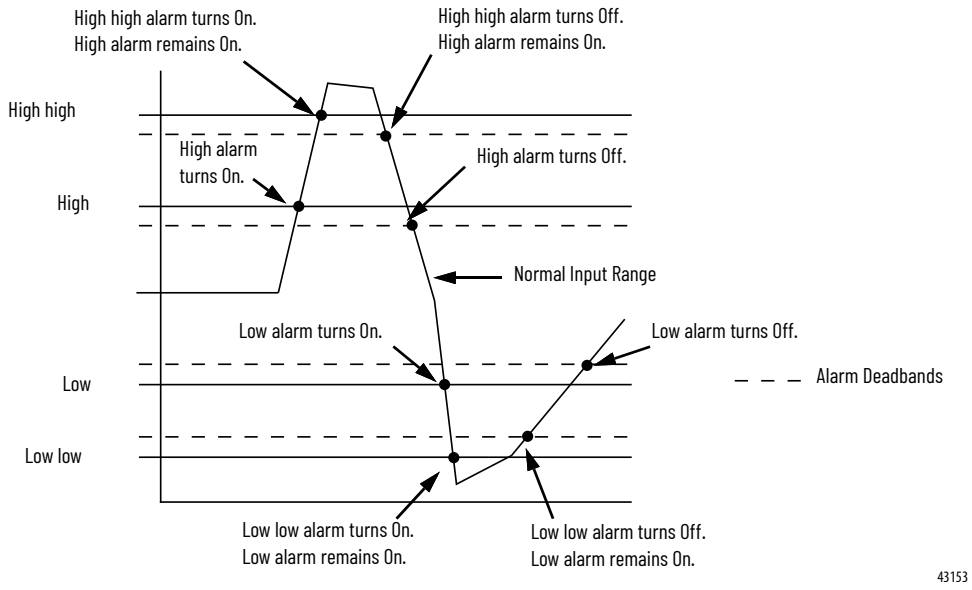
https://rockwellautomation.custhelp.com/

Alarm Deadband

You can configure an alarm deadband to work with these alarms. The deadband lets the process alarm status bit remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm. If the Alarm Deadband is mixed with Alarm Latching, an Unlatch command while the Alarm is within the Deadband causes the Alarm to be cleared.

Figure 4 shows the input data that sets each of the four alarms at some point during module operation. In this example, latching is disabled; therefore, each alarm turns Off when the condition that caused it to set ceases to exist.

Figure 4 - Alarm Deadband Alarm Settings



To see where to set the Alarm Deadband, see page 109.

Rate Alarm

The rate alarm triggers if the rate of change between input samples for **each channel** exceeds the specified trigger point for that channel. The actual rate of change for the last sample is returned in the *Ch[x].RateOfChange* input tag of each channel.

EXAMPLE If scaling mA to mA, if you configure a channel's rate alarm to 1.0 mA/s, the rate alarm triggers only if the difference between measured input samples changes at a rate > 1.0 mA/s.

Consider the following conditions:

- The module's RPI is 100 ms, that is, new data is sampled every 100 ms.
- At **input sample 1**, the channel measures 5.0 mA.
- At **input sample 2**, (100 ms later) the channel measures 5.08 mA.

At this sample instance, the **rate alarm is not triggered** because the rate of change is less than 1.0 mA/s.

The rate of change is 0.8 mA/s [(5.08 mA - 5.0 mA) / (100 ms)].

- At **input sample 3** (100 ms later) the channel measures 4.9 mA.

At this sample instance, the **rate alarm is triggered** because the rate of change is greater than 1.0 mA/s.

The rate of change is 1.8 mA/s. [(4.9 mA - 5.08 mA) / (100 ms)].

At this sample instance, the absolute value of this result is > 1.0 mA/s, so the rate alarm sets. Absolute value is used because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

To see where to set the Rate Alarm, see page 109.

Sensor Offset

The sensor offset compensates for any known error on the sensor or channel to which the sensor is connected. The value is set in signal units and is added to the data value.

For example, if the sensor has an error such that the channel consistently reports current signal values by 0.2 mA lower than the actual value, you set this parameter to 1.25% in channel configuration if using the default scaling of 4...20 mA = 0...100%.

You set this value via the module output tags. That is, tag *O.Ch[x].SensorOffset*. Where x represents the module channel.

In the example above, the *O.Ch[x]SensorOffset* tag = 1.25.

Wire Off Detection

The module alerts you when a wire is disconnected from a channel or the RTB is removed from the module. The following events occur when a wire off condition exists:

- Module Operating in **Voltage Mode**
  - Input data for that channel changes to a specific scaled value corresponding to the Overrange value.
  - The Overrange bit is set in the *I:Ch[x].Overrange* tag.
- Module Operating in **Current Mode**
  - Input data for that channel changes to a specific scaled value corresponding to the Underrange value.
  - The Underrange bit is set in the *I:Ch[x].Underrange* tag.
- A fault bit is set in the owner-controller that can indicate the presence of a wire off condition.

IMPORTANT Be aware that the Disable All Alarms feature, does not disable the wire off detection feature. The Disable All Alarms feature disables all alarms on the module.

The wire off detection feature is not an alarm. It is an indicator that a wire has been disconnected from the channel but does not trigger an alarm.

To disable the wire off detection feature, you must disable the channel.

Because the module can be used in voltage or current applications, differences exist as to how a wire off condition is detected in voltage or current applications.

1756-IF8I, 1756-IF8IK Module - Wire Off Conditions in Different Applications

Application Configuration	Wire Off Condition Cause	Resulting Module Behavior
Voltage Applications	Either of the following: • A wire is disconnected from the module. • The RTB is disconnected from the module.	• Input data for that channel changes to the scaled value associated with the **overrange** signal value of the selected operational range. • The *I.Ch[x].Overrange* (x=channel number) tag is set to 1.
Current Applications		• Input data for that channel changes to the scaled value associated with the **underrange** signal value of the selected operational range. • The *I.Ch[x].Underrange* (x=channel number) tag is set to 1.

Synchronized Sampling

This feature lets you synchronize input sampling across inputs on multiple modules, forcing those inputs to sample simultaneously within approximately 20 µS of each other. The modules do not need to be in the same chassis, if the system clocks are synchronized via CIP Sync.

IMPORTANT Synchronized Sampling is not limited to input samples across inputs of the same module type.

You can use Synchronized Sampling across inputs on 1756-IF8I modules and 1756-IRT8I modules in the same system.

For example, if you have 12 input devices that are connected to one 1756-IF8I, 1756-IF8IK module and two 1756-IRT8I modules in the same chassis, or different chassis that are synchronized to the same CIP Sync Time Master, use Synchronized Sampling to take a snapshot of the input data available at each input at a moment in time.

For the example, you cannot have 12 devices connected a single input module. Either lower the count to <= 8, or make it two input modules.

The following conditions must exist to use this feature:

- A 1588 CIP Sync Time Master is configured for the chassis.
- All modules in the set use the same RPI value or values that are multiples of each other.
- Synchronized Sampling with Other Synchronized Modules is enabled for all input channels in the set.

  For these input modules, configuring one channel for Synchronized Sampling synchronizes all eight channels.

While setting the RPI to the same value on all 1756-IF8I, 1756-IF8IK modules makes sure that each module samples at the same rate, it does not guarantee that they sample at the same time. When enabled, Synchronized Sampling provides each module a synchronized starting point for its respective input scans. Because the RPI values are the same, the inputs on the modules are sampled at the same rate and the same time. To see where to enable Synchronized Sampling, see page 103.

1756-IF8I, 1756-IF8IK Diagrams

Figure 5 - 1756-IF8I, 1756-IF8IK Module Block Diagram

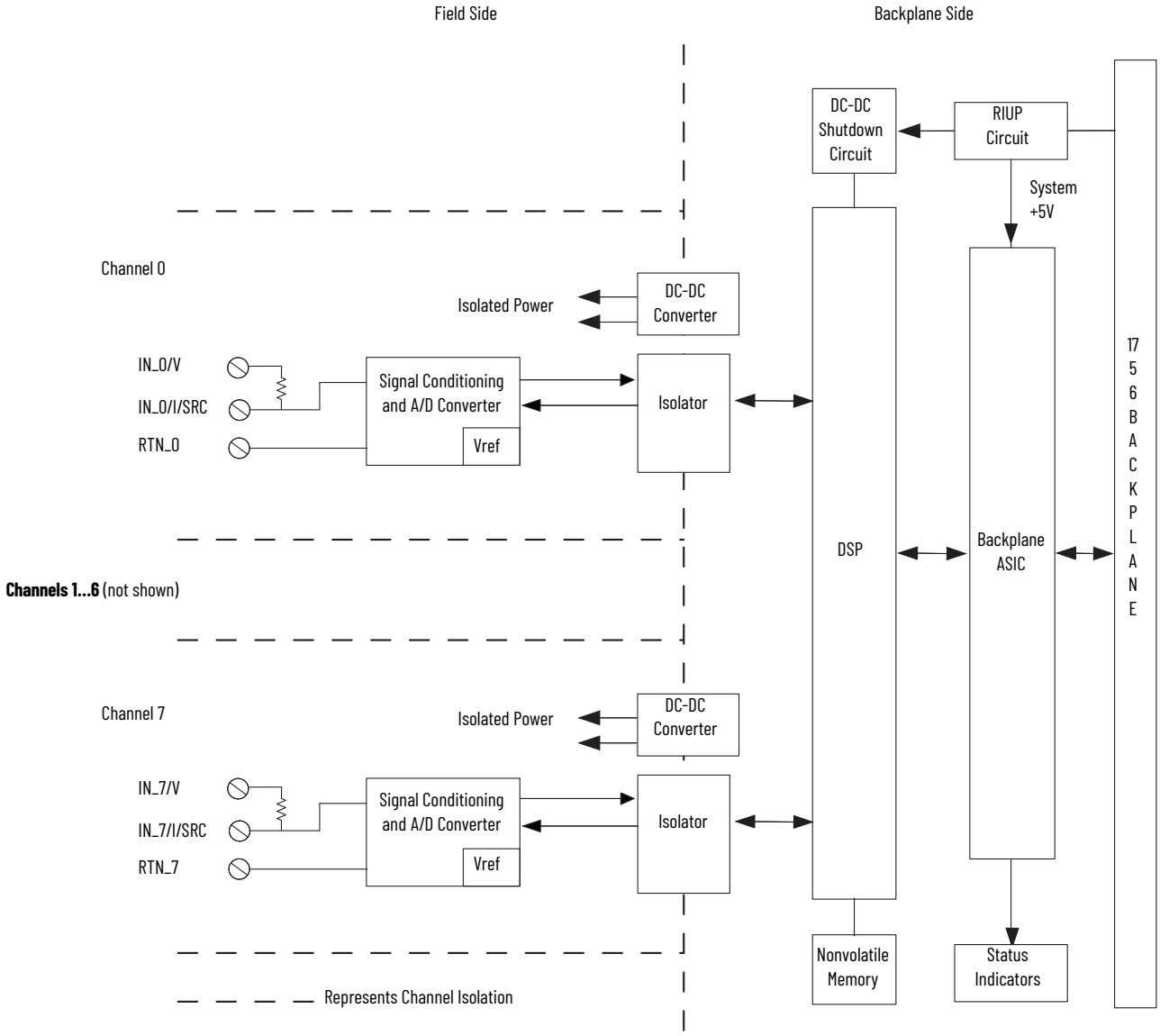


Figure 6 - 1756-IF8I, 1756-IF8IK Module Field-side Circuit with Voltage Input

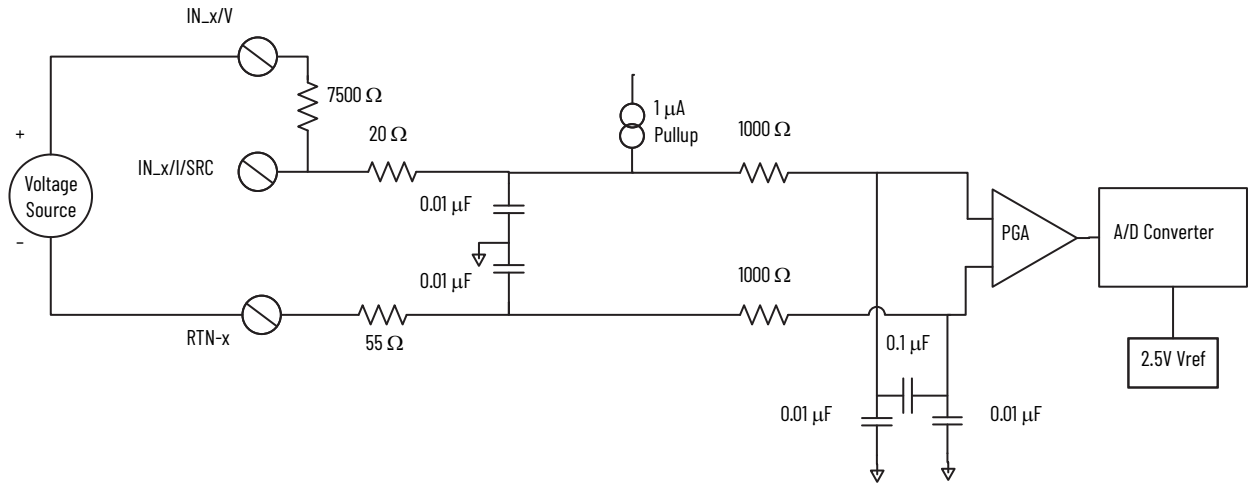


Figure 7 - 1756-IF8I, 1756-IF8IK Input Module Field-side Circuit with an Externally-powered Current Input Loop

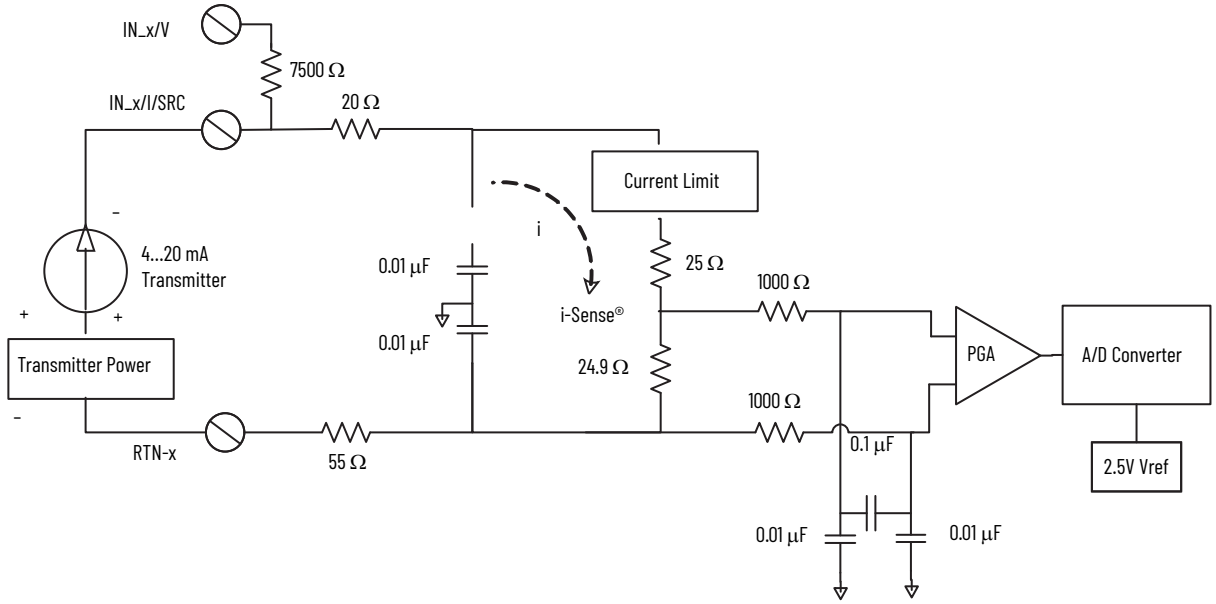


Figure 8 - 1756-IF8I, 1756-IF8I Module Field-side Circuit with the Module Sourcing the Current Input Loop

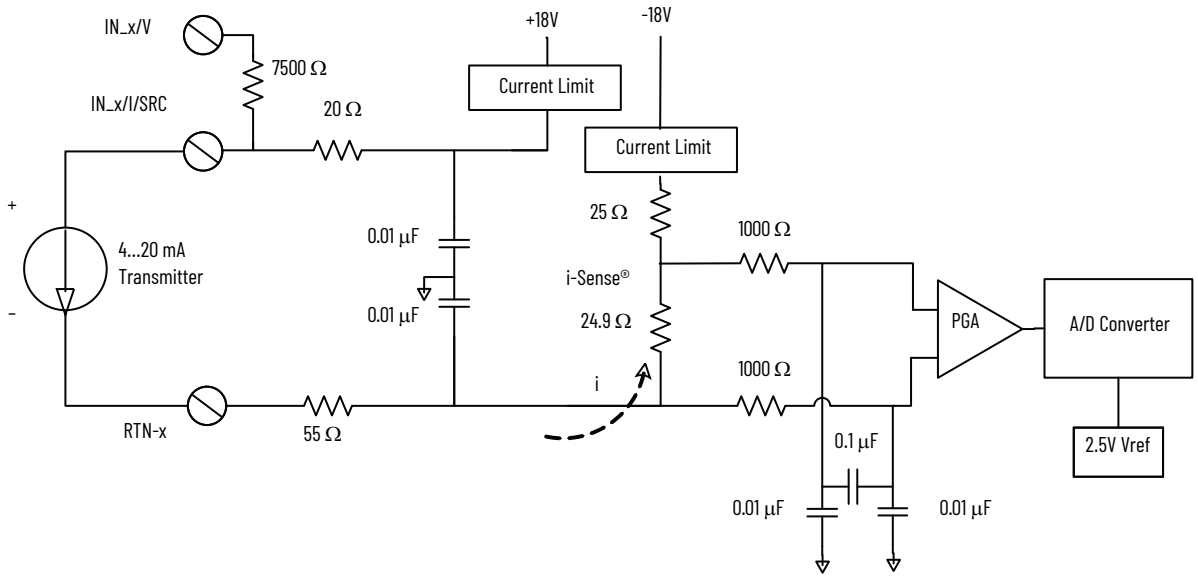


Figure 9 - 1756-IF8I, 1756-IF8IK Module Wiring Diagram -Current Mode with External Loop Power

IMPORTANT In this wiring diagram, an external, user-provided power supply provides 24V DC loop power.

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Place additional loop devices, for example, strip chart recorders, at either 'A' location in the current loop.

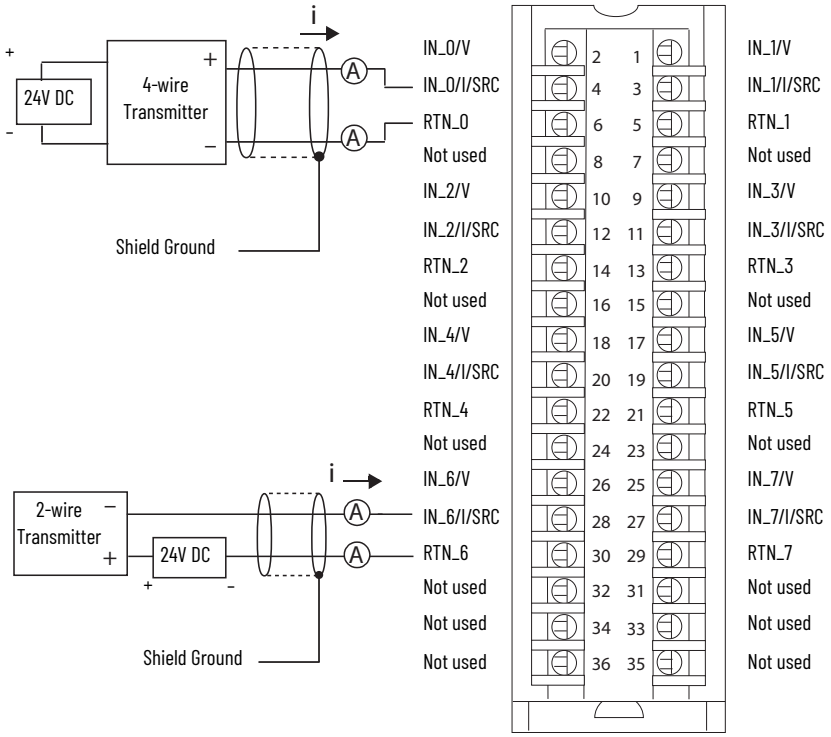


Figure 10 - 1756-IF8I, 1756-IF8IK Module Wiring Diagram -Current Mode with Internal Loop Power

IMPORTANT In this wiring diagram, the module provides 24V DC loop power.

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Place additional loop devices, for example, strip chart recorders, at either 'A' location in the current loop.

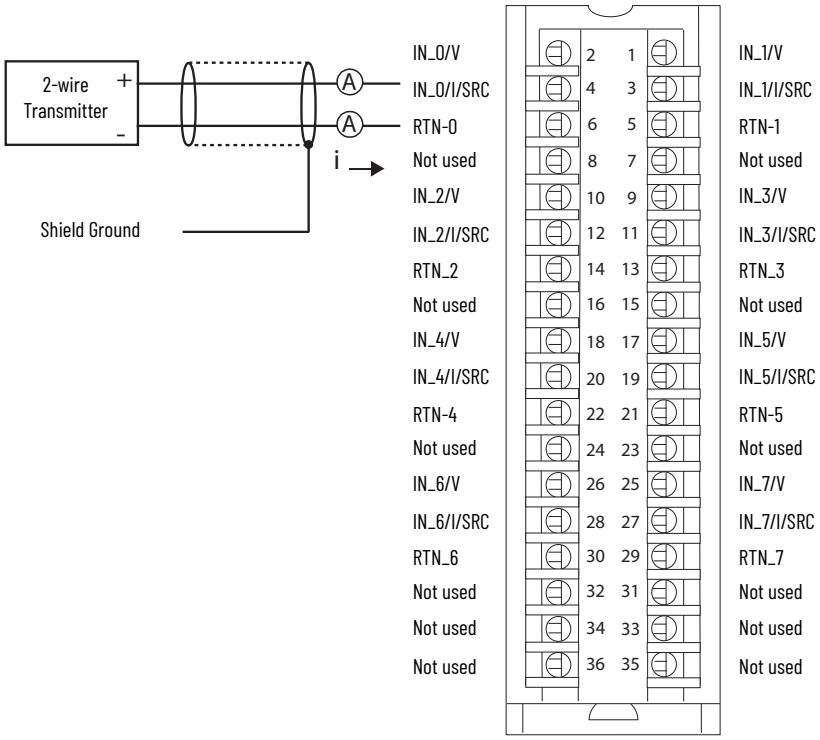
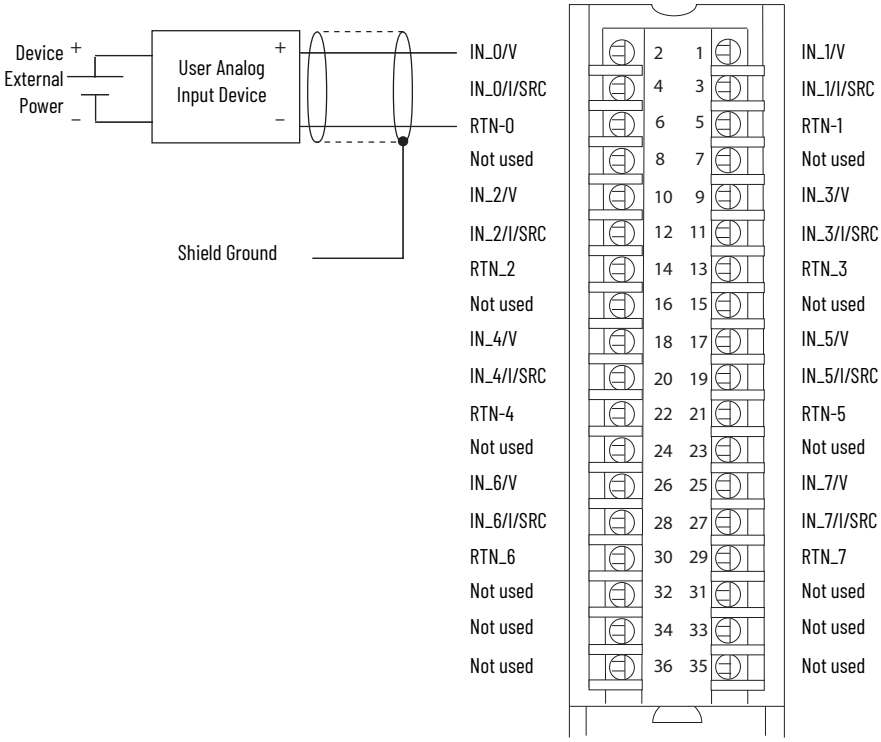


Figure 11 - 1756-IF8I, 1756-IF8IK Module Wiring Diagram - Voltage Mode

IMPORTANT: If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.



Fault and Status Reporting

The 1756-IF8I, 1756-IF8IK module multicasts fault and status data with channel data to the owner and listening controllers. The data is returned via module tags that you can monitor in your Logix Designer application.

With some exceptions, as noted in the following table, the module provides the fault and data status in a channel-centric format.

The following table lists the fault and status tags for the module available in the Logix Designer application.

Data Type	Tag Name	Triggering Event That Sets Tag
Fault	Fault(1)	The owner-controller loses its connection to the module.
	Ch[x].Fault	The channel data quality is bad.
	Ch[x].Underrange	The channel data is beneath the absolute minimum for this channel.
	Ch[x].Overrange	The channel data is above the absolute maximum for this channel.
Status	CIPSyncValid(1)	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.
	CIPSyncTimeout(1)	Indicates whether a valid time master on the backplane has timed out.
	CIPSyncOffsetJump(1)	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred.
	Ch[x].Uncertain	The channel data can be imperfect.
	Ch[x].LLAlarm	The *I.Ch[x].Data* tag value is less than the *C.Ch[x].LLAlarmLimit* tag value, the *O.Ch[x].LLAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].LAlarm	The *I.Ch[x].Data* tag value is less than the *C.Ch[x].LAlarmLimit* tag value, the *O.Ch[x].LAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].HAlarm	The *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HAlarmLimit* tag value, the *O.Ch[x].HAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].HHAlarm	The *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HHAlarmLimit* tag value, the *O.Ch[x].HHAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].RateAlarm	The absolute change between consecutive channel samples exceeds the *C.Ch[x].RateAlarmLimit* tag value. This alarm only applies to enabled Process alarms.
	Ch[x].CalibrationFault	Channel is not calibrated or the last attempted Calibration for this channel failed.
	Ch[x].Calibrating	The channel is currently being calibrated.
	Ch[x].CalGoodLowRef	A valid Low Reference signal has been sampled on this channel.
	Ch[x].CalBadLowRef	An invalid Low Reference signal has been sampled on this channel.
	Ch[x].CalGoodHighRef	An valid High Reference signal has been sampled on this channel.
	Ch[x].CalBadHighRef	An invalid High Reference signal has been sampled on this channel.
	Ch[x].CalSuccessful	Calibration on this channel is complete and the Calibrating state has been exited.
	Ch[x].RateOfChange	The change in channel data since last sample in Engineering Units/Second.
	Ch[x].Data	The channel data in scaled Engineering Units.
	Timestamp(1)	A 64-bit Timestamp that indicates when all eight channels were last sampled in terms of CIP Sync time.
	RollingTimestamp(1)	16-bit timestamp that 'rolls' from 0...32,767 ms. Compatible with existing PID instruction to automatically calculate sample deltas.

(1) This tag provides module-wide data and affects all channels simultaneously.

Notes:

Temperature-sensing Analog Modules

Module	Description
1756-IRT8I, 1756-IRT8IK	The module has eight isolated channels. Each channel supports connection to the following input types: • RTD, both 3-wire and 4-wire • Thermocouple mV devices The module provides 24-bit data resolution. Additional features are described in this chapter. The 1756-IRT8IK catalog number has conformal coating.
1756-IR12, 1756-IR12K	The module has 12 non-isolated channels. Each channel supports 3-wire RTD connections. The module provides 24-bit data resolution. Additional features are described in this chapter. The 1756-IR12K catalog number has conformal coating.
1756-IT16, 1756-IT16K	The module has 16 non-isolated channels. Each channel supports connection to thermocouple mV devices. The module provides 24-bit data resolution. Additional features are described in this chapter. The 1756-IT16K catalog number has conformal coating.

Common Module Features

The modules have the following features:

Feature	1756-IRT8I, 1756-IRT8IK	1756-IR12, 1756-IR12K	1756-IT16, 1756-IT16K
Module Input Ranges	X	X	
Notch Filter	X	X	X
Underrange/Overrange Detection	X	X	X
Digital Filter	X	X	X
Process Alarms	X		
Rate Alarm	X		
Sensor Offset	X	X	X
10 Ohm Copper Offset	X	X	
Wire Off Detection	X	X	X
Temperature Units	X	X	X
Sensor Types	X	X	X
1756-IRT8I, 1756-IRT8IK Thermocouple Wire Length Compensation	X		
Synchronized Sampling	X		
Cold Junction Compensation	X		X

IMPORTANT Most of the features are software configurable. For more information on how to configure the module, see Chapter 6, Configure ControlLogix Analog I/O Modules on page 99.

Module Input Ranges

The modules offer multiple input ranges. The input type and sensor type selections determine the available ranges.

The following table describes the modules' input ranges in relation to the sensor type. If a single range is listed in the Input Range column, the programming application automatically selects the range used with the previously listed sensor type.

Table 10 - Module - Channel Input Ranges

Module	Input Type	Sensor Type	Input Range
1756-IRT8I, 1756-IRT8IK, and 1756-IR12, 1756-IR12K	RTD	Ohm	One of the following: • 0...500 Ω • 0...1000 Ω • 0...2000 Ω • 0...4000 Ω
		100 Ω PT 385	0...500 Ω
		200 Ω PT 385	0...1000 Ω
		500 Ω PT 385	0...2000 Ω
		1000 Ω PT 385	0...4000 Ω
		100 Ω PT 3916	0...500 Ω
		200 Ω PT 3916	0...1000 Ω
		500 Ω PT 3916	0...2000 Ω
		1000 Ω PT 3916	0...4000 Ω
		10 Ω CU 427	0...500 Ω
		120 Ω NI 672	0...500 Ω
		100 Ω NI 618	0...500 Ω
		120 Ω NI 618	0...500 Ω
		200 Ω NI 618	0...1000 Ω
		500 Ω NI 618	0...2000 Ω
1756-IRT8I, 1756-IRT8IK and 1756-IT16, 1756-IT16K	Thermocouple	mV	-100...100 mV
		TC Type B	
		TC Type C	
		TC Type E	
		TC Type J	
		TC Type K	
		TC Type N	
		TC Type R	
		TC Type S	
		TC Type T	
		TC Type TXK/XK(L)	
		TC Type D	

To see where to select the input range, see page 103.

Notch Filter

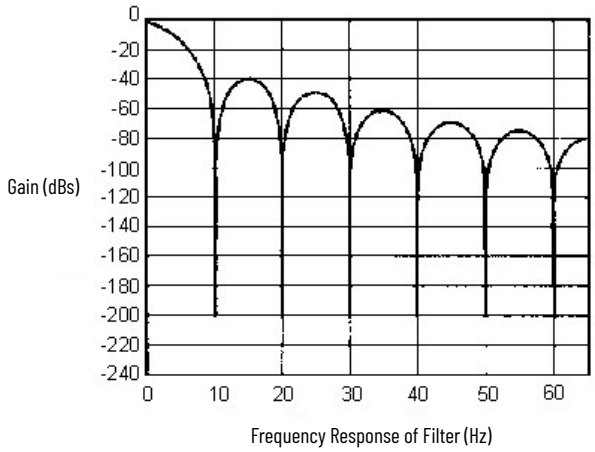
The Notch Filter is a built-in feature of the Analog-to-Digital convertor (ADC) that removes line noise in your application for **each channel**. The removal of line noise is also known as noise immunity.

The Notch Filter attenuates the input signal at the specified frequency. That is, the filter reduces the amplitude of the signal with minimal signal distortion.

Choose a Notch Filter based on what noise frequencies are present in the module's operating environment and any sampling requirements needed for control. The default Notch Filter setting is 60 Hz.

For example, a Notch Filter is typically set to 60 Hz to filter out 60 Hz AC line noise and its overtones. A 60 Hz Notch Filter setting attenuates frequencies of 60 Hz, 120 Hz, 180 Hz and so forth.

The following graphic shows 10 Hz Notch Filter selection and how the noise is dissipated over the entire spectrum but especially at the Notch Filter setting and its overtones.



Relationship between Noise Rejection Level and RPI Setting

The modules offer two levels of line noise rejection. Each level has a filter associated with it. The module automatically determines which filter is used based on the Notch Filter setting and RPI rate.

A trade-off exists between sampling speed and level of noise rejection:

- The faster the sampling speed, the less noise rejection. In this case, the 1756-IRT8I, 1756-IRT8IK module automatically uses a SINC^1 filter. The 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K modules use a Sinc^5+Sinc^1 filter combination.

  This filtering option offers 34 dB noise rejection at the Notch Filter frequency and its overtones.
- At slower sampling rates (RPI > 3/Notch), the module has better noise rejection. In this case, the module automatically uses a SINC^3 filter.

  The SINC^3 filter offers 100 dB noise rejection at the Notch Filter frequency and its overtones.

1756-IRT8I, 1756-IRT8IK Notch Filter Settings

The following tables lists the available Notch Filter settings.

Table 11 - 1756-IRT8I, 1756-IRT8IK Notch Filter Settings

Notch Setting	5 Hz	10 Hz	15 Hz	20 Hz	50 Hz	60 Hz (Default)	100 Hz	500 Hz	1000 Hz	5000 Hz
Minimum Sample Time (RPI) - SINC^1 Filter[1]	207.0 ms	103.5 ms	69.1 ms	51.8 ms	20.7 ms	17.3 ms	10.4 ms	2.1 ms	1.1 ms	1.0 ms
Minimum Sample Time (RPI) - SINC^3 Filter[1]	621.0 ms	310.5 ms	207.1 ms	153.4 ms	62.1 ms	51.9 ms	31.2 ms	6.1 ms	3.1 ms	1.0 ms
0...100% Step Response Time[2][3]	600 ms + 1RPI	300 ms + 1RPI	200 ms + 1RPI	150 ms + 1RPI	60 ms + 1RPI	50 ms + 1RPI	30 ms + 1RPI	6 ms + 1 RPI	3 ms + 1RPI	1 ms + 1RPI
-3 dB Frequency[2]	1.3 Hz	2.7 Hz	4.3 Hz	5.1 Hz	13 Hz	15 Hz	26 Hz	128 Hz	258 Hz	1296 Hz
Typical Effective Resolution[2][4]	19 bits	18 bits	18 bits	18 bits	17 bits	17 bits	17 bits	16 bits	15 bits	14 bits

(1) The minimum RPI value for the module depends on the channel with the lowest Notch Filter setting. For example, if three of the channels on a module use a Notch Filter setting of 20 Hz and one channel uses a Notch Filter setting of 60 Hz, you cannot set the module RPI lower than 50.1 ms.
(2) Using the SINC^3 filter.
(3) Worst case settling time to 100% of step change includes 0...100% step response time plus one RPI sample time.z
(4) Measured in ±100 mV range.

If your application requires a Notch Filter setting of 50 Hz, the module's minimum RPI rate is 20.7 ms. In this case, sampling speed is more important than noise rejection. The module automatically uses a SINC^1 filter.

If your application requires a Notch Filter setting of 50 Hz and the greater level of noise rejection provided by a SINC^3 filter, the minimum RPI rate is 62.1 ms. The module automatically uses a SINC^3 filter.

The RPI must be > 1/Notch Filter plus some small scan time for the ADC to sample properly. The SINC^3 filter takes three times as long and thus requires RPI > 3/Notch plus some small scan time. The module rejects combinations which violate that relationship.

Table 12 - 1756-IRT8I, 1756-IRT8IK Notch Filter Settings and the RPI Values

Notch Filter	Fastest Available RPI	Fastest RPI for a SINC^3 Filter
5 Hz	207.0 ms	621.0 ms
10 Hz	103.5 ms	310.5 ms
15 Hz	69.1 ms	207.1 ms
20 Hz	51.8 ms	153.4 ms
50 Hz	20.7 ms	62.1 ms
60 Hz (default)	17.3 ms	51.9 ms
100 Hz	10.4 ms	31.2 ms
500 Hz	2.1 ms	6.1 ms
1000 Hz	1.1 ms	3.1 ms
5000 Hz	1.0 ms	1.0 ms

To see where to set the Notch Filter, see page 104.

1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K Notch Filter Settings

The following tables lists the available Notch Filter settings.

Table 13 - 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K Notch Filter Settings

Notch Setting	20 Hz	50 Hz	60 Hz (Default)	100 Hz	500 Hz	1000 Hz	5000 Hz
Minimum Sample Time (RPI) - SINC^1 Filter[1]	200.4 ms	80.4 ms	67.1 ms	50.0 ms	50.0 ms	50.0 ms	50.0 ms
Minimum Sample Time (RPI) - SINC^3 Filter[1]	600.4 ms	240.4 ms	200.4 ms	120.4 ms	50.0 ms	50.0 ms	50.0 ms
0...100% Step Response Time[2][3]	600 ms + 1RPI	240 ms + 1RPI	200 ms + 1RPI	120 ms + 1RPI	6 ms + 1 RPI	3 ms + 1RPI	1 ms + 1RPI
-3 dB Frequency[2]	5.1 Hz	13 Hz	15 Hz	26 Hz	128 Hz	258 Hz	1296 Hz
Typical Effective Resolution[2][4]	18 bits	17 bits	17 bits	17 bits	16 bits	15 bits	14 bits

(1) The notch filter setting is set on a module basis.
(2) Using the SINC^3 filter.
(3) Worst case settling time to 100% of step change includes 0...100% step response time plus one RPI sample time.
(4) The 1756-IR12, 1756-IR12K setting is measured in 0...5000 Ω range. The 1756-IT16, 1756-IT16K setting is measured in ±100 mV range.

If your application requires a Notch Filter setting of 50 Hz, the module's minimum RPI rate is 80.4 ms. In this case, sampling speed is more important than noise rejection. The module automatically uses a SINC^1 filter.

If your application requires a Notch Filter setting of 50 Hz and the greater level of noise rejection provided by a SINC^3 filter, the minimum RPI rate is 240.4 ms. The module automatically uses a SINC^3 filter.

The RPI must be > 4/Notch Filter plus some small scan time for the ADC to sample properly. The SINC^3 filter takes three times as long and thus requires RPI > 12/Notch plus some small scan time. The module rejects combinations which violate that relationship.

Notch Filter	Fastest Available RPI	Fastest RPI for a SINC^3 Filter
20 Hz	200.4 ms	600.4 ms
50 Hz	80.4 ms	240.4 ms
60 Hz (default)	67.1 ms	200.4 ms
100 Hz	50.0 ms	120.4 ms
500 Hz	50.0 ms	50.0 ms
1000 Hz	50.0 ms	50.0 ms
5000 Hz	50.0 ms	50.0 ms

To see where to set the Notch Filter, see page 104.

Underrange/Overrange Detection

This feature detects when a temperature-measuring input module is operating beyond limits set by the input range. For example, if you are using the module in the 0...1000 Ω input range and the module resistance increases to 1050 Ω, the overrange detection detects this condition.

The table lists the input ranges of non-isolated input modules and the lowest/highest signal available in each range before the module detects an underrange/overrange condition.

Table 14 - Low and High Signal Limits on Temperature-measuring Input Modules

Input Type	Available Range	Underrange Threshold	Overrange Threshold
RTD	0...500 Ω	≤ 0.00 Ω	510.00 Ω
	0...1000 Ω	≤ 0.00 Ω	1020.00 Ω
	0...2000 Ω	≤ 0.00 Ω	2040.00 Ω
	0...4000 Ω	≤ 0.00 Ω	4080.00 Ω
Thermocouple	-100...100 mV	- 101.00 mV	101.00 mV

IMPORTANT Be aware that the Disable All Alarms feature, does not disable the underrange/overrange detection feature. The Disable All Alarms feature disables all alarms on the module.

The underrange/overrange detection feature is not an alarm. It is an indicator that channel data has gone beyond the absolute maximum or minimum, respectively, for the channel's chosen range but does not trigger an alarm.

To disable the underrange/overrange detection feature, you must disable the channel.

To see where to set the Underrange/Overrange detection values, see page 109.

Digital Filter

The digital filter smooths input data noise transients on each input channel. This value specifies the time constant for a digital first order lag filter on the input. It is specified in units of milliseconds. A value of 0 disables the filter.

The digital filter equation is a classic first order lag equation.

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + TA} X_n - Y_{n-1}$$

Y_n = Present output, filtered peak voltage (PV)

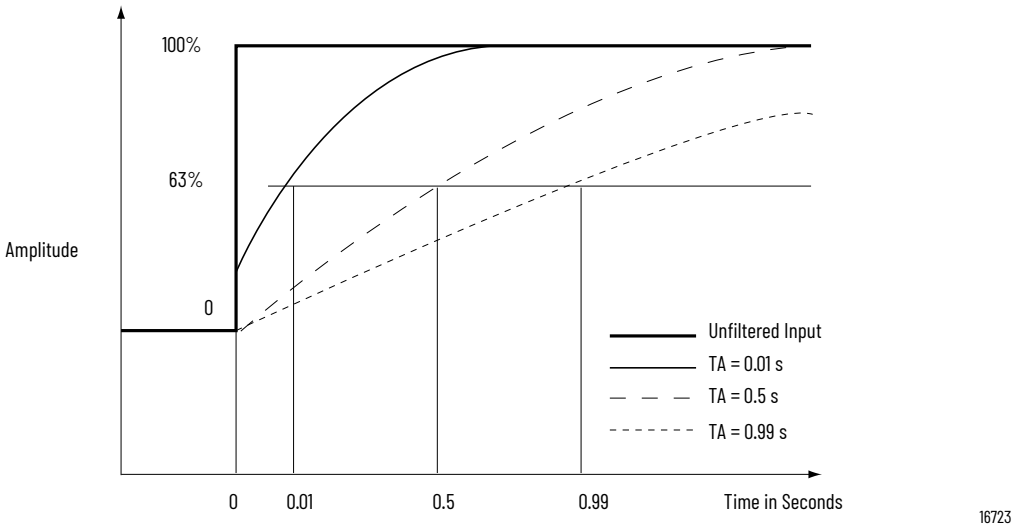
Y_{n-1} = Previous output, filtered PV

Δt = Module channel update time (seconds)

TA = Digital filter time constant (seconds)

X_n = Present input, unfiltered PV

By using a step input change to illustrate the filter response, you can see that when the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.



To see where to set the Digital Filter, see page 103.

Process Alarms

The 1756-IRT8I, 1756-IRT8IK supports process alarms. Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. These are set at four, user-configurable, alarm trigger points:

- High high
- High
- Low
- Low low

You can enable or disable Process Alarms individually via the Output tags for each channel. When a module is added to your Logix Designer application project and tags are created, the Alarms are disabled by default.

Each individual Process Alarm enable tag, that is, *O.Ch[x].LLAlarmEn, O.Ch[x].LAlarmEn, O.Ch[x].HAlarmEn and O.Ch[x].HHAlarmEn*, is disabled when the module is created. You must enable the tags in the Output Data to allow the individual alarm to trigger.

If an enable bit of a Process Alarm is not set, the corresponding Input Process Alarm never triggers. To see where to set the Process Alarms, see page 109.

You can latch process alarms. The alarm remains on, even if the condition causing it to occur disappears, until the alarm is unlatched.

IMPORTANT You must manually unlatch the alarm. You can unlatch the alarm, by using one of the following methods:

- While the project is online, click the Alarm Configuration tab on the Module. Then click Unlatch to unlatch a specific alarm or Unlatch All to unlatch all alarms.
- Change the module output tag for the alarm that you want to unlatch. For example, the *Ch[x].LLAlarmUnlatch* tag to unlatch a Low Low Alarm.

For more information on module tags, see Appendix A, Analog I/O Module Tag Definitions on page 157.

- Use a CIP Generic message.

For more information how to use a CIP Generic message, see Rockwell Automation Knowledgebase article #63046, How to Reset Latched Status of an Analog Module. You can access the article at:

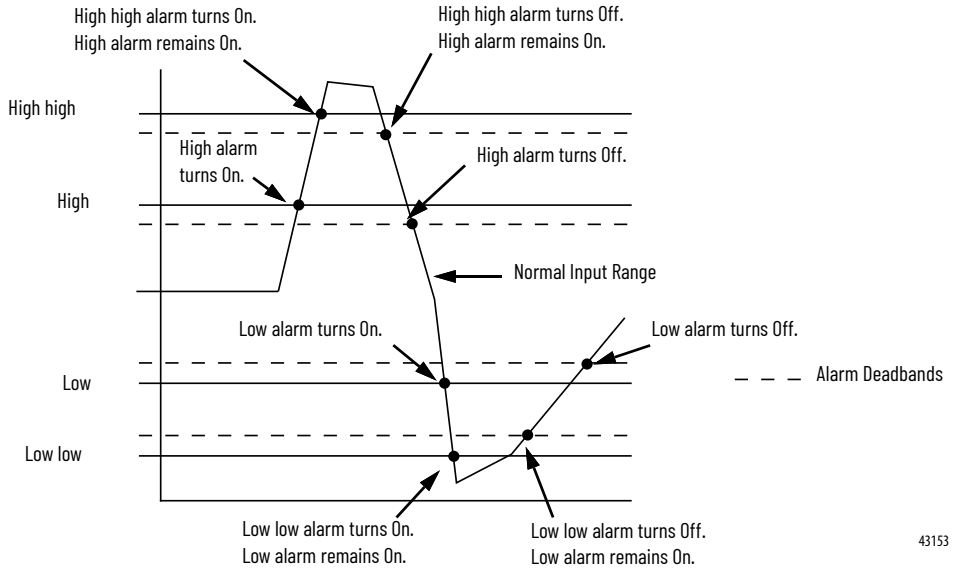
https://rockwellautomation.custhelp.com/

Alarm Deadband

You can configure an alarm deadband to work with these alarms. The deadband lets the process alarm status bit remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm. If the Alarm Deadband is mixed with Alarm Latching, an Unlatch command while the Alarm is within the Deadband causes the Alarm to be cleared.

Figure 12 shows input data that sets each of the four alarms at some point during module operation. In this example, latching is disabled; therefore, each alarm turns Off when the condition that caused it to set ceases to exist.

Figure 12 - Alarm Deadband Alarm Settings



To see where to set the Alarm Deadband, see page 109.

Rate Alarm

The rate alarm triggers if the rate of change between input samples for **each channel** exceeds the specified trigger point for that channel. The actual rate of change for the last sample is returned in the *Ch[x].RateOfChange* input tag of each channel.

EXAMPLE In normal scaling in Celsius, if you configure a channel's rate alarm to 100.1 °C/s, the rate alarm triggers only if the difference between measured input samples changes at a rate > 100.1 °C/s.

Consider the following conditions:

- The module's RPI is 100 ms, that is, new data is sampled every 100 ms.
- At **input sample #1**, the channel measures 355 °C.
- At **input sample #2**, (100 ms later) the channel measures 363 °C.

At this sample instance, the **rate alarm is not triggered** because the rate of change is less than 100.1 °C/s.

The rate of change is 80 °C/s [(363 °C- 355 °C) / (100 ms)].

- At **input sample #3** (100 ms later) the channel measures 350.3 °C.

At this sample instance, the **rate alarm is triggered** because the rate of change is greater than 100.1 °C.

The rate of change is 127 °C. [(350.3 °C - 363 °C) / (100 ms)].

At this sample instance, the absolute value of this result is > 100.1 °C, so the rate alarm sets. Absolute value is used because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

To see where to set the Rate Alarm, see page 109.

Sensor Offset

The sensor offset value compensates for any known error on the sensor or channel to which the sensor is connected. The value is set in engineering units.

You set this value via the module output tags. That is, tag *O.Ch[x].SensorOffset*, where x represents the module channel.

10 Ohm Copper Offset

With this feature, you can compensate for a small offset error in a 10 ohm copper RTD. The channel must be connected to the 10 Ohm CU 427 Sensor Type to use this feature. The offset value is indicated in units of 0.01 Ohms.

You can set the 10 Ohm copper offset in either of the following ways:

- On the Configuration tab of the Module Properties dialog box. In this case, valid values are from -0.99...0.99.
- Directly in the channel's *C.Ch[x].TenOhmOffset* tag. In this case, valid values are -99...99

For example, if the resistance of a copper RTD used with a channel is 9.74 Ω at 25 °C, you account for error by setting the 10 Ohm Copper Offset field on the Configuration tab to -0.26 or by setting the *C.Ch[x].TenOhmOffset* to -26.

To see where to set the 10 Ohm Copper Offset on the Configuration tab, see page 103.

Wire Off Detection

The module alerts you when one or more wires have been disconnected from a channel.

When a wire off condition occurs, the following events occur:

- Input data for the channel changes to a specific scaled value.
- A fault bit is set in the owner-controller indicating the presence of a wire off condition.

For more information on module behavior when a wire off condition occurs, see Table 15 on page 63.

IMPORTANT Be aware that the Disable All Alarms feature, does not disable the wire off detection feature. The Disable All Alarms feature disables all alarms on the module.

The wire off detection feature is not an alarm. It is an indicator that a wire has been disconnected from the channel but does not trigger an alarm.

To disable the wire off detection feature, you must disable the channel.

Because these modules can each be used in various applications, differences exist when a wire off condition is detected in each application. The table lists the differences that occur when a wire off condition occurs in various applications.

Table 15 - Module Wire Off Conditions

Application Configuration	Wire Off Condition Cause	Resulting Module Behavior
Input Type = RTD Sensor Type = Temperature or Ohm	When using a **3-wire RTD** device and any of the following exists: • One wire is disconnected from any of the channel's terminals. • Wires are disconnected from any combination of terminals: 1756-IRT8I, 1756-IRT8IK – IN_*x*(+)/A – IN_*x*(-)/B – IN_*x*/RTD C 1756-IR12, 1756-IR12K – IN_*x*/A – IN_*x*/B – RTN_*x*/C • All of the wires are disconnected from the channel. With the 3-wire RTD device, the wire off condition is **detected within two seconds** of wires getting disconnected.	The following occurs: • Input data for the channel changes to the highest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.
	When using a **4-wire RTD** device and any of the following exists: • A wire is disconnected from only terminal IN_*x*(-)/B. • Wires are disconnected from any combination of the channel's terminals, that is: – IN_*x*(+)/A – IN_*x*(-)/B – IN_*x*/RTD C – IN_*x*/RTD D **IMPORTANT**: There is one combination exception that does not apply. A wire off condition is not detected when wires are simultaneously disconnected from only IN_*x*/RTD C and IN_*x*/RTD D terminals. • All wires are disconnected from the module. With the 4-wire RTD device, the wire off condition is **detected within five seconds** of wires getting disconnected.	If bullet 1, the following occurs: • Input data for the channel changes to the lowest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Underrange* tag is set to 1. *x* represents the channel number. If bullets 2 or 3, the following occurs: • Input data for the channel changes to the highest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.
Input Type = Thermocouple Sensor Type = Temperature	A wire is disconnected from the module. With the Thermocouple input type, the wire off condition is **detected within two seconds** of wires getting disconnected. When a Wire Off condition is detected from the ADC, it is delayed by ~1 second to ensure it is a real condition. During that delay, the Uncertain bit is set for the channel, but the Data is not forced to a rail until the second has passed and the Wire Off has been continuously maintained.	• Input data for the channel changes to the highest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.
Input Type = Thermocouple Sensor Type = mV		• Input data for the channel changes to the scaled value associated with the overrange signal value. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.

Temperature Units

You can use the following temperature units with your module:

- Celsius
- Kelvin
- Fahrenheit
- Rankine

Each channel is individually configurable for its temperature units.

To see where to set the Temperature Units, see page 103.

Sensor Types

This module supports multiple sensor types with the available selections dictated by the input type configuration.

Table 16 - Available Sensor Types

Input Type	Available Sensor Types
RTD	100 Ω PT 385 200 Ω PT 385 500 Ω PT 385 1000 Ω PT 385 100 Ω PT 3916 200 Ω PT 3916 500 Ω PT 3916 1000 Ω PT 3916 10 Ω CU 427 120 Ω NI 672 100 Ω NI 618 120 Ω NI 618 200 Ω NI 618 500 Ω NI 618
Thermocouple	B, C, D, E, J, K, N, R, S, T, TXK/XK (L)

To see where to set the Sensor Type, see page 103.

Sensor Type Temperature Limits

Determine sensor type temperature limits by your choice of Input Type, Sensor Type, and Temperature Units.

IMPORTANT For the 1756-IRT8I, 1756-IRT8IK module, the **Scaling parameters are automatically set** on the Configuration tab of the Module Properties dialog box. The Scaling parameters **cannot be changed** in the software when configured for a Sensor Type that returns Temperature.

The Low Signal value equals the Low Engineering value. The High Signal value equals the High Engineering value.

For example, you can configure a channel with the following parameters:

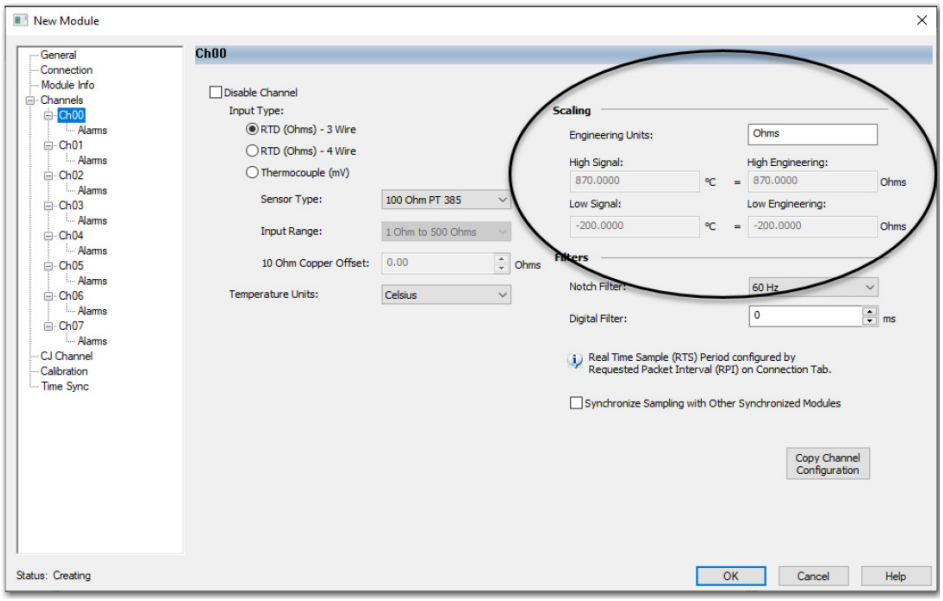
- Input Type = RTD (Ohms)
- Sensor Type = 100 Ohm Pt 385
- Temperature Units = Celsius

For the 1756-IRT8I, 1756-IRT8IK module, the Scaling parameters are set as follows:

- Low Signal = -200.0000 °C

  Low Engineering = -200.0000
- High Signal = 870.0000 °C

  High Engineering = 870.0000



The following table lists temperature range limits on the module.

Table 17 - Temperature Limits for RTD and Thermocouple Sensor Types

Input Type	Sensor Type	Temperature Range Limits
RTD (Ohms) - 3-wire or 4-wire	100 Ohm PT 385 200 Ohm PT 385 500 Ohm PT 385 1000 Ohm PT 385	-200...870 °C (-328...1598 °F) 73...1143 °K 132...2058 °R
	100 Ohm PT 3916 200 Ohm PT 3916 500 Ohm PT 3916 1000 Ohm PT 3916	-200...630 °C (-328...1166 °F) 73...903 °K 132...1626 °R
	10 Ohm CU 247	-200...260 °C (-328...500 °F) 73...533 °K 132...960 °R
	120 Ohm NI 672	-80...320 °C (-112...608 °F) 193...593 °K 348...1068 °R
	100 Ohm NI 618 120 Ohm NI 618 200 Ohm NI 618 500 Ohm NI 618	-60...250 °C (-76...482 °F) 213...523 °K 384...942 °R

Table 17 - Temperature Limits for RTD and Thermocouple Sensor Types (Continued)

Input Type	Sensor Type	Temperature Range Limits
Thermocouple (mV)	TC Type B	21...1820 °C (68...3308 °F) 293...2093 °K 528...3768 °R
	TC Type C	0...2320 °C (32...4208 °F) 273...2593 °K 492...4668 °R
	TC Type D	0...2320 °C (32...4208 °F) 273...2593 °K 492...4668 °R
	TC Type E	-270...1000 °C (-454...1832 °F) 3...1273 °K 6...2292 °R
	TC Type J	-210...1200 °C (-346...2192 °F) 63...1473 °K 114...2652 °R
	TC Type K	-270...1372 °C (-454...2502 °F) 3...1645 °K 6...2961 °R
	TC Type N	-270...1300 °C (-454...2372 °F) 3...1573 °K 6...2832 °R
	TC Type R	-50...1768 °C (-58...3215 °F) 223...2041 °K 402...3674 °R
	TC Type S	-50...1768 °C (-58...3215 °F) 223...2041 °K 402...3674 °R
	TC Type T	-270...400 °C (-454...752 °F) 3...673 °K 6...1212 °R
	TC Type TXK/XK (L)	-200...800 °C (-328...1472 °F) 73...1073 °K 132...1932 °R

1756-IRT8I, 1756-IRT8IK Thermocouple Wire Length Compensation

Wires that connect a thermocouple to the module have an intrinsic resistance that can negatively impact the accuracy of the module. The wire length and gauge are directly related to resistance level and, by extension, to impact on the module accuracy. The longer the wire length, the greater the resistance, the greater the possible negative impact on module accuracy.

To avoid increased module error resulting from increased resistance levels, the module can automatically compensate for resistance levels and maintain its accuracy. The module measures the wire resistance and actively compensates for that resistance with each sample.

IMPORTANT This functionality works when thermocouple wiring is connected to the module before the module is powered or power is cycled to the module.

Connect wiring to the module before applying or cycling module power.

You can disable compensation by removing the wiring prior to a power cycle and reconnecting the wiring later.

Synchronized Sampling

This feature lets you synchronize input sampling across inputs on multiple modules in the same chassis, or same system if time is synchronized via CIP Sync, forcing those inputs to sample simultaneously within approximately 20 µS of each other.

IMPORTANT Synchronized Sampling is not limited to input sample across inputs on the same module types.

You can use Synchronized Sampling across inputs on isolated analog input modules and temperature-sensing analog modules in the same system.

For example, if you have 12 input devices connected to two temperature-sensing analog modules and one isolated analog input module in the same chassis, or different chassis synchronized to the same CIP Sync Time Master, use Synchronized Sampling to take a snapshot of the input data available at each input at a single moment in time.

The following conditions must exist to use this feature:

- A 1588 CIP Sync Time Master is configured for the chassis.
- All modules in the set use the same RPI value or values that are multiples of each other.
- Synchronized Sampling with Other Synchronized Modules is enabled for all input channels in the set.

  For these input modules, configuring one channel for Synchronized Sampling synchronizes all eight channels.

While setting the RPI to the same value on all modules guarantees that each module samples at the same rate, it does not guarantee that they sample at the same time.

When enabled, Synchronized Sampling provides each module a synchronized starting point for its respective input scans. Because the RPI values are the same, the inputs on the modules are sampled at the same rate and the same time.

To see where to enable Synchronized Sampling, see page 103.

Cold Junction Compensation

When using the module with a thermocouple input type, the channel must account for the thermoelectric effect of a junction of the thermocouple field wires and the screw terminals of an RTB or IFM.

The junction at which temperature is measured is the hot junction. The junction where the thermocouple wire interfaces with copper is the cold junction. The module always measures and reports the cold junction temperature in °C. The transition from thermocouple wire to copper typically happens either on the module screw terminal itself or at an IFM.

The thermoelectric effect alters the input signal and must be compensated for to measure temperatures accurately. To accurately compensate the input signal from your module, you must use a cold junction compensation (CJC) sensor to account for the increased voltage.

IMPORTANT CJC sensors are only required with use of the Thermocouple input type and when channel wiring is connected via an RTB.

If you are using an IFM to connecting wiring to a channel using the Thermocouple input type, you do not need to use CJC sensors.

CJC sensors **do not** come with the module. You must order CJC sensors, product catalog number 1756-CJC, separately from the module for CJC sensors which attach directly to the module's screw terminals. Catalog number 1756-CJC includes two CJC sensors.

To order CJC sensors, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Remember the following when compensating the input signal from your module:

- CJC is optional and can be disabled.
- The module uses two channels for CJC. When using an RTB, you must connect CJC sensors at RTB terminals 1, 2, 35, and 36.

  IMPORTANT If you use CJC, you must connect CJC sensors to both channels, that is, terminals 1, 2, 35, and 36.

  You cannot use CJC and connect a CJC sensor to only one channel.

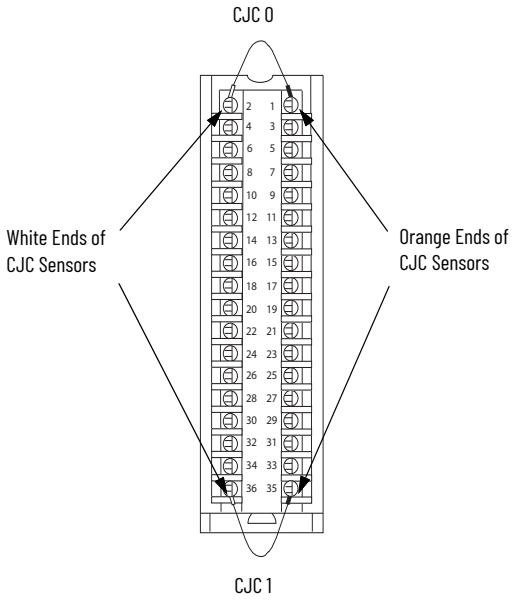
- Differences exist between using an RTB or IFM to connect wiring to the module. They are described in the rest of this section.

Connecting a CJC via a Removable Terminal Block

When using an RTB, if you choose to connect CJC sensors to your module, you must connect a CJC sensor at the top of the RTB and one at the bottom of the RTB.

IMPORTANT Remember the following:

- Connect the white end of the CJC sensor to the even-numbered terminals. For CJ 0, connect the white end to terminal 2. For CJ 1, connect the white end to terminal 36.
- Connect the orange end of the CJC sensor to the odd-numbered terminals. For CJ 0, connect the orange end to terminal 1. For CJ 1, connect the orange end to terminal 35.
- Two CJC values indicate the temperature of the top and bottom CJC sensor.
- CJC sensor temperatures are indicated in degrees Celsius.

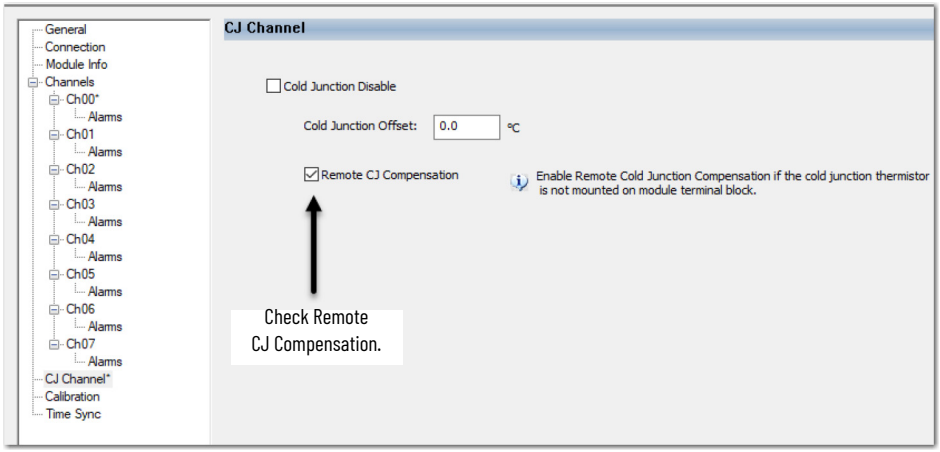


Connecting a Cold Junction Sensor via an Interface Module

The IFMs use an isothermal bar to maintain a steady temperature at all module terminations. When using the IFM, we recommend that you mount it so that the black anodized aluminum bar is in the horizontal position.

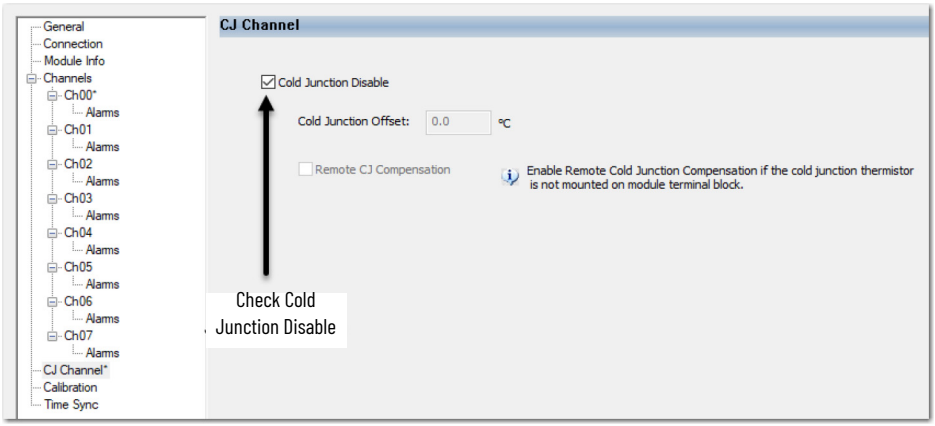
When using an IFM, do not connect a CJC sensor to the module because it is built into the IFM. However, you must enable the Remote CJ Compensation field in the Logix Designer application as shown below.

If you connect a CJS via an IFM, configure the module as shown on the Module Properties Configuration tab.



Cold Junction Disable Option

You can disable cold junction compensation on your module. Check Cold Junction Disable to disable compensation as shown below.

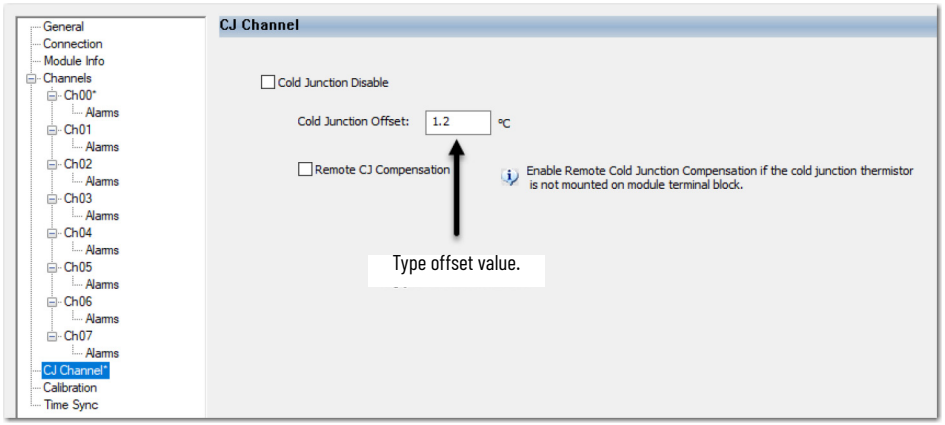


IMPORTANT Consider the following before disabling cold junction compensation:

- We recommend that you do not disable the cold junction disable option. Typically, this option is used only in systems that have no thermoelectric effect, such as test equipment in a controlled lab.
- The Cold Junction Disable box on the Module Properties Configuration tab disables cold junction compensation on all module channels.

Cold Junction Offset Option

The Cold Junction Offset box on the Module Properties Configuration Tab lets you make module-wide adjustments to cold junction compensation values. The single Cold Junction Offset affects all channels equally. If you know that your cold junction compensation values are consistently inaccurate by some level, for example, 1.2 °C, type the value into the box to account for this inaccuracy.



IMPORTANT Cold Junction temperatures are always reported as Celsius temperature units, and, offset values are always set in Celsius temperature units. You cannot change the temperature units.

1756-IRT8I, 1756-IRT8IK Diagrams

Figure 13 - 1756-IRT8I, 1756-IRT8IK Block Diagram

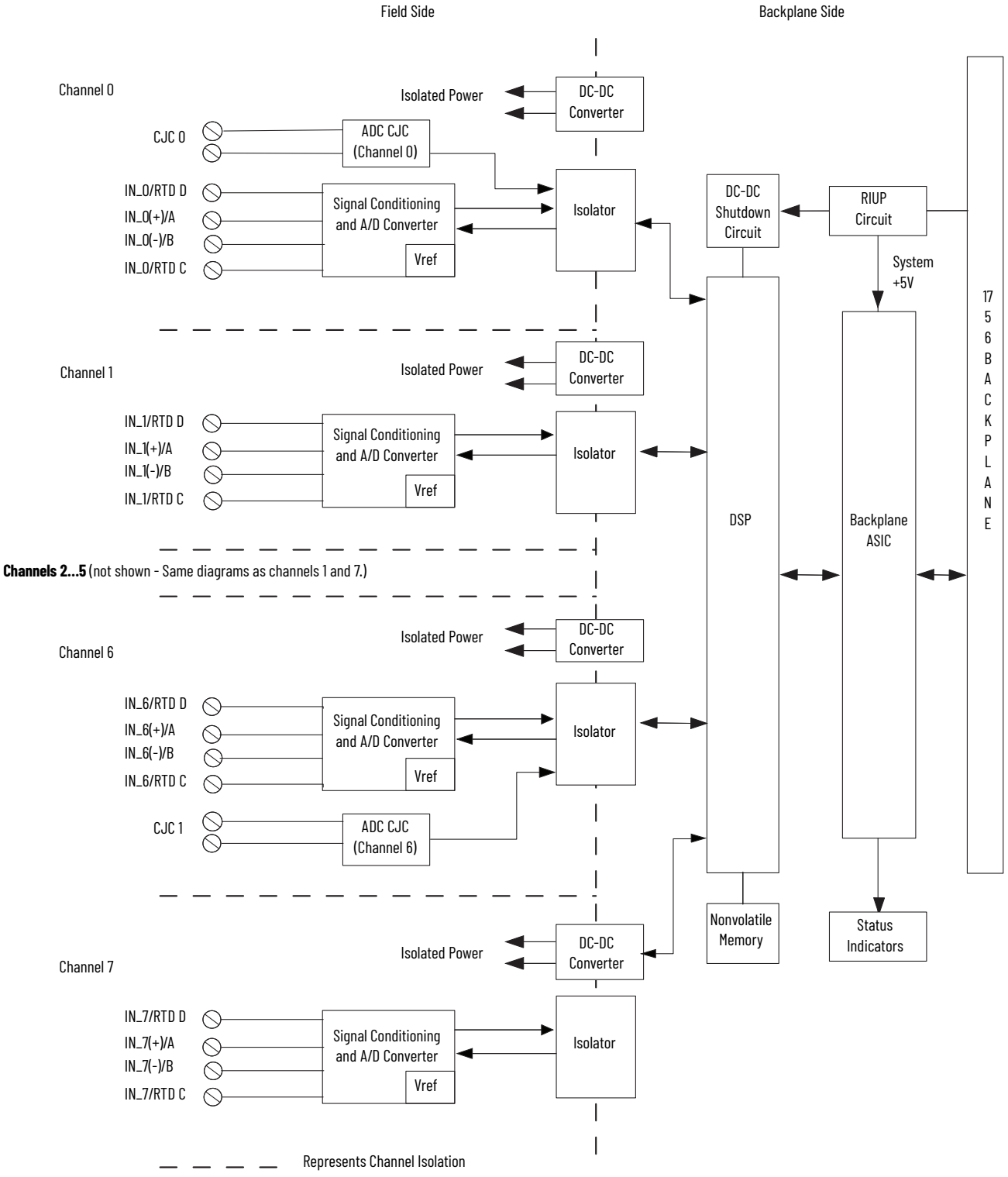


Figure 14 - 1756-IRT8I, 1756-IRT8IK Field-side with 3-wire RTD Input

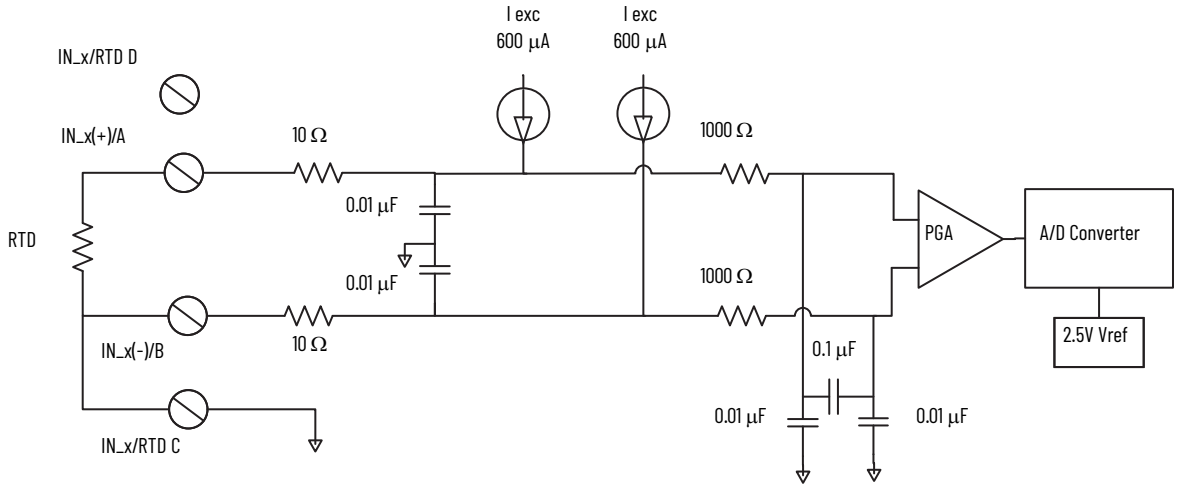


Figure 15 - 1756-IRT8I, 1756-IRT8IK Field-side with 4-wire RTD Input

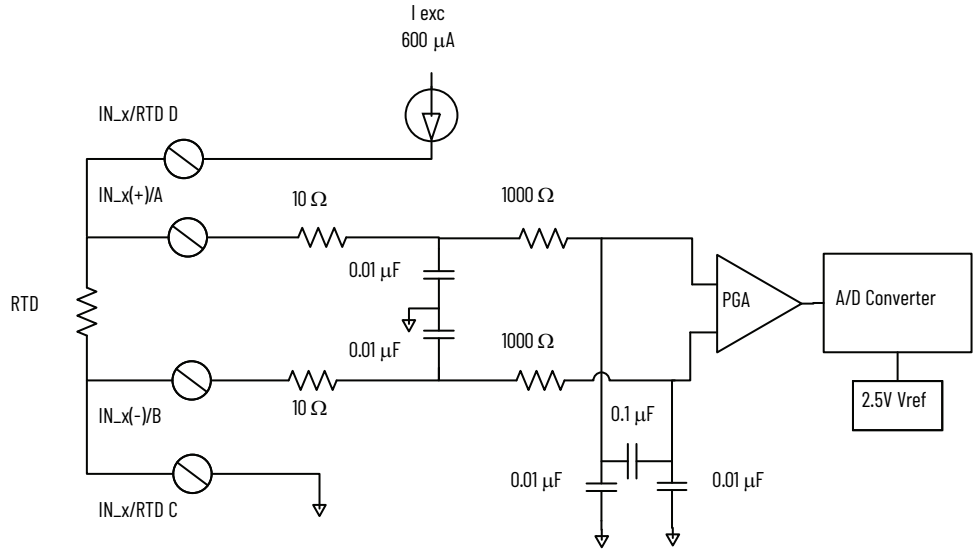


Figure 16 - 1756-IRT8I, 1756-IRT8IK Field-side Circuit with Thermocouple Input

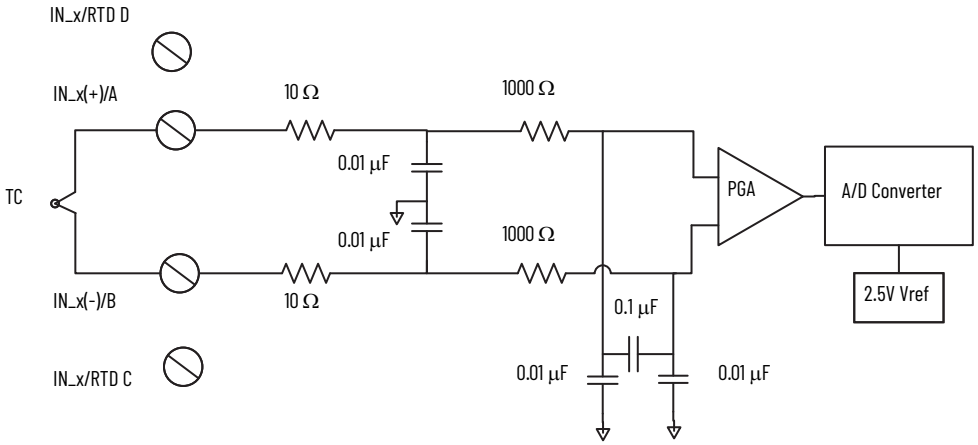


Figure 17 - 1756-IRT8I, 1756-IRT8IK Wiring Diagram - 3-wire RTD Input

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Terminals 1, 2, 35, and 36 are not used in RTD applications.
- For 2-wire resistor applications including calibration, make sure IN_x(-)/B and IN_x/RTD C are shorted together.

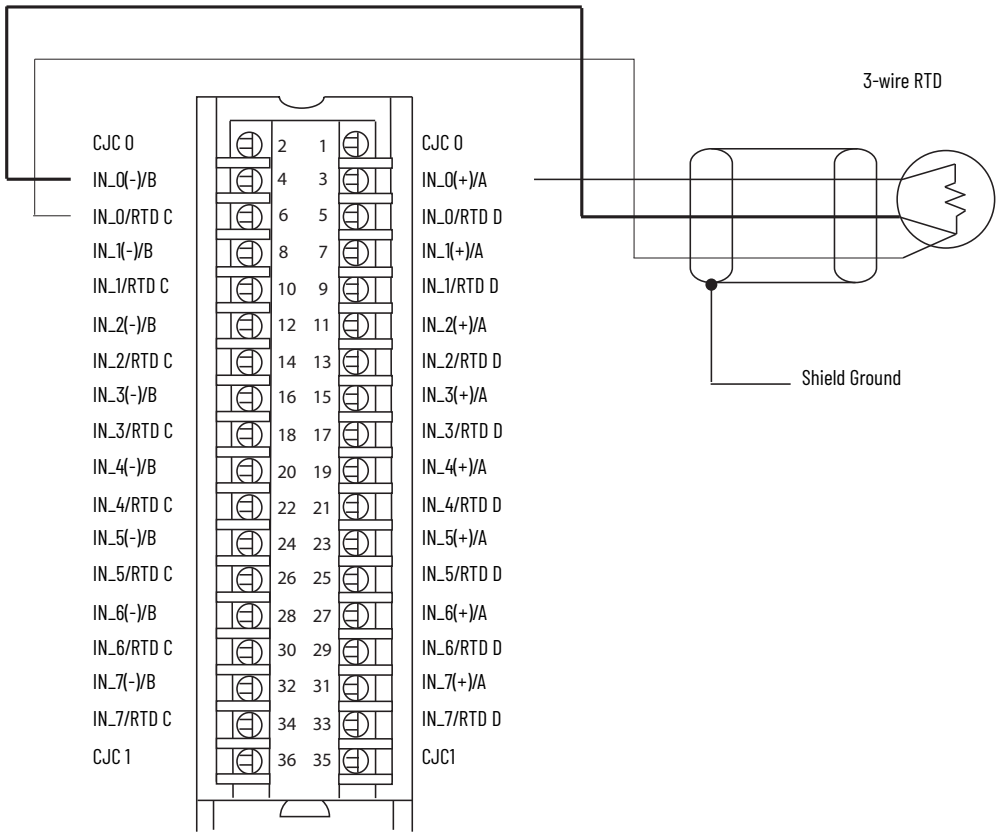


Figure 18 - 1756-IRT8I, 1756-IRT8IK Wiring Diagram - 4-wire RTD Input

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Terminals 1, 2, 35, and 36 are not used in RTD applications.

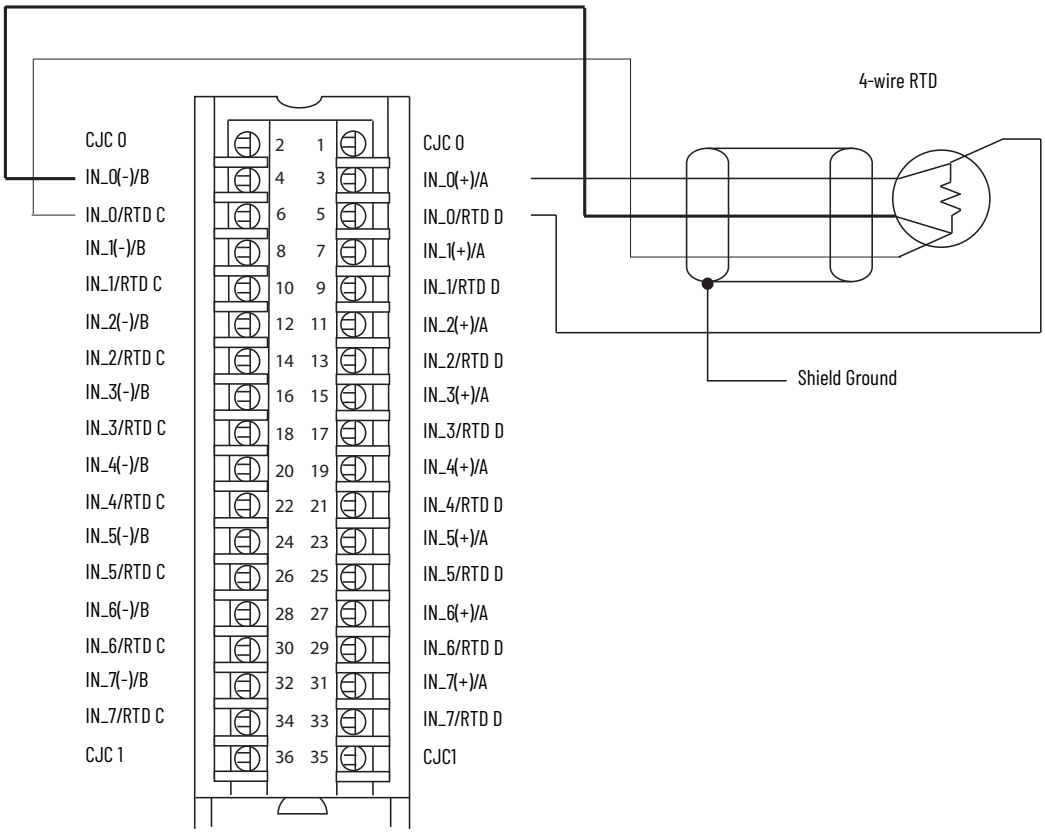
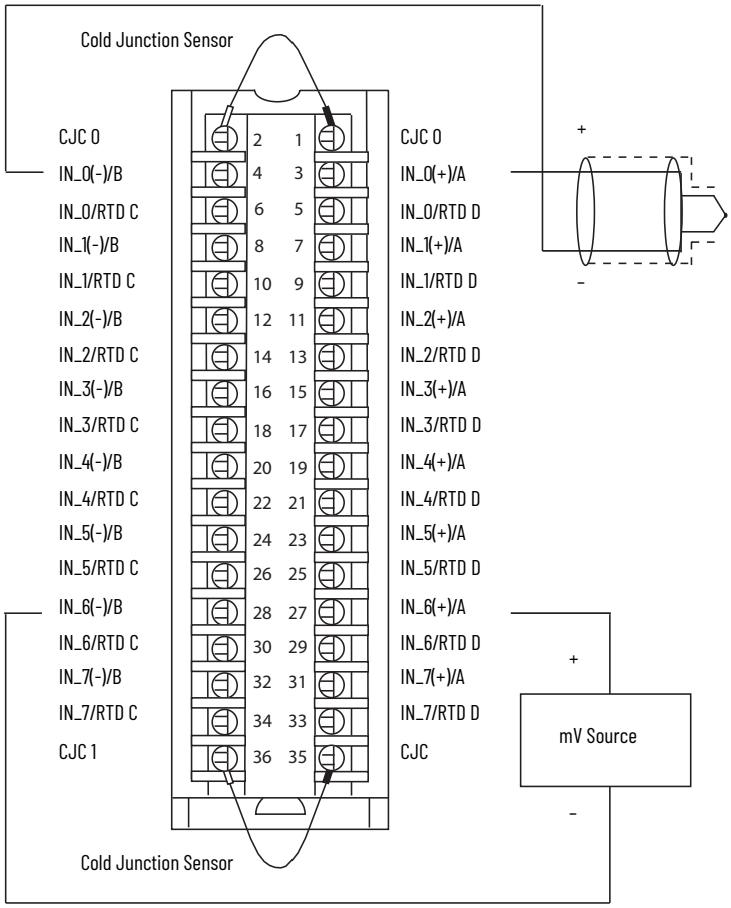


Figure 19 - 1756-IRT8I, 1756-IRT8IK Wiring Diagram - Thermocouple Input

IMPORTANT: Remember the following:

- Connect the white end of the CJC sensor to the even-numbered terminal., and connect the orange end of the CJC sensor to the odd-numbered terminals.
  For CJC 0:
  - White end - Connected to terminal number 2
  - Orange end - Connected to terminal number 1

  For CJC 1:
  - White end - Connected to terminal number 36
  - Orange end - Connected to terminal number 35
- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.



1756-IR12, 1756-IR12K Diagrams

Figure 20 - 1756-IR12, 1756-IR12K Block Diagram

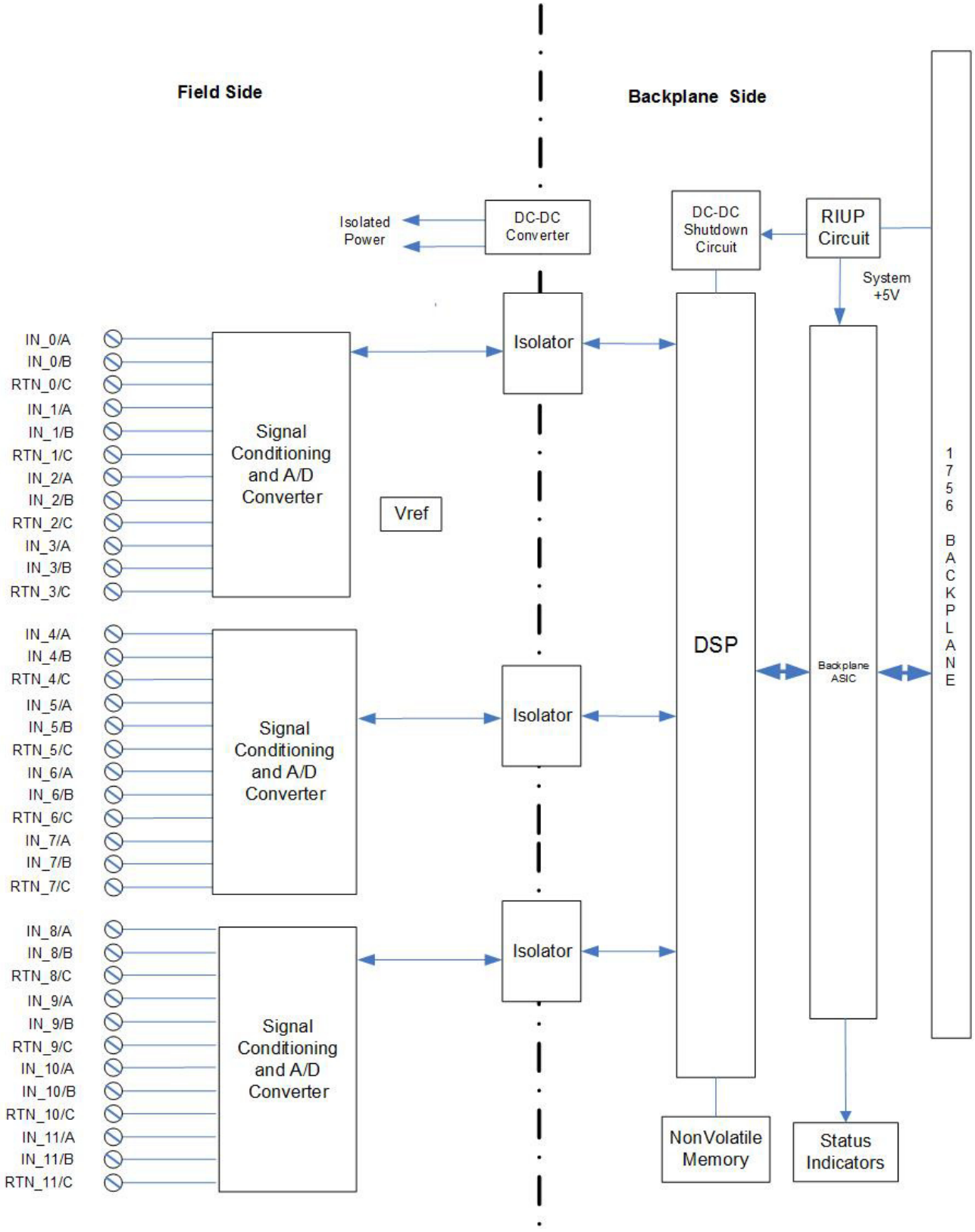


Figure 21 - 1756-IR12, 1756-IR12K Field-side Circuit with RTD Input

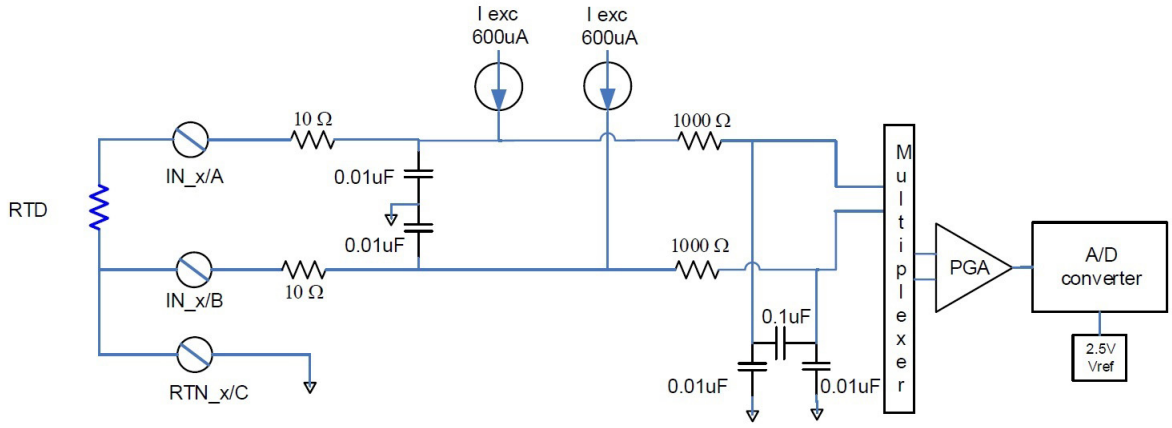
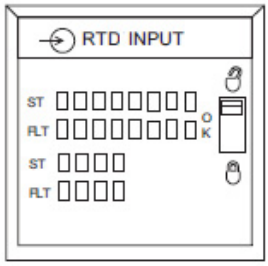
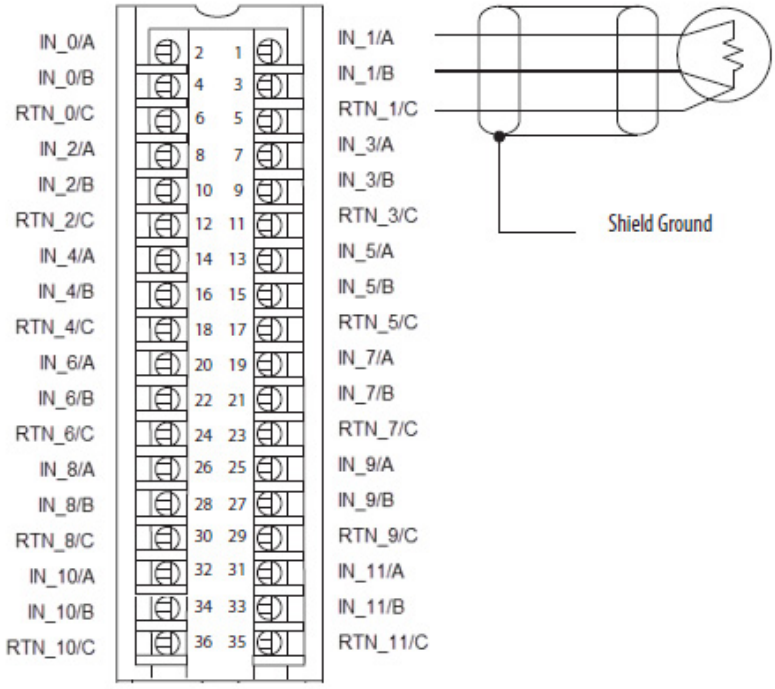


Figure 22 - 1756-IR12, 1756-IR12K Wiring Diagram - 3-wire RTD Input

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.
- For 2-wire resistor applications including calibration, make sure IN_x/B and RTN_x/C are shorted together.





1756-IT16, 1756-IT16K Diagrams

Figure 23 - 1756-IT16, 1756-IT16K Block Diagram

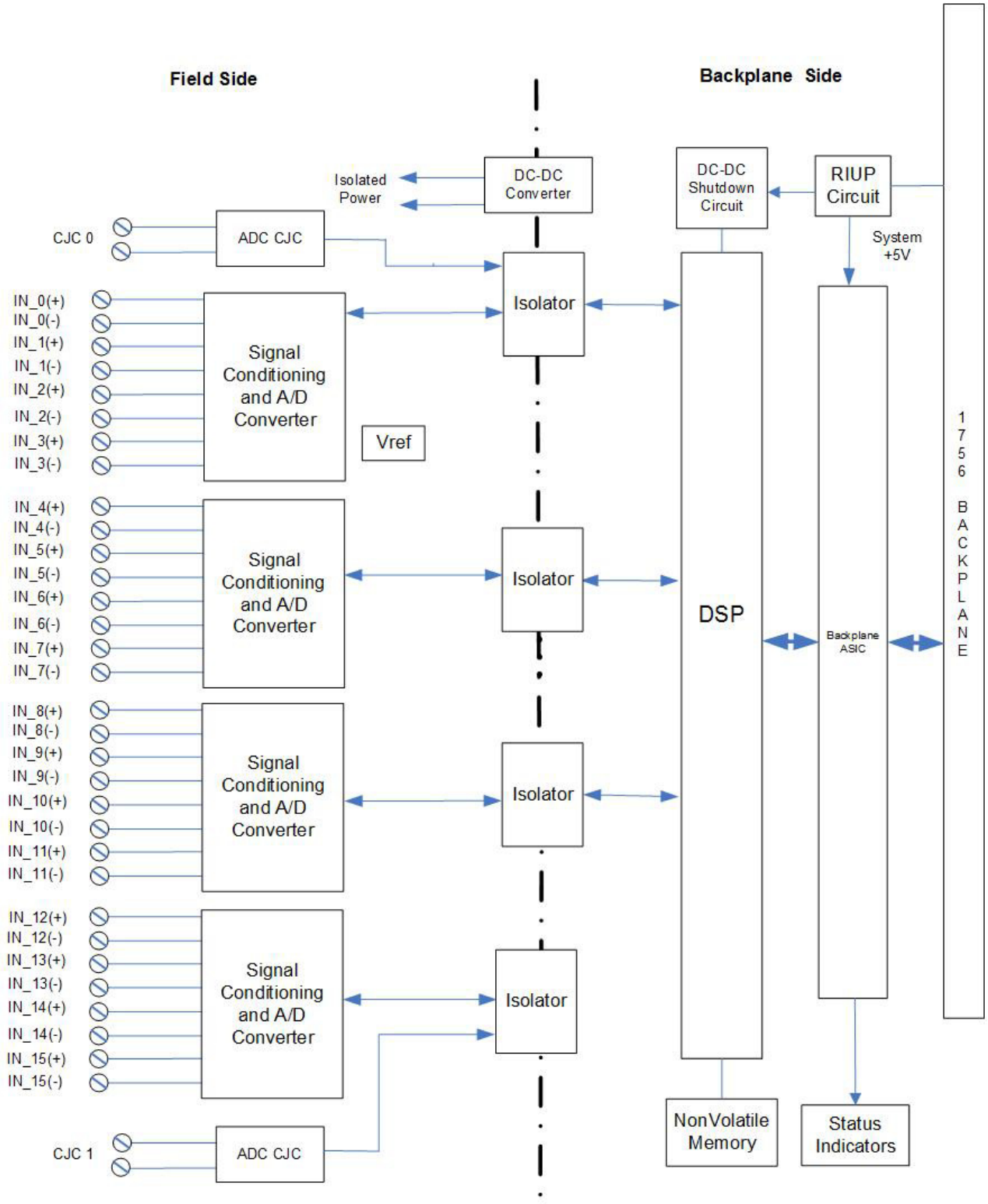


Figure 24 - 1756-IT16, 1756-IT16K Field-side Circuit with Thermocouple Input

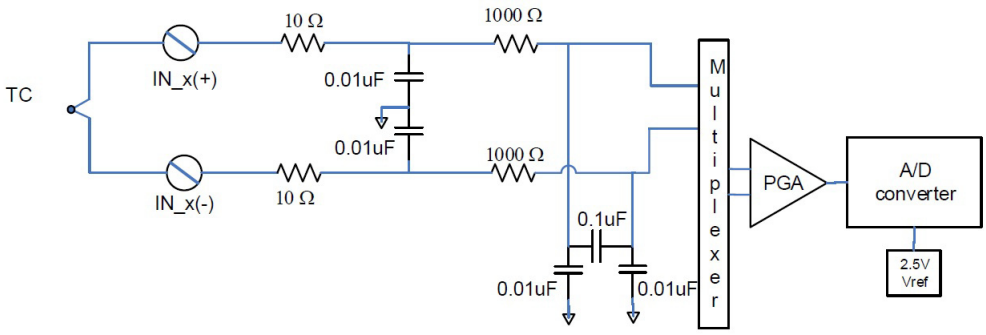
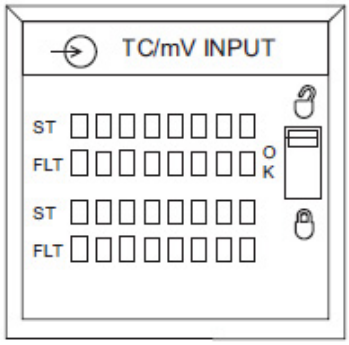
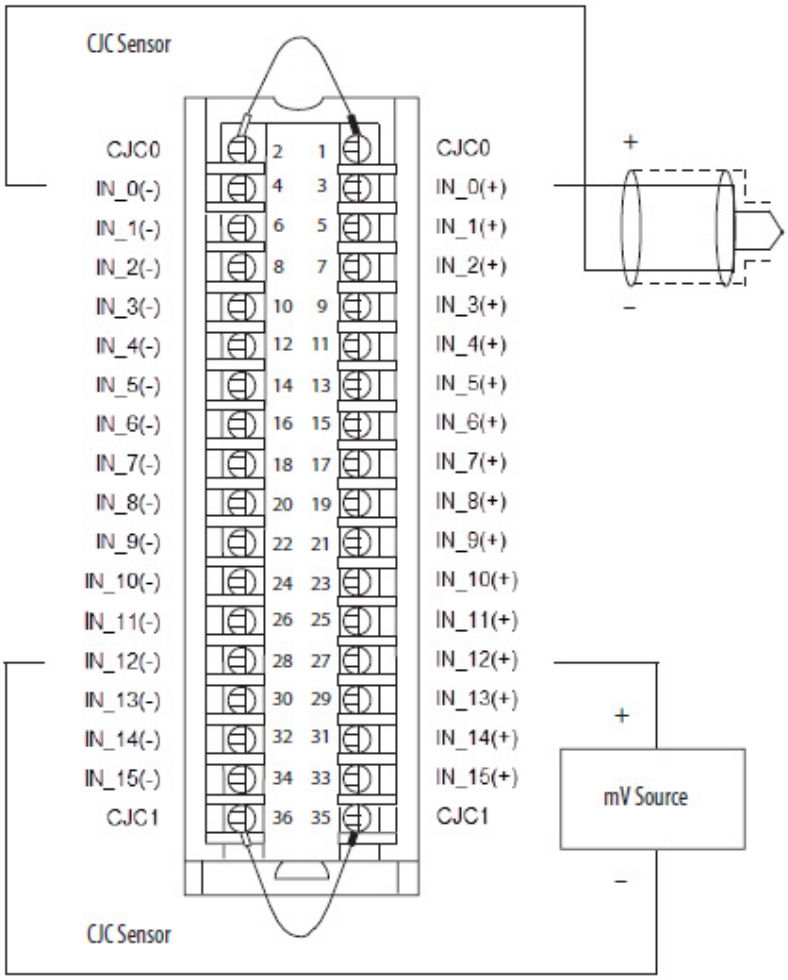


Figure 25 - 1756-IT16, 1756-IT16K Wiring Diagram - Thermocouple Input

IMPORTANT: Remember the following:

- Connect the white end of the CJC sensor to the even-numbered terminal. Connect the orange end of the CJC sensor to the odd-numbered terminals.
  For CJC 0:
  - White end - Connected to terminal number 2
  - Orange end - Connected to terminal number 1
  For CJC 1:
  - White end - Connected to terminal number 36
  - Orange end - Connected to terminal number 35
- CJC sensors do not come with the module. You must order the sensors, product catalog number 1756-CJC, separately.
- If separate power sources are used, do not exceed the specific isolation voltage as listed in the specifications.





Fault and Status Reporting

The module multicasts fault and status data with channel data to the owner and listening controllers. The data is returned via module tags that you can monitor in your Logix Designer application.

The following table lists the complete set of fault and status tags for temperature-sensing modules. Check your module's configuration in the Logix Designer application to determine which tags are available. Refer to Analog I/O Module Tag Definitions on page 157 for specific information on applying tags to each module.

Table 18 - Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets Tag
Fault	Fault(1)	The owner-controller loses its connection to the module.
	CJ[x].Underrange	The cold junction for the channel is below 0 °C.
	CJ[x].Overrange	The cold junction for the channel is above 86 °C.
	Ch[x].Fault	The channel data quality is bad.
	Ch[x].Underrange	The channel data is beneath the absolute minimum for this channel.
	Ch[x].Overrange	The channel data is above the absolute maximum for this channel.
Status	CIPSyncValid(1)	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.
	CIPSyncTimeout(1)	Indicates whether a valid time master on the backplane has timed out.
	CIPSyncOffsetJump(1)	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred.
	Ch[x].Uncertain	The channel data can be imperfect.
	Ch[x].LLAlarm	The *I.Ch[x].Data* tag value is less than the *C.Ch[x].LLAlarmLimit* tag value, the *O.Ch[x].LLAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].LAlarm	The *I.Ch[x].Data* tag value is less than the *C.Ch[x].LAlarmLimit* tag value, the *O.Ch[x].LAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].HAlarm	The *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HAlarmLimit* tag value, the *O.Ch[x].HAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].HHAlarm	The *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HHAlarmLimit* tag value, the *O.Ch[x].HHAlarmEn* tag is set and alarms are enabled for the channel.
	Ch[x].RateAlarm	The absolute change between consecutive channel samples exceeds the *C.Ch[x].RateAlarmLimit* tag value. This alarm only applies to enabled Process alarms.
	Ch[x].CalibrationFault	The channel is not calibrated or the last attempted calibration for this channel failed.
	Ch[x].Calibrating	The channel is currently being calibrated.
	Ch[x].CalGoodLowRef	A valid Low Reference signal has been sampled on this channel.
	Ch[x].CalBadLowRef	An invalid Low Reference signal has been sampled on this channel.
	Ch[x].CalGoodHighRef	An valid High Reference signal has been sampled on this channel.
	Ch[x].CalBadHighRef	An invalid High Reference signal has been sampled on this channel.
	Ch[x].CalSuccessful	Calibration on this channel is complete and the Calibrating state has been exited.
	Ch[x].RateOfChange	The change in channel data since last sample in Engineering Units/Second.
	Ch[x].Data	The channel data in scaled Engineering Units.
	Timestamp(1)	A 64-bit timestamp indicating when all 8 channels were last sampled in terms of CIPSync time.
	RollingTimestamp(1)	16-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID instruction to automatically calculate sample deltas. The timestamp changes when any one of the output channels is updated.

(1) This tag provides module-wide data and affects all channels simultaneously.

1756-OF8I, 1756-OF8IK Isolated Analog Output Module

The 1756-OF8I, 1756-OF8IK module has eight isolated channels. Each channel supports the following output types:

- Current
- Voltage

The module provides 16-bit resolution. Additional features are described in this chapter.

1756-OF8I, 1756-OF8IK Module Features

The 1756-OF8I, 1756-OF8IK module has the following features:

- Multiple Output Ranges
- Channel Offset
- Ramping/Rate Limiting
- Hold for Initialization
- Clamping/Limiting
- Clamp/Limit Alarms
- Data Echo
- Redundant Ownership

IMPORTANT Most of the features are software configurable. For more information on how to configure the module, see Chapter 6 on page 99.

Multiple Output Ranges

The module offers multiple output ranges that are dictated by channel configuration choices. The output type selection determines the available ranges.

Table 19 - Channel Output Ranges

Output Type	Output Range
Current (mA)	0...20 mA
Voltage (V)	Any of the following: • -10…10V • 0…5V • 0…10V

To see where to select the output range, see page 103.

Channel Offset

With this feature, you can compensate for any known error on the sensor or channel to which the sensor is connected. This value is in engineering units and is added to the output data.

You can set the channel offset in either of the following ways:

- On the Configuration tab of the Module Properties dialog box.
- Directly in the channel's *C.Ch[x].Offset* tag.

For example, if the channel has an error such that it reads 8 mA as 7.8 mA, you account for the error by setting the Channel Offset field on the Configuration tab to 1.2500 if using the default scaling of 4...20 ma = 0...100%, or by setting the *C.Ch[x].Offset* tag to 1.25.

To see where to set the Channel Offset, see page 103.

Ramping/Rate Limiting

Ramping limits the speed at which an analog output signal can change. This prevents fast transitions in the output from damaging the devices that an output module controls. Ramping is also known as rate limiting.

The table describes the types of ramping that are possible.

Ramping type	Description
Run mode ramping	When the module is in Run mode, ramping occurs to all new output values at the MaxRampRate.
Ramp to Program mode	When the present output value changes to the Program value after a Program command is received from the controller.
Ramp to Fault mode	When the present output value changes to the Fault value after a communication fault occurs.

The maximum rate of change in outputs is expressed in engineering units per second (Engineering Units/second) and called the maximum ramp rate. To see where to set ramping, see page 112.

Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value commanded by the controller matches the value at the output screw terminal within 0.1% of full scale, providing a bumpless transfer.

If Hold for Initialization is selected, outputs hold if there is an occurrence of any of these three conditions:

- Initial connection is established after power up.
- A new connection is established after a communication fault occurs.
- There is a transition to Run mode from Program state.

The *I.Ch[x].InHold* tag for a channel indicates that the channel is holding.

Clamping/Limiting

Clamping limits the output from the analog module to remain within a range configured by the controller, even when the controller commands an output outside that range. This safety feature sets a high clamp and a low clamp.

Once clamps are determined for a module and enabled, any data received from the controller that exceeds those clamps sets an appropriate limit alarm and transitions the output to that limit but not beyond the requested value.

For example, an application can set the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value corresponding to 9V to the module, the module applies only 8V to its screw terminals.

You can disable or latch clamping alarms on a per channel basis. The alarms are disabled by default.

IMPORTANT Clamp values are in engineering units and are **not automatically updated** when the scaling high and low engineering units are changed. Failure to update the clamp values can generate a very small output signal that could be misinterpreted as a hardware problem.

For example, a 1756-OF8I module channel that uses a Current (mA) output type with Clamping enabled has the following configuration parameters:

- Scaling values:
  - High Engineering = 100.0000%
  - Low Engineering = 0.0000%
- Clamp Limits:
  - High Clamp = 100.0000%
  - Low Clamp = 0.0000%

If you change the Scaling High Engineering value to 90.0000%, the High Clamp value remains at 100.0000.

You must change the High Clamp value to 90.0000 to make sure the application continues to operate as expected.

Clamp/Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies signal values to the clamping limit but also sends a status bit to the controller notifying it that the value sent exceeds the clamping limits.

With the previous example, if a module has clamping limits of 8V and -8V but then receives data to apply 9V, only 8V is applied to the screw terminals and the module sends a status bit back to the controller informing it that the 9V value exceeds the module's clamping limits.

To see where to set clamp and limit alarms, see page 112.

Data Echo

Data Echo automatically multicasts channel data values that match the analog value that was sent to the module's screw terminals at that time.

The module returns a status word that represents the value sent to it by the controller. The echoed value is indicated in input tag *I.Ch[x].Data* and is represented in Engineering Units.

Fault and status data are also sent. This data is sent at the RPI.

1756-OF8I, 1756-OF8IK Diagrams

Figure 26 - 1756-OF8I, 1756-OF8IK Block Diagram

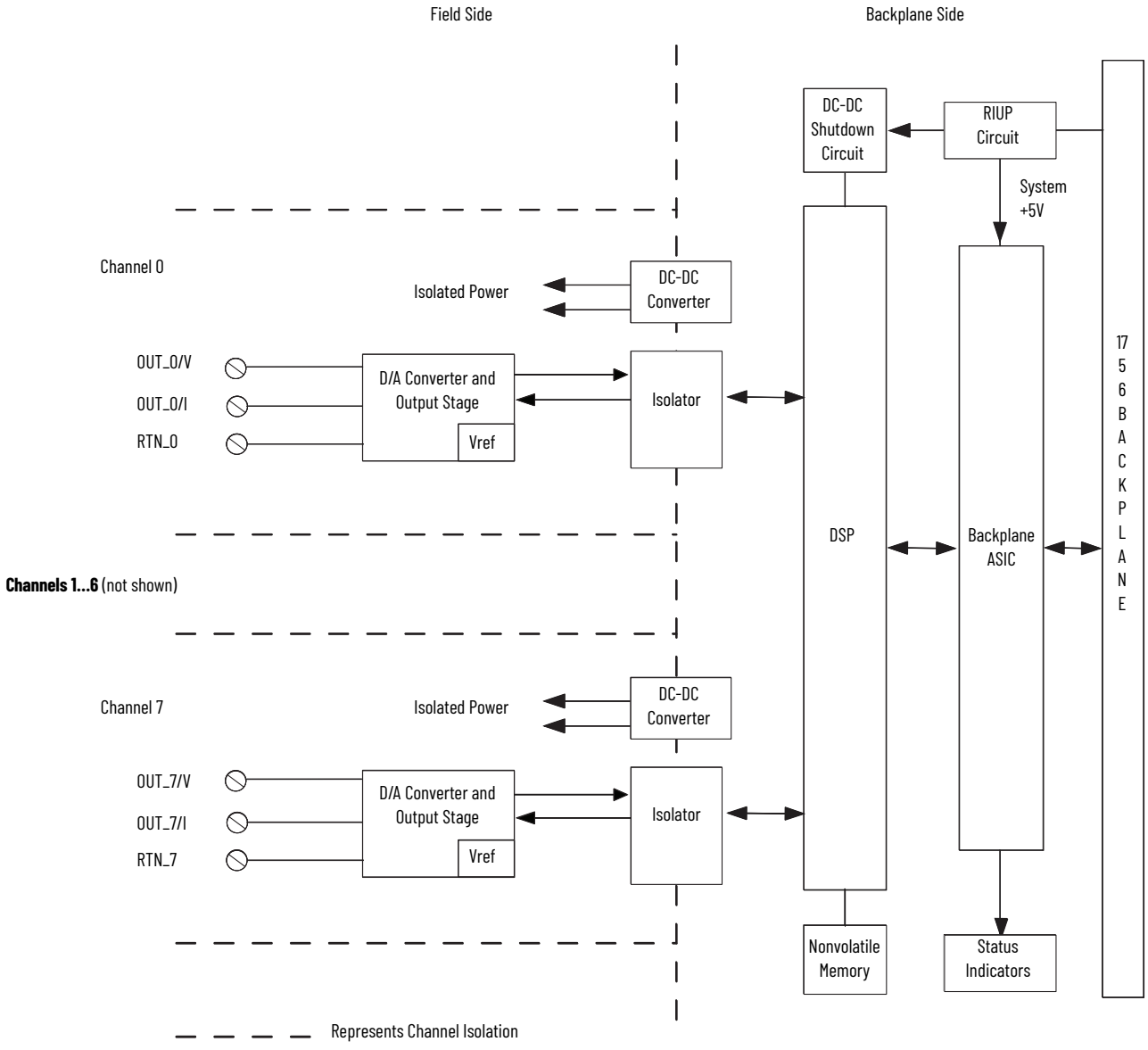


Figure 27 - 1756-OF8I, 1756-OF8IK Field-side Circuit with Current Output

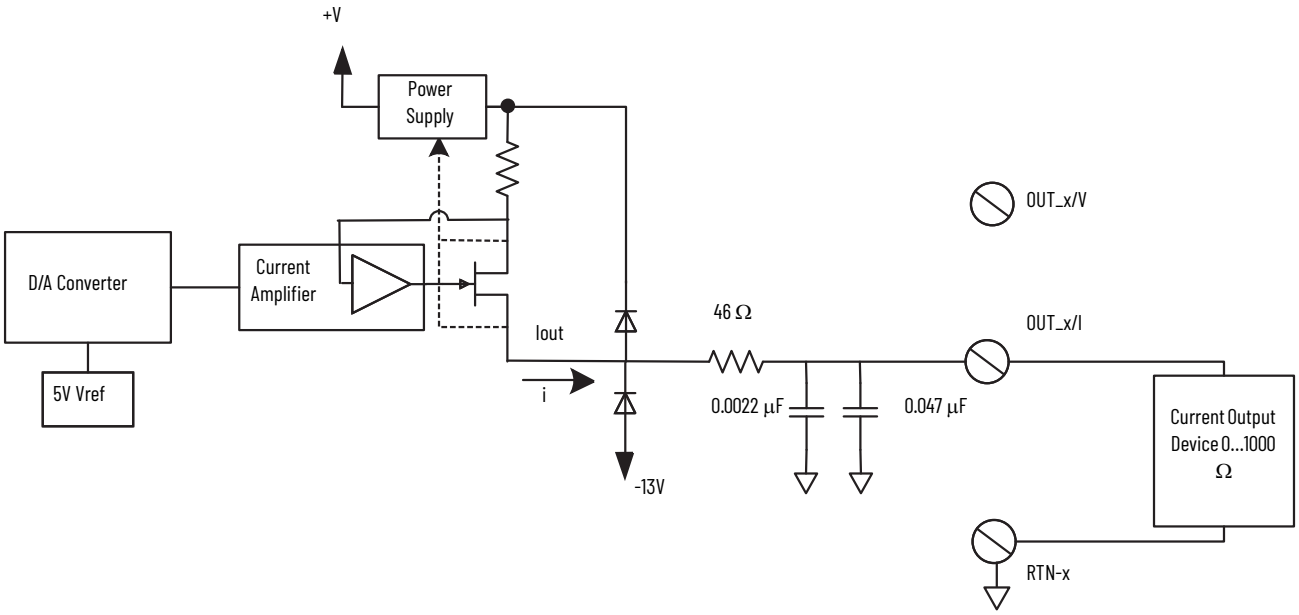


Figure 28 - 1756-OF8I, 1756-OF8IK Field-side Circuit with Voltage Output

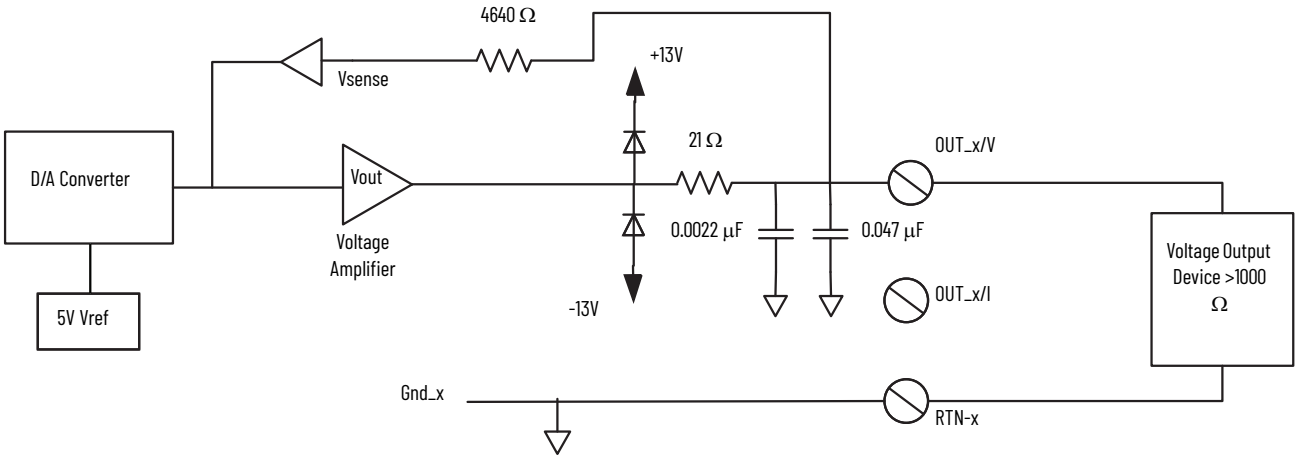


Figure 29 - 1756-OF8I, 1756-OF8IK Wiring Diagram - Current Output Type

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Place additional devices anywhere in the loop.

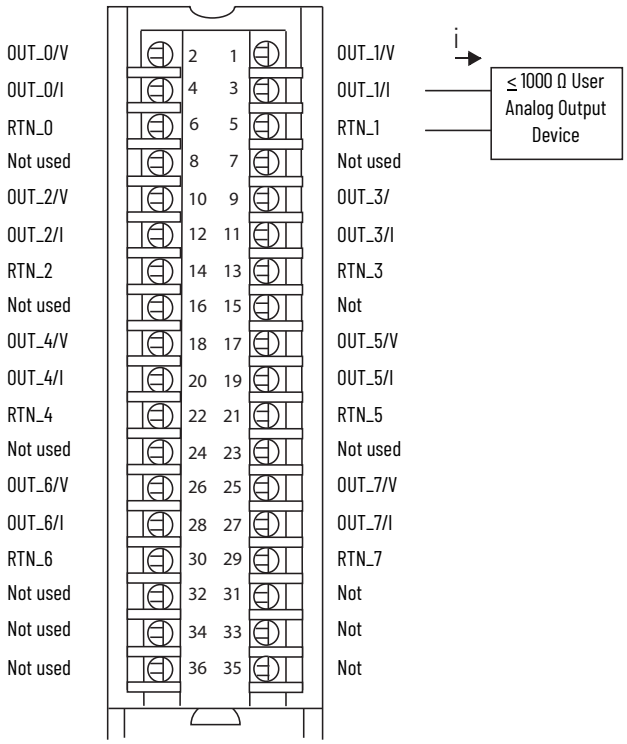
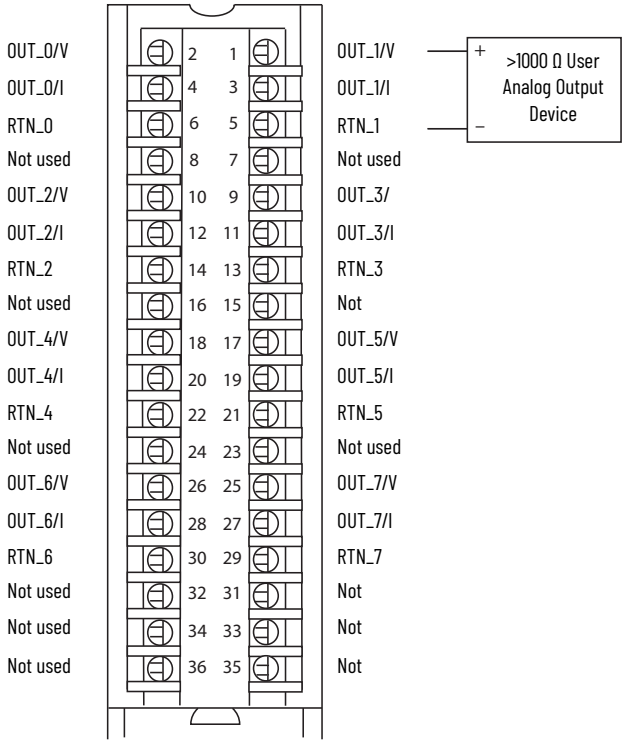


Figure 30 - 1756-OF8I, 1756-OF8IK Wiring Diagram - Voltage Output Type

IMPORTANT: Remember the following:

- If separate power sources are used, do not exceed the specific isolation voltage. For more information on module specifications, see the 1756 ControlLogix I/O Specifications Technical Data, publication 1756-TD002.
- Place additional devices anywhere in the loop.



Drive Different Loads with the 1756-OF8I, 1756-OF8IK Module

When the module operates with a Current output load, each channel automatically adjusts its output power for 0...1000 ohm loads. The module's 24V backplane current requirements vary based on load.

For more information the module's 24V current requirements, see the 1756 ControlLogix® I/O Specifications Technical Data, publication 1756-TD002.

Fault and Status Reporting

The module multicasts fault and status data with channel data to the owner and listening controllers. The data is returned via module tags that you can monitor in your Logix Designer application.

With some exceptions, as noted in the following table, the 1756-OF8I module provides the fault and data status in a channel-centric format.

The following table lists the fault and status tags for the module available in the Logix Designer application.

Figure 31 - 1756-OF8I, 1756-OF8IK Module - Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets Tag
Fault	Fault(1)	The owner-controller loses its connection to the module.
	Ch[x].Fault	The channel data quality is bad.

Figure 31 - 1756-OF8I, 1756-OF8IK Module - Fault and Status Data Tags (Continued)

Data Type	Tag Name	Triggering Event That Sets Tag
Status	CIPSyncValid(1)	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.
	CIPSyncTimeout(1)	Indicates whether a valid time master on the backplane has timed out.
	CIPSyncOffsetJump(1)	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred.
	Ch[x].Uncertain	The channel data can be imperfect.
	Ch[x].LowClampAlarm	The following events occur: • Clamping is enabled on this channel. • One of the following: – The channel data requested, indicated in the *O.Ch[x].Data* tag, is currently less than the configured LowLimit. – Latching is enabled and the *O:Ch[x].Data* tag was less than the configured LowLimit at some points and the alarm has not been unlatched.
	Ch[x].HighClampAlarm	The following events occur: • Clamping is enabled on this channel. • One of the following: – The channel data requested, indicated in the *O.Ch[x].Data* tag, is currently greater than the configured HighLimit. – Latching is enabled and the *O:Ch[x].Data* tag was greater than the configured HighLimit at some points and the alarm has not been unlatched.
	Ch[x].RampAlarm	The channel is currently limited to changing the output at the Maximum Ramp rate or once was and is now latched.
	Ch[x].NotANumber	The most recently-received data value was not a number.
	Ch[x].InHold	The channel is currently holding until the received channel data is within 0.1% of the current channel data value.
	Ch[x].CalibrationFault	The channel is not calibrated or the last attempted calibration for this channel failed.
	Ch[x].Calibrating	The channel is currently being calibrated.
	Ch[x].CalGoodLowRef	A valid Low Reference signal has been sampled on this channel.
	Ch[x].CalBadLowRef	An invalid Low Reference signal has been sampled on this channel.
	Ch[x].CalGoodHighRef	An valid High Reference signal has been sampled on this channel.
	Ch[x].CalBadHighRef	An invalid High Reference signal has been sampled on this channel.
	Ch[x].CalSuccessful	Calibration on this channel is complete and the calibrating state has been exited.
	Ch[x].Data	The channel data in scaled Engineering Units. This data is the Output Data Echo data returned from the D/A convertor.
	Timestamp(1)	A 64-bit Timestamp indicating when any one of the output channels was last updated with new output data in terms of CIP Sync time.
	RollingTimestamp	16-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID instruction to automatically calculate sample deltas. The timestamp changes when any one of the output channels is updated.

(1) This tag provides module-wide data and affects all channels simultaneously.

Redundant Ownership

Redundant ownership lets a single controller use redundant network paths to communicate with a single output or lets two separate controllers coordinate to control the output.

Configure Redundant Ownership

To enable Redundant Ownership mode in the output module, each connection to the output module is via a redundant owner module definition. In the module definition, you select between Redundant Output Owner A and Redundant Output Owner B. Each pair of connections must have an A and a B requested—that is, if the first is A, the second must be B.

If the second connection does not pair with the original connection, it is rejected with a general status = 0x01 and extended status = 0x031D. All other aspects of configuration between the two connections must be identical.

After the connection is established, a redundant owner uses the Claim Owner Output (COO) tag to indicate that it is ready for ownership of the outputs. The Ready Owner Output (ROO) tag indicates that an owner is ready to take ownership if needed. The ROO is implemented as a single bit, OwnerReady, as this implementation is intended for only two controllers.

When the OwnerClaim bit is set, it indicates that the controller wants to claim ownership of the redundant connection and have its outputs actively used. If both redundant owners have COO set, the last originator application that transitioned its COO flag from cleared to set is the owner.

Only a received 0-to-1 transition, and not simply the receipt of a new connection, is considered such a transition for ownership.

If neither redundant owner has OwnerClaim set, then the controller that has the OwnerReady bit set becomes the owner. If neither controller has OwnerClaim set and both have OwnerReady set, owner A becomes the owner. If both controllers have OwnerClaim=0 and OwnerReady=0, then the outputs go to IDLE (Program mode).

Finally, the Input data adds status fields that indicate if the output module has an active owner (OwnerActive) and for which controller, A or B (OwnerID). For each of owner A and B, three status fields indicate if the controller is connected (OwnerAConnected/OwnerBConnected) and echo the output values received for each owner via OwnerAClaim/OwnerBClaim and OwnerAReady/OwnerBReady, respectively.

Requirements

You must use output modules that support redundant ownership:

- 1756-OF8I, 1756-OF8IK output module
- Any Allen-Bradley® 1756 input module that supports multiple owners
- 1756-OB16IEF digital output module described in the ControlLogix Digital I/O Modules User Manual, publication 1756-UM058

Redundant ownership supports these ControlLogix 1756 Ethernet modules:

- 1756-EN2T
- 1756-EN2TP
- 1756-EN2TR
- 1756-EN3TR
- 1756-EN4TR
- 1756-EN2F

About Redundant Ownership

Redundant ownership can work in single-controller and multiple-controller applications, with or without redundancy.

Your application determines which controller is the Claiming Owner and which is the Ready Owner. The relationship is akin to a primary and secondary relationship.

Restrictions

Redundant ownership uses two connections for every I/O module–one for each of the redundant connections. Each connection is shown in the Studio 5000 Logix Designer® I/O Configuration–two entries for each I/O module.

- The two I/O module configurations must match.
- Two connections are used for each I/O module.
- An output module's ideal RPI is 25 ms.

  This speed is for the fastest response to an event. Any output module RPI can be used, but may have increased response time to a fault.
- An input module's ideal RPI is 25 ms, though any input module RPI can be used.
- Direct I/O connections must be used.

Also see Redundant Owner Configuration Tags on page 179.

Single Controller Behavior

In the case of a single controller, both connections are owned by the same controller. There is never a case where one connection is in Run mode and the other connection is in Program mode, so synchronization is not required.

You can also achieve the same behavior by using two communication modules in the controller chassis.

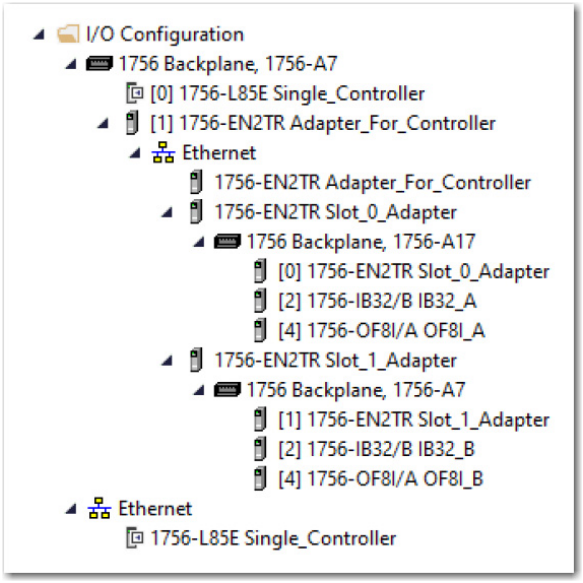
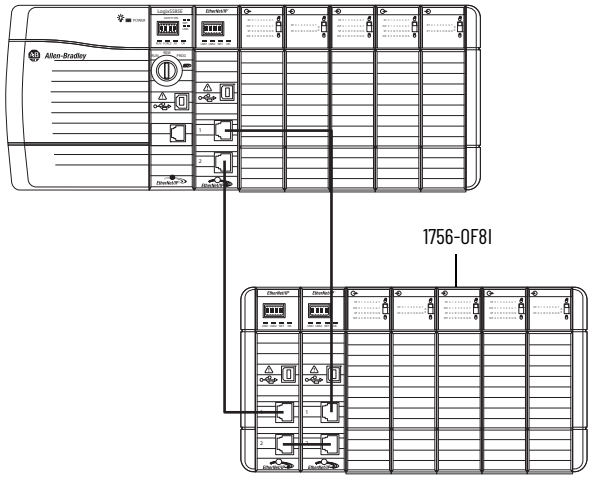


Figure 32 - Single Controller



1. Initialize I/O tags.
2. Set Claim in one connection.
3. Set Ready in the other connection.
4. Monitor which connection is the owner and update tags accordingly (Non Owner before Owner to make sure that they're always in sync).

That single controller behavior should result in the following:

1. Output is not owned until the Claim connection is made.
2. Any disruption in the Claim connection causes the I/O module to switch to the Ready path.
3. When the Claim connection recovers from the disruption, the I/O module switches back to Claim.

Multiple Controller Behavior

For multiple controllers, the applications synchronize the behavior between the controllers. Note Ethernet modules A and B, and RedundantOutputA and RedundantOutputB.

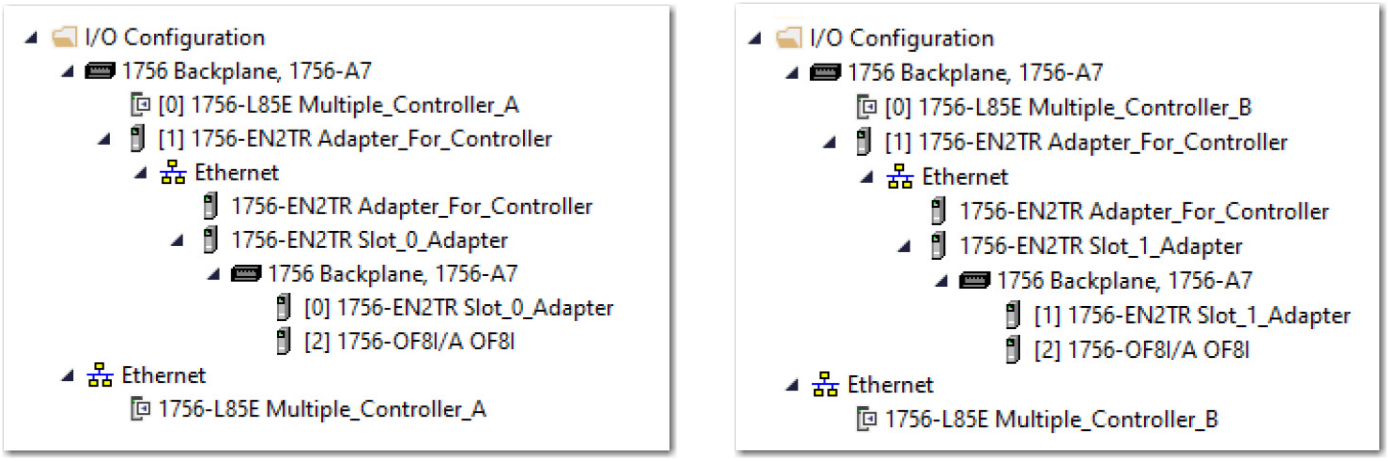
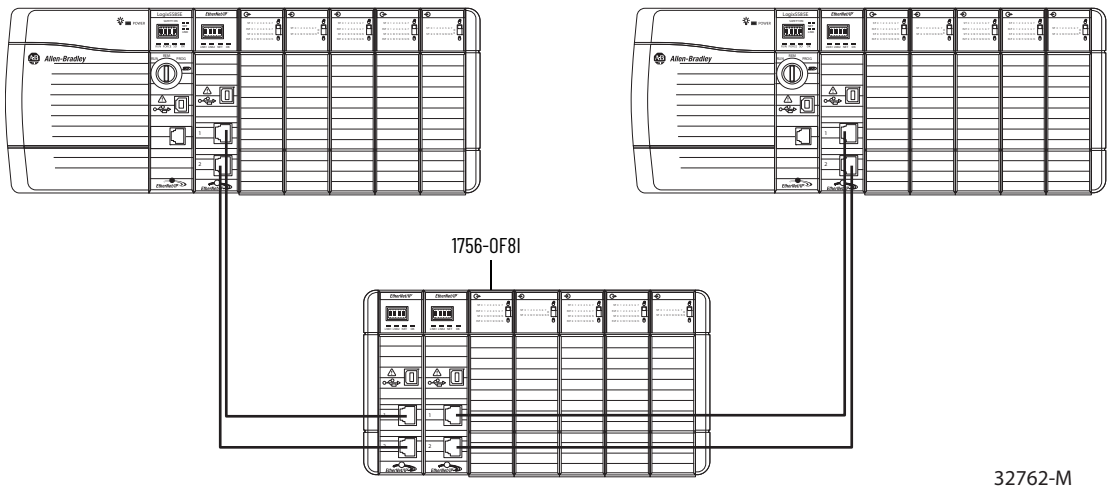


Figure 33 - Multiple Controller



IMPORTANT If you use ControlLogix Redundancy as the multiple controller system, then you do not have to manage the dual controllers. If you use any other method, then you must manage the primary and secondary controllers yourself. This application does not manage the controllers, just the I/O.

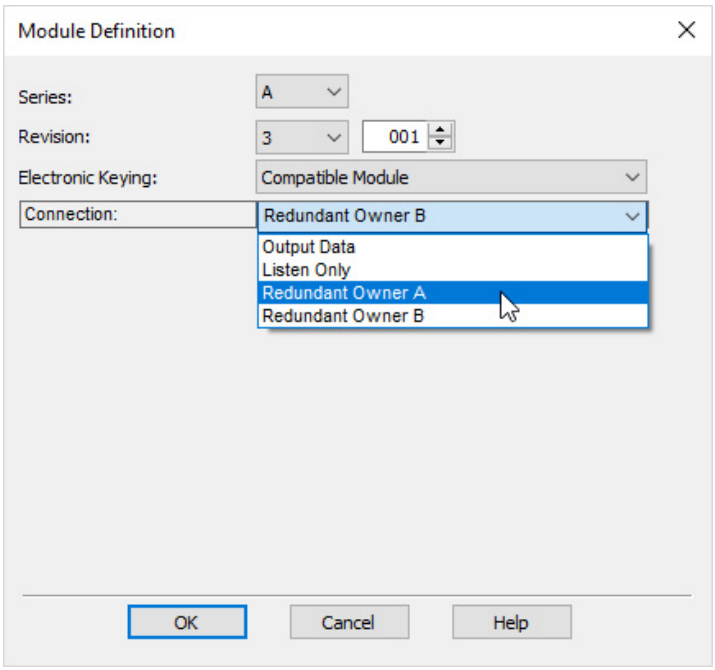
You can use Produced/Consumed tags for synchronization; however, the Redundant Owner Input tags provide the majority of information needed for synchronization.

- After both controllers decide it is safe, the primary controller sets Claim.
- After the secondary controller sees that the primary controller has taken ownership, the secondary controller sets Ready.
- The secondary controller monitors the I/O and the other controller to determine the current owner.
- If the secondary controller becomes the owner, it can set its Claim bit to take or hold ownership, or can just maintain Ready.
- Once the primary controller comes back and is in Run mode, that controller toggles its Claim bit, and the I/O switches back to that controller.
  - A “S:FS” XIC should be used to disable Claim/Ready bits until the controller has entered Run mode and can evaluate if it should make a Claim or Ready transition.
  - Failure to do this could lead to a ‘claim’ happening before the controller is back in Run mode. Thus, the output would transition briefly to its Program Mode Safe State prior to entering Run mode rather than making a smooth transition from secondary controller back to primary controller.
- When the secondary controller sees that the primary controller has retaken ownership, it clears its Claim bit and goes back to Ready.
- Monitor for Connection Loss on controller. Add GSV to monitor connection status and clear Claim and Ready flags on Connection Loss to prevent undesired behavior when connection is restored.
- Monitor for Major Fault on controller. Optionally, add Fault Routine to clear Claim and Ready owner flags if Major Fault is not to be cleared in faulted controller to allow secondary controller to take immediate control.

Configure the Output Module

In a redundant owner application, configure one output module as Redundant Owner A and the second as Redundant Owner B. In our example project, Redundant Owner A is the module connected to Ethernet A, and Redundant Owner B is the module connected to Ethernet B.

1. In the Module Definition dialog box, in the Connection field, choose Redundant Owner A.



2. To configure the second output module as Redundant Owner B, repeat steps 1, choosing Redundant Owner B.

   The module definition is shown in the Module Properties dialog box.

Follow these steps to implement Redundant Ethernet modules in your project.

1. Add the additional I/O configuration to your project for the second Ethernet module.

   In the example project, this is EN2T_B.

   To simplify testing you may want to create a project just for the redundant Ethernet modules and test that project before adding in your application code.

   We recommend following the module naming examples used in the example project.

   - Ethernet module in Slot 0: EN2T_A_<your name for the chassis>
   - Ethernet module in Slot 1: EN2T_B_<your name for the chassis>
   - Reference the example application for more naming examples
2. Add in the task for I/O_Mapping_25ms.
3. Set the periodic rate of this task to 25 ms or a multiple of the fastest output module RPI.
4. Import the example Program into the I/O_Mapping_25ms task.

5. For each chassis that you have in your system, modify the imported routines.

   In the example project, the routines are called R001, R002, and so on. One chassis per routine.

6. Add an I/O module to the chassis routines.
7. For each digital input module you have in the chassis, insert an Add-On Instruction.

   You can download Add-On Instructions for 1756 Redundant I/O Ownership from the Product Compatibility and Download Center.

8. If the digital input module is only 16 channels, set the I16_Ch tag to 1 (true).

   This will limit input processing to the first 16 Booleans and reduce controller scan time.

   If you have a digital module that is not compatible with any of the Add-On Instructions from the example project, you can use the Redundant_Digital_Input Add-On Instruction to map each channel individually. You can also create your own Add-On Instruction for the module.

9. Add the default value for each channel to the Add-On Instruction.

   The default value is the value the input will be set to when communication through both Ethernet modules to the input module is faulted.

10. Insert a rung with two CPS (Synchronous Copy File) instructions for each Digital Output module that you have in the chassis.

    In the example project, the rung number was equal to the slot number of the module being referenced. We used rungs with only an NOP (No Operation) instruction to hold the rung number for slots without an analog module.

11. In each routine add rungs for the analog modules that you have.

    Most analog modules have their own Add-On Instructions. You can download Add-On Instructions for 1756 Redundant I/O Ownership from the Product Compatibility and Download Center.

    Be aware of the channel count of the AOI and module.

    - If the analog module is in Differential mode, the channel count is cut in half.
    - If you have an analog module that is not compatible with any of the Add-On Instructions from the example project, you can use the Redundant_Analog_Input Add-On Instruction to map each channel individually. You can also create your own Add-On Instruction for the module.
    - In the example project, the rung number was equal to the slot number of the module being referenced. We used rungs with only an NOP (No Operation) instruction to hold the rung number for slots without an analog module.

12. Keep the Add-On Instruction at Hold Last State or set Hold Last State to 0 (zero) to use the default value.
13. Add the default value for each channel to the Add-On Instruction.

    The default value is the value the input will be set to when communication through both Ethernet modules to the input module is faulted.

Response Times for Output Modules

Response time to a change in ownership is from the time the event takes place until the time that the output modules uses the connection data from the redundant connection.

Digital output response to a change in ownership in less than 250 ms. The average time is 220 ms. A faster RPI does not increase the response time. We recommend a digital output RPI of 25 ms.

These recommendations are for response performance:

- Faster RPIs have a longer response time.
- Slower RPIs can have a much longer response time.
- RPIs should be 4 x RPI = 200 ms, 8 x RPI = 200 ms, or 16 x RPI = 200 ms, so 25 is the recommended RPI.
- If the prior RPI criterion is not met, the CIP connection timeout delay minimum will be 200 ms + 1 RPI. If the 4/8/16 x RPI does not equal 200 ms (or 100 ms), then the response will be longer.
- For non-redundant ControlLogix applications, the CIP connection timeout delay minimum is 100 ms.
- Slower RPIs greatly limit the effect of the response time on the application.

IMPORTANT This information pertains only to output modules.
Use existing guidelines for setting input module RPIs.

Input Modules

Only a received 0-to-1 transition, and not simply the receipt of a new connection, is considered such a transition for ownership.

Many ControlLogix® 1756 input modules support multiple owners.

Table 20 lists bulletin number 1756 input modules that **do not** support multiple module owners.

IMPORTANT You must use input modules that support multiple owners.

Table 20 - Input modules that do not support multiple owners

Catalog Number	Module Type	Replacement Module
1756-IR12, 1756-IR12K	Analog Input, 12-channel RTD	Must replace with a 1756-ITR8I module and use in 1756-IR6I compatibility mode. You lose 6 channels and inputs are isolated.
1756-IT16, 1756-IT16K	Analog Input, 16-channel non-isolated thermocouple/mV	Replace with 1756-IRT8I, 1756-ITR8IK module and use in 1756-IT6I or 1756-IT6I2 compatibility mode.
1756-IRT8I, 1756-IRT8IK	Analog Input, 8-channel thermocouple or RTD isolated	Must use in 1756-IR6I or 1756-IT6I compatibility mode. You lose 2 channels and all of the new features of the 1756-IRT8I module. Use the 1756-ITR8I module in a remote I/O chassis and 1756-IR6I or 1756-IT6I module in Logix Designer I/O configuration.
1756-IF8I, 1756-IF8IK	Analog Input, 8-channel current or voltage isolated	Must use in 1756-IF6I or 1756-IF6CIS compatibility mode: • In 1756-IF6I compatibility mode, you lose 2 channels and all of the new features of the 1756-IF8I module. • In 1756-IF6CIS compatibility mode, you lose 2 channels and the module can be used as a source configuration. Use the 1756-IF8I in a remote I/O chassis and the 1756-IF6I or 1756-IF6CIS in the Logix Designer I/O configuration.
1756-IB16ISOE	Sequence of Events Digital Input	–
1756-IF16IH	16 isolated differential inputs, 1 HART modem per channel	Use 1756-IF16H.
1756-IF8IH	8 isolated differential inputs, 1 HART modem per channel	Use 1756-IF8H. Both are non-isolated. You can use differential mode input wiring for isolation.
1756-IF4FXOF2F	High-speed input/output analog module	–

Troubleshooting

Issue: I/O Module Connection Error **or** I/O Module Configuration Error (yellow triangle in Logix Designer I/O configuration)

1. Verify that both entries in the Logix Designer I/O Configuration have the same **RPI**.
2. Verify that both entries in the Logix Designer I/O Configuration have the same **configuration**.

   You can toggle the Sync_Module_Config BOOL tag in the IO_Mapping Program MainRoutine Rung 1. This will trigger a copy of the module A configuration to the module B configuration, making them the same.

   IMPORTANT This copy will not change the module RPI.
   The two I/O module entries must have the same configuration.

3. Remove the module from the chassis.
4. Reinsert the module.
5. If you still have the error, delete one of the module entries in the Logix Designer I/O Configuration and add it into your project again.

These troubleshooting steps **below** assume that the system was commissioned and running without any errors before the issue occurred.

Issue: Output is ON in the user application code, but is not ON at the Output module.

1. Verify that at least one of the connections to the output module is active.
2. Verify that the output is ON in the output module tags.
3. Confirm whether all of the connections in the chassis are faulted, including the Ethernet modules.
4. Troubleshoot the Ethernet communication issue to the Ethernet modules.
5. Troubleshoot the error code displayed in Module Properties > Connection tab.

   In the example project, this is EN2T_B.

Issue: Incorrect output behavior on response

1. Verify that only one of the connections to the Output module has the .OwnerClaim output set to true (1).
2. Verify that only one of the connections to the Output module has the .OwnerReady output set to true (1).

Name	Value	Style	Data Type	Description	Constant
Slot_0_Adapter:4:C	{...}		AB:1756_OF8I:C:0		☐
Slot_0_Adapter:4:I	{...}		AB:1756_OF8I_RedundantO...		☐
Slot_0_Adapter:4:O	{...}		AB:1756_OF8I_RedundantO...		☐
Slot_0_Adapter:4:O.Ch	{...}		AB:1756_OF8I_Struct:O:0[8]		
Slot_0_Adapter:4:O.OwnerClaim	1	Decimal	BOOL		
Slot_0_Adapter:4:O.OwnerReady	0	Decimal	BOOL		
Slot_1_Adapter:4:C	{...}		AB:1756_OF8I:C:0		☐
Slot_1_Adapter:4:I	{...}		AB:1756_OF8I_RedundantO...		☐
Slot_1_Adapter:4:O	{...}		AB:1756_OF8I_RedundantO...		☐
Slot_1_Adapter:4:O.Ch	{...}		AB:1756_OF8I_Struct:O:0[8]		
Slot_1_Adapter:4:O.OwnerClaim	0	Decimal	BOOL		
Slot_1_Adapter:4:O.OwnerReady	1	Decimal	BOOL		

For all of the issues described in this section, you can consult product manuals, Rockwell Automation KnowledgeBase, and Rockwell Automation Technical Support.

Configure ControlLogix Analog I/O Modules

IMPORTANT	This chapter describes how to configure your module with Studio 5000 Logix Designer® application, version 21 and later. You can use the ControlLogix® analog I/O modules in RSLogix 5000® software projects as well. You must install AOPs to use the modules in any Logix Designer application or RSLogix 5000 software project.

You must configure your analog I/O module upon installation. It does not work if it is not configured.

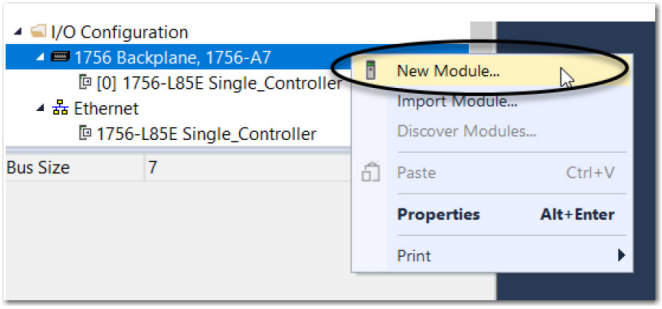
This section describes how to use the Logix Designer application to configure I/O modules in a local chassis. If you plan to use the I/O module in a remote chassis, you must add a ControlNet or EtherNet/IP communication module to the I/O configuration tree:

- For more information on the ControlLogix ControlNet module, see ControlNet Modules in Logix5000™ Control Systems, publication CNET-UM001.
- For more information on the ControlLogix EtherNet/IP bridge, see EtherNet/IP Modules in Logix5000 Control Systems User Manual, publication ENET-UM001.

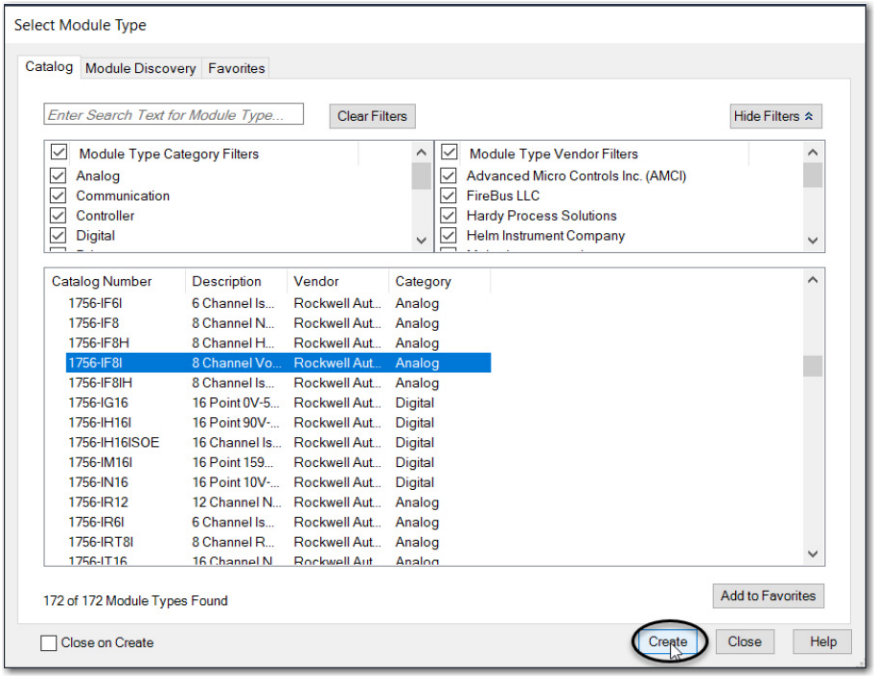
Create a New Module

After you create a Logix Designer application project, complete the following steps to create a module in the project.

1. Under I/O Configuration, right-click 1756 Backplane and choose New Module.



2. Select the module and click Create.



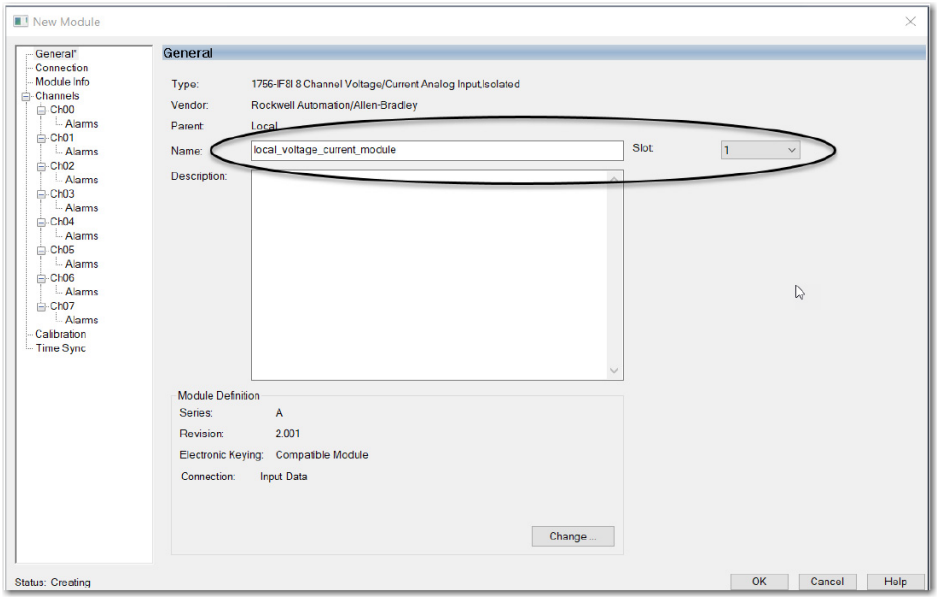
3. Click OK to accept the default major revision.

You can verify the revision of the module in RSLinx® Classic software.

The New Module dialog box appears.

4. On the General tab, name the module.

   Make sure that the slot number in the configuration matches the physical slot number of the chassis housing the module.

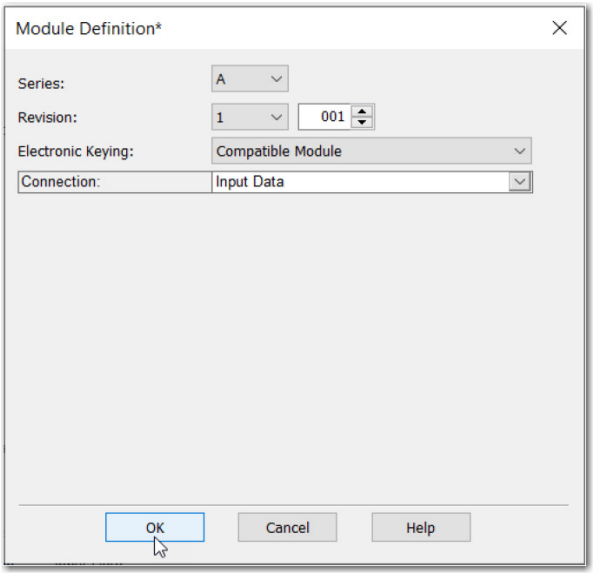


5. To accept the default configuration, click OK.

Module Definition

On the General tab, click Change to access the Module Definition dialog box. The following parameters are available on the Module Definition dialog box:

- Series - Module hardware series
- Revision - Module firmware revision
- Electronic Keying - For more information, see page 25.
- Connection - For more information, see page 102.



IMPORTANT When you use the Listen Only connection format, only the following tabs appear in the New Module dialog box:

- General
- Connection
- Module Info
- Time Sync

For more information on using the Listen Only connection format, see page 17.

Connection Type

The communication format determines the following for the module type you configure:

- Available configuration parameters
- Data type that is transferred between the module and the controller
- Which tags are generated when configuration is complete

The following table describes connection formats used with analog I/O modules.

Connection Type	Definition
Input Data	All available configuration, input and output data. This connection type creates all of the appropriate controller tags for the module type being used. For example, tags specific to a channel on the 1756-IRT8I, 1756-IRT8IK module using the RTD input type are different from those specific to a channel on the same module using the thermocouple input type.
Listen-only	Controller and module establish communication without the controller sending any configuration or output data to the module. A full input data connection is established but is dependent on the owner-controller's connection.

Edit the Configuration

You use the tabs in the New Module dialog box to edit module configuration. Some tabs show the same fields regardless of the module type you are configuring, and other tabs show fields specific to the module type.

The following tabs show the same fields regardless of module type. These tabs are not shown in this section:

- General (described on page 101)
- Connection
- Module Info
- Time Sync

The following tabs show fields specific to the module type:

- Configuration
- Calibration
- Alarm Configuration - Available with only the 1756-IF8I, 1756-IF8IK, 1756-IRT8I, and 1756-IRT8IK modules.
- CJ Configuration - Available with only the 1756-IRT8I, 1756-IRT8IK, 1756-IT16, and 1756-IT16K modules.
- Limit Configuration - Available with only the 1756-OF8I, 1756-OF8IK module.

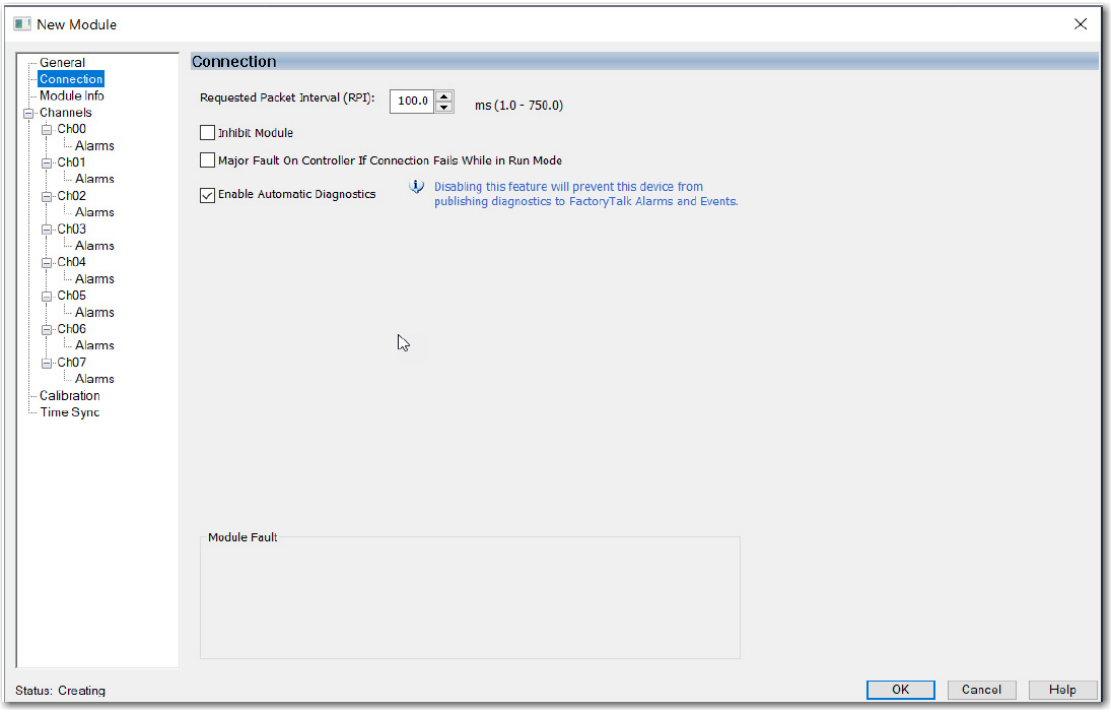
Connection Tab

The Connection tab lets you complete the following tasks:

- Set the RPI rate. For more information about the RPI, see page 13.
- Inhibit the module. For more information on inhibiting the module, see page 24.
- Configure whether a connection failure while the controller is in Run module causes a major or minor fault.

The Module Fault area of the Connection tab is useful during module troubleshooting. For more information on the Module Fault area, see page 147.

The configurable parameters on this tab do not differ by module type.



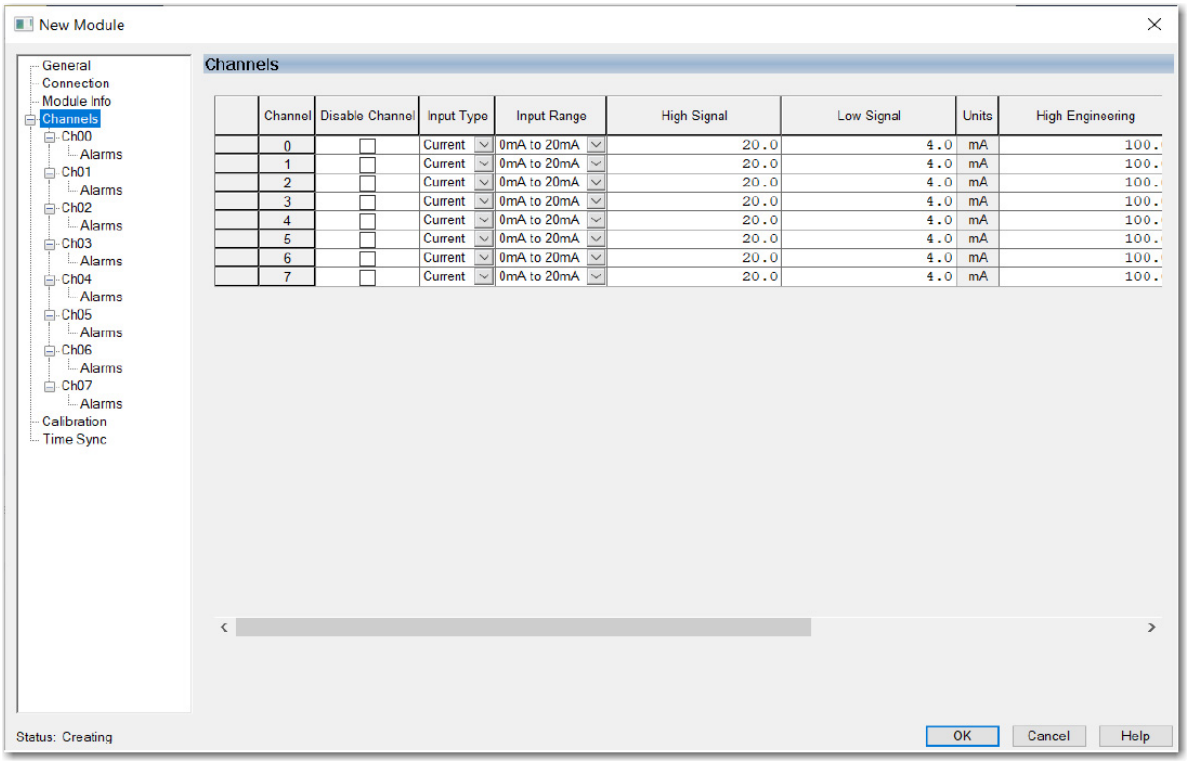
Configuration Tab

The fields on the Configuration tab are specific to the module type. The following are examples of tasks you complete via this tab:

- Select an input or output type.
- Select a module's operating range.
- Define scaling parameters.

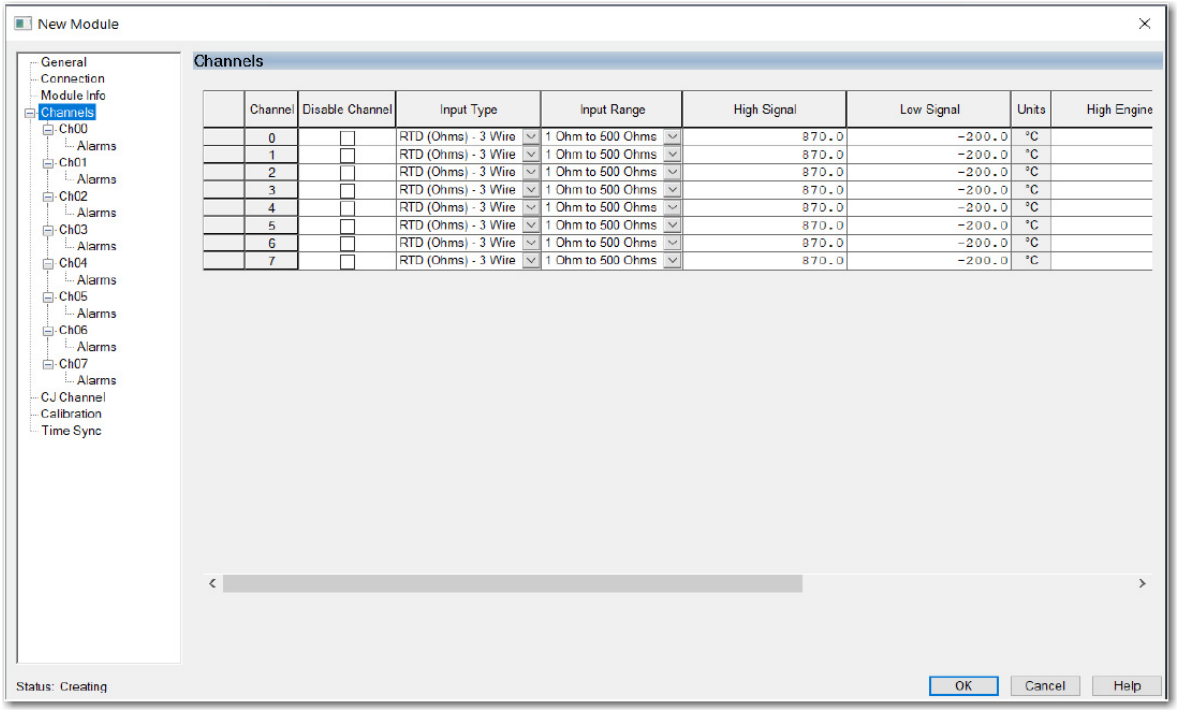
1756-IF8I, 1756-IF8IK Module

For information about configurable parameters, see Chapter 3 on page 35.



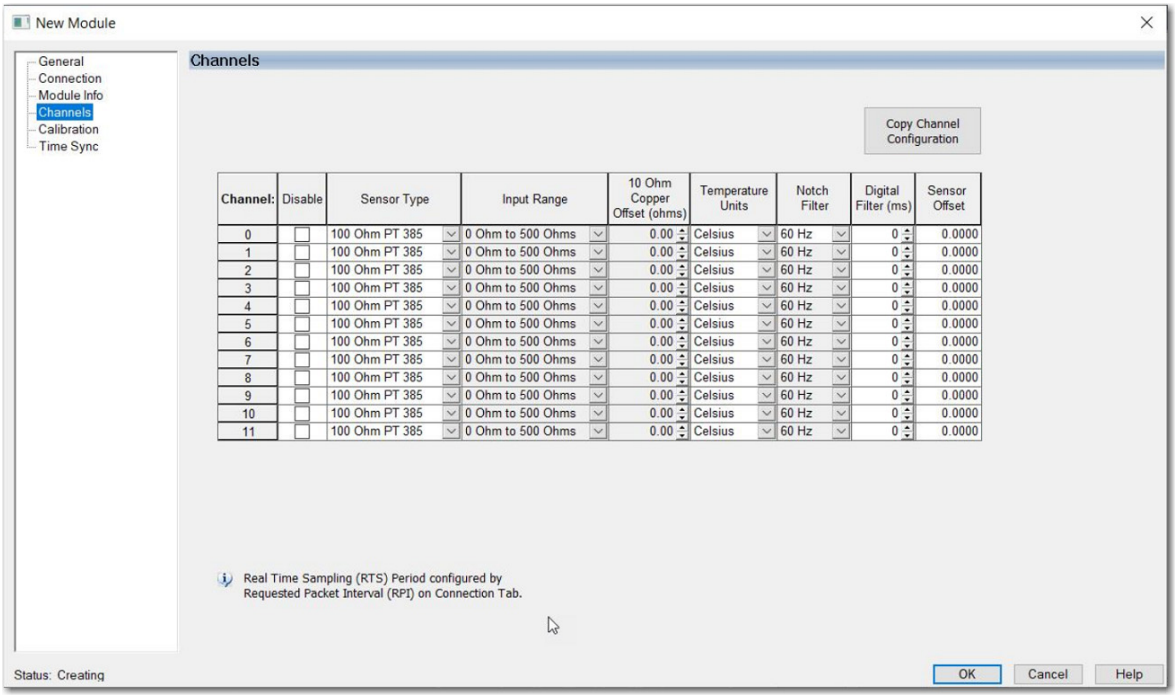
1756-IRT8I, 1756-IF8IK Module

For information about configurable parameters, see Chapter 4, Temperature-sensing Analog Modules on page 53.



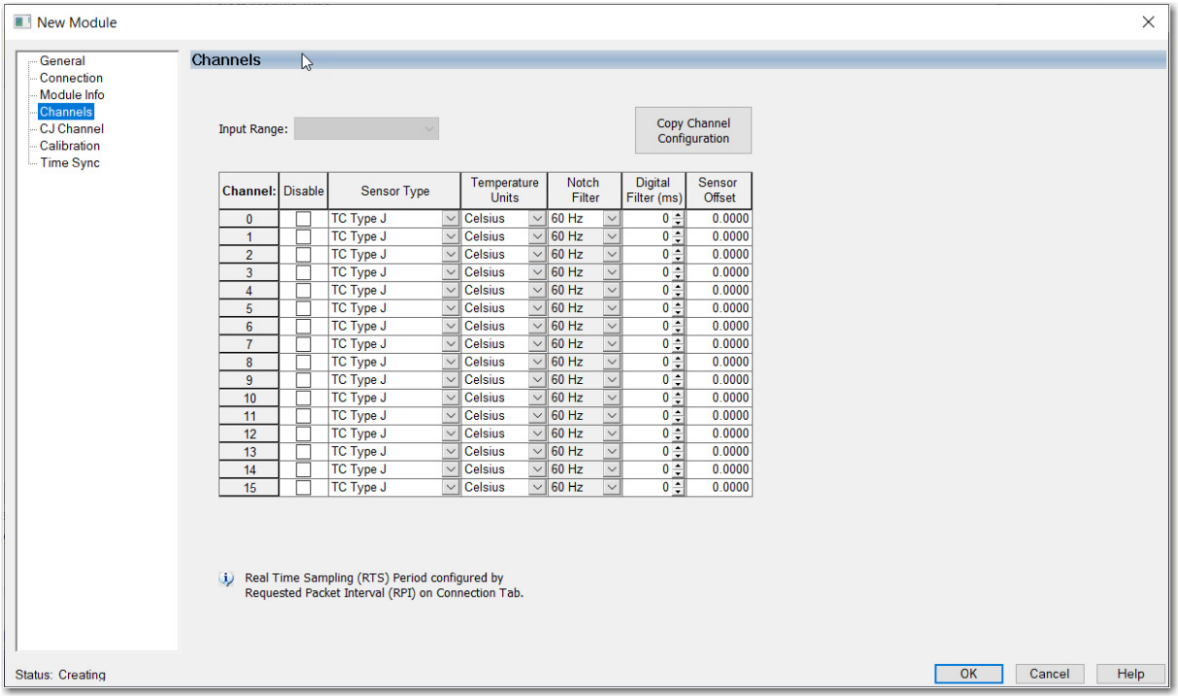
1756-IR12, 1756-IR12K Module

For information about configurable parameters, see Chapter 4 on page 53.



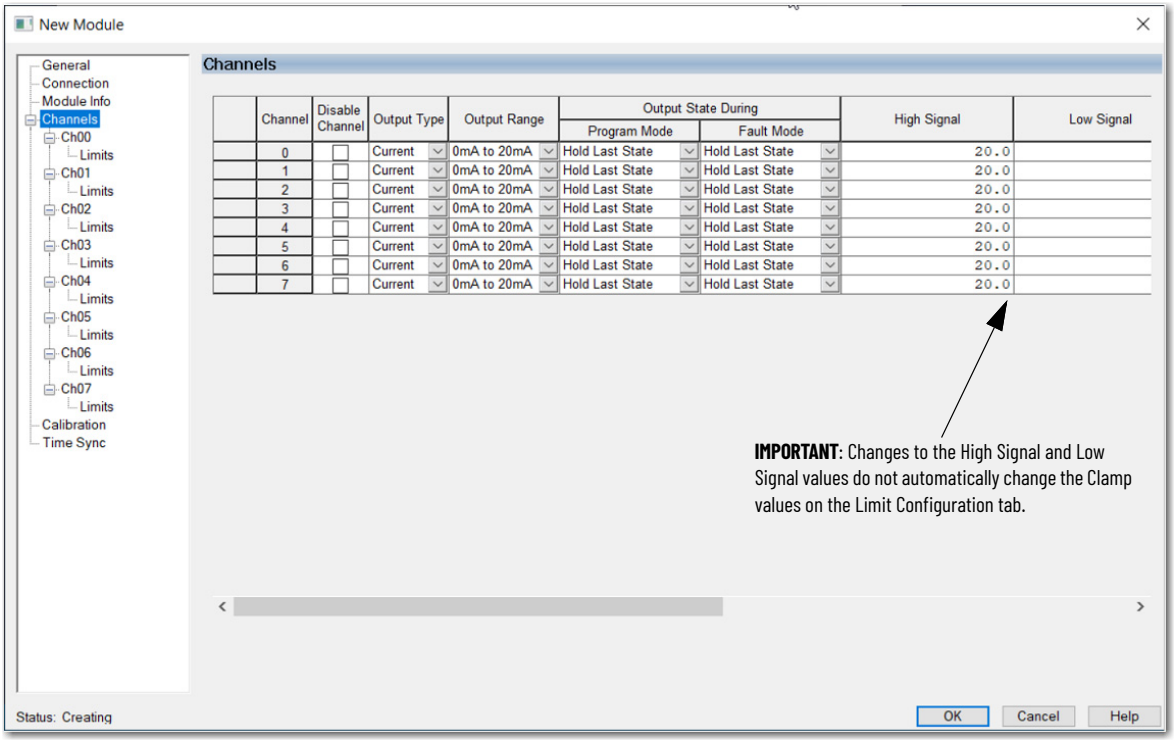
1756-IT16, 1756-IT16K Module

For information about configurable parameters, see Chapter 4 on page 53.



1756-OF8I, 1756-OF8IK Module

For information on this tab's configurable parameters, see Chapter 5 on page 81.



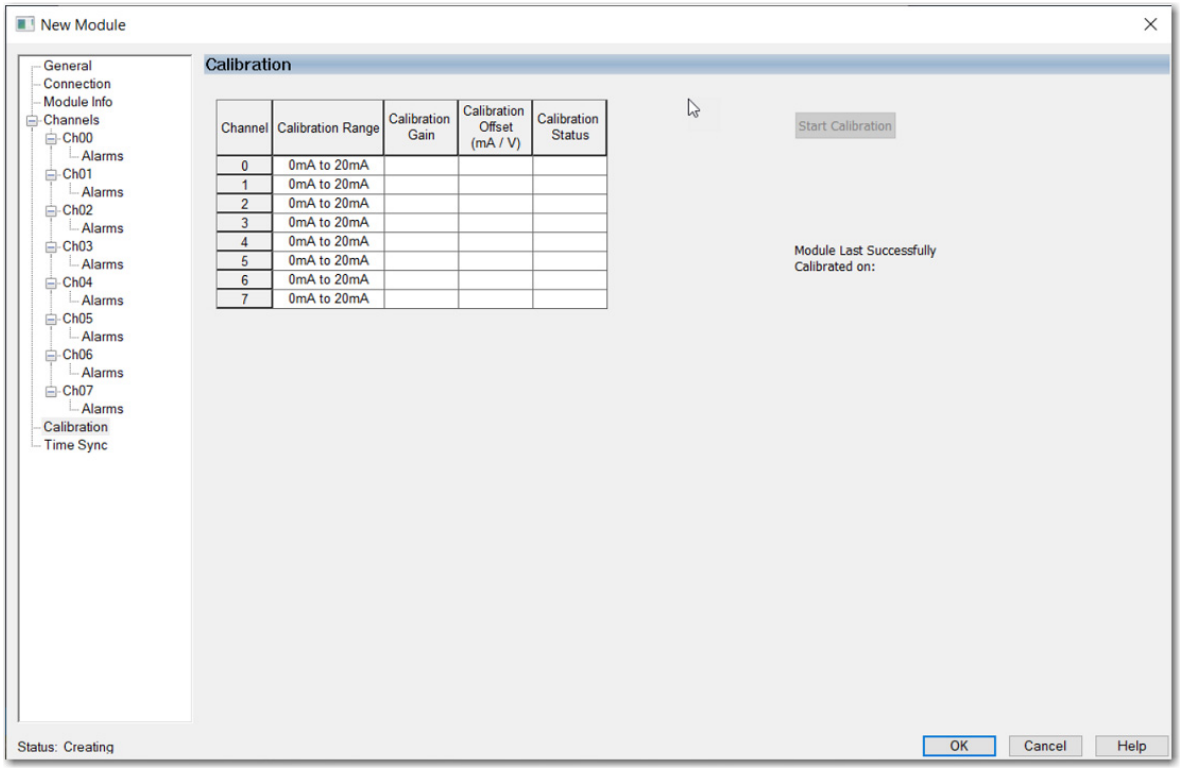
Calibration Tab

The Calibration tab lets you recalibrate the module. Calibration corrects any hardware inaccuracies on a module.

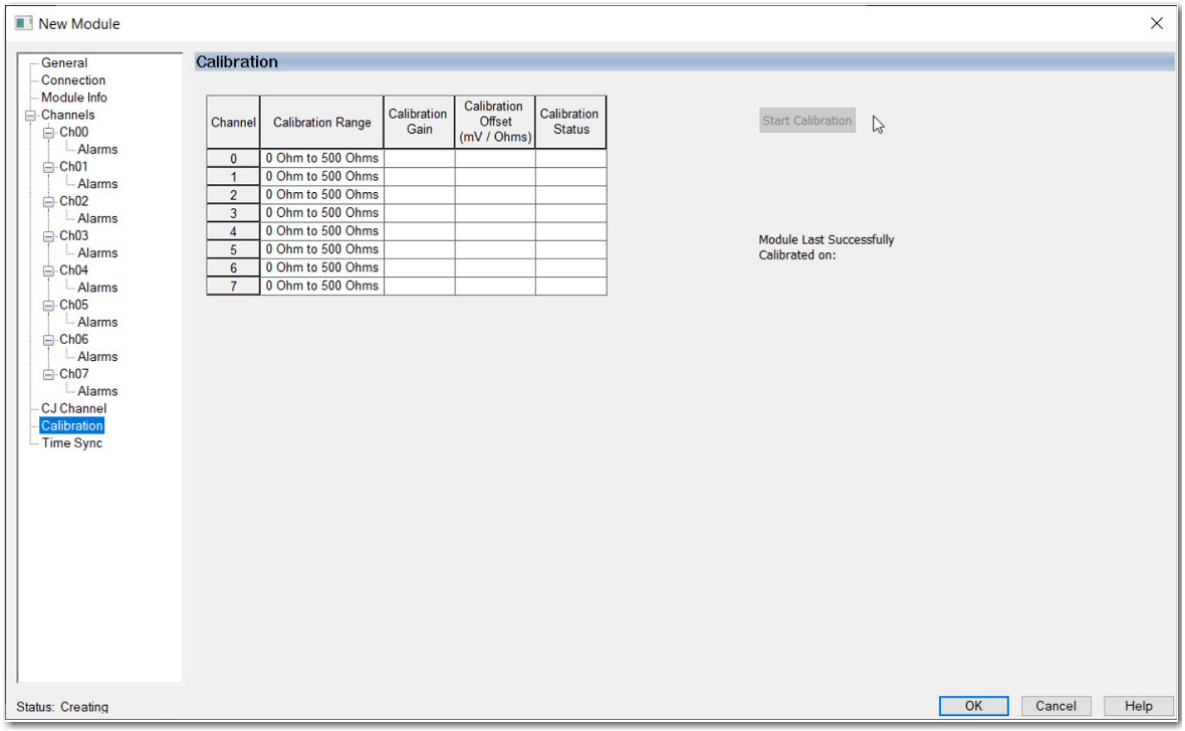
IMPORTANT	The analog I/O modules do not **require** recalibration after operating in an application.

For information about how to configure each module type, see Chapter 7 on page 117.

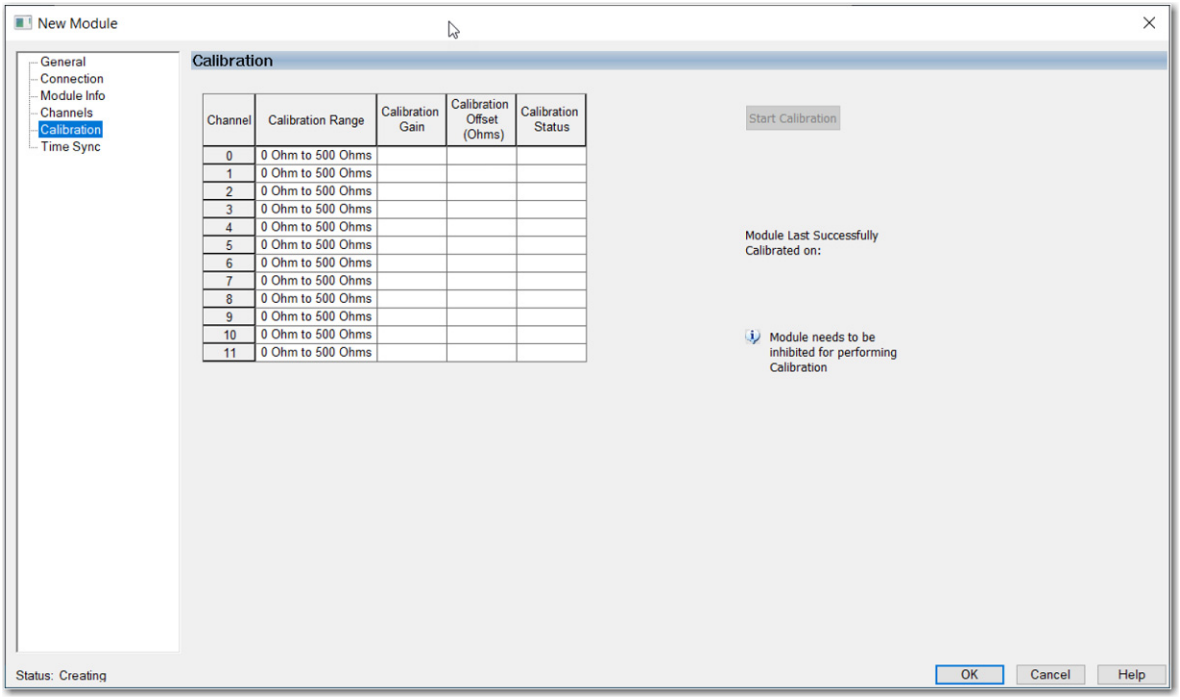
1756-IF8I, 1756-IF8IK Module



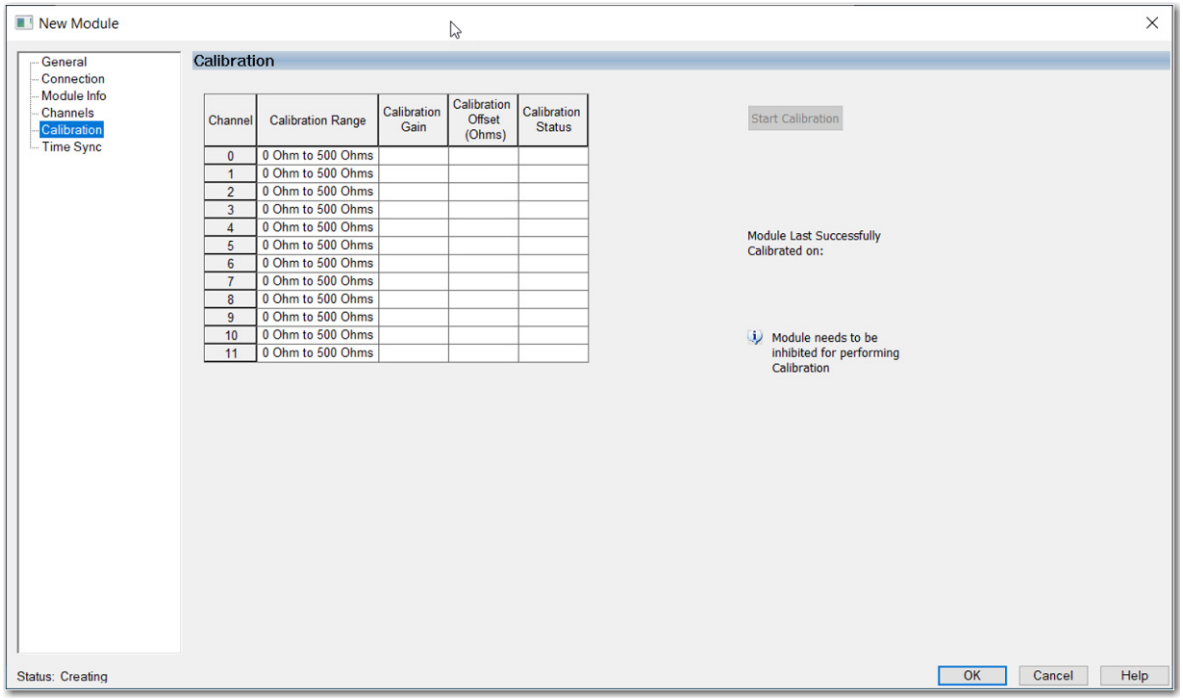
1756-IRT8I, 1756-IRT8IK Module



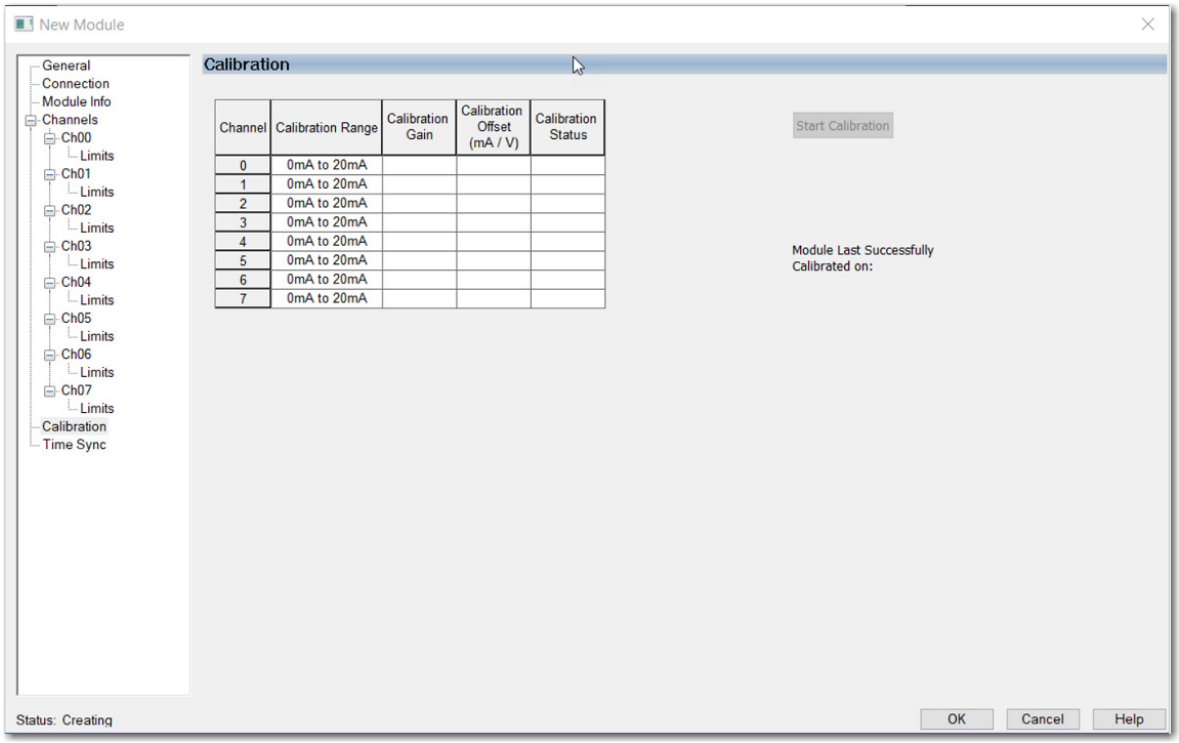
1756-IR12, 1756-IR12K Module



1756-IT16, 1756-IT16K Module



1756-OF8I, 1756-OF8IK Module



Alarm Configuration Tab

The 1756-IF8I, 1756-IF8IK, 1756-IRT8I, 1756-IRT8IK modules support alarms. The fields on the Alarm Configuration tab are specific to the module type. The following are examples of tasks you complete via this tab:

- Disable alarms.
- Set alarm parameters.
- Set rate limits.

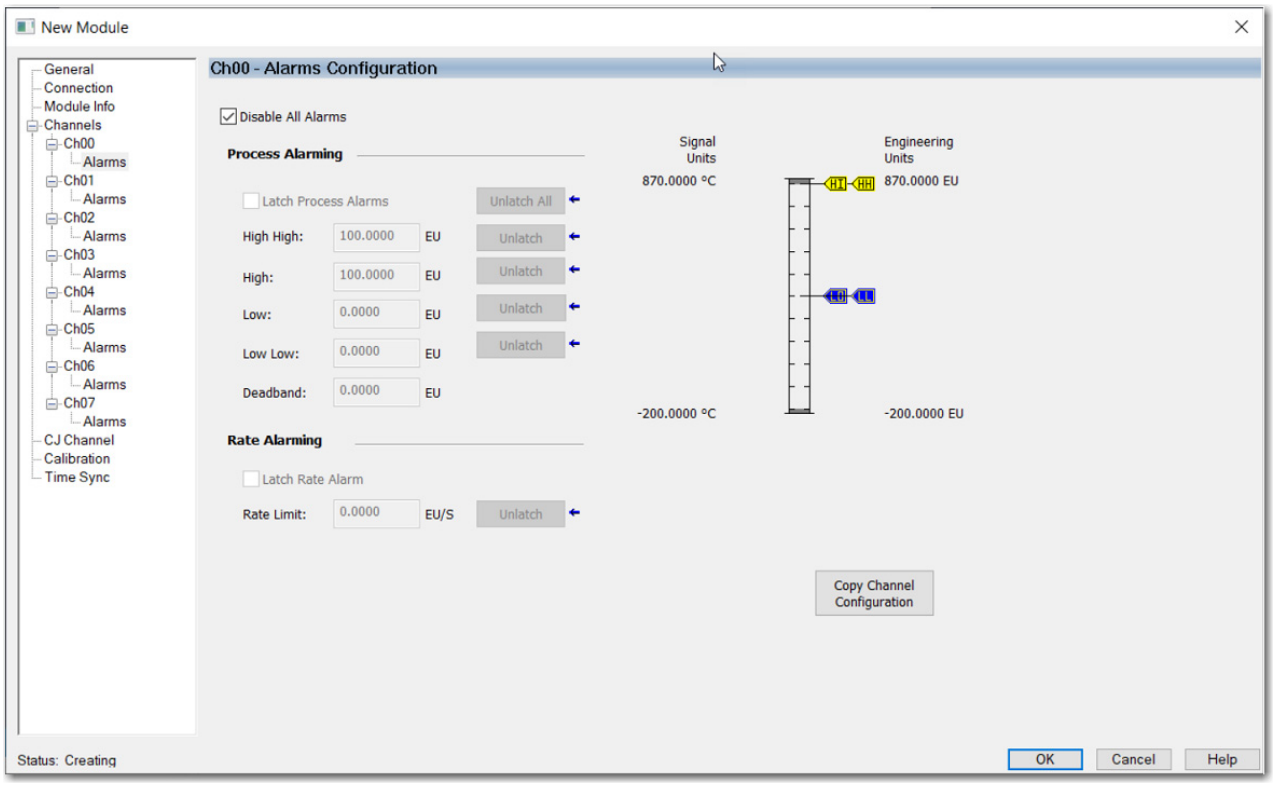
This tab is available only for input modules.

1756-IF8I, 1756-IF8IK Module

For information about configurable parameters, see Chapter 3 on page 35.

1756-IRT8I, 1756-IRT8IK Module

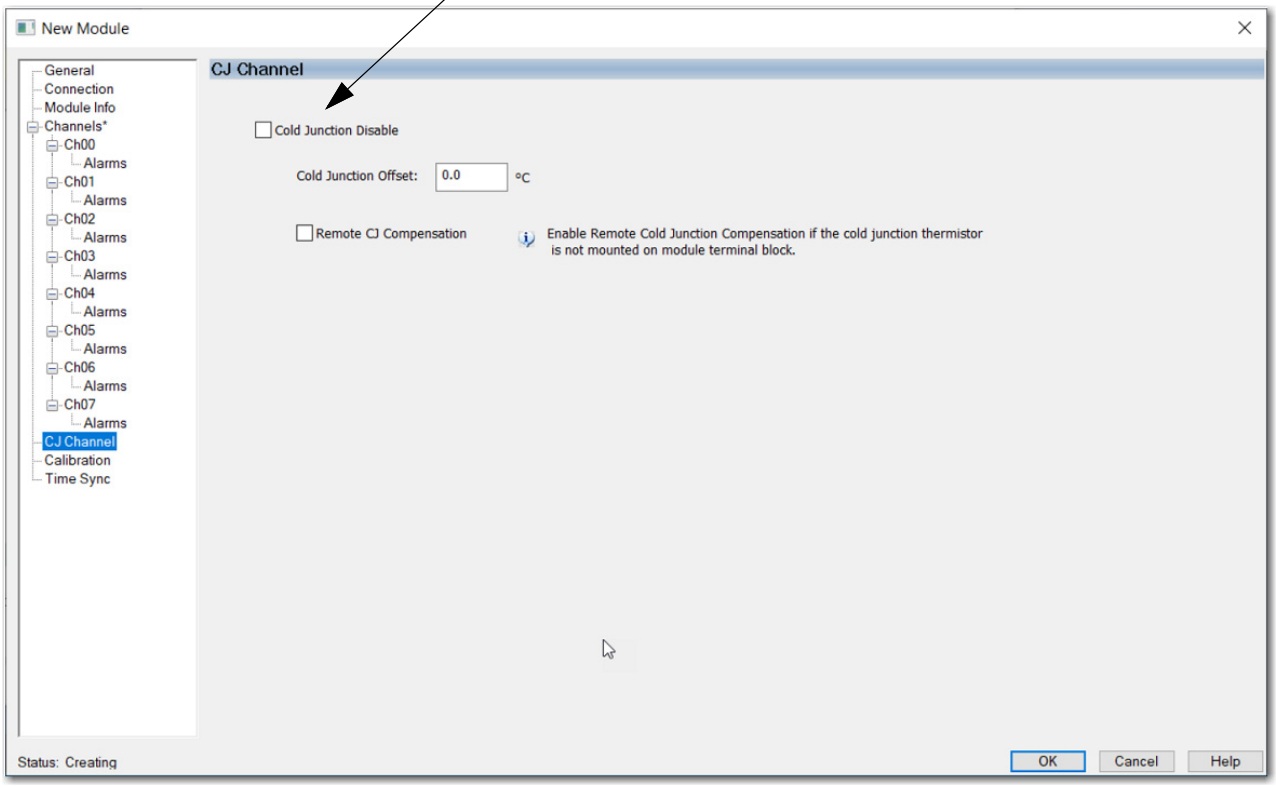
For information about configurable parameters, see Chapter 4 on page 53.



CJ Configuration Tab

The CJ Configuration tab is available with the 1756-IRT8I, 1756-IRT8IK, 1756-IT16, and 1756-IT16K modules. You use this tab to configure the cold junction compensation option.

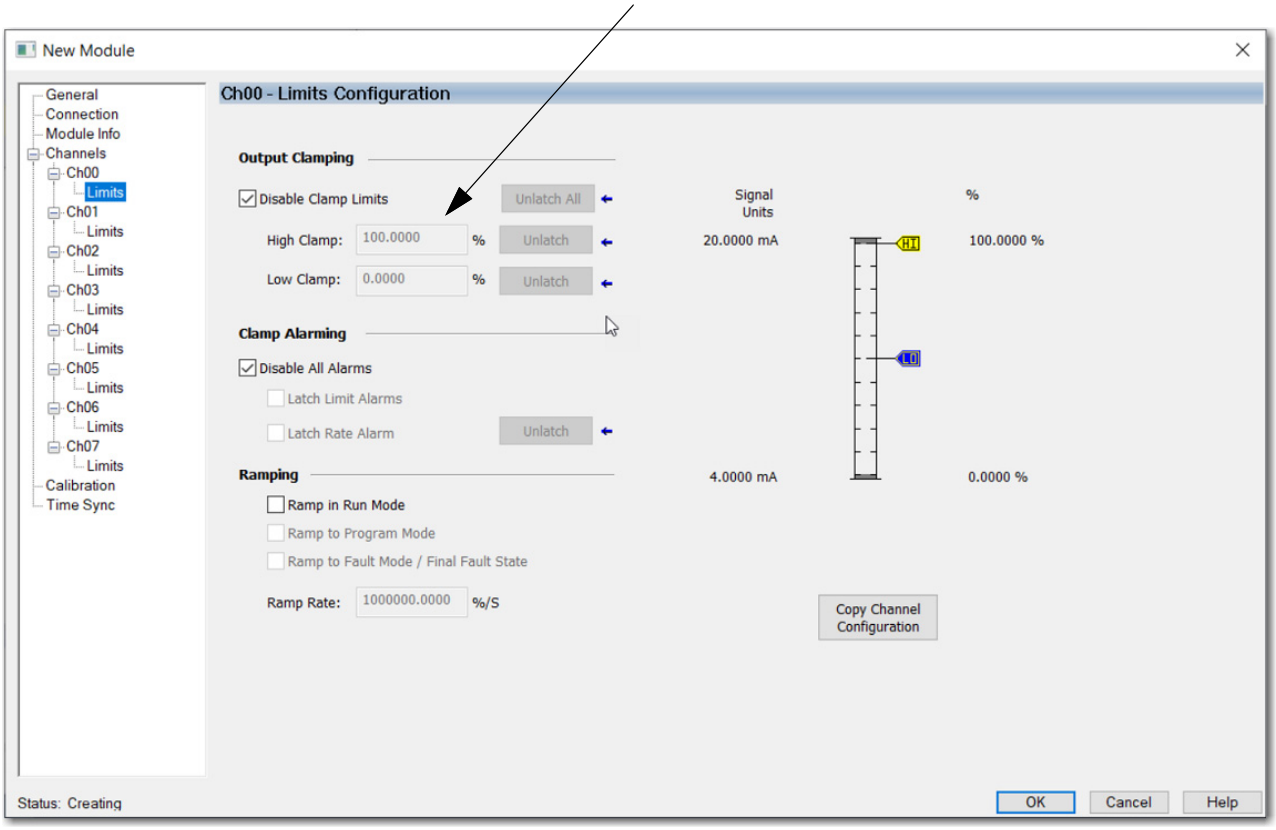
IMPORTANT: If all channels on the module use the RTD input type, the Cold Junction Disable option appears dimmed and the checkbox is automatically checked.



Limit Configuration Tab

The Limit Configuration tab is available with only the 1756-OF8I, 1756-OF8IK module. You use this tab to configure clamp limits and module ramping

IMPORTANT: Changes to the High Signal and Low Signal values on the Limits tab do not change the High Clamp and Low Clamp values on this tab when clamp limits are enabled.



Copy Channel Configuration

The Copy Channel Configuration feature lets you quickly and easily use the same configuration across multiple channels on a module. You can configure channel parameters on Module Properties dialog box and copy them to other channels.

Copy Channel Configuration is available on the Module Properties dialog box tabs as follows for the ControlLogix analog I/O modules:

- 1756-IF8I, 1756-IRT8I, 1756-IR12, 1756-IT16 modules:
  - Configuration tab
  - Alarm Configuration tab
- 1756-OF8I module:
  - Configuration tab
  - Limit Configuration tab

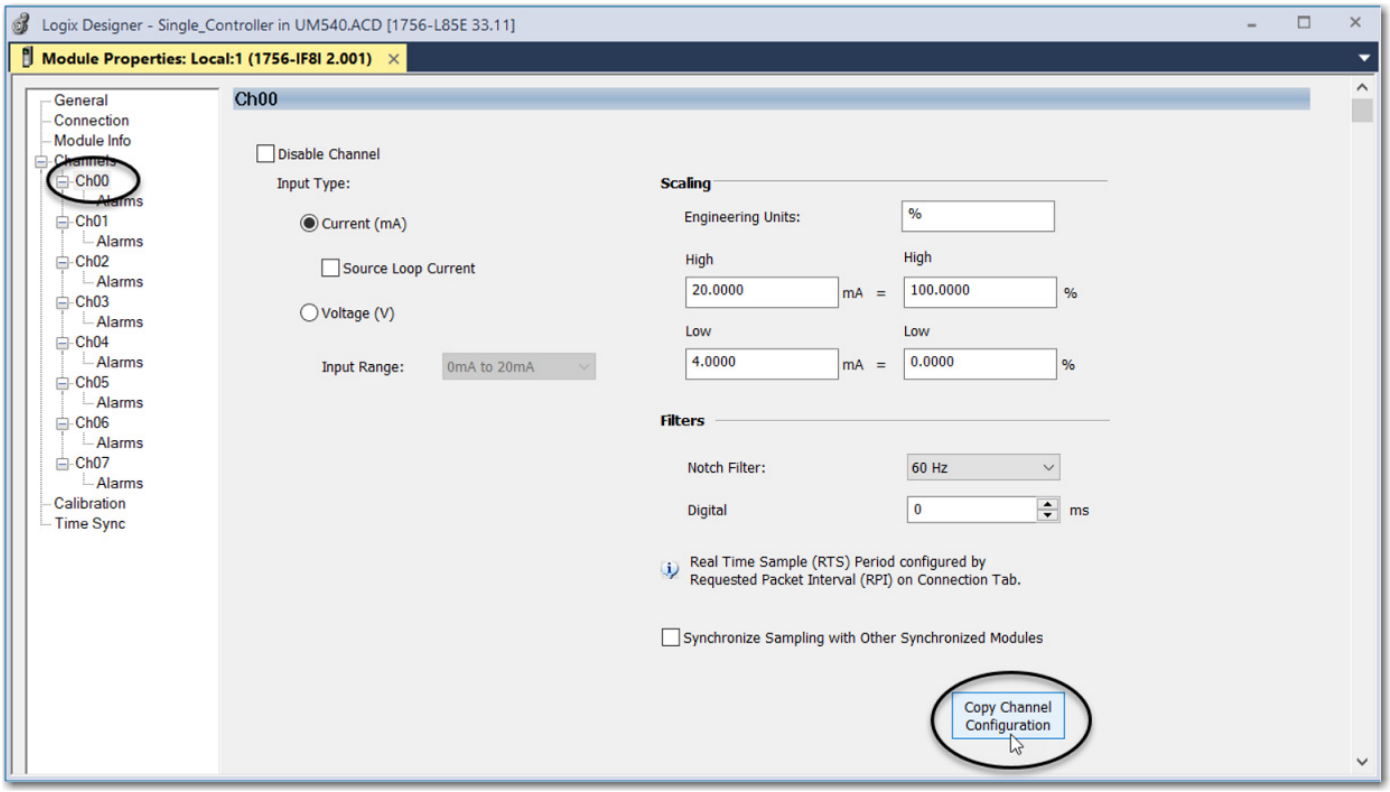
The Copy Channel Configuration feature copies all channel configuration from one channel to one or more other channels. For example, if you use the Copy Channel Configuration feature on the Configuration tab for a 1756-IF8I module, the configuration values on the Configuration tab and the Alarm Configuration tab are copied to the selected channels.

Complete the following steps to copy channel configuration from one channel to others.

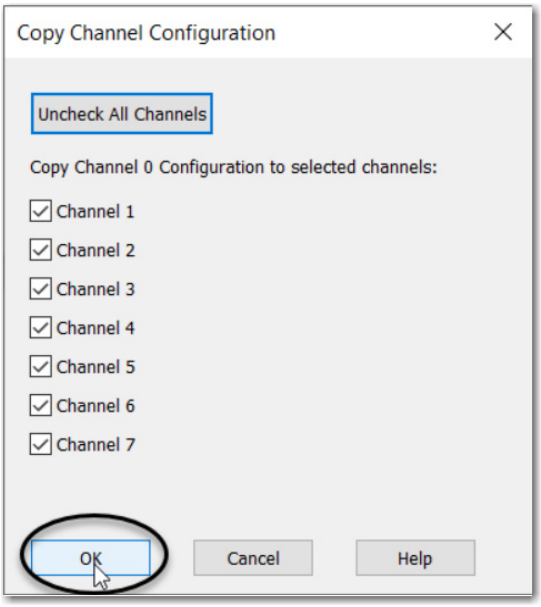
1. Verify that your controller is not in Run mode.

   If so, change it to Remote Run, Remote Program, or Program mode, as applicable to your system.
2. Access the Module Properties dialog box.
3. Click the Configuration tab and make the required configuration changes.

   In this example, the channel 0 configuration for a 1756-IF8I module is copied to all other channels on the module.
4. Click Copy Channel Configuration.



5. Click the channels to which you want to copy channel configuration and click OK.



The configuration is copied to the other channels.

6. Click OK or Apply for the new channel configuration to take effect

You can apply configuration changes to the first channel, as described in step 3, before moving to the next step and copying channel configuration.

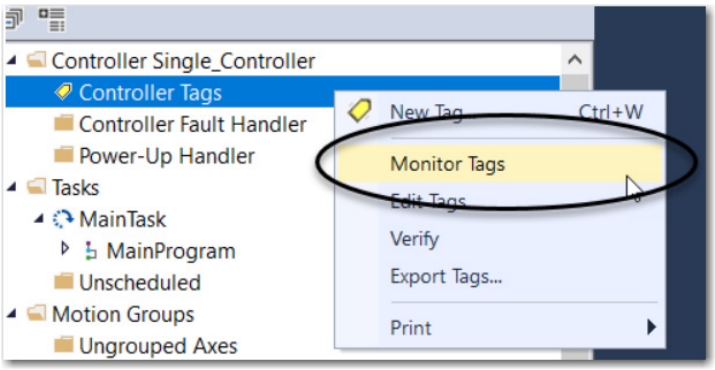
We recommend that you copy channel configuration before applying the changes. In this manner, the controller sends the changes to the module only once and, therefore, needs to make only one connection to the module.

View the Module Tags

When you create a module, the Logix Designer application creates a set of tags that you can view in the Tag Editor. Each configured feature on your module has a distinct tag that is available for use in the controller's programming logic.

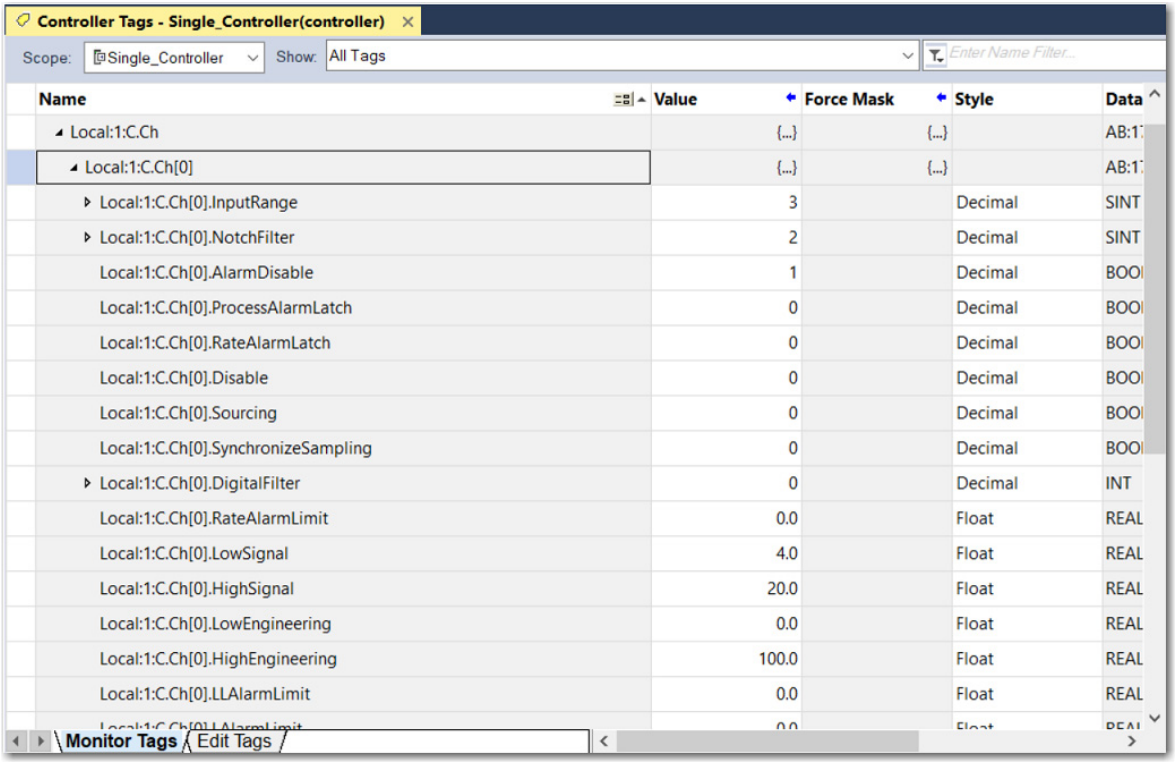
Complete these steps to access the tags in a module.

1. In the Controller Organizer, right-click Controller Tags and choose Monitor Tags.



The Controller Tags dialog box appears with data.

2. Expand a channel to view module tags as shown in the following graphic.



For more information on module tags, see Appendix A, Analog I/O Module Tag Definitions on page 157.

Notes:

Calibrate the ControlLogix Analog I/O Modules

The ControlLogix® analog I/O modules are calibrated during the manufacturing process. Each module's accuracy remains high throughout its lifespan.

IMPORTANT	You are **not required** to calibrate the module at any point in its lifespan. This chapter describes the tasks that are associated with module calibration if you choose to calibrate the module at any point in their lifespan.

Before you can calibrate the module, you must add the module to your Studio 5000 Logix Designer® project as described in Chapter 6.

You calibrate analog I/O modules on a channel-by-channel basis or with the channels grouped together.

If you choose to calibrate your module, we recommend the following:

- Calibrate all channels on your module each time you calibrate.

  This maintains consistent calibration readings and improves module accuracy.
- Use an extra 1756-TBCH RTB to calibrate your module.

Difference between Calibrating an Input Module and an Output Module

Although the purpose of calibrating analog modules is the same for input and output modules, to improve the module's accuracy and repeatability, the procedures that are involved differs for each:

- When you calibrate input modules, you use current, voltage, or ohms reference signals to send a signal to the module to calibrate it.
- When you calibrate output modules, you use a digital multimeter (DMM) to measure the signal that the module is sending out.

To maintain the factory calibration accuracy of your module, we recommend instrumentation with the specifications listed in Table 21. A high-resolution DMM can also be used to adjust a voltage/current calibrating source to its value.

Table 21 - Calibration Instrumentation Specifications

Module	Channel Input Type	Recommended Instrument Specifications
1756-IF8I, 1756-IF8IK	Current (mA)	1.00…20.00 mA source ±100 nA current
	Voltage (V)	0…10V source ±2 µV voltage
1756-IRT8I, 1756-IRT8IK	RTD	1.0…487.0 Ω resistors ±0.01%
	Thermocouple (mV)	0…100 mV source ±0.5 µV
1756-IR12, 1756-IR12K	RTD	1.0…487.0 Ω resistors ±0.01%
1756-IT16, 1756-IT16	Thermocouple (mV)	0…100 mV source ±0.5 µV
1756-OF8I, 1756-OF8IK	Current (mA)	DMM with resolution better than 0.15 µA
	Voltage (V)	DMM with resolution better than 1.0 µV

IMPORTANT Do not calibrate your module with an instrument that is less accurate than those recommended. The following events can result:

- Calibration appears to occur normally but the module gives inaccurate data during operation.
- A calibration fault occurs, forcing you to abort calibration.
- The *I.Ch[x].CalibrationFault* tag is set for the channel you attempted to calibrate.

You can clear the tag by completing a valid calibration or cycling power to the module. In this case, you must recalibrate the module with an instrument as accurate as recommended.

Calibrate Via Profile or Ladder

Your project must be online with the controller to calibrate ControlLogix analog I/O modules via the software. You can calibrate in the following conditions:

- Via ladder logic by using the output tags: place the controller in Run mode-either Remote Run or Run mode.

  Use the output tags to calibrate the module by initiating calibration and providing/recording the low and high calibration reference points.

  The input/output range to be calibrated must be what the module is configured for when the calibration is initiated when calibrating via the output tags.

  We recommend that a special calibration program is used when calibrating with the output tags to make sure that the channels under calibration are not being used for active control.
- Via the module profile: place the controller in Program mode, either Remote Program or Program mode or inhibit the connection from the controller.

  This is required to calibrate the 1756-IR12, 1756-IR12K, 1756-IT16, or 1756-IT16K via the profile as they are input only modules that do not have a sense of Program mode.

  These analog modules cannot be calibrated via the module profile while in Run mode.

IMPORTANT	The module freezes the state of each channel and does not update the controller with new data until after the calibration ends. This could be hazardous if active control were attempted during calibration.

Calibrate the Input Modules

Input calibration is a multi-step process. You apply low and high signal references to the module at different steps in the process.

Topic	Page
Calibrate the 1756-IF8I, 1756-IF8IK Module via the Profiles	120
Calibrate the Temperature-sensing Modules	125

Calibrate the 1756-IF8I, 1756-IF8IK Module via the Profiles

You can calibrate the 1756-IF8I module for use with the following input types:

- Current (mA)
- Voltage (V)

IMPORTANT This section shows how to calibrate the 1756-IF8I, 1756-IF8IK module for use with only voltage inputs.

The calibration process is generally the same if you calibrate the module for use with current inputs except for the following differences:

- You connect a current calibrator to the module.
- The low reference signal applied to the module = 4 mA.
- The high reference signal applied to the module = 20 mA.

Calibrate the Module For Voltage Input Type

During voltage calibration, 0.0V and +10.0V external references are applied to the module's channels. The module records the deviation from these reference values and stores it as calibration constants in the module's firmware.

The internal calibration constants are then used in every subsequent signal conversion to compensate for circuit inaccuracies, including the input amplifier, resistors, and the A/D convertor.

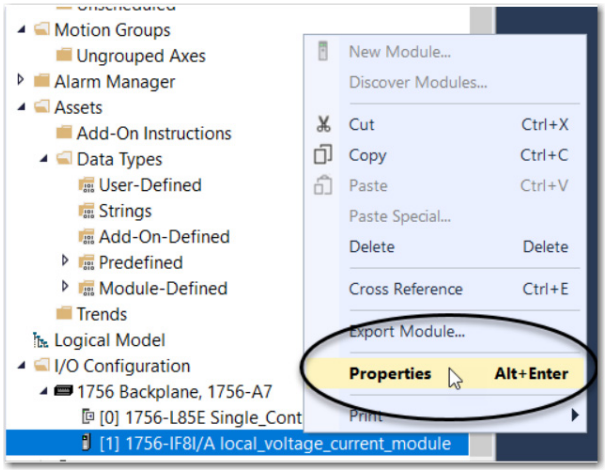
The module offers three input voltage ranges:

- -10...10V
- 0...5V
- 0...10V

IMPORTANT Regardless of the input voltage range selected prior to calibration, all voltage calibration uses the -10...10V range.

Follow these steps to calibrate your module.

1. Connect your voltage calibrator to all module channels being calibrated.
2. Go online with your project.
3. Right-click the module you want to calibrate and choose Properties.



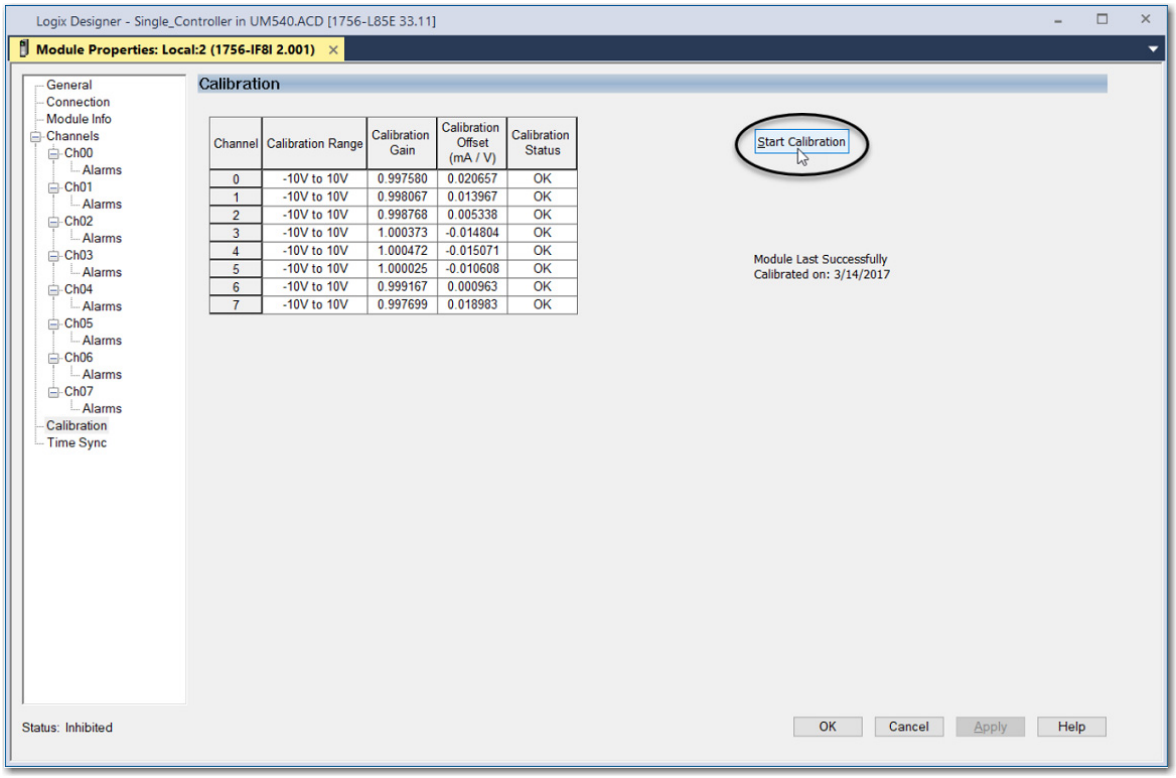
4. On the Configuration tab, make sure the Input Type for each channel to be calibrated is set to Voltage (V).

   The input range selection does not impact calibration.

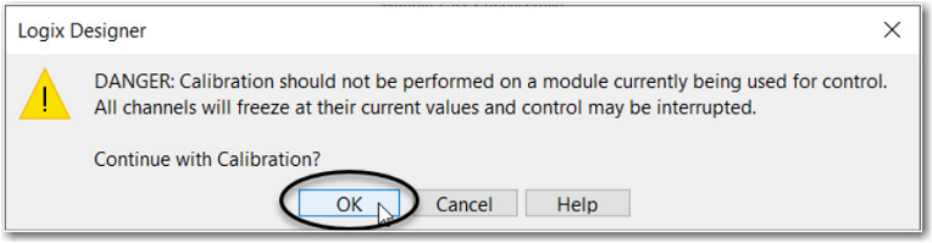
5. Make sure that the controller is in Program Mode or the Connection is Inhibited (available via the Connection tab).

   The 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K modules can only be calibrated when the Connection is inhibited.

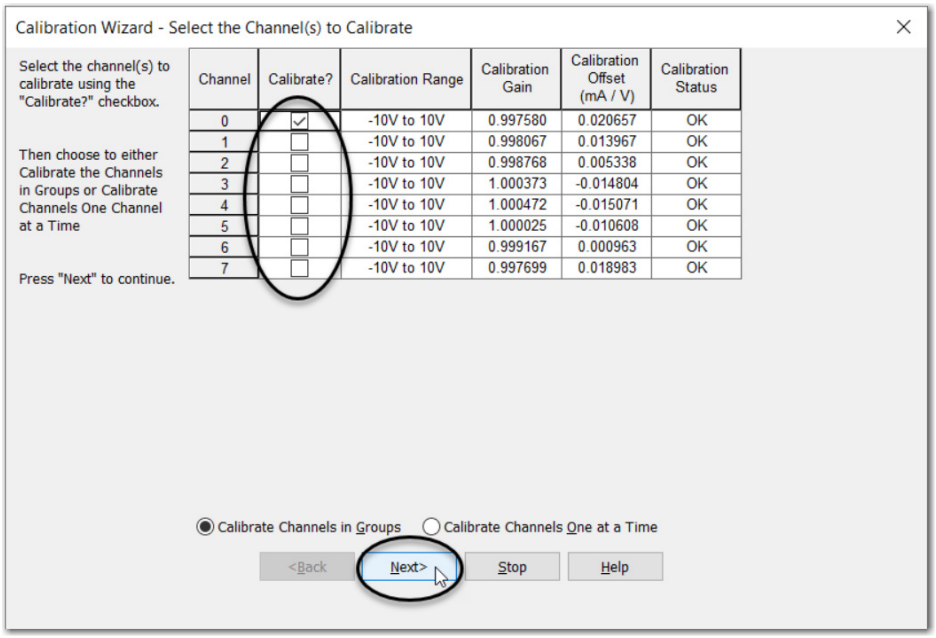
6. On the Calibration tab, click Start Calibration.



7. Verify the warning message and when safe to proceed, click OK.

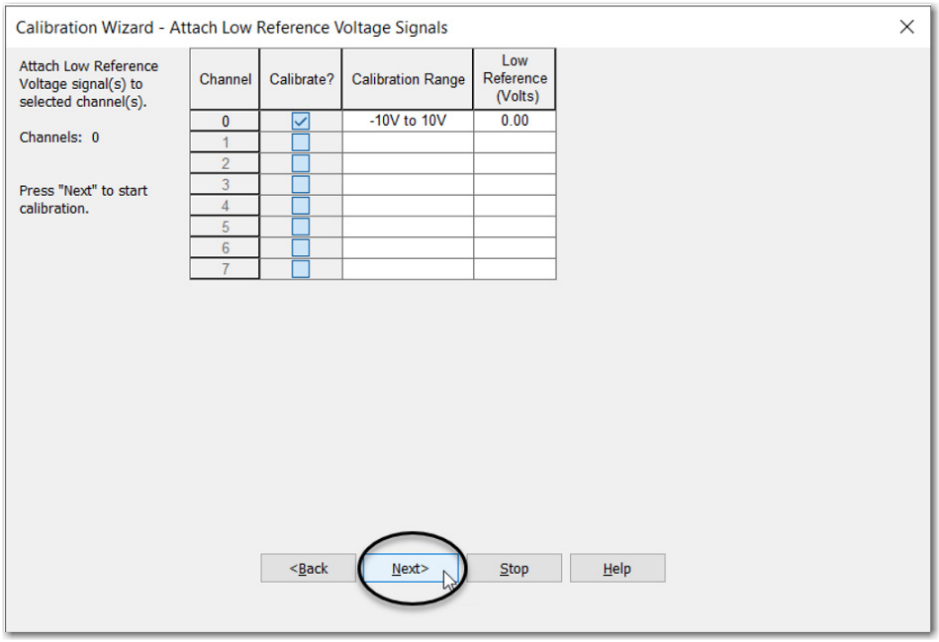


8. Select the channels to be calibrated and click Next.



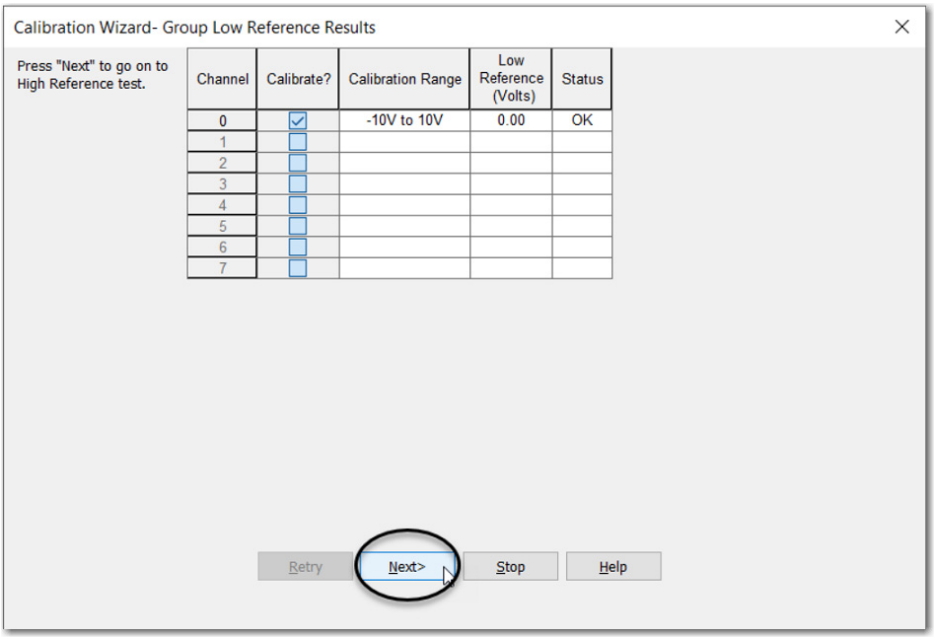
The Attach Low Reference Voltage Signals dialog box appears, as shown below. It indicates the channels are calibrated for a low reference and the range of the calibration.

9. Set the calibrator for the low reference and apply it to the module.
10. Click Next.



The Group Low Reference Results dialog box indicates the status of each channel after calibrating for a low reference.

11. If channels are OK, click Next.

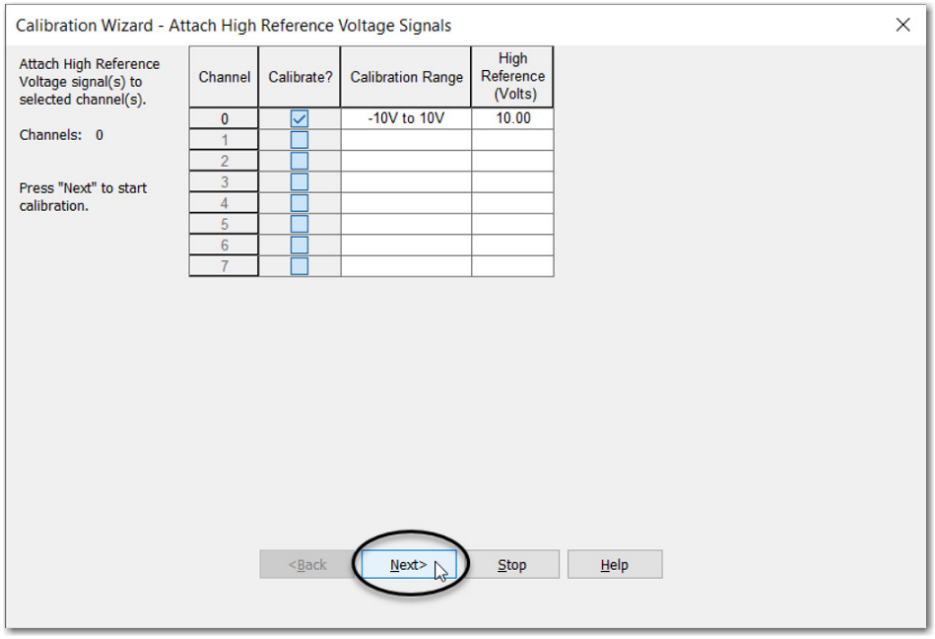


If any channel reports an error, return to step 9 and click Retry until the status is OK.

If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

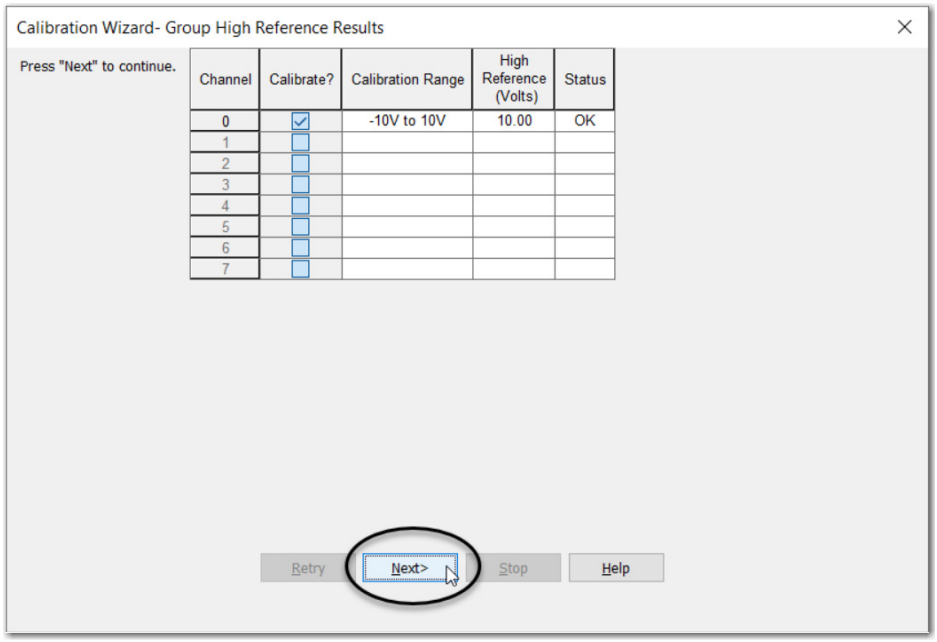
The Attach High Reference Voltage Signals dialog box appears, as shown below. It indicates the channels are calibrated for a high reference and the range of the calibration.

12. Set the calibrator for the high reference voltage and apply it to the module.
13. Click Next.



The Group High Reference Results dialog box indicates the status of each channel after calibrating for a high reference.

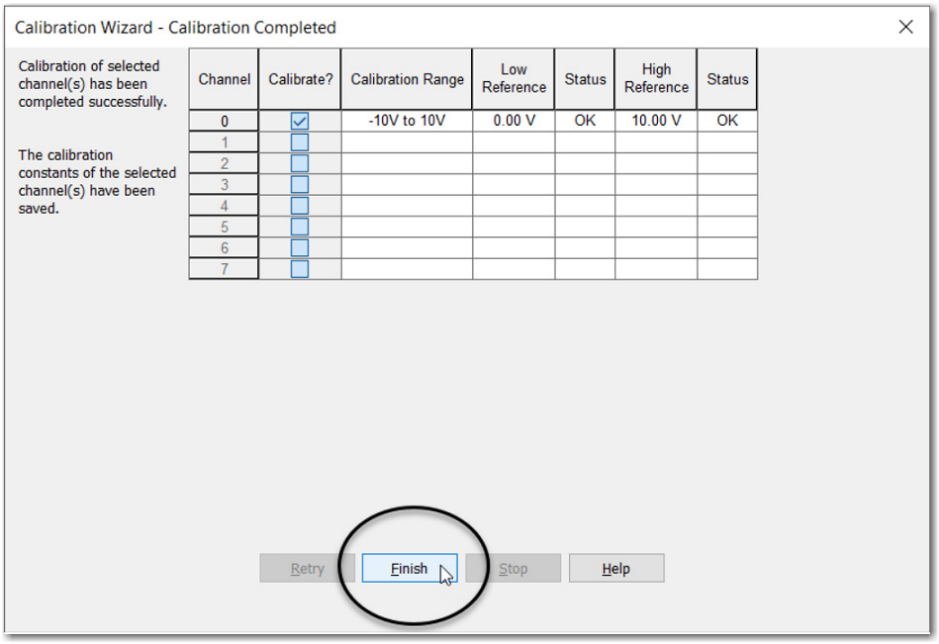
14. If channels are OK, click Next.



If any channel reports an error, return to step 12 and click Retry until the status is OK.

If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

15. When the Calibration Completed dialog box appears, click Finish.



Calibrate the Temperature-sensing Modules

You can calibrate the 1756-IRT8I, 1756-IRT8IK, 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K modules for use with the following input types:

- RTD (Ohms) - 3- and 4-wire types (the 4-wire type is available only for the 1756-IRT8I module)
- Thermocouple (mV)

You must inhibit the 1756-IR12, 1756-IR12K, 1756-IT16, and 1756-IT16K modules before you perform the calibration. Calibration via messaging is not allowed when the modules are in Run mode (any time they have a connection open to the module).

Calibrate the Module for an RTD Input Type

The module uses two precision resistors to calibrate the channels in ohms. You connect the following:

- 1 Ω precision resistor for low reference calibration
- 487 Ω precision resistor for high reference calibration

IMPORTANT After you connect either precision resistors to the 1756-IRT8I, 1756-IRT8IK module, we recommend that you wait for a minimum of two minutes before proceeding to the next task to obtain the highest calibration accuracy.

For more information, see step 8 and step 11.

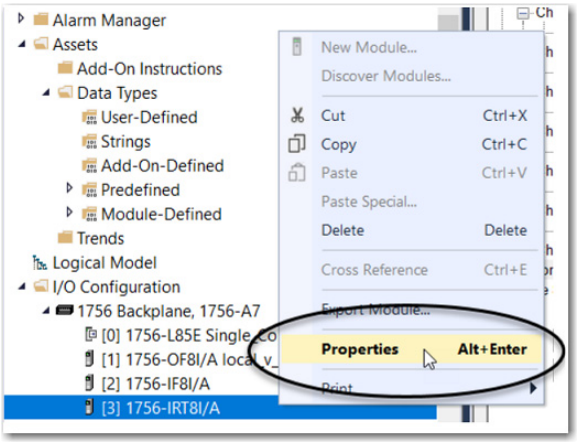
The module can operate in multiple input ranges when an RTD is connected. However, the module calibrates only in the 0...500 Ω range.

IMPORTANT When you are wiring precision resistors for calibration, follow the wiring diagrams. Make sure terminals IN_x(-)/B and IN_x/RTD C are shorted together at the RTB.

You can calibrate the 1756-IRT8I, 1756-IRT8IK module for 3-wire or 4-wire mode. Calibrate in the mode in which the module operates.

Follow these steps to calibrate your module.

1. Go online with your project.
2. Right-click the module you want to calibrate and choose Properties.



3. On the Configuration tab, make sure that the Input Type for each channel to be calibrated is set to the same RTD input type.

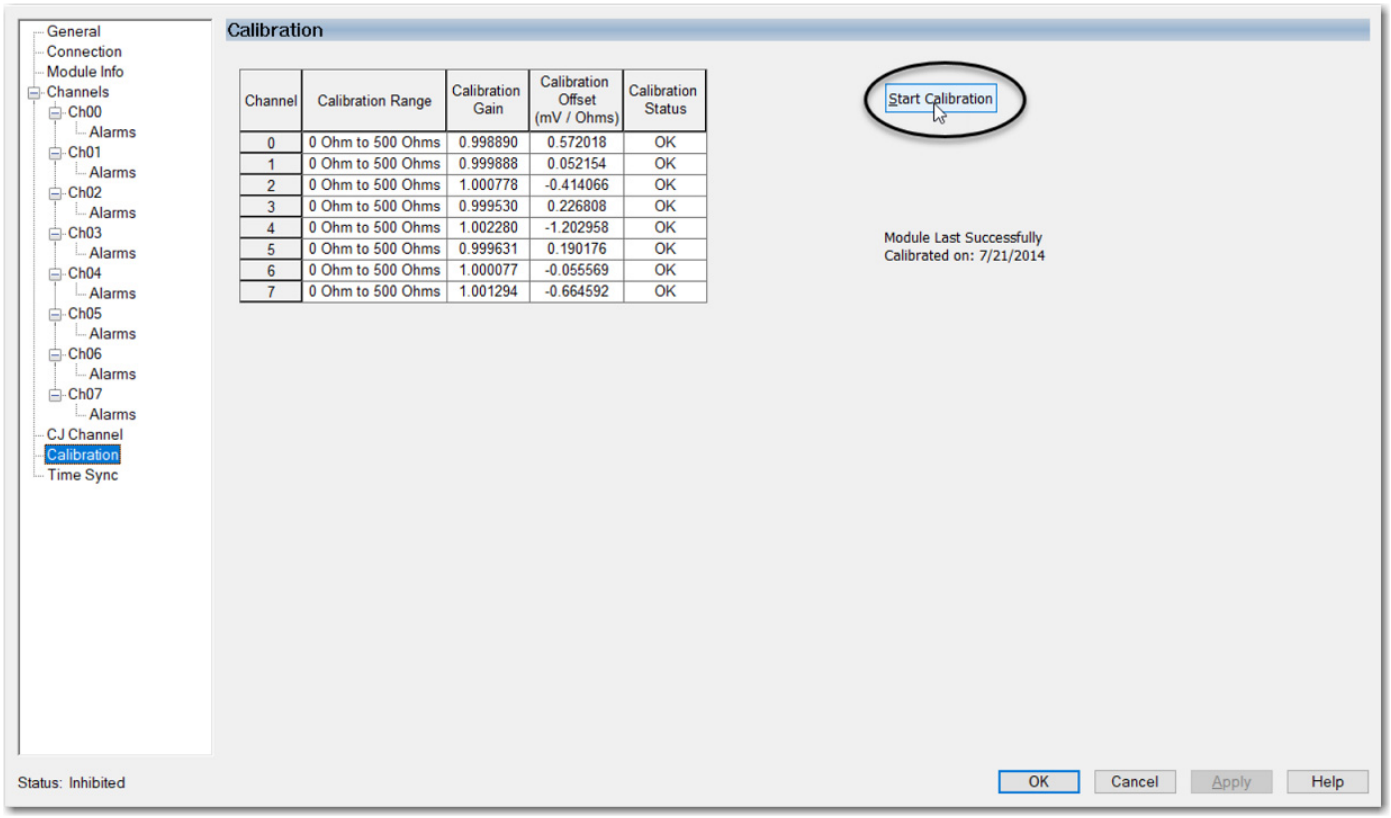
   The sensor type selection does not impact calibration.

   The 1756-IRT8I, 1756-IRT8IK module has eight channels, the 1756-IR12, 1756-IR12K module has 12, and 1756-IT16, 1756-IT16K module has 16.

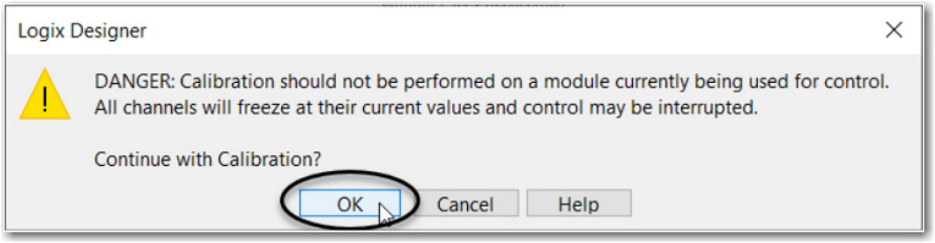
4. Make sure that the controller is in Program Mode or the Connection is Inhibited (available via the Connection tab).

   The 1756-IRT8I, 1756-IRT8IK, 1756-IR12, 1756-IR12K, 1756-IT16 and 1756-IT16 K modules can only be calibrated when the Connection is inhibited.

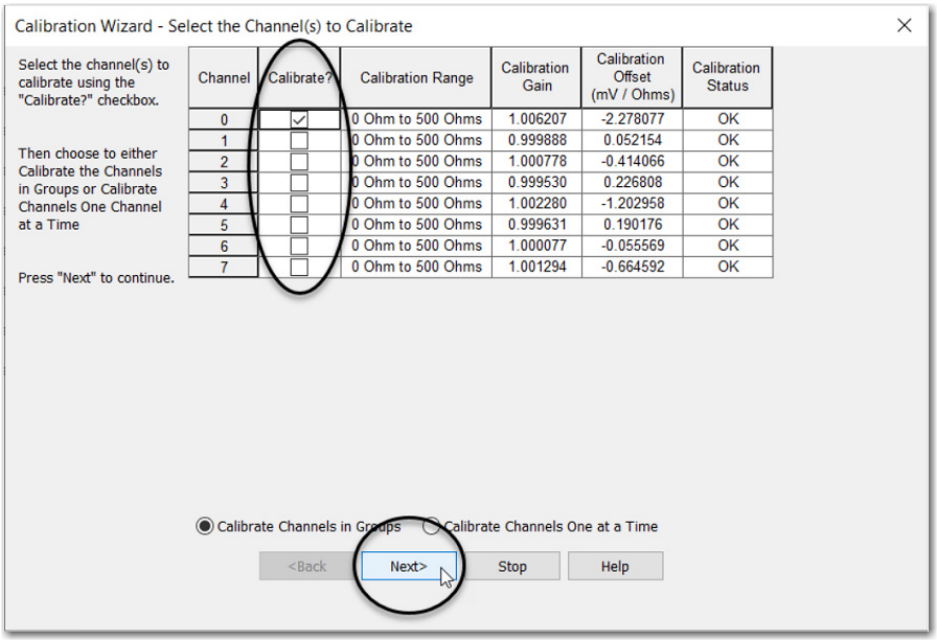
5. On the Calibration tab, click Start Calibration.



6. Verify the warning message and when safe to proceed, click OK.



7. Select the channels to be calibrated and click Next.

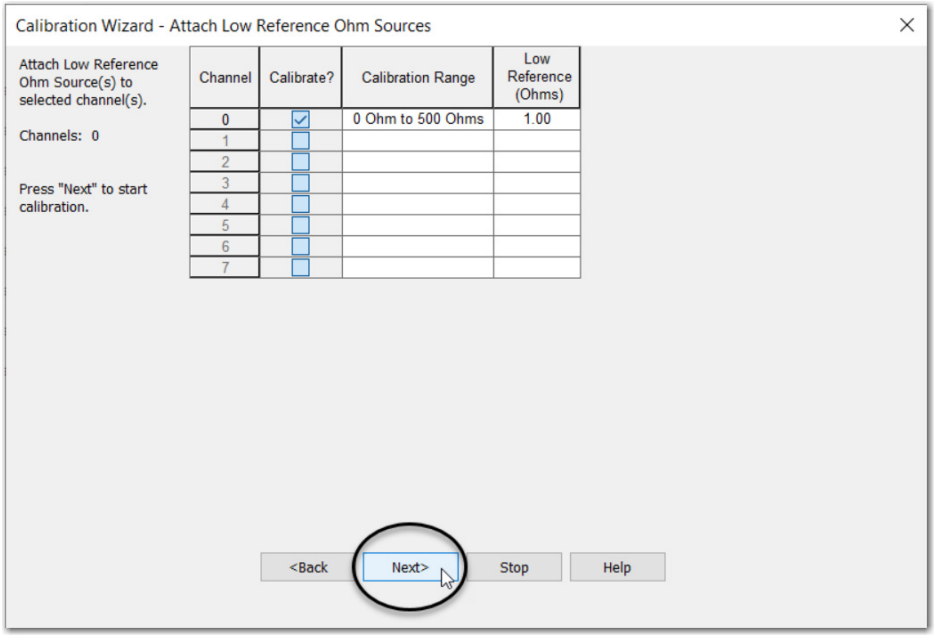


The Attach Low Reference Ohms Sources dialog box appears, as shown in step 9. It indicates the channels are calibrated for a low reference and the range of the calibration.

8. Connect a 1 Ω precision resistor to all module channels being calibrated.

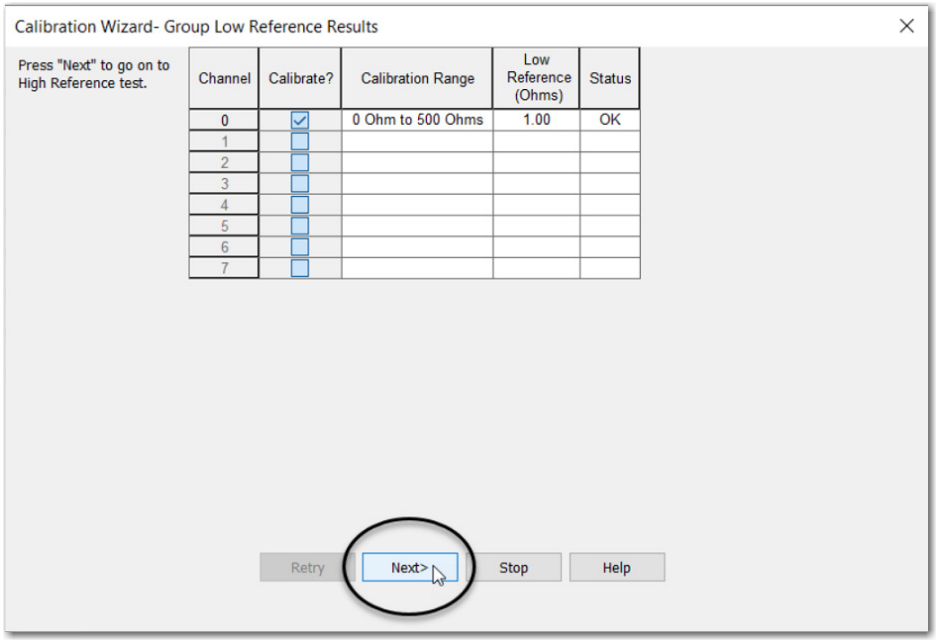
IMPORTANT After you connect the precision resistor, we recommend that you wait for a minimum of two minutes before proceeding to the next task to obtain the highest calibration accuracy.

9. Click Next.



The Group Low Reference Results dialog box indicates the status of each channel after calibrating for a low reference.

10. If channels are OK, click Next.



If any channel reports an error, return to step 8 and click Retry until the status is OK.

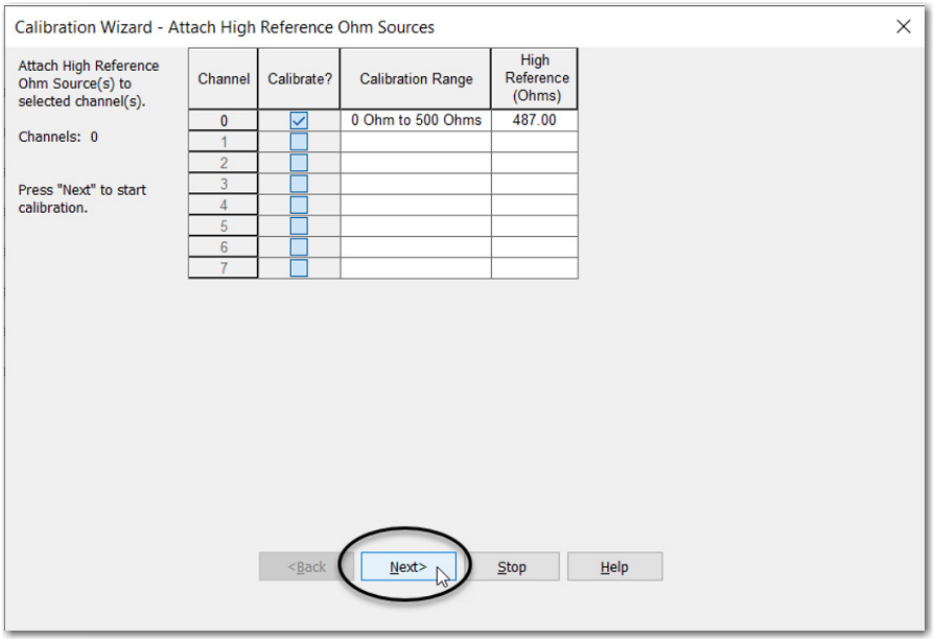
If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

The Attach High Reference Ohms Sources dialog box appears. It indicates the channels are calibrated for a high reference and the range of the calibration.

11. Connect a 487 Ω precision resistor to all module channels being calibrated.

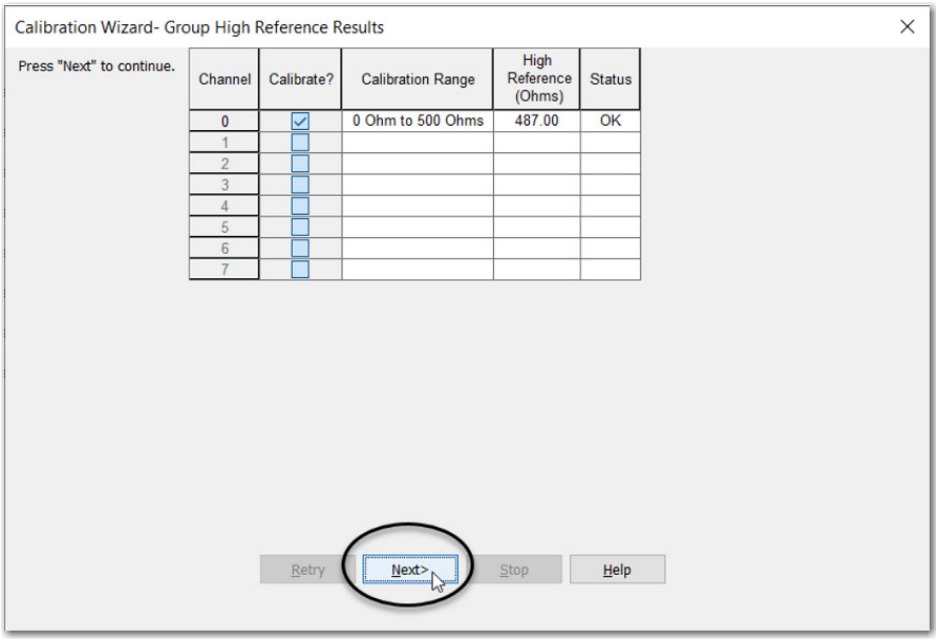
IMPORTANT After you connect the precision resistor to the 1756-IRT8I, 1756-IRT8IK module, we recommend that you wait for a minimum of two minutes before proceeding to the next task to obtain the highest calibration accuracy.

12. Click Next.



The Group High Reference Results dialog box indicates the status of each channel after calibrating for a high reference.

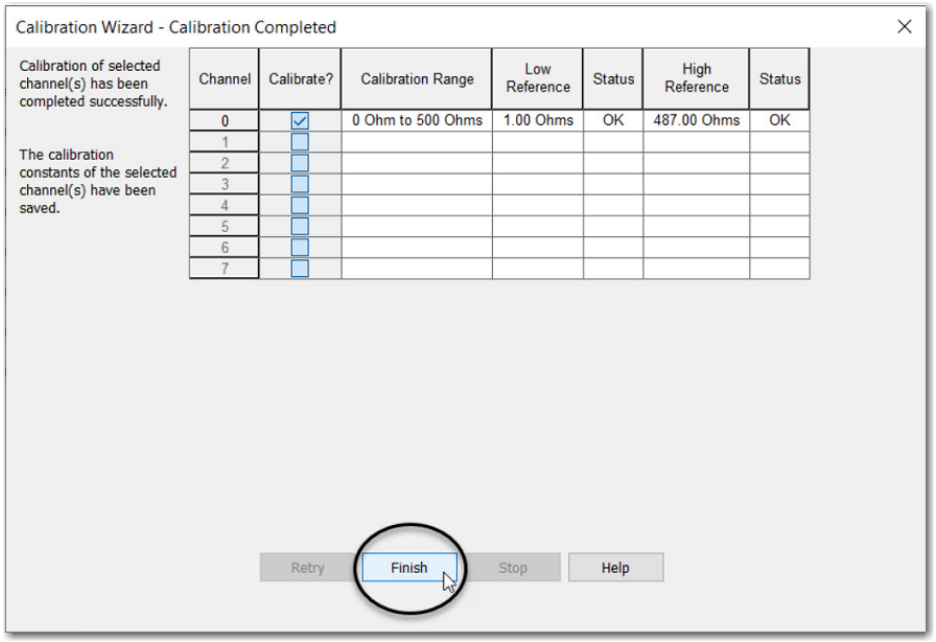
13. If channels are OK, click Next.



If any channel reports an error, return to step 11 and click Retry until the status is OK.

If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

14. When the Calibration Completed dialog box appears, click Finish.

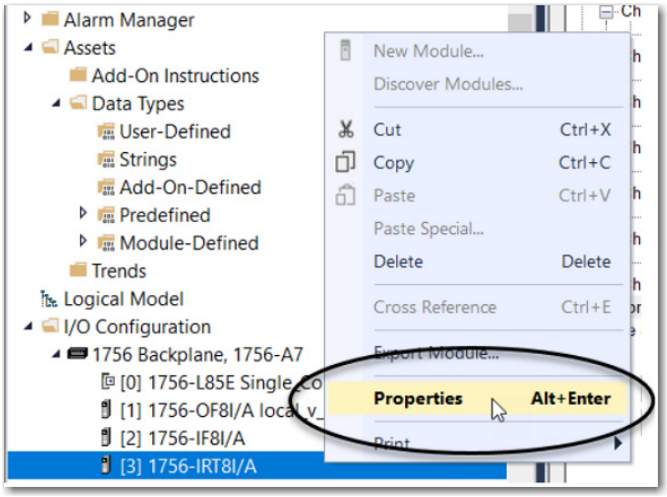


Calibrate the Module for a Thermocouple Input Type

IMPORTANT The 1756-IRT8I, 1756-IRT8IK module channels configured for Thermocouple inputs perform a wire resistance self-calibration when the module power is cycled.

Follow these steps to calibrate your module.

1. Connect your voltage calibrator to all module channels being calibrated.
2. Go online with your project.
3. Right-click the module you want to calibrate and choose Properties.



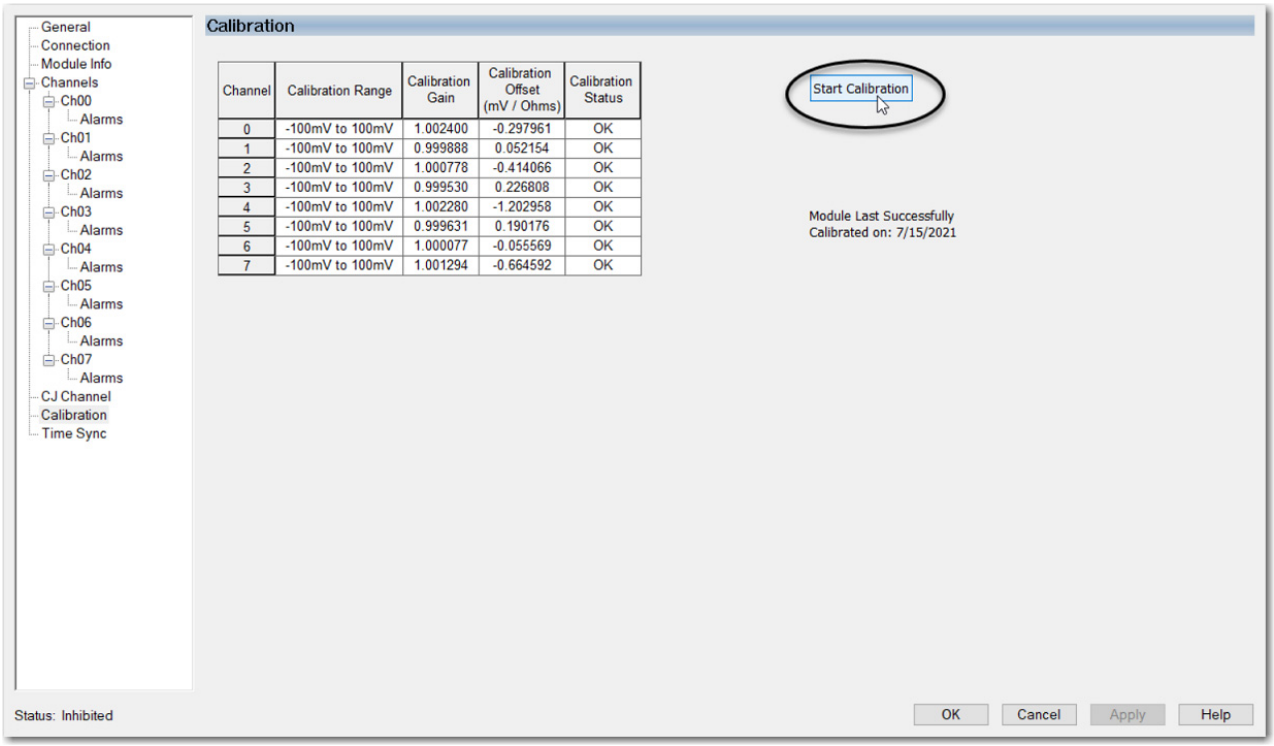
4. On the Configuration tab, make sure the Input Type for each channel to be calibrated is set to Thermocouple (mV).

   The sensor type selection does not impact calibration.

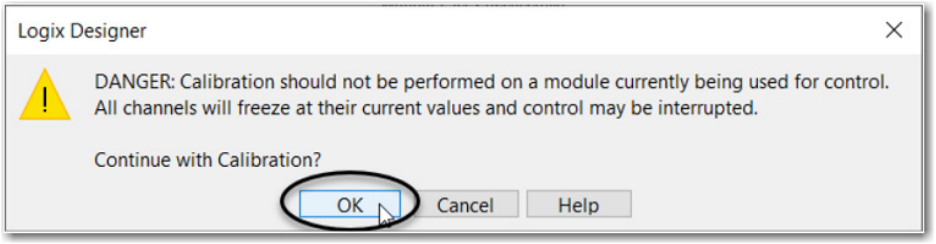
5. Make sure that the controller is in Program Mode or the Connection is Inhibited (available via the Connection tab).

   The 1756-IRT8I, 1756-IRT8IK module can only be calibrated when the Connection is inhibited.

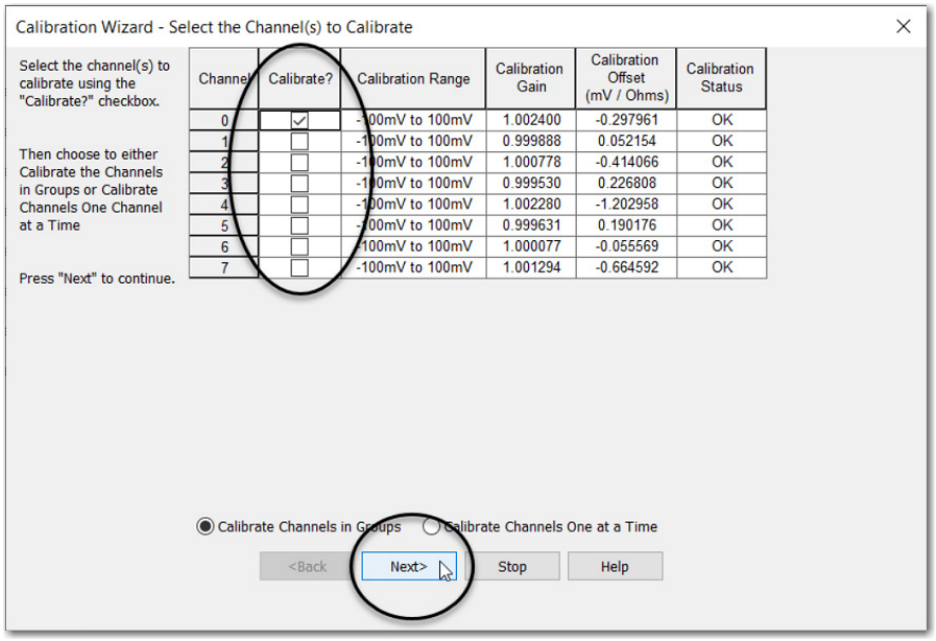
6. On the Calibration tab, click Start Calibration.



7. Verify the warning message and when safe to proceed, click OK.

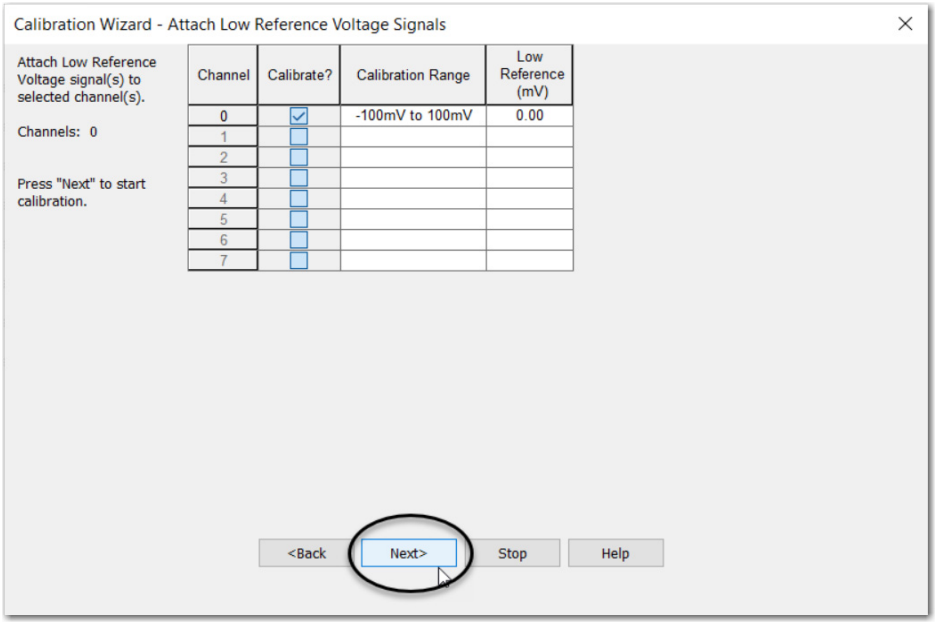


8. Select the channels to be calibrated and click Next.



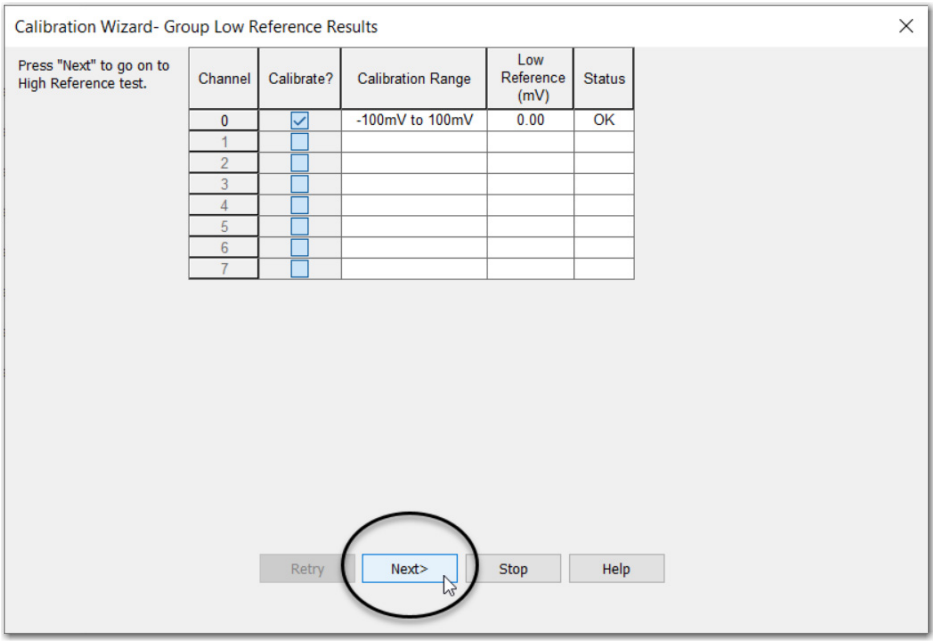
The Attach Low Reference Voltage Signals dialog box appears, as shown below. It indicates the channels are calibrated for a low reference and the range of the calibration.

9. Set the calibrator for the low reference and apply it to the module.
10. Click Next.



The Group Low Reference Results dialog box appears, as shown below. It indicates the status of each channel after calibrating for a low reference.

11. If channels are OK, click Next.

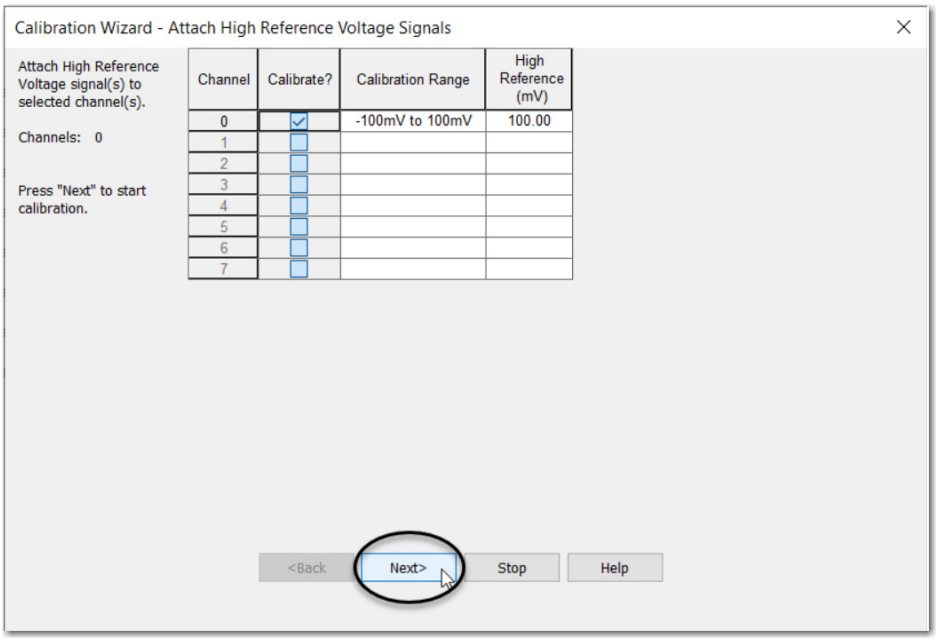


If any channel reports an error, return to step 9 and click Retry until the status is OK.

If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

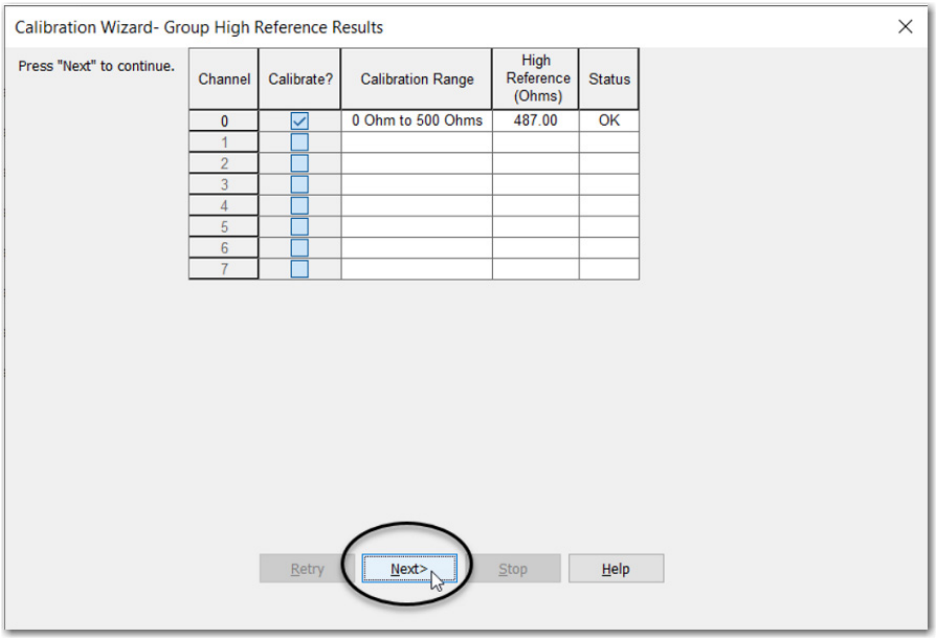
The Attach High Reference Voltage Signals dialog box appears, as shown below. It indicates the channels are calibrated for a high reference and the range of the calibration.

12. Set the calibrator for the high reference voltage and apply it to the module.
13. Click Next.



The Group High Reference Results dialog box indicates the status of each channel after calibrating for a high reference.

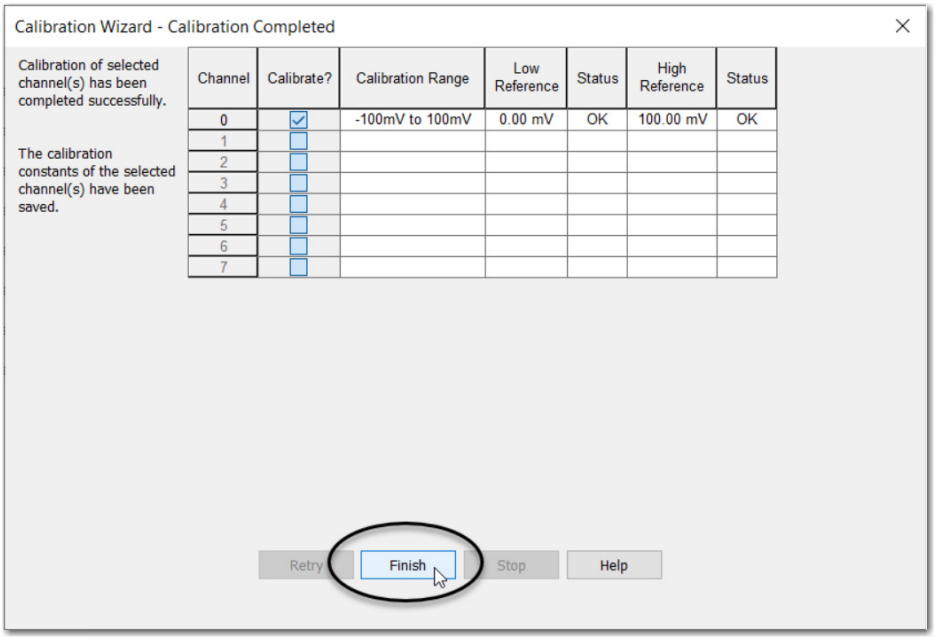
14. If channels are OK, click Next.



If any channel reports an error, return to step 12 and click Retry until the status is OK.

If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

15. When the Calibration Completed dialog box appears, click Finish.



Calibrate the Output Module

You can calibrate the 1756-OF8I, 1756-OF8IK module for use with the following output types:

- Current (mA)
- Voltage (V)

IMPORTANT This section shows how to calibrate the 1756-OF8I, 1756-OF8IK modules for use with only current outputs.

The calibration process is generally the same if you calibrate the module for use with voltage inputs except for the following differences:

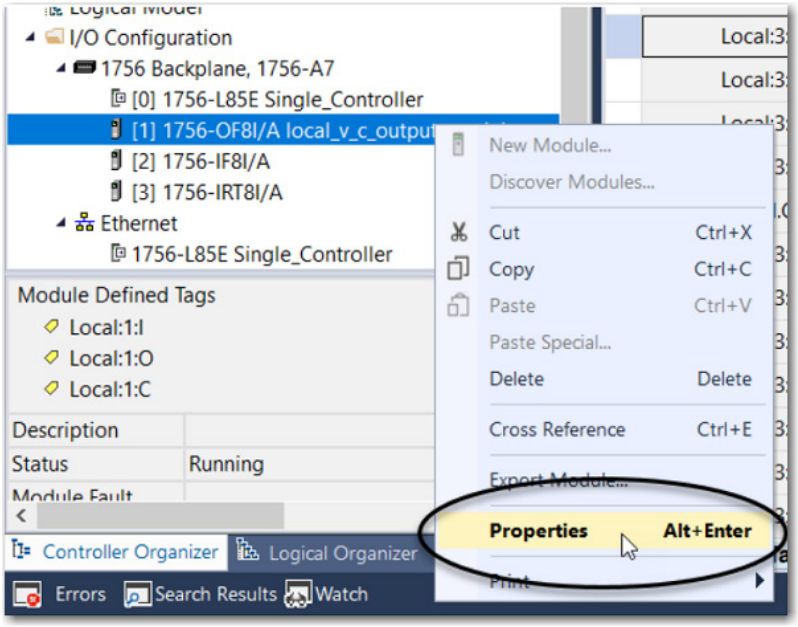
- You connect a voltage meter to the module.
- The low reference signal measured at the module is in volts.
- The high reference signal measured at the module is in volts.

Calibrate the 1756-OF8I, 1756-OF8IK Module for a Current Output Type

When calibrating an output channel for use with a current output type, the Logix Designer application commands the module to output specific levels of current. You must measure the actual level and record the results to account for any module inaccuracies.

Follow these steps to calibrate your module.

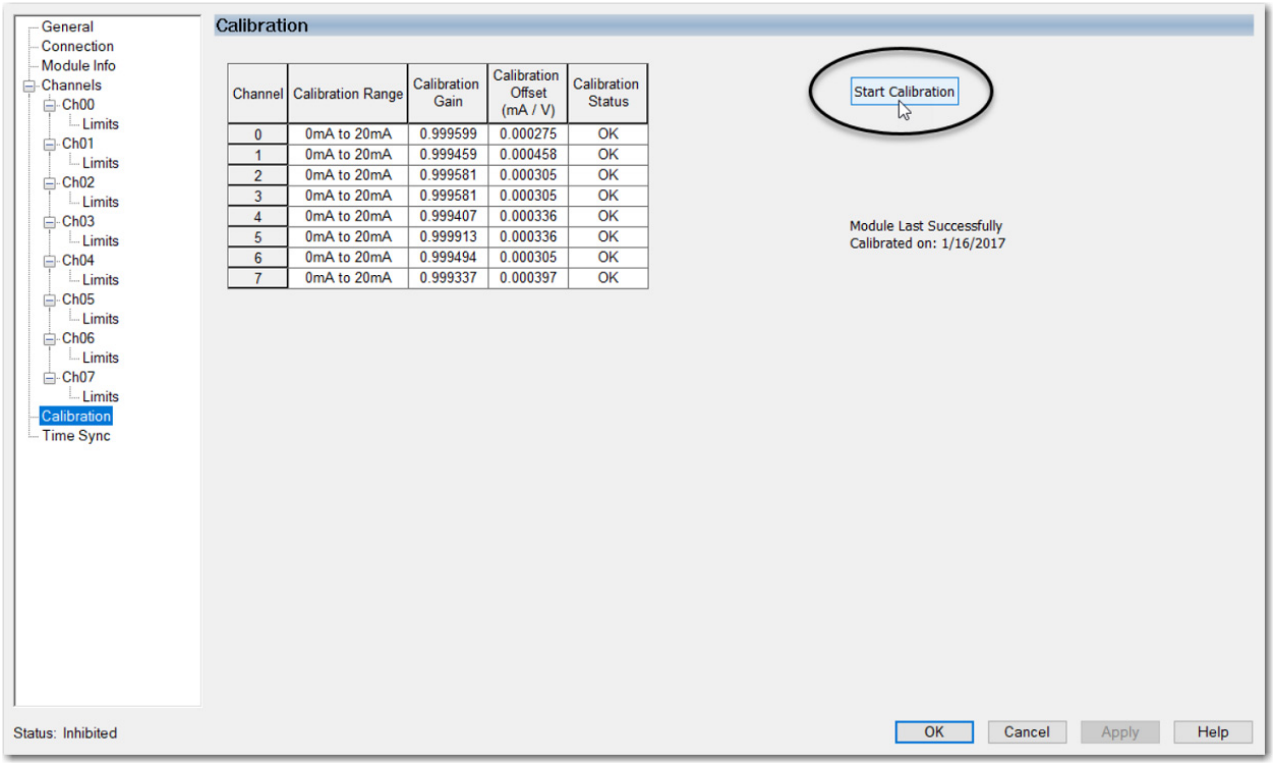
1. Connect your current meter to all module channels being calibrated.
2. Go online with your project.
3. Right-click the module you want to calibrate and choose Properties.



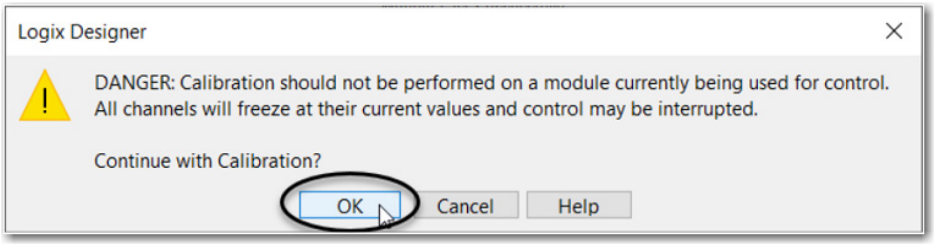
4. On the Configuration tab, make sure the Output Type for each channel to be calibrated is set to Current (mA).
5. Make sure that the controller is in Program Mode or the Connection is Inhibited (available via the Connection tab).

   The module can only be calibrated when the Connection is inhibited.

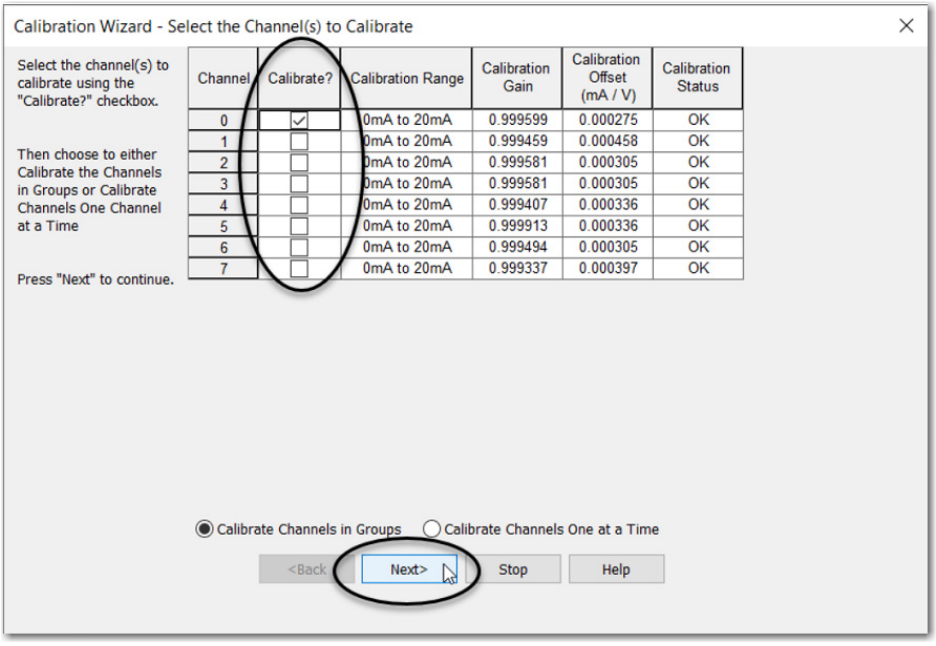
6. On the Calibration tab, click Start Calibration.



7. Verify the warning message and when safe to proceed, click OK.

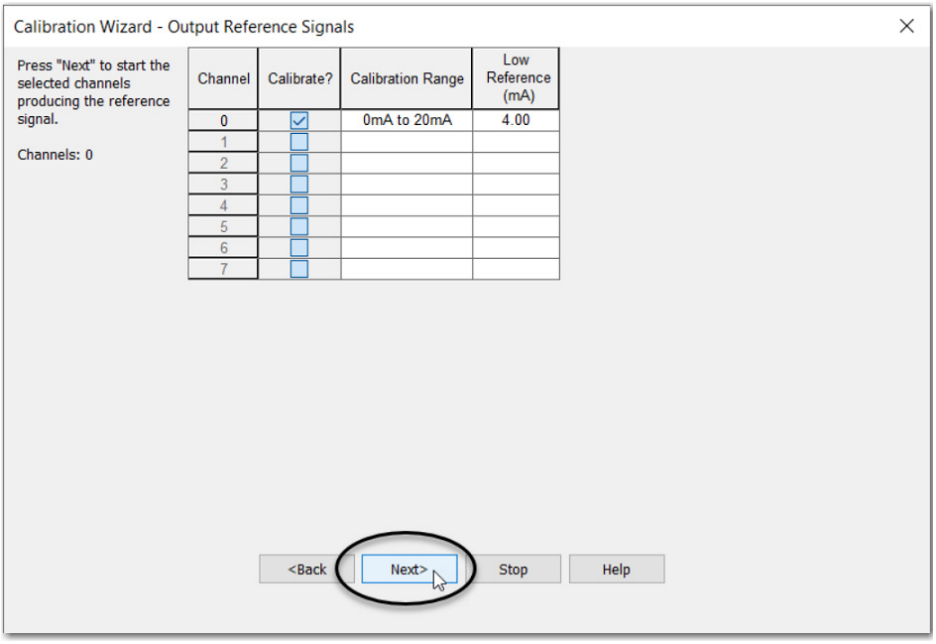


8. Select the channels to be calibrated and click Next.



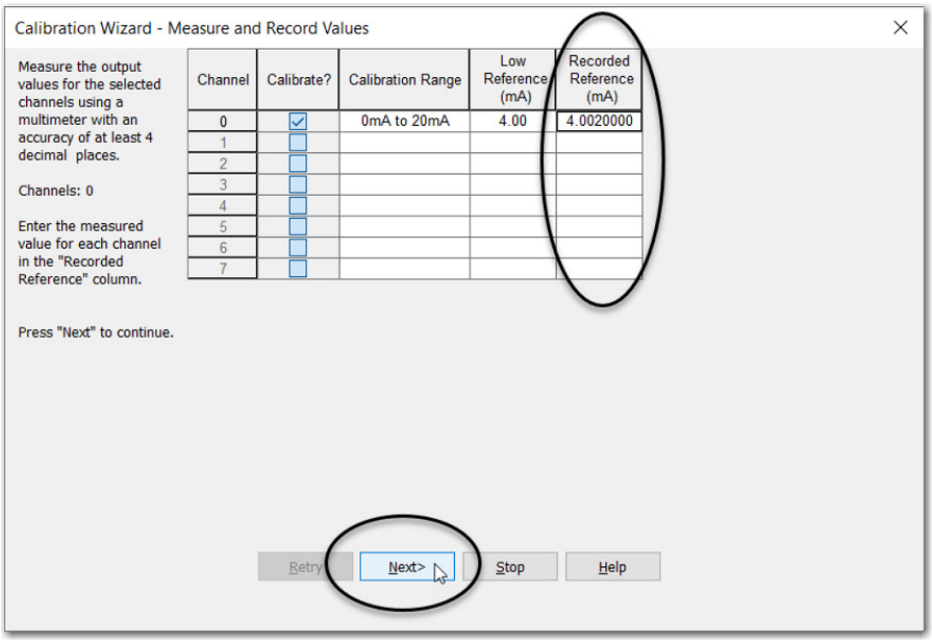
The Output Reference Signals dialog box appears. It indicates the channels are calibrated for a low reference and the calibration range.

9. Click Next.



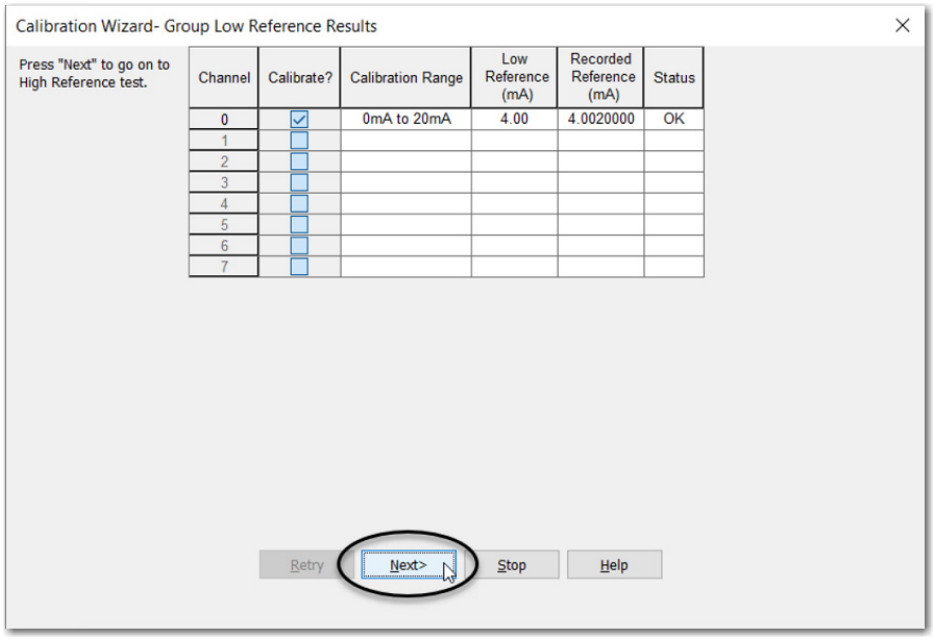
The Measure and Record Values dialog box appears.

10. For each channel being calibrated, use your current meter to measure the reference value of each channel individually.
11. In the Recorded Reference (mA) column record the measured value for each channel that was recorded and click Next.



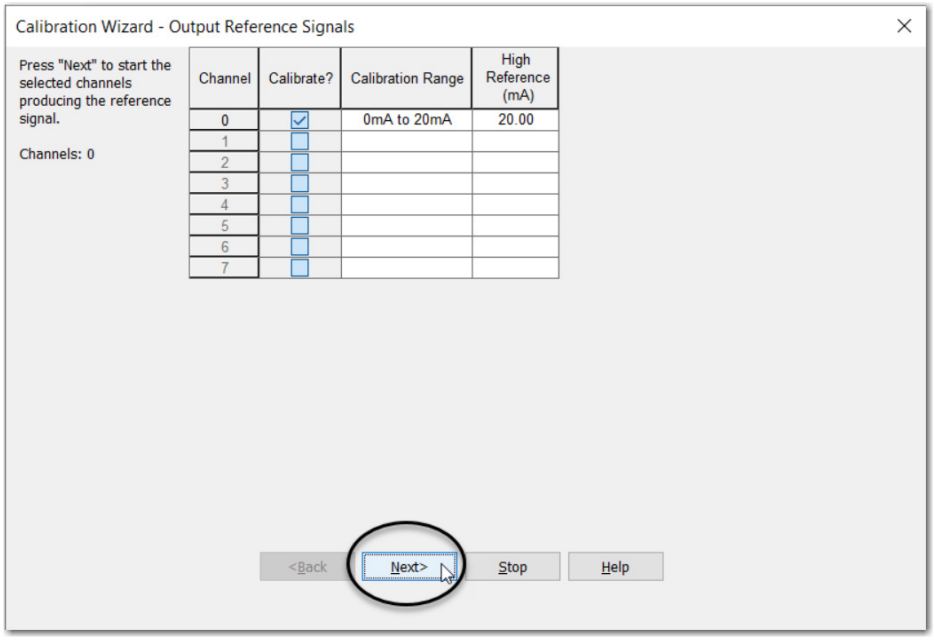
The Group Low Reference Results dialog box indicates the status of each channel. If the status is not OK for any channels, repeat the calibration process.

12. Click Next.



The Output Reference Signals dialog box appears, as shown below. It indicates the channels are calibrated for a high reference and the calibration range.

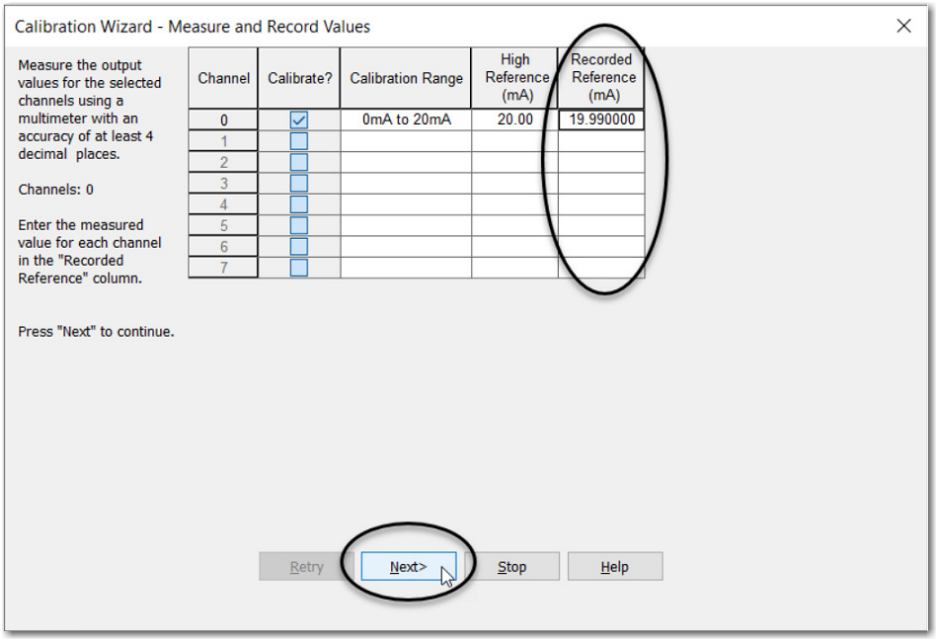
13. Click Next.



The Measure and Record Values dialog box appears.

14. For each channel being calibrated, use your current meter to measure the reference value of each channel individually.

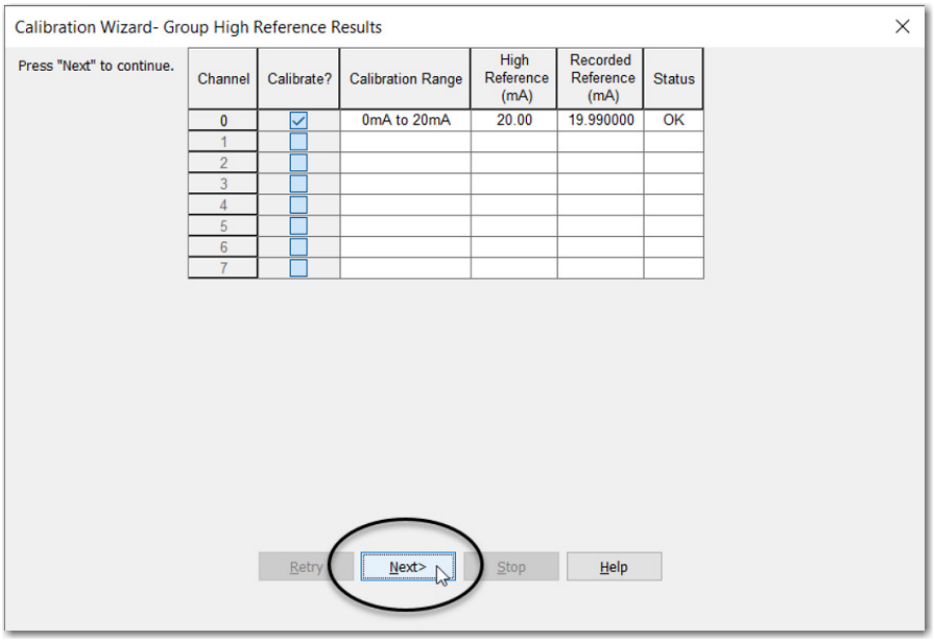
15. In the Recorded Reference (mA) column record the measured value for each channel that was recorded and click Next.



The Group High Reference Results dialog box indicates the status of each channel. If the status is not OK for any channels, repeat the calibration process.

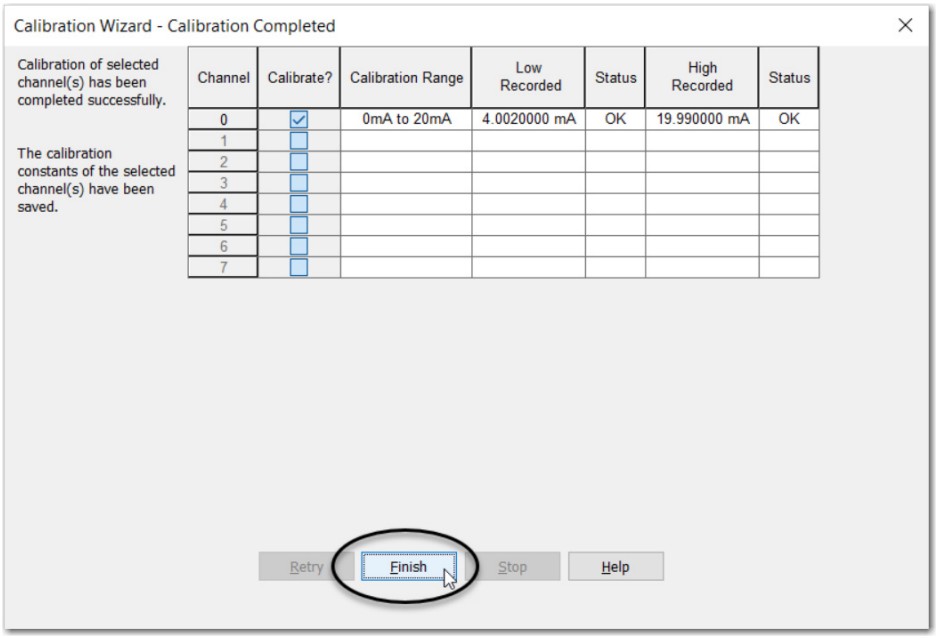
If the error persists indefinitely, click Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory calibration.

16. Click Next.



The Calibration Completed dialog box indicates the status of each channel.

17. Click Finish.

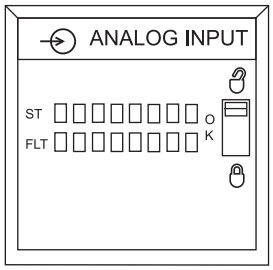


Notes:

Troubleshoot Your Module

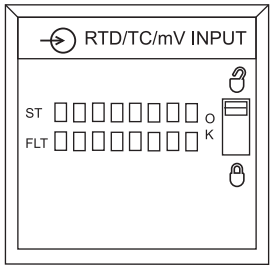
ControlLogix® analog I/O module have status indicators on the front of the module that are used to monitor module operation.

Status Indicators for the 1756-IF8I, 1756-IF8IK Module



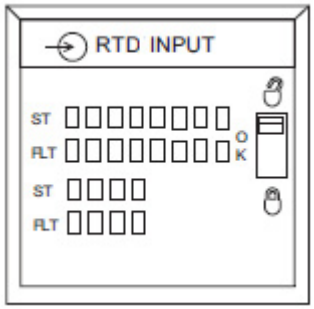
Indicator	Status	Description
OK	Steady green	The module is in a normal operating state in Run mode.
	Flashing green	The module passed internal diagnostics and is not actively controlled or the connection is open and the controller is in Program mode.
	Flashing red	Previously established communication has timed out.
	Steady red	Replace the module.
ST	Steady yellow	The channel is operating as expected.
	Flashing yellow	The channel is being calibrated.
	Off	The channel is not in use or is faulted.
FLT	Off	The channel is operating as expected or it is not in use.
	Steady red	The channel is faulted. Possible causes of the fault include: • Underrange/overrange detection • Sourcing Over Current • CRC from ADC always Bad • Wire off detection For more information on these causes see Chapter , 1756-IF8I, 1756-IF8IK Isolated Analog Input Module on page 35
	Flashing red	The channel is faulted and is being calibrated. See the previous row for more information about faults.

Status Indicators for the 1756-IRT8I, 1756-IRT8IK Module



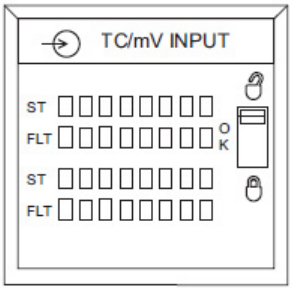
Indicator	Status	Description
OK	Steady green	The module is in a normal operating state in Run mode.
	Flashing green	The module passed internal diagnostics and is not actively controlled or the connection is open and the controller is in Program mode.
	Flashing red	Previously established communication has timed out.
	Steady red	Replace the module.
ST	Steady yellow	The channel is operating as expected.
	Flashing yellow	The channel is being calibrated.
	Off	The channel is not in use or is faulted.
FLT	Off	The channel is operating as expected or it is not in use.
	Steady red	The channel is faulted. Some possible causes of the fault include: • Underrange/overrange detection • Wire off detection • CRC from ADC always Bad For more information about these causes, see Chapter 4 on page 53.
	Flashing red	The channel is faulted channel is being calibrated. See the previous row for more information about faults.

Status Indicators for the 1756-IR12, 1756-IR12K Module



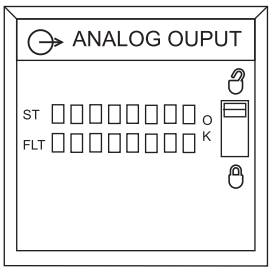
Indicator	Status	Description
OK	Steady green	The module is in a normal operating state in Run mode.
	Flashing green	The module passed internal diagnostics and is not actively controlled or the connection is open and the controller is in Program mode.
	Flashing red	Previously established communication has timed out.
	Steady red	Replace the module.
ST	Steady yellow	The channel is operating as expected.
	Flashing yellow	The channel is being calibrated.
	Off	The channel is not in use or is faulted.
FLT	Off	The channel is operating as expected or it is not in use
	Steady red	The channel is faulted. Some possible causes of the fault include: • Underrange/overrange detection • Wire off detection • CRC from ADC always Bad For more information on these causes see Chapter 4, Temperature-sensing Analog Modules on page 53
	Flashing red	The channel is faulted and is being calibrated. See the previous row for more information about faults.

Status Indicators for the 1756-IT16, 1756-IT16K Module



Indicator	Status	Description
OK	Steady green	The module is in a normal operating state in Run mode.
	Flashing green	The module passed internal diagnostics and is not actively controlled or the connection is open and the controller is in Program mode.
	Flashing red	Previously established communication has timed out.
	Steady red	Replace the module.
ST	Steady yellow	The channel is operating as expected.
	Flashing yellow	The channel is being calibrated.
	Off	The channel is not in use or is faulted.
FLT	Off	The channel is operating as expected or it is not in use.
	Steady red	The channel is faulted. Some possible causes of the fault include: • Underrange/overrange detection • Wire off detection • CRC from ADC always Bad For more information on these causes see Chapter , Temperature-sensing Analog Modules on page 53
	Flashing red	The channel is faulted and is being calibrated. See the previous row for more information about faults.

Status Indicators for the 1756-OF8I, 1756-OF8IK Module

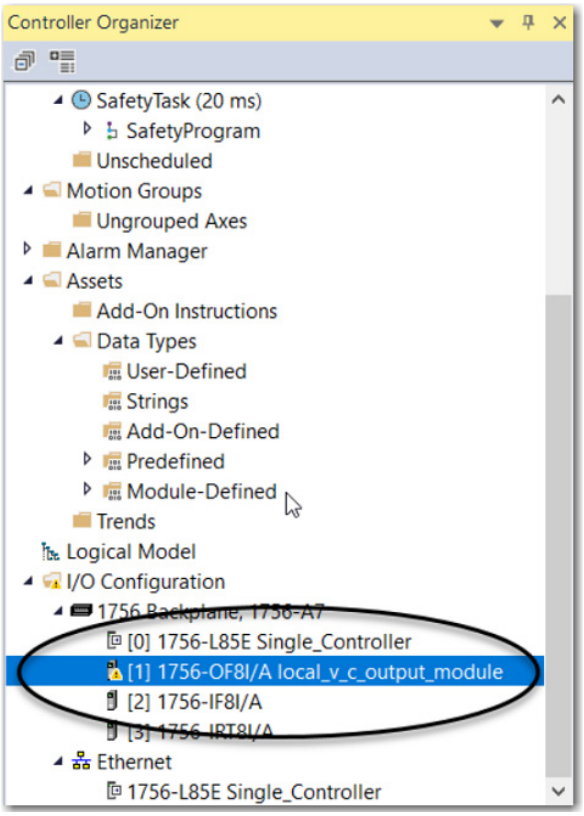


Indicator	Status	Description
OK	Steady green	The module is in a normal operating state in Run mode.
	Flashing green	The module passed internal diagnostics and is not actively controlled or the connection is open and the controller is in Program mode.
	Flashing red	Previously established communication has timed out.
	Steady red	Replace the module.
ST	Steady yellow	The channel is operating as expected.
	Flashing yellow	The channel is being calibrated.
	Off	The channel is not in use or is faulted.
FLT	Off	The channel is operating as expected or it is not in use
	Steady red	The channel is faulted. Some possible causes of the fault include: • Triggered clamp alarm • Wire off detection • Output Data received was NotANumber • DAC error • CRC writing to DAC bad for last 10 attempts • Value written to DAC does not match value read from DAC (checked once a second) For more information on these causes see Chapter , 1756-OF8I, 1756-OF8IK Isolated Analog Output Module on page 81
	Flashing red	The channel is faulted and is being calibrated. See the previous row for more information about faults.

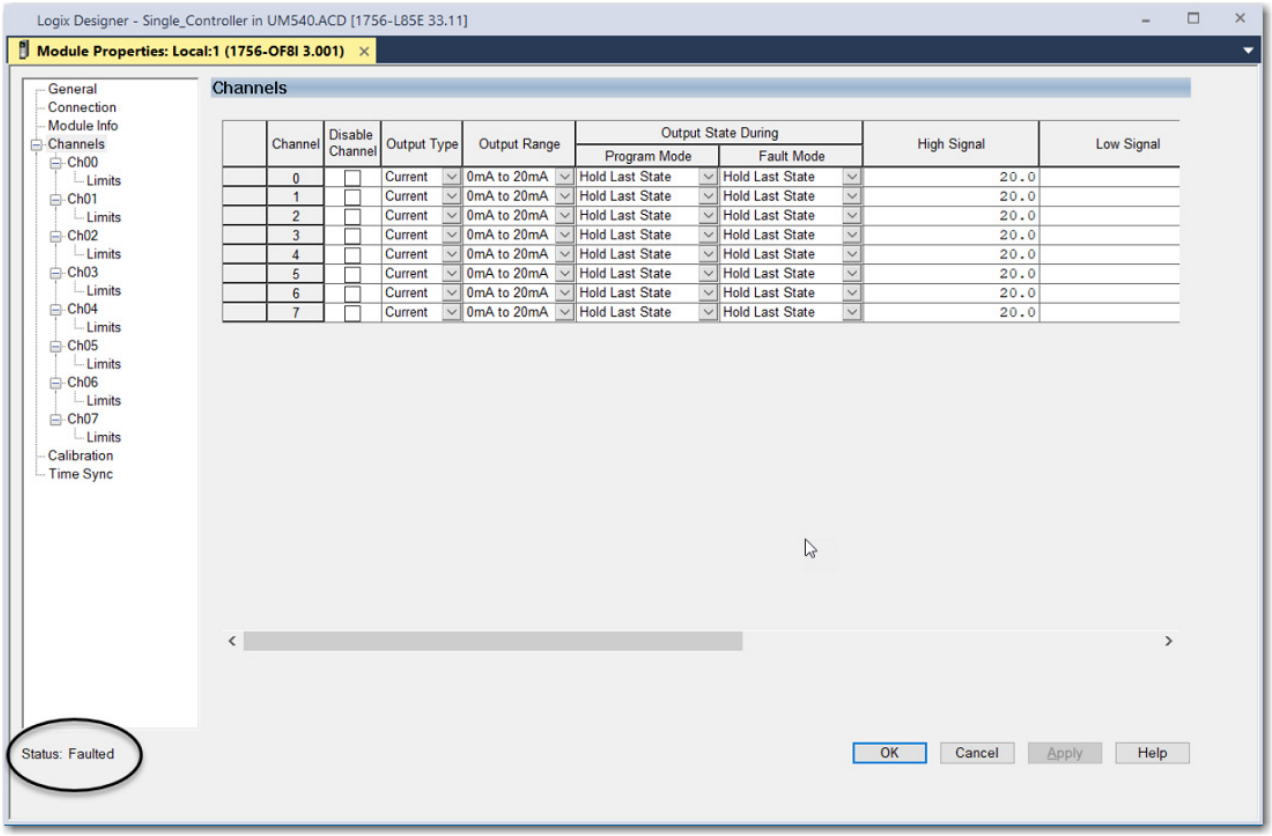
Use Logix Designer Application for Troubleshooting

The Logix Designer application indicates fault conditions in the following ways:

- **Warning signal** on the main screen next to the module - This occurs when the connection to the module is broken.



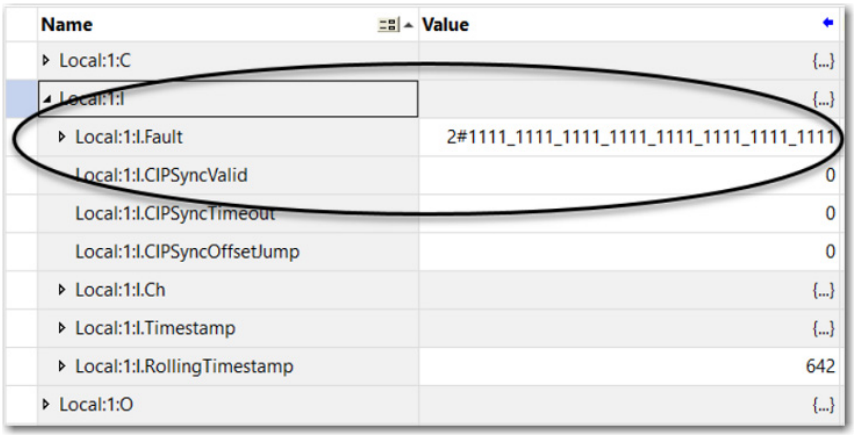
- Message in a screen's **status line**.



On the Module Info tab, in the Status section, the Major and Minor Faults are listed along with the Internal State of the module.

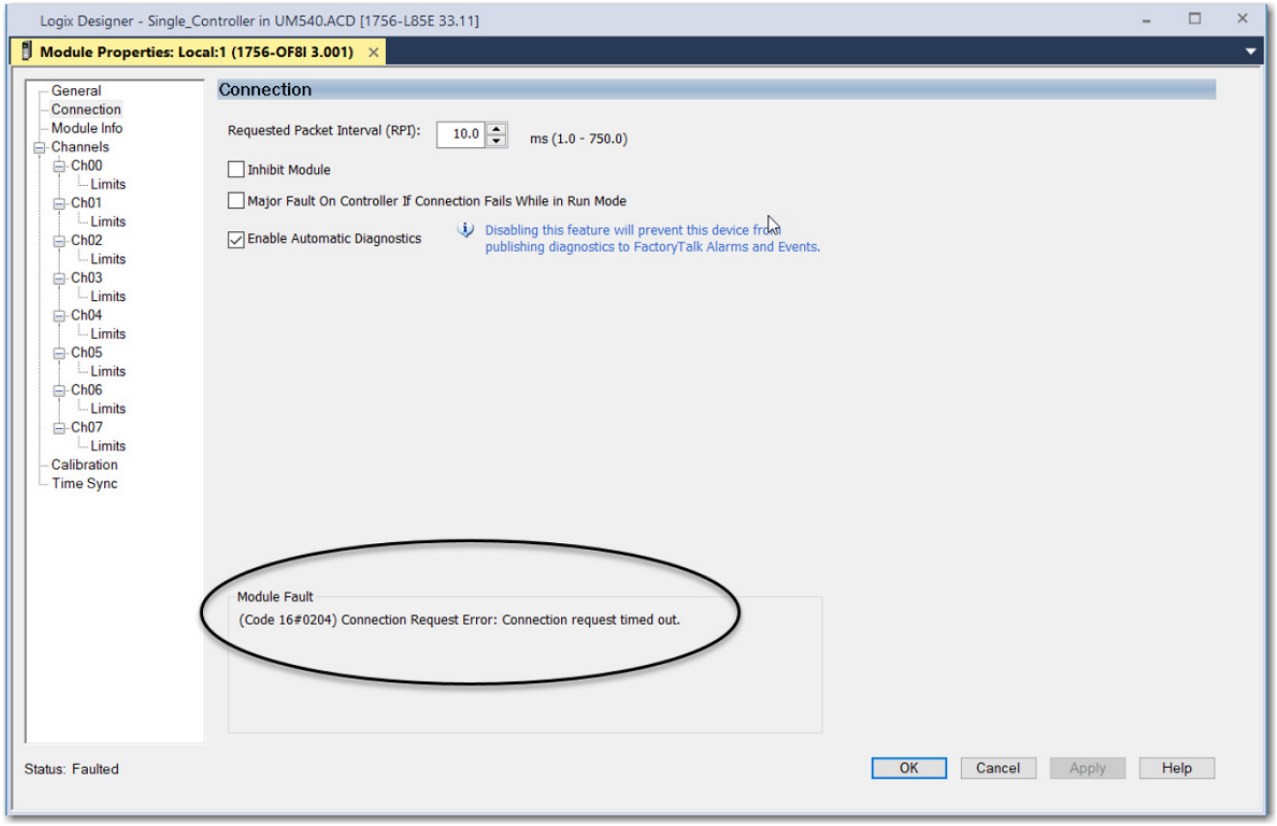
- **Notification in the Tag Editor** - General module faults are also reported in the Tag Editor. Diagnostic faults are reported only in the Tag Editor.

  The Value field indicates a fault with the number 1.



Fault Type Determination

When you are monitoring configuration properties in the Logix Designer application and receive a communication fault message, the Connection tab indicates the type of fault under Module Fault.



Troubleshoot Incorrect Readings on the Module

Incorrect temperature, current, or voltage readings on temperature-sensing and current/voltage I/O modules are often considered to be the result of a module needing to be calibrated. This is typically not the case.

ControlLogix analog I/O modules are calibrated before shipment from the factory and maintain a high degree of module accuracy throughout their lifespan. Additionally, 1756-IRT8I, 1756-IRT8IK module channels that are configured for Thermocouple inputs perform a resistance self-calibration when the module power is cycled.

The following sections describe tasks that you can use to troubleshoot your module:

- 1756-IRT8I, 1756-IRT8IK and 1756-IT16, 1756-IT16K Modules - Incorrect Temperature Readings
- 1756-IRT8I, 1756-IRT8IK and 1756-IR12, 1756-IR12K Modules - Incorrect RTD Readings
- 1756-IF8I, 1756-IF8IK Module - Incorrect Input Voltage/Current Readings
- 1756-OF8I, 1756-OF8IK Module - Incorrect Output Voltage/Current Readings

1756-IRT8I, 1756-IRT8IK and 1756-IT16, 1756-IT16K Modules - Incorrect Temperature Readings

To determine the cause of the incorrect reading, first determine the nature of the incorrect reading. For example, the module can perform as follows:

- The module always reads maximum.
- The module always reads minimum.
- The module reads erratically (data jumping around).
- The module reads with an offset over the entire range.

First, complete the following tasks.

1. To verify that the module is powered and communicating, check the status indicators.

   Red or flashing green status indicators indicate a problem. For more information on the module status indicators, page 143.

2. Check the module wiring to verify the following:
   - The wiring is correct.
   - The wiring is intact.
   - The CJC sensors, if being used, are installed correctly.

   IMPORTANT Remember, if you choose to use CJC sensors with the module, you must use the sensors at both connection positions, that is, the top and bottom of the module.

   You cannot use only one CJC sensor with the module.

   For more information on using CJC sensors with the module, see Cold Junction Compensation on page 68.

3. If the status indicators indicate that the module is communicating as expected and all module wiring is correct, complete the following tasks.
   a. Disconnect the thermocouple from the channel in question.
   b. Connect a thermocouple emulator directly to the channel in question.

The emulator provides voltage at the channel that is equivalent to the voltage expected for the thermocouple type it is emulating:

- If the emulator temperature report is correct, the module is performing as expected. In this case, the thermocouple and wiring are likely the cause and must be checked again.
- If the emulator temperature report is incorrect, the module hardware, configuration, or the software application are likely the cause. In this case, check the Logix Designer application project.

We **highly recommend** using a thermocouple emulator for initial troubleshooting. In lieu of an emulator, you can apply a millivolt signal to the input. The module must be configured to read a millivolt signal. If the module is reading back the millivolt correctly, then the module is performing as expected.

If the previously listed tasks fail to resolve your issue with incorrect temperature readings on your module, use the following table.

Table 22 - Troubleshoot Incorrect Temperature Readings

Possible Cause of Incorrect Reading	Description	Recommended Action
Open circuit	A thermocouple reading maximum (upscale) usually means that there is an open circuit condition. The module indicates this condition through the following: • The FLT status indicator for the channel becomes steady red. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number. • If the **sensor type is Temperature**, input data from the channel changes to the highest scaled temperature value associated with the sensor type. • If the **sensor type is mV**, the input data for the channel changes to the scaled value associated with the overrange signal value.	One of the following: • Check the wiring, terminations, and for an open thermocouple. • Make sure that the length of the thermocouple cable is within module specifications. Wire length that is too long has a higher impedance, and can be interpreted as an open circuit.
Short-circuited input	Thermocouple reading 0 mV can mean that there is a short-circuited input. In some applications, the thermocouple reading 0 mV is correct.	Check wiring and correct terminations.
Electrical noise	Erratic readings, that is, data fluctuating more than is typical, are a product of noise. An oscilloscope shows the magnitude of noise.	• Disconnect all but one thermocouple to see if channels are affecting each other, that is, there is bleed-over. • Eliminate or suppress the effect of noise. Employ hardware or software filters provided by the 1756-IRT8I, 1756-IRT8IK module, such as the Notch Filter.
DC signal on top of the thermocouple signal	Offset readings can be caused by a DC signal riding on top of the thermocouple signal. An oscilloscope shows the magnitude of the offset.	Disconnect all but one thermocouple to see if channels are affecting each other, that is, there is bleed-over.
Module is in calibration mode	Incorrect readings can be a result of the module being calibrated when the reading occurs.	Make sure that the module is not in calibration mode. This symptom is module-dependant, but in general, specific bits have to be turned on to enable calibration.
Temperature reading difference between maximum and minimum temperatures	All input channels on a module can use the same configuration and measure the same ambient temperature. A temperature reading difference between upper and lower channels up to -13.33…-12.22 °C (8…10 °F). can cause incorrect readings.	To improve the temperature reading, we recommend that you select remote cold junction compensation and wire to a 1492-AIFM8TC-3 IFM module.
CJC sensor is defective or installed incorrectly	Offset readings can be a result of a defective CJS or incorrect CJS properly.	Check the module input data for a CJC sensor defective diagnostic bit. Thermocouples also report back ambient temperature and provide an accurate ambient temperature if the CJC sensor is healthy, wired properly, and the module is operating within specifications.
Incorrect reading soon after module installation	One of the following: • Incorrect readings at initial module installation and configuration are often the result of installation and configuration errors. • Incorrect readings at installation of an existing, previously-working module are more likely the result of a hardware failure.	One of the following: • If the error is occurring on a new module installation and configuration, make sure that those tasks were completed corrected and correct any errors that you find. • If the error is occurring on an existing, previously working module, diagnose the hardware failure and correct it. If more than one channel is experiencing the incorrect readings in this case, disconnect all thermocouples except one. This can help determine if it is external hardware or the module itself is the cause.

1756-IRT8I, 1756-IRT8IK and 1756-IR12, 1756-IR12K Modules - Incorrect RTD Readings

To determine the cause of the incorrect reading, first determine the nature of the incorrect reading. For example, the module can perform as follows:

- The module always reads maximum.
- The module always reads minimum.
- The module reads erratically (data jumping around).
- The module reads with an offset over the entire range.

First, complete the following tasks.

1. Check the status indicators to verify that the module is powered and communicating.

   Red or flashing green status indicators indicate a problem. For more information on the module status indicators, page 143.
2. Make sure wiring is intact and correct.
3. If the status indicators indicate that the module is communicating as expected and all module wiring is correct, complete the following tasks.
   a. Disconnect the RTD from the channel in question.
   b. Connect an RTD emulator directly to the channel in question.

      The emulator provides voltage at the channel that is equivalent to the voltage expected for the RTD type it is emulating.
   - If the ohms value reports back correctly then the module is performing as expected. In this case, the RTD and wiring are likely the cause and must be checked again.
   - If the ohms value reports back incorrectly, the module hardware, configuration, or the software application are likely the cause. In this case, check the Logix Designer application project.

   We **highly recommend** using an RTD emulator for initial troubleshooting. In lieu of an emulator, you can apply a known ohms value to the input. The module must be configured to read an ohms value. If the module is reading back the ohms correctly, then the module is performing as expected.

If the previously listed tasks fail to resolve your issue with incorrect RTD readings on your module, use the following table.

Table 23 - Troubleshoot Incorrect RTD Readings

Possible Cause of Incorrect Reading	Description		Recommended Action
Wire Off	When using a **3-wire RTD** device and any of the following: • One wire is disconnected from any of the channel's terminals. • Wires are disconnected from any combination of terminals: – IN_*x*(+)/A – IN_*x*(-)/B – IN_*x*/RTD C • All of the wires are disconnected from the channel.	The following occurs: • Input data for the channel changes to the highest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.	• Check the wiring, terminations, and for an open wire. • Make sure the length of the RTD cable is within module specifications. Wire length that is too long has a higher impedance, and can be interpreted as an open circuit.
	When using a **4-wire RTD** device and any of the following: • A wire is disconnected from only terminal IN_*x*(-)/B. • Wires are disconnected from any combination of the channel's terminals, that is: – IN_*x*(+)/A – IN_*x*(-)/B – IN_*x*/RTD C – IN_*x*/RTD D **IMPORTANT**: There is one combination exception that does not apply. A wire off condition is not detected when wires are simultaneously disconnected from only IN_*x*/RTD C and IN_*x*/RTD D terminals. • All wires are disconnected from the module.	If bullet 1, the following occurs: • Input data for the channel changes to the lowest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Underrange* tag is set to 1. *x* represents the channel number. If bullets 2 or 3, the following occurs: • Input data for the channel changes to the highest scaled temperature value associated with the selected sensor type. • The *I.Ch[x].Overrange* tag is set to 1. *x* represents the channel number.	
Electrical noise	Erratic readings, that is, data fluctuating more than is typical, are a cause of noise. An oscilloscope shows the magnitude of noise.		• Disconnect all but one RTD to see if channels are affecting each other, that is, there is bleed-over. • Eliminate or suppress the effect of noise. Employ hardware or software filters provided by the 1756-IRT8I, 1756-IRT8IK module, such as the Notch Filter.
DC signal on top of the thermocouple signal	Offset readings can be caused by a DC signal riding on top of the thermocouple signal. An oscilloscope shows the magnitude of the offset.		Disconnect all but one RTD to see if channels are affecting each other, that is, there is bleed-over.
Module is in calibration mode	Incorrect readings can be a result of the module being calibrated when the reading occurs.		Make sure the module is not in calibration mode. This symptom is module dependent, but in general, specific bits have to be turned on to enable calibration.
Incorrect reading soon after module installation	One of the following: • Incorrect readings at initial module installation and configuration are often the result of installation and configuration errors. • Incorrect readings at installation of an existing, previously-working module are more likely the result of a hardware failure.		One of the following: • If error is occurring on a new module installation and configuration, make sure that those tasks were completed corrected and correct any errors you find. • If the error is occurring on an existing, previously-working module, diagnose the hardware failure and correct it. If more than one channel is experiencing the incorrect readings in this case, disconnect all thermocouples except one. This can help determine if it is external hardware or the module itself is the cause
Grounded RTD	Due to the module's excitation current traveling on an RTD lead that is grounded there can be errant ground paths which would cause inaccuracies to the RTD measurements.		Eliminate the ground or use a signal conditioner/isolator.

Table 23 - Troubleshoot Incorrect RTD Readings (Continued)

Possible Cause of Incorrect Reading	Description	Recommended Action
Lead Compensation	An RTD sensor requires at least three leads to compensate for lead resistance error, caused by resistance mismatch. The amount of error eliminated depends upon the difference between the resistance values of the lead wires. The closer the resistance values are to each other, the greater the amount of error that is eliminated	To verify that the lead resistance values match as closely as possible: • use heavy gauge wire (16–18 gauge) • keep lead distances less than 1000 feet • use quality cable that has a small tolerance impedance rating.
Sensor Offset	The software configured Sensor Offset value is summed with the input data value.	Verify that the Sensor Offset feature is desired.
Programming and Configuration	One of the following: • Input value read from correct data tag. • Channel configured for correct range. • Signal and Engineering units are set correctly and equal.	If the incorrect input data value is in a secondary location, for example, an HMI device, verify the base tag value in the controller. Correct module configuration as needed.

1756-IF8I, 1756-IF8IK Module - Incorrect Input Voltage/Current Readings

To determine the cause of the incorrect reading, first determine the nature of the incorrect reading. For example, the module can perform as follows:

- The module always reads maximum.
- The module always reads minimum/zero/negative.
- The module reads voltage/current erratically (data jumping around).
- The module reads with an offset over the entire range.

First, complete the following tasks.

1. Check the status indicators to verify that the module is powered and communicating.

   Red or flashing green status indicators indicate a problem. For more information about status indicators, page 143.
2. Make sure that wiring is intact and correct, and that the current or voltage input is wired to the corresponding terminals and with proper polarity.
3. If the status indicators indicate that the module is communicating as expected and all module wiring is correct, complete the following tasks.
   a. Disconnect the transmitter from the channel in question.
   b. Connect a known voltage/current source directly to the module.

      A known voltage/current source provides voltage/current at the channel equivalent to the voltage/current expected from the transmitter.

   - If the voltage/current reports back correctly then the module is performing as expected. In this case, the transmitter or wiring are likely the cause.
   - If the applied voltage/current source is not reporting back correctly, then the module hardware, configuration, or the software application are likely the cause.

   We **highly recommend** using a known voltage/current source for initial troubleshooting.

If the previously listed tasks fail to resolve your issue with incorrect voltage or current readings on your module, use the following table.

Table 24 - 1756-IF8I, 1756-IF8IK Module - Troubleshoot Incorrect Input Voltage/Current Readings

Possible Cause of Incorrect Reading	Description		Recommended Action
Open wire	When the module is used in **Voltage mode** and any of the following: • A wire is disconnected from the module. • A 4-wire transmitter has no power applied.	The following occurs: • Input data for that channel changes to the scaled value associated with the **overrange** signal value of the selected operational range. • The *I.Ch[x].Overrange* (x=channel number) tag is set to 1.	• Check the wiring to verify that all wires are connected. • Verify that the 4-wire transmitter, if used, is powered.
	When the module is used in **Current mode** and any of the following: • A wire is disconnected from the module. • The RTB is disconnected from the module. • The external loop power is not wired correctly, not working or the module is configured to supply loop power and is not required. • The module supplied loop power is not wired correctly, not working or not configured to supply loop power when required.	The following occurs: • Input data for that channel changes to the scaled value associated with the **underrange** signal value of the selected operational range. • The *I.Ch[x].Underrange* (x=channel number) tag is set to 1.	• Check all wiring to verify that all wires are connected. • Check the RTB to verify that it is fully seated on the module. • If an external power source is providing loop power, verify the following: – The external power source is properly wired. – Module configuration accurately indicates that an external power source is providing loop power. • If the module is providing loop power internally, verify the following: – The module is properly wired. – Module configuration accurately indicates that loop power is being supplied internally.
Short-circuited input	Reading the minimum can mean that there is a short-circuited input.		Check wiring and correct terminations.
Incorrect polarity	The wiring polarity of the transmitter and loop power must match the wiring diagrams, or negative readings can result.		Check wiring polarity of the transmitter and the loop power source.
Electrical noise	Erratic readings, that is, data fluctuating more than is typical, are a cause of noise. An oscilloscope shows the magnitude of noise.		• Disconnect all but one input to see if channels are affecting each other, that is, there is bleed-over. • Eliminate or suppress the effect of noise. Employ hardware or software filters provided by the 1756-IF8I, 1756-IF8IK module, such as the Notch Filter.
DC signal on top of the input signal	Offset readings can be caused by a DC signal riding on top of the input signal. An oscilloscope shows the magnitude of the offset.		Disconnect all but one input to see if channels are affecting each other, that is, there is bleed-over.
Module is in calibration mode	Incorrect readings can be a result of the module being calibrated when the reading occurs.		Make sure the module is not in calibration mode. This symptom is module dependent, but in general, specific bits have to be turned on to enable calibration.
Incorrect reading soon after module installation	One of the following: • Incorrect readings at initial module installation and configuration are often the result of installation and configuration errors. • Incorrect readings at installation of an existing, previously-working module are more likely the result of a hardware failure.		One of the following: • If the error is occurring on a new module installation and configuration, make sure that those tasks were completed corrected and correct any errors you find. • If the error is occurring on an existing, previously-working module, diagnose the hardware failure and correct it. If more than one channel is experiencing the incorrect readings in this case, disconnect all inputs except one. This can help determine if it is external hardware or the module itself is the cause.

Table 24 - 1756-IF8I, 1756-IF8IK Module - Troubleshoot Incorrect Input Voltage/Current Readings (Continued)

Possible Cause of Incorrect Reading	Description	Recommended Action
One of the following: • Short-circuit condition - Typically, caused by a short between terminal. With this module the short is between terminals IN_x/I/SRC and RTN_x (where x is the channel number). • Sourcing overcurrent condition - Caused by a current signal >24 mA.	When a short-circuit or sourcing overcurrent condition exists, the module sets the input to 24 mA, that is, the equivalent engineering unit value. This value indicates a special error condition beyond the normal Overrange value, that is, 21 mA: The following events occur: 1. For one second, the short-circuit or overcurrent condition self-corrects if the condition trigger is removed. 2. After one second, the condition latches, the channel disables Source Loop. 3. Current and continue to send 24 mA with an Overrange indication.	Check wiring and correct terminations. To unlatch the condition after the conditioning trigger is removed, perform one of the following: • Cycle power to the module. • Reset the module. • Inhibit and uninhibit the module.
Sensor Offset	The software configured Sensor Offset value is summed with the input data value	Insure that the Sensor Offset feature is desired.
Programming and Configuration	One of the following: • The input value is not read from correct data tag. • The channel is not configured for correct range. • The Signal and Engineering units are not set correctly.	If the incorrect input data value is in a secondary location, for example, an HMI device, verify the base tag value is in the controller. Correct programming or configuration as needed.

1756-OF8I, 1756-OF8IK Module - Incorrect Output Voltage/Current Readings

To determine the cause of the incorrect reading, first determine the nature of the incorrect reading. For example, the module can perform as follows:

- The module always outputs maximum.
- The module always outputs zero.
- The module outputs a smaller value than expected.
- The module outputs erratic voltage/current data.

First, complete the following tasks.

1. Check the status indicators to verify that the module is powered and communicating.

   Red or flashing green status indicators indicate a problem. For more information about status indicators, page 145.
2. Make sure wiring is intact and correct, current or voltage input wired to the corresponding terminals and with proper polarity.
3. If the status indicators indicate that the module is communicating as expected and all module wiring is correct, complete the following tasks.
   a. Disconnect the load from the channel in question.
   b. Insert a resistor with the module's voltage/current output range.
   c. With a voltmeter or in line current meter, verify that the voltage or current is as expected.
   - If the voltage/current reads correctly the module is performing as expected. In this case, the load or wiring are likely the cause.
   - If the sourcing voltage/current is not read back correctly, then the module hardware, configuration, or the software application are suspect.

If the previously listed tasks fail to resolve your issue with incorrect voltage or current readings on your module, use the following table.

Table 25 - 1756-OF8I, 1756-OF8IK Module - Troubleshoot Incorrect Input Voltage/Current Readings

Possible Cause of Incorrect Output	Description	Recommended Action
Open wire	One of the following: • The load does not respond to the applied voltage/current output. • A wire is disconnected from the module. • The RTB is disconnected from the module.	One of the following: • Check that the load is functioning properly. • Check wiring to verify that all wires are connected. • Check the RTB to verify that it is fully seated on the module.
Short-circuited output	Reading minimum (downscale) can mean that there is a short-circuited output. One of the following: • Output to return short. • Short to supply power. • Short to ground.	Check wiring and correct terminations.
Electrical noise	Erratic readings, that is, data fluctuating more than is typical, are a cause of noise. An oscilloscope shows the magnitude of noise.	• Disconnect all but one output to see if channels are affecting each other, that is, there is bleed-over. • Eliminate or suppress the effect of noise. Employ hardware or software filters provided by the 1756-OF8I, 1756-OF8IK module.
DC signal on top of the output signal	Offset readings can be caused by a DC signal riding on top of the output signal. An oscilloscope shows the magnitude of the offset.	Disconnect all but one input to see if channels are affecting each other, that is, there is bleed-over.
Module is in calibration mode	Incorrect readings can be a result of the module being calibrated when the reading occurs.	Make sure the module is not in calibration mode. This symptom is module dependent, but in general, specific bits have to be turned on to enable calibration.
Incorrect reading soon after module installation	One of the following: • Incorrect readings at initial module installation and configuration are often the result of installation and configuration errors. • Incorrect readings at installation of an existing, previously-working module are more likely the result of a hardware failure.	One of the following: • If error is occurring on a new module installation and configuration, make sure that those tasks were completed corrected and correct any errors you find. • If the error is occurring on an existing, previously-working module, diagnose the hardware failure and correct it. If more than one channel is experiencing the incorrect readings in this case, disconnect all outputs except one. This can help determine if it is external hardware or the module itself is the cause.
Load Compatibility	The module is capable of driving current input load impedance of up to 1000 ohms. The module is capable of driving voltage input load impedance of 1000 ohms.	Verify the loop impedance of the load driven by the module.
Invalid Clamp Values	Check the Clamp values on the module configuration Limits tab. They are **not** automatically changed when the scaling engineering units are changed. If they are not changed a small value of voltage/current out results.	Change the Clamp values with respect to the scaling engineering units.
Hold for Initialization	If this feature is used, the output value does not change (hold value) until the commanded value is at the output screw terminal within 0.1% of full scale.	Verify that the Hold for Initialization feature is desired.
Channel Offset	The software configured Channel Offset value is summed with the output.	Verify that the Channel Offset feature is desired.
Programming and Configuration	One of the following: • The output value is written to the incorrect data tag. • The channel is not configured for correct range. • The Signal and Engineering units are not set correctly.	If the incorrect output data is written from a secondary location, for example, an HMI device, verify that the output base tag value is correct in the controller. Correct programming or configuration as needed.

Notes:

Analog I/O Module Tag Definitions

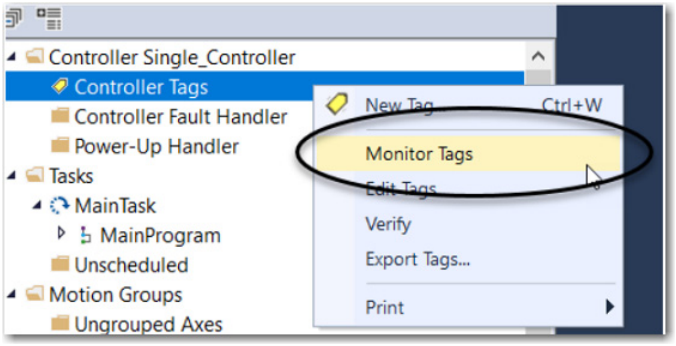
Module tags are created when you add a module to the Studio 5000 Logix Designer® application project. The set of tags that are associated with any module depends on the module type and the connection type. There are three sets of tags for each module:

- Configuration
- Input
- Output

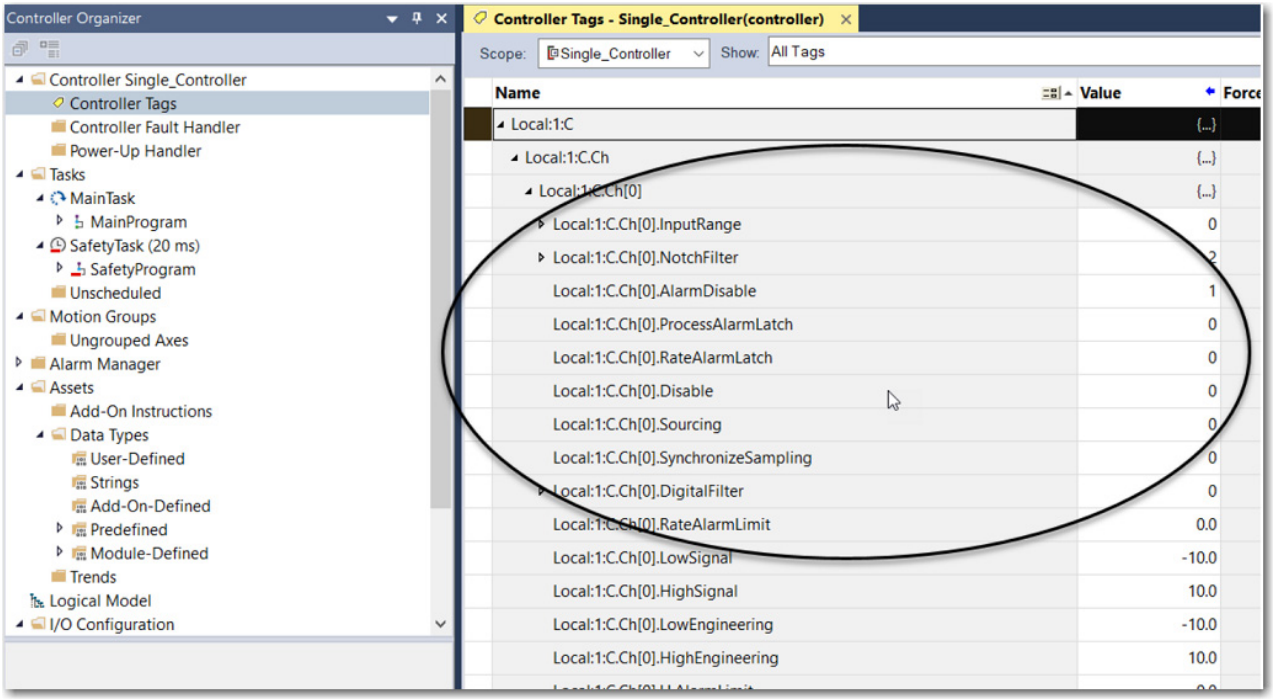
Access the Tags

You can view tags from the Tag Editor. Complete the following steps.

1. Open your Logix Designer application project.
2. Right-click Controller Tags and choose Monitor Tags.



3. Open the tags as needed to view specific tags.



1756-IF8I, 1756-IF8IK Module Tags

This section describes the tags associated with the 1756-IF8I, 1756-IF8IK module.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Configuration Tags

The following table describes the Configuration tags.

Table 26 - 1756-IF8I, 1756-IF8IK Module - Configuration Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].InputRange	SINT	Channel's operating range.	• 0 = -10...10V • 1 = 0...5V • 2 = 0...10V • 3 = 0...20 mA (default)
Ch[x].NotchFilter	SINT	Notch Filter removes line noise for the channel. There is a relationship between this setting and the RPI setting. For more information on Notch Filter, see page 38.	• 0 = 10 Hz • 1 = 50 Hz • 2 = 60 Hz (default) • 3 = 100 Hz • 5 = 1000 Hz • 6 = 20 Hz • 7 = 15 Hz • 8 = 500 Hz • 9 = 5000 Hz • 10 = 5 Hz
Ch[x].AlarmDisable	BOOL	Disables all alarms on the module.	• 0 = Enabled • 1 = Disabled (default)
Ch[x].ProcessAlarmLatch	BOOL	Latches Process alarms. If this tag is set to latch the process alarms, the I:Ch[x].LLAlarm, I:Ch[x].LAlarm, I:Ch[x].HAlarm or I:Ch[x].HHAlarm tags do not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled

Table 26 - 1756-IF8I, 1756-IF8IK Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].RateAlarmLatch	BOOL	Latches the Ramp alarm. If this tag is set to latch the ramp alarm, the I:Ch[x].RampAlarm tag does not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
Ch[x]. Disable	BOOL	Disables the channel.	• 0 = Enabled (default) • 1 = Disabled
Ch[x].Sourcing	BOOL	When in current mode, indicates if channel is Sinking or Sourcing.	• 0 = Sinking (default) • 1 = Sourcing
Ch[x].SynchronizeSampling	BOOL	Determines if the sampling of the channel is synchronized with other modules configured as synchronized.	• 0 = Not synchronized (default) • 1 = Synchronized
Ch[x].DigitalFilter	INT	Time Constant for First Order Lag firmware filter.	0...32,767 ms (0 = default)
Ch[x].RateAlarmLimit	REAL	Rate of change in Engineering Units/Second If the absolute value of the change between samples divided by the sample time exceeds this value, the *I.Ch[x].RateAlarm* tag is sets.	Any positive value 0.0 = default (This value represents no change between samples.)
Ch[x].LowSignal	REAL	Signal value that lets you scale signal units (V, mA) into Engineering Units. Corresponds to the *C.Ch[x].LowEngineering* tag. That is, this tag's value is scaled to the lowest Engineering Unit. For more information on how Signal values correspond to Engineering values, see page 29	Any value that is less than the *C.Ch[x].HighSignal* tag value. • Current input type: 4.0 mA = default • Voltage input type: -10.0V= default
Ch[x].HighSignal	REAL	Signal scaling value that lets you scale signal units (V, mA) into Engineering Units. Corresponds to the *C.Ch[x].HighEngineering* tag. That is, this tag's value is scaled to the highest Engineering Unit. For more information on how Signal values correspond to Engineering values, see page 29	Any value that is greater than the *C.Ch[x].LowSignal* tag value • Current input type: 20.0 mA = default • Voltage input type: 10.0V= default
Ch[x].LowEngineering	REAL	Low engineering scaling point Corresponds to the *C.Ch[x].LowSignal* tag value. For more information on how Signal values correspond to Engineering values, see page 29	0.0 = default (In voltage applications, default = *C.Ch[x].LowSignal* tag value)
Ch[x].HighEngineering	REAL	High engineering scaling point Corresponds to the *C.Ch[x].HighSignal* tag value. For more information on how Signal values correspond to Engineering values, see page 29	100.0 = default (In voltage applications, default = *C.Ch[x].HighSignal* tag value)
Ch[x].LLAlarmLimit	REAL	Low Low Process Alarm limit Triggers the *I.Ch[x].LLAlarm* tag when the *I.Ch[x].Data* tag value is less than this tag's value.	0.0 = default
Ch[x].LAlarmLimit	REAL	Low Process Alarm limit Triggers the *I.Ch[x].LAlarm* tag when the *I.Ch[x].Data* tag value is less than this tag's value	0.0 = default
Ch[x].HAlarmLimit	REAL	High Process Alarm Limit Triggers the *I.Ch[x].HAlarm* tag when the *I.Ch[x].Data* tag value is greater than this tag's value.	100.0 = default
Ch[x].HHAlarmLimit	REAL	High High Process Alarm Limit Triggers the *I.Ch[x].HHAlarm* tag when the *I.Ch[x].Data* tag value is greater than this tag's value.	100.0 = default
Ch[x].AlarmDeadband	REAL	Deadband that keeps Process Alarms triggered as long as the *I.Ch[x].Data* tag value remains within the deadband of the Process Alarm's value	Any non-negative value 0.0 = default

Input Tags

The following table describes the Input tags associated with the module.

Table 27 - 1756-IF8I, 1756-IF8IK Module - Input Tags

Tag Name	Data Type	Definition	Valid Values
Fault	DINT	Standard Analog Fault mask – controller sets all 32 bits on connection loss.	• 0000_0000= Connection is good • FFFF_FFFF Hex = Connection has failed
CIPSyncValid	BOOL	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.	• 0 = CIP Sync is not available • 1 = CIP Sync is available
CIPSyncTimeout	BOOL	Indicates whether a valid time master on the backplane has timed out.	• 0 = A valid time master has not timed out. • 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock with old synchronized time data.
CIPSyncOffsetJump	BOOL	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred. We recommend that you refresh the Diagnostic Assembly to get more data on the jump if precise time tracking is important to your application.	• 0 = No significant jump occurred • 1 = Significant jump occurred
Ch[x].Fault	BOOL	Indicates that channel data is inaccurate and cannot be trusted for use in the application. If the tag is set to 1, you cannot trust the data reported. You must troubleshoot the module to correct the cause of the inaccuracy.	• 0 = Good • 1 = Bad
Ch[x].Uncertain	BOOL	Indicates that channel data can be inaccurate but it is not known to what degree of inaccuracy. If the tag is set to 1, you know the data can be inaccurate but you can troubleshoot the module to discover what degree of inaccuracy exists.	• 0 = Good • 1 = Uncertain
Ch[x].Underrange	BOOL	Indicates the channel data is beneath the absolute minimum for this channel. For example, when the channel operates in the 0…20 mA input range, the underrange threshold on the channel is ≤ 3.6 mA. If the input signal is 0 mA, this tag is set to 1.	• 0 = Channel data is not beneath the absolute minimum • 1 = Channel data is beneath the absolute minimum
Ch[x].Overrange	BOOL	Indicates the channel data is above the absolute maximum for this channel. For example, when the channel operates in the 0…20 mA input range, the absolute maximum on the channel is ≥ 21.0 mA. If the input signal is 22 mA, this tag is set to 1.	• 0 = Channel data is not above the absolute minimum • 1 = Channel data is above the absolute minimum
Ch[x].LLAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is less than the *C.Ch[x].LLAlarmLimit*. tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].LAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is less than the *C.Ch[x].LAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].HAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is set
Ch[x].HHAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HHAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].RateAlarm	BOOL	Triggered when the absolute change between consecutive channel samples exceeds the *C.Ch[x].RateAlarmLimit* tag value. If latched, this tag remains set until it is unlatched.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].CalibrationFault	BOOL	Indicates that the channel is not calibrated or the last attempted calibration for this channel failed. If the last calibration failed, this tag is cleared, that is, set to 0, when power is cycled to the module.	• 0 = Calibration did not fail • 1 = Calibration failure
Ch[x].Calibrating	BOOL	Indicates the channel is currently being calibrated.	• 0 = Channel is not being calibrated • 1 = Channel is being calibrated

Table 27 - 1756-IF8I, 1756-IF8IK Module - Input Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].CalGoodLowRef	BOOL	Indicates that a valid Low Reference signal has been sampled on this channel.	• 0 = Valid Low Reference signal has not been sampled on this channel • 1 = Valid Low Reference signal has been sampled on this channel
Ch[x].CalBadLowRef	BOOL	Indicates that an invalid Low Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid Low Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed or a reset or RIUP occurs.	• 0 = Invalid Low Reference signal has not been sampled on this channel • 1 = Invalid Low Reference signal has been sampled on this channel
Ch[x].CalGoodHighRef	BOOL	Indicates that a valid High Reference signal has been sampled on this channel.	• 0 = Valid High Reference signal has not been sampled on this channel • 1 = Valid High Reference signal has been sampled on this channel
Ch[x].CalBadHighRef	BOOL	Indicates that an invalid High Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid High Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	• 0 = Invalid High Reference signal has not been sampled on this channel • 1 = Invalid High Reference signal has been sampled on this channel
Ch[x].CalSuccessful	BOOL	Indicates calibration on this channel is complete and the Calibrating state has been exited. This tag remains set after valid calibration for 1000 samples.	• 0 = Calibration was not successful • 1 = Calibration was successful and calibrating state has been exited.
Ch[x].RateOfChange	REAL	Change in channel data since last sample in Engineering Units/Second.	Value representing the rate of change 0.0 = default (This value indicates no change occurred since sample.)
Ch[x].Data	REAL	Channel data in scaled Engineering Units.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.
Timestamp	DINT[2]	64-bit timestamp indicating when all 8 channels were last sampled in terms of CIPSync time.	CIPSync Timestamp data
RollingTimestamp	DINT	16-bit timestamp that 'rolls' from 0...32,767 ms. Compatible with existing PID/PIDE instructions to automatically calculate sample deltas. With this module, this PID/PIDE instruction uses the RPI because there is no RTS available. For more information on the Rolling Timestamp, see page 20.	0...32,767 ms; where 1 ms = 1 count

Output Tags

The following table describes the Output tags associated with the module.

Table 28 - 1756-IF8I, 1756-IF8IK Module - Output Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].LLAlarmEn	BOOL	Enables the Low Low Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].LAlarmEn	BOOL	Enables the Low Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].HAlarmEn	BOOL	Enables the High Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].HHAlarmEn	BOOL	Enables the High High Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled

Table 28 - 1756-IF8I, 1756-IF8IK Module - Output Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].LLAlarmUnlatch	BOOL	Unlatches a latched Low Low Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Low Low alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Low Low alarm unlatching.	• 0 = LLAlarm remains latched • 1 = LLAlarm unlatches
Ch[x].LAlarmUnlatch	BOOL	Unlatches a latched Low Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Low alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Low alarm unlatching.	• 0 = Low Alarm remains latched • 1 = Low Alarm unlatches
Ch[x].HAlarmUnlatch	BOOL	Unlatches a latched High Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the High alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the High alarm unlatching.	• 0 = High Alarm remains latched • 1 = High Alarm unlatches
Ch[x].HHAlarmUnlatch	BOOL	Unlatches a set High High Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the High High alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the High High alarm unlatching.	• 0 = High High Alarm remains latched • 1 = HHAlarm unlatches
Ch[x].RateAlarmUnlatch	BOOL	Unlatches a set Rate Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Process alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Process alarm unlatching.	• 0 = Rate Alarm remains latched • 1 = Rate Alarm unlatches
Ch[x].Calibrate	BOOL	Initiates the Calibration process. This tag must remain set until a valid Low Reference and High Reference values are applied to the input. If the tag value transitions to 0 before calibration is finished, the process stops and calibration fails.	• 0 = Calibration process is not started • 1 = Calibration process is started
Ch[x].CalLowRef	BOOL	Rising edge triggers the Low Calibration at the Low Reference Point for the current *C.Ch[x].InputRange* tag value. A valid Low Reference signal must be connected to the channel before setting this tag.	• 0 = Do not sample the Low Reference Calibration Point. • 1 = Sample the Low Reference Calibration point on rising edge.
Ch[x].CalHighRef	BOOL	Rising edge triggers a High Calibration at the High Reference Point for the current *C.Ch[x].InputRange* tag value. A valid High Reference signal must be connected to the channel before setting tag.	• 0 = Do not sample the High Reference Calibration Point. • 1 = Sample the High Reference Calibration point on rising edge.
Ch[x].SensorOffset	REAL	Compensates for any known error on the sensor or channel to which the sensor is connected.	Any (We recommend that you use a small value in the channel's operating range.) 0.0 = default

1756-IRT8I, 1756-IRT8IK Module Tags

This section describes the tags associated with the module.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Configuration Tags

The following table describes the Configuration tags associated with the module.

Table 29 - 1756-IRT8I, 1756-IRT8IK Module - Configuration Tags

Tag Name	Data Type	Definition	Valid Values
RemoteTermination	BOOL	Indicates CJC Sensor is connected remotely or locally. • If the CJC sensor if connected remotely, we recommend that you use an isothermal bar. With an isothermal bar, the CJC sensor is the same for all eight channels. 1492 IFMs use a built-in isothermal bar. • If the CJC sensor is connected locally, thermal gradients exist on the RTB because heat rises. With an RTB, temperature differences exist between the CJC sensors. Correction factors are applied internally to account for the differences.	• 0 = CJC sensor is connected locally via the RTB • 1 = CJC sensor is connected remotely (default)
CJDisable	BOOL	Removes cold junction compensation from Thermocouple calculations. By default module configuration, cold junction is compensated for each Thermocouple channel returning temperature.	• 0 = CJ compensation enabled • 1 = No CJ compensation
CJOffset	REAL	User-defined offset value, measure in temperature units, to add to the channel's CJC sensor reading.	Default = 0.0 C
Ch[x].InputRange	SINT	Channel's operating range.	• 4 = -100...100 mV • 6 = 0...500 Ω • 7 = 0...1000 Ω • 8 = 0...2000 Ω • 9 = 0...4000 Ω
Ch[x].SensorType	SINT	Sensor type used on the channel. The Input Type connected to the channel determine the sensor type.	If an RTD input type is connected to the channel: • 0 = Ω • 1 = 100Ω PT 385 • 2 = 200Ω PT 385 • 3 = 500Ω PT 385 • 4 = 1000Ω PT 385 • 5 = 100Ω PT 3916 • 6 = 200Ω PT 3916 • 7 = 500Ω PT 3916 • 8 = 1000Ω PT 3916 • 9 = 10Ω CU 427 • 10 = 120Ω NI 672 • 11 = 100Ω NI 618 • 12 = 120Ω NI 618 • 13 = 200Ω NI 618 • 14 = 500Ω NI 618 If a Thermocouple input type is connected to the channel: • 0 = mV • 1 = B • 2 = C • 3 = E • 4 = J • 5 = K • 6 = N • 7 = R • 8 = S • 9 = T • 10 = TXK/XK(L) • 11 = D

Table 29 - 1756-IRT8I, 1756-IRT8IK Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].NotchFilter	SINT	Notch Filter removes line noise for the channel. There is a relationship between this setting and the RPI setting. For more information on Notch Filter, see page 55.	• 0 = 10 Hz • 1 = 50 Hz • 2 = 60 Hz • 3 = 100 Hz • 5 = 1000 Hz • 6 = 20 Hz • 7 = 15 Hz • 8 = 500 Hz • 9 = 5000 Hz • 10 = 5 Hz
Ch[x].AlarmDisable	BOOL	Disables all alarms on the module.	• 0 = Enabled • 1 = Disabled (default)
Ch[x].ProcessAlarmLatch	BOOL	Latches Process alarms. If this tag is set to latch the process alarms, the I:Ch[x].LLAlarm, I:Ch[x].LAlarm, I:Ch[x].HAlarm or I:Ch[x].HHAlarm tags do not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
Ch[x].RateAlarmLatch	BOOL	Latches the Ramp alarm. If this tag is set to latch the ramp alarm, the I:Ch[x].RampAlarm tag does not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
Ch[x].Disable	BOOL	Disables the channel.	• 0 = Enabled (default) • 1 = Disabled
Ch[x]. TempEnglish	BOOL	Used with the TempAbsolute tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	• 0 = Standard (default) • 1 = English **IMPORTANT**: The combination of this value with that of the TempAbsolute tag value determine the temperature unit used. For example, if TempEnglish = 0 and TempAbsolute = 0, the combination is 00. Thus, Celsius units are used. The following combinations are possible: • 00 = Celsius • 01 = Fahrenheit • 10 = Kelvin • 11 = Rankine
Ch[x].TempAbsolute	BOOL	Used with the TempEnglish tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	• 0 = Familiar (default) • 1 = Absolute **IMPORTANT**: See the TempEnglish tag Valid Values description for more information on using this tag's value.
Ch[x].FourWireRTD	BOOL	Sets what type of RTD, that is, 3-wire or 4-wire, is connected to the channel.	• 0 = 3-wire RTD (default) • 1 = 4-wire RTD
Ch[x].SynchronizeSampling	BOOL	Determines if the sampling of the channel is synchronized with other channels configured for synchronized sampling.	• 0 = Not synchronized (default) • 1 = Synchronized
Ch[x].TenOhmOffset	INT	Specific offset for 10 Ohm Copper Sensor Type. Value is measured in **Hundredths of Ω** with two implied decimal places.	-100...100 in hundredths of Ω 0 = default
Ch[x].DigitalFilter	INT	Time Constant for a First Order Lag filter.	0...32,767 ms 0 = default
Ch[x].RateAlarmLimit	REAL	Rate of change in Engineering Units/Second If the absolute value of the change between samples divided by the sample time exceeds this value, the *I.Ch[x].RateAlarm* tag is sets.	Any positive value 0.0 = default (This value represents no change between samples.)
Ch[x].LowSignal	REAL	Signal scaling value that lets you scale signal units (mV, Ω, °F or °C) into Engineering Units. Corresponds to the *C.Ch[x].LowEngineering* tag. That is, this tag's value is scaled to the lowest Engineering Unit.	Any value that is less than the *C.Ch[x].HighSignal* tag value. 0 = default
Ch[x].HighSignal	REAL	Signal scaling value that lets you scale signal units (mV, Ω, °F or °C) into Engineering Units. Corresponds to the *C.Ch[x].HighEngineering* tag. That is, this tag's value is scaled to the highest Engineering Unit.	Any value that is greater than the *C.Ch[x].LowSignal* tag value. 100.0 = default
Ch[x].LowEngineering	REAL	Low engineering scaling point Corresponds to the *C.Ch[x].LowSignal* tag value.	0.0 = default This value can correspond to signal values in units or temperature.

Table 29 - 1756-IRT8I, 1756-IRT8IK Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].HighEngineering	REAL	High engineering scaling point Corresponds to the *C.Ch[x].HighSignal* tag value.	100.0 = default This value can correspond to signal values in units or temperature.
Ch[x].LLAlarmLimit	REAL	Low Low Process Alarm limit Triggers the *I.Ch[x].LLAlarm* tag when the *I.Ch[x].Data* tag value is less than this tag's value.	0.0 = default
Ch[x].LAlarmLimit	REAL	Low Process Alarm limit Triggers the *I.Ch[x].LAlarm* tag when the *I.Ch[x].Data* tag value is less than this tag's value	0.0 = default
Ch[x].HAlarmLimit	REAL	High Process Alarm Limit Triggers the *I.Ch[x].HAlarm* tag when the *I.Ch[x].Data* tag value is greater than this tag's value.	100.0 = default
Ch[x].HHAlarmLimit	REAL	High High Process Alarm Limit Triggers the *I.Ch[x].HHAlarm* tag when the *I.Ch[x].Data* tag value is greater than this tag's value.	100.0 = default
Ch[x].AlarmDeadband	REAL	Deadband that keeps Process Alarms triggered as long as the *I.Ch[x].Data* tag value remains within the deadband of the Process Alarm's value	Any positive value 0.0 = default

Input Tags

The following table describes the Input tags associated with the module.

Table 30 - 1756-IRT8I, 1756-IRT8IK Module - Input Tags

Tag Name	Data Type	Definition	Valid Values
Fault	DINT	Standard Analog Fault mask – controller sets all 32 bits on connection loss.	• 0000_0000= Connection is good • FFFF_FFFF Hex = Connection has failed
CIPSyncValid	BOOL	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.	• 0 = CIP Sync is not available • 1 = CIP Sync is available
CIPSyncTimeout	BOOL	Indicates whether a valid time master on the backplane has timed out.	• 0 = A valid time master has not timed out. • 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock with old synchronized time data.
CIPSyncOffsetJump	BOOL	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred. We recommend that you refresh the Diagnostic Assembly to get more data on the jump if precise time tracking is important to your application.	• 0 = No significant jump occurred • 1 = Significant jump occurred
CJ[0].Underrange CJ[1]Underrange	BOOL	The cold junction at channel *x* is below 0 °C.	• 0 = Cold junction is not below 0 °C • 1 = Cold junction is below 0 °C
CJ[0].Overrange CJ[1].Overrange	BOOL	The cold junction at channel *x* is above 86 °C.	• 0 = Cold junction is not above 86 °C • 1 = Cold junction is above 86 °C
CJ[0].Data CJ[1].Data	REAL	The cold junction at the top module terminal, that is, CJ[0], or the bottom module terminal, that is, CJ[1] *x* in °C.	
Ch[x].Fault	BOOL	Quality of channel data.	• 0 = Good • 1 = Bad
Ch[x].Uncertain	BOOL	Channel data can be imperfect.	• 0 = Good • 1 = Uncertain
Ch[x].Underrange	BOOL	Indicates the channel data is beneath the absolute minimum for this channel. For example, when the channel operates in the -100…100 mV input range, the absolute minimum on the channel is -101.00 mV. If the input signal is -102.00 mV, this tag is set to 1.	• 0 = Channel is not beneath the absolute minimum • 1 = Channel is beneath the absolute minimum
Ch[x].Overrange	BOOL	Indicates the channel data is above the absolute maximum for this channel. For example, when the channel operates in the -100…100 mV input range, the absolute maximum on the channel is 101.00 mV. If the input signal is 102.00 mV, this tag is set to 1.	• 0 = Channel is not above the absolute minimum • 1 = Channel is above the absolute minimum
Ch[x].LLAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is less than the *C.Ch[x].LLAlarmLimit*. tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].LAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is less than the *C.Ch[x].LAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].HAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is set
Ch[x].HHAlarm	BOOL	Triggered when the *I.Ch[x].Data* tag value is greater than the *C.Ch[x].HHAlarmLimit* tag value. If latched, this tag remains set until unlatched or if the *I.Ch[x].Data* tag value is within Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
Ch[x].RateAlarm	BOOL	Triggered when the absolute change between consecutive channel samples exceeds the *C.Ch[x].RateAlarmLimit* tag value. If latched, this tag remains set until it is unlatched.	• 0 = Alarm is not triggered • 1 = Alarm is triggered

Table 30 - 1756-IRT8I, 1756-IRT8IK Module - Input Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].CalibrationFault	BOOL	Indicates the channel is not calibrated or the last attempted calibration for this channel failed. If the last calibration failed, this tag is cleared, that is, set to 0, when power is cycled to the module.	• 0 = Calibration did not fail • 1 = Calibration failure
Ch[x].Calibrating	BOOL	Indicates the channel is currently being calibrated.	• 0 = Channel is not being calibrated • 1 = Channel is being calibrated
Ch[x].CalGoodLowRef	BOOL	Indicates that a valid Low Reference signal has been sampled on this channel.	• 0 = Valid Low Reference signal has not been sampled on this channel • 1 = Valid Low Reference signal has been sampled on this channel
Ch[x].CalBadLowRef	BOOL	Indicates that an invalid Low Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid Low Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	• 0 = Invalid Low Reference signal has not been sampled on this channel • 1 = Invalid Low Reference signal has been sampled on this channel
Ch[x].CalGoodHighRef	BOOL	Indicates that a valid High Reference signal has been sampled on this channel.	• 0 = Valid High Reference signal has not been sampled on this channel • 1 = Valid High Reference signal has been sampled on this channel
Ch[x].CalBadHighRef	BOOL	Indicates that an invalid High Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid High Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	• 0 = Invalid High Reference signal has not been sampled on this channel • 1 = Invalid High Reference signal has been sampled on this channel
Ch[x].CalSuccessful	BOOL	Indicates calibration on this channel is complete and the Calibrating state has been exited. This tag remains set after valid calibration for 1000 samples.	• 0 = Calibration was not successful • 1 = Calibration was successful and calibrating state has been exited.
Ch[x].RateOfChange	REAL	Indicates the change in channel data since last sample in Engineering Units/Second.	Value representing the rate of change
Ch[x].Data	REAL	Indicates channel data in scaled Engineering units.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.
Timestamp	DINT[2]	64-bit timestamp value that indicates when all eight channels were last sampled. This value is provided in terms of CIPSync time.	CIPSync Timestamp data
RollingTimestamp	DINT	16-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID/PIDE instructions to automatically calculate sample deltas. With this module, this PID/PIDE instruction uses the RPI because there is no RTS available. For more information on the Rolling Timestamp, see page 20.	0…32,767 ms; where 1 ms = 1 count

Output Tags

The following table describes the Output tags associated with the module.

Table 31 - 1756-IRT8I, 1756-IRT8IK Module - Output Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].LLAlarmEn	BOOL	Enables the Low Low Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].LAlarmEn	BOOL	Enables the Low Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].HAlarmEn	BOOL	Enables the High Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].HHAlarmEn	BOOL	Enables the High High Process alarm.	• 0 = Alarm is disabled • 1 = Alarm is enabled
Ch[x].LLAlarmUnlatch	BOOL	Unlatches a latched Low Low Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Low Low alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Low Low alarm unlatching.	• 0 = LLAlarm remains latched • 1 = LLAlarm unlatches
Ch[x].LAlarmUnlatch	BOOL	Unlatches a latched Low Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Low alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Low alarm unlatching.	• 0 = Low Alarm remains latched • 1 = Low Alarm unlatches
Ch[x].HAlarmUnlatch	BOOL	Unlatches a latched High Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the High alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the High alarm unlatching.	• 0 = High Alarm remains latched • 1 = High Alarm unlatches
Ch[x].HHAlarmUnlatch	BOOL	Unlatches a latched High High Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the High High alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the High High alarm unlatching.	• 0 = High High Alarm remains latched • 1 = HHAlarm unlatches
Ch[x].RateAlarmUnlatch	BOOL	Unlatches a latched Rate Alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Process alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Process alarm unlatching.	• 0 = Rate Alarm remains latched • 1 = Rate Alarm unlatches
Ch[x].Calibrate	BOOL	Initiates the Calibration process. This tag must remain set until a valid Low Reference and High Reference values are applied to the channel.	• 0 = Calibration process is not started • 1 = Calibration process is started
Ch[x].CalLowReference	BOOL	Rising edge triggers the Low Calibration at the Low Reference Point for the current *InputRange* tag value. A valid Low Reference signal must be connected to the channel before setting this tag.	• 0 = Do not sample the Low Reference Calibration Point. • 1 = Sample the Low Reference Calibration point on rising edge.
Ch[x].CalHighReference	BOOL	Rising edge triggers a High Calibration at the High Reference Point for the current *InputRange* tag value. A valid High Reference signal must be connected to the channel before setting tag.	• 0 = Do not sample the High Reference Calibration Point. • 1 = Sample the High Reference Calibration point on rising edge.
Ch[x].SensorOffset	REAL	Compensates for any known error on the sensor or channel to which the sensor is connected.	Any (We recommend that you use a small value in the channel's operating range.) 0.0 = default

1756-IR12, 1756-IR12K Module Tags

This section describes the tags associated with the 1756-IR12, 1756-IR12K module.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Configuration Tags

The following table describes the Configuration tags associated with the module.

Table 32 - 1756-IR12, 1756-IR12K Module - Configuration Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].InputRange	SINT	Indicates the channel's operating range.	• 6 = 0...500 Ω • 7 = 0...1000 Ω • 8 = 0...2000 Ω • 9 = 0...4000 Ω
Ch[x].SensorType	SINT	RTD sensor type used on the channel. The Input Type connected to the channel determine the sensor type	• 0 = Ω • 1 = 100Ω PT 385 • 2 = 200Ω PT 385 • 3 = 500Ω PT 385 • 4 = 1000Ω PT 385 • 5 = 100Ω PT 3916 • 6 = 200Ω PT 3916 • 7 = 500Ω PT 3916 • 8 = 1000Ω PT 3916 • 9 = 10Ω CU 427 • 10 = 120Ω NI 672 • 11 = 100Ω NI 618 • 12 = 120Ω NI 618 • 13 = 200Ω NI 618 • 14 = 500Ω NI 618
Ch[x].NotchFilter	SINT	Notch Filter removes line noise for the channel. All channels have the same setting based on Channel 0 For more information on Notch Filter, see page 55. Default = 2 (60 Hz)	• 1 = 50 Hz • 2 = 60 Hz • 3 = 100 Hz • 5 = 1000 Hz • 6 = 20 Hz • 8 = 500 Hz • 9 = 5000 Hz
Ch[x].Disable	BOOL	Disables the channel.	B3 • 0 = Enabled (default) • 1 = Disabled
Ch[x]. TempEnglish	BOOL	Used with the TempAbsolute tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	B4 • 0 = Standard (default) • 1 = English **IMPORTANT**: The combination of this value with that of the TempAbsolute tag value determine the temperature unit used. For example, if TempEnglish = 0 and TempAbsolute = 0, the combination is 00. Thus, Celsius units are used. The following combinations are possible: • 00 = Celsius • 01 = Fahrenheit • 10 = Kelvin • 11 = Rankine
Ch[x].TempAbsolute	BOOL	Used with the TempEnglish tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	B5 • 0 = Familiar (default) • 1 = Absolute **IMPORTANT**: See the TempEnglish tag Valid Values description for more information on using this tag's value.

Table 32 - 1756-IR12, 1756-IR12K Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].TenOhmOffset	INT	Specific offset for 10 Ohm Copper Sensor Type. Value is measured in **Hundredths of Ω** with two implied decimal places.	-100...100 in hundredths of Ω 0 = default
Ch[x].DigitalFilter	INT	Time Constant for a First Order Lag filter.	0...32,767 ms 0 = default
Ch[x].SensorOffset	REAL	Indicates the sensor offset in either Temperature Units or Ohms to add into the Input Value to compensate for any sensor error in the system.	Any positive value 0.0 = default

Input Tags

The following table describes the Input tags associated with the module.

Table 33 - 1756-IR12, 1756-IR12K Module - Input Tags

Tag Name	Data Type	Definition	Valid Values
Fault	DINT	Standard Analog Fault mask – controller sets bottom 16 bits on connection loss.	0000...0000= Connection is good
CIPSyncValid	BOOL	Indicates whether the module has synchronized to a valid CIP Sync time master on the backplane.	B0 = CIP Sync is available
CIPSyncTimeout	BOOL	Indicates whether a valid time master on the backplane has timed out.	B1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock with old synchronized time data.
CIPSyncOffsetJump	BOOL	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) We recommend that you refresh the Diagnostic Assembly to get more data on the jump if precise time tracking is important to your application.	B2
Ch[x].Fault	BOOL	Indicates the quality of Input Data.	B0 • 0 = Good • 1 = Bad
Ch[x].Uncertain	BOOL	Indicates the Input Data can be imperfect.	B1 • 0 = Good • 1 = Uncertain
Ch[x].Underrange	BOOL	Input is beneath absolute minimum for this channel. If temperature, set when beneath minimum for that SensorType.	B2
Ch[x].Overrange	BOOL	Input is above absolute maximum for this channel. If temperature, set when above maximum for that SensorType.	B3
Ch[x].CalibrationFault	BOOL	Indicates the last attempted calibration for this channel failed.	B9
Ch[x].Calibrating	BOOL	Indicates the channel is currently being calibrated.	B10
Ch[x].CalGoodLowRef	BOOL	Indicates that a valid Low Reference signal has been sampled on this channel.	B11
Ch[x].CalBadLowRef	BOOL	Indicates that an invalid Low Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid Low Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	B12
Ch[x].CalGoodHighRef	BOOL	Indicates that a valid High Reference signal has been sampled on this channel.	B13
Ch[x].CalBadHighRef	BOOL	Indicates that an invalid High Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid High Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	B14

Table 33 - 1756-IR12, 1756-IR12K Module - Input Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].CalSuccessful	BOOL	Indicates calibration on this channel is complete and the Calibrating state has been exited. This tag remains set after valid calibration as long as connection is open.	B15
Ch[x].Data	REAL	Indicates channel data in ohms or Temperature.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.
Timestamp	DINT[2]	64-bit timestamp value that indicates when all eight channels were last sampled. This value is provided in terms of CIPSync time.	CIPSync Timestamp data
RollingTimestamp	DINT	16-bit timestamp that 'rolls' from 0...32,767 ms. Compatible with existing PID/PIDE instructions to automatically calculate sample deltas. With this module, this PID/PIDE instruction uses the RPI because there is no RTS available. For more information on the Rolling Timestamp, see page 20.	0...32,767 ms; where 1 ms = 1 count

Output Tags

The 1756-IR12, 1756-IR12K module is a dedicated input module that does not contain any output data in the user connection. The module utilizes a Controlling Heartbeat for the owner or a Listening Heartbeat for a Listen-Only connection.

1756-IT16, 1756-IT16K Module Tags

This section describes the tags associated with the module.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Configuration Tags

The following table describes the Configuration tags associated with the module.

Table 34 - 1756-IT16, 1756-IT16K Module - Configuration Tags

Tag Name	Data Type	Definition	Valid Values
RemoteTermination	BOOL	Indicates CJC Sensor is connected remotely or locally. • If the CJC sensor if connected remotely, we recommend that you use an isothermal bar. With an isothermal bar, the CJC sensor is the same for all 8 channels. 1492 IFMs use a built-in isothermal bar. • If the CJC sensor is connected locally, thermal gradients exist on the RTB because heat rises. With an RTB, temperature differences exist between the CJC sensors. Correction factors are applied internally to account for the differences.	• 0 = CJC sensor is connected locally via the RTB • 1 = CJC sensor is connected remotely (default)
CJDisable	BOOL	Removes cold junction compensation from Thermocouple calculations. By default module configuration, cold junction is compensated for each Thermocouple channel returning temperature.	• 0 = CJ compensation enabled • 1 = No CJ compensation
CJOffset	REAL	User-defined offset value, measure in temperature units, to add to the channel's CJC sensor reading.	Default = 0.0 C
Ch[x].InputRange	SINT	Channel's operating range.	4 = -100...100 mV

Table 34 - 1756-IT16, 1756-IT16K Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].SensorType	SINT	Thermocouple sensor type used on the channel. The Input Type connected to the channel determine the sensor type	• 0 = mV • 1 = B • 2 = C • 3 = E • 4 = J • 5 = K • 6 = N • 7 = R • 8 = S • 9 = T • 10 = TXK/XK(L) • 11 = D
Ch[x].NotchFilter	SINT	Notch Filter removes line noise for the channel. All channels have the same setting based on Channel 0 For more information on Notch Filter, see page 55. Default = 2 (60 Hz)	• 1 = 50 Hz • 2 = 60 Hz • 3 = 100 Hz • 5 = 1000 Hz • 6 = 20 Hz • 8 = 500 Hz • 9 = 5000 Hz
Ch[x].Disable	BOOL	Disables the channel.	• 0 = Enabled (default) • 1 = Disabled
Ch[x]. TempEnglish	BOOL	Used with the TempAbsolute tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	• 0 = Standard (default) • 1 = English **IMPORTANT**: The combination of this value with that of the TempAbsolute tag value determine the temperature unit used. For example, if TempEnglish = 0 and TempAbsolute = 0, the combination is 00. Thus, Celsius units are used. The following combinations are possible: • 00 = Celsius • 01 = Fahrenheit • 10 = Kelvin • 11 = Rankine
Ch[x].TempAbsolute	BOOL	Used with the TempEnglish tag for the same channel to determine the temperature units for the channel when linearizing (non-zero sensor type).	• 0 = Familiar (default) • 1 = Absolute **IMPORTANT**: See the TempEnglish tag Valid Values description for more information on using this tag's value.
Ch[x].DigitalFilter	INT	Determines the time constant for a first order lag filter. Default = 0 (no filtering).	0...32,767 ms
Ch[x].SensorOffset	REAL	Sensor offset in either temperature units or mV to add into the input value to compensate for any sensor error in the system. Default = 0.0.	Any

Input Tags

The following table describes the Input tags associated with the module.

Table 35 - 1756-IT16, 1756-IT16K Module - Input Tags

Tag Name	Data Type	Definition	Valid Values
Fault	DINT	Standard Analog Fault mask – controller sets bottom 16 bits on connection loss.	0000_0000= Connection is good
CIPSyncValid	BOOL	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.	B0 = CIP Sync is not available
CIPSyncTimeout	BOOL	Indicates whether a valid time master on the backplane has timed out.	B1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock with old synchronized time data.

Table 35 - 1756-IT16, 1756-IT16K Module - Input Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
CIPSyncOffsetJump	BOOL	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) We recommend that you refresh the Diagnostic Assembly to get more data on the jump if precise time tracking is important to your application.	B2
CJ[x].Fault	BOOL	Quality of channel data.	• 0 = Good • 1 = Bad
CJ[x].Uncertain	BOOL	Channel data can be imperfect.	• 0 = Good • 1 = Uncertain
CJ[x].Underrange	BOOL	Indicates that Cold Junction Channel x is below 0 °C.	B2
CJ[x].Overrange	BOOL	Indicates that Cold Junction Channel x is above 86 °C.	B3
CJ[0].Data	REAL	Indicates the CJ input data in °C.	
Ch[x].Fault	BOOL	Indicates the quality of Input Data.	• 0 = Good • 1 = Bad
Ch[x].Uncertain	BOOL	Indicates the Input Data can be imperfect.	• 0 = Good • 1 = Uncertain
Ch[x].Underrange	BOOL	Input is beneath absolute minimum for this channel. If temperature, set when beneath minimum for that SensorType.	B2
Ch[x].Overrange	BOOL	Input is above absolute maximum for this channel. If temperature, set when above maximum for that SensorType.	B3
Ch[x].CalibrationFault	BOOL	Indicates the last attempted calibration for this channel failed.	B9
Ch[x].Calibrating	BOOL	Indicates the channel is currently being calibrated.	B10
Ch[x].CalGoodLowRef	BOOL	Indicates that a valid Low Reference signal has been sampled on this channel.	B11
Ch[x].CalBadLowRef	BOOL	Indicates that an invalid Low Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid Low Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	B12
Ch[x].CalGoodHighRef	BOOL	Indicates that a valid High Reference signal has been sampled on this channel.	B13
Ch[x].CalBadHighRef	BOOL	Indicates that an invalid High Reference signal has been sampled on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid High Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed.	B14
Ch[x].CalSuccessful	BOOL	Indicates calibration on this channel is complete and the Calibrating state has been exited. This tag remains set after valid calibration as long as connection is open.	B15
Ch[x].Data	REAL	Indicates channel data in Ohms or Temperature.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.
Timestamp	DINT[2]	64-bit timestamp value that indicates when all eight channels were last sampled. This value is provided in terms of CIPSync time.	CIPSync Timestamp data
RollingTimestamp	DINT	16-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID/PIDE instructions to automatically calculate sample deltas. With this module, this PID/PIDE instruction uses the RPI because there is no RTS available. For more information on the Rolling Timestamp, see page 20.	0…32,767 ms; where 1 ms = 1 count

Output Tags

The 1756-IT16, 1756-IT16K is a dedicated input module that does not contain any output data in the user connection. The module utilizes a Controlling Heartbeat for the owner or a Listening Heartbeat for a Listen-Only connection.

1756-OF8I, 1756-OF8IK Module Tags

This section describes the tags associated with the module.

IMPORTANT Each application's series of tags varies but no output module application contains any tags that are not listed here.

Configuration Tags

Table 36 describes the Configuration tags associated with the module.

Table 36 - 1756-OF8I, 1756-OF8IK Module - Configuration Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].HoldForInit	BOOL	When this tag is set, the channel holds the current value until the received I:Ch[x].*Data* tag value is within 0.1% of the current Echo O:Ch[x].*Data* tag value. If this tag is set to Hold, the *I:Ch[x].InHold* tag is triggered when the module transitions into Run mode from a Program or Fault states.	• 0 = Not holding (default) • 1 = Holding
Ch[x].AlarmDisable	BOOL	Disables all alarms on the module.	• 0 = Alarms Enabled • 1 = Alarms Disabled (default)
Ch[x].RampAlarmLatch	BOOL	Latches the Ramp alarm. If this tag is set to latch the ramp alarm, the *I:Ch[x].RampAlarm* tag does not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
Ch[x].LimitAlarmLatch	BOOL	Latches the Low alarm and the High alarms. If this tag is set to latch the alarms, the I:Ch[x].*LLimitAlarm* and I:Ch[x].*HLimitAlarm* tags do not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
Ch[x].FaultMode	BOOL	Determines channel action when a fault occurs, for example, a connection loss. At the fault occurrence, the module holds its last state or transitions to the channel value used in the *C.Ch[x].FaultValue* tag. If configured to Hold Last State, the channel Holds Last State for the length of time set by the *C.Ch[x].FaultValueStateDuration* tag.	• 0 = Hold Last State (default) • 1 = Transition to fault channel value
Ch[x].ProgMode	BOOL	Determines channel action when the module transitions to Program mode. At the transition to Program mode, the module holds its last state or transitions to the channel value used in the *C.Ch[x].ProgValue* tag.	• 0 = Hold Last State (default) • 1 = Transition to program channel value
Ch[x].ProgToFaultEn	BOOL	Determines channel action if a connection faults while the module is in a safe state for Program mode. The channel can remain in the safe state for Program mode or transition to a safe state for Fault mode. If the channel remains in safe state for Program mode, the *C.Ch[x].FinalFaultState* tag value is ignored.	• 0 = Channel remains in the safe state for Program mode • 1 = Channel transitions to the safe state for the Fault mode
Ch[x].ClampingDisable	BOOL	Disables Clamping on the channel.	• 0 = Clamping enabled • 1 = Clamping disabled (default)
Ch[x].RampInRun	BOOL	Enables Output Ramping when the module is in Run mode. Output changes during Run mode are limited to the *C.Ch[x].MaxRampRate* tag value.	• 0 = Ramping disabled (default) • 1 = Ramping enabled in Run mode

Table 36 - 1756-OF8I, 1756-OF8IK Module - Configuration Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].RampToProg	BOOL	Enables Output Ramping when the channel is transitioning to Program mode. Output changesduring Program mode are limited to the *C.Ch[x].MaxRampRate* tag value.	• 0 = Ramping disabled (default) • 1 = Ramping enabled to Program mode state
Ch[x].RampToFault	BOOL	Enables Output Ramping when the channel is transitioning to Fault mode. Output changes during Fault mode are limited to the *C.Ch[x].MaxRampRate* tag value.	• 0 = Ramping disabled (default) • 1 = Ramping enabled to Fault mode state
Ch[x].Disable	BOOL	Disables the channel.	• 0 = Channel enabled (default) • 1 = Channel disabled
Ch[x].FaultValueStateDuration	SINT	Determines the length of time the *C.Ch[x].FaultValue* tag value is held prior to the *C.Ch[x].FaultFinalState* being applied.	• 0 = Hold forever (default) • Any of the following: – 1, 2, 5, or 10 seconds
Ch[x].OutputRange	SINT	Channel's operating range.	0 = -10...10V 1 = 0...20 mA (default) 2 = 0...5V 3 = 0...10V
Ch[x].MaxRampRate	REAL	Maximum rate at which the channel can transition the output in Engineering Units/Second. This tag is used only if at least one of the following tags is enabled: • C.Ch[x].RampInRun • C.Ch[x].RampToFault • C.Ch[x].RampToProgram	Any value > 0.0 1,000,000.00 = default
Ch[x].FaultValue	REAL	Value to which the channel changes if the following events exist: • Connection is lost • *C.Ch[x].FaultMode* tag is enabled	Any 0.0 = default
Ch[x].FaultFinalState	REAL	Value to which the channel changes if the following events exist: • Connection is lost • Time defined by the *C.Ch[x].FaultValueStateDuration* tag has been exceeded	Any 0.0 = default
Ch[x].ProgValue	REAL	Value to which the channel changes if the following events exist: • Module transitions to Program mode • *C.Ch[x].ProgMode* tag is enabled	Any 0.0 = default
Ch[x].LowSignal	REAL	Signal value that lets you scale signal units (V, mA) into Engineering Units. Corresponds to the *C.Ch[x].LowEngineering* tag. That is, this tag's value is scaled to the lowest Engineering Unit.	Any value less the *C.Ch[x].HighSignal* tag value. Current input type: 4.0 = default Voltage input type: -10.0 = default
Ch[x].HighSignal	REAL	Signal scaling value that lets you scale signal units (V, mA) into Engineering Units. Corresponds to the *C.Ch[x].HighEngineering* tag. That is, this tag's value is scaled to the highest Engineering Unit.	Any value greater than the *C.Ch[x].LowSignal* tag value Current input type: 20.0 = default Voltage input type: 10.0 = default
Ch[x].LowEngineering	REAL	Low engineering scaling point Corresponds to the *C.Ch[x].LowSignal* tag value.	Any lower than the *C.Ch[x].HighEngineering* tag Default values: • 0.0 for current • -10.0 for voltage
Ch[x].HighEngineering	REAL	High engineering scaling point Corresponds to the *C.Ch[x].HighSignal* tag value.	Any higher than the *C.Ch[x].LowEngineering* tag Default values: • 100.0 for current • 10.0 for voltage
Ch[x].LowLimit	REAL	LowLimit setpoint below which the output cannot go when Clamping is enabled.	Any lower than the HighLimit 0.0 = default
Ch[x].HighLimit	REAL	HighLimit setpoint above which the output cannot go when Clamping is enabled.	Any higher than the LowLimit 0.0 = default
Ch[x].Offset	REAL	Compensates for any known error on the sensor or channel to which the sensor is connected. The value is set in signal units.	Any (We recommend that you use a small value.) 0.0 = default

Input Tags

Table 37 describes the Input tags associated with the module.

Table 37 - 1756-OF8I, 1756-OF8IK Module - Input Tags

Tag Name	Data Type	Definition	Valid Values
CIPSyncValid	BOOL	Indicates whether the module is synchronized to a valid CIP Sync time master on the backplane.	• 0 = CIP Sync is not available • 1 = CIP Sync is available
CIPSyncTimeout	BOOL	Indicates whether a valid time master on the backplane has timed out.	• 0 = A valid time master has not timed out. • 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock and can be drifting away from the last known time master.
CIPSyncOffsetJump	BOOL	Indicates a significant jump, that is, 1 ms or greater, in the CST and CIP Sync times sent from the Time Master to the module. (The Time Master sends the CST and CIP Sync times to the module every second.) When a significant jump occurs, this tag value becomes 1 but changes to 0 a second later unless another jump occurred. We recommend that you refresh the Diagnostic Assembly to get more data on the jump if precise time tracking is important to your application.	• 0 = No significant jump occurred • 1 = Significant jump occurred
Ch[x].Fault	BOOL	Quality of channel data.	• 0 = Good • 1 = Bad
Ch[x].Uncertain	BOOL	Channel data can be imperfect.	• 0 = Good • 1 = Uncertain
Ch[x].LLimitAlarm	BOOL	Channel data value that causes the channel to clamp in the following conditions: • Clamping is enabled on this channel, that is, the *C.Ch[x].ClampingDisable* tag value = 0 • *O.Ch[x].Data* tag value requested is less than the value configured in the *C.Ch[x].LowLimit* tag	• 0 = Channel is not clamped • 1 = Channel is clamped
Ch[x].HLimitAlarm	BOOL	Channel data value that causes the channel to clamp in the following conditions: • Clamping is enabled on this channel, that is, the *C.Ch[x].ClampingDisable* tag value = 0 • *O.Ch[x].Data* tag value requested is greater than the value configured in the *C.Ch[x].HighLimit* tag	• 0 = Channel is not clamped • 1 = Channel is clamped
Ch[x].RampAlarm	BOOL	Indicates that the channel is currently limited to changing at the *C.Ch[x].MaxRampRate* tag value or is latched.	• 0 = Channel is not limited to the *C.Ch[x].MaxRampRate* tag value or latched • 1 = channel is limited
Ch[x].NotANumber	BOOL	Indicates that the last value last received for the *O.Ch[x].Data* tag was not a number.	• 0 = Last channel data received was a number • 1 = Last channel data received was not a number
Ch[x].InHold	BOOL	Indicates that the channel is currently holding until the received *O.Ch[x].Data* tag value is within 0.1% of the current *I.Ch[x].Data* tag value.	• 0 = Channel is not holding • 1 = Channel is holding
Ch[x].CalibrationFault	BOOL	Indicates that the channel is not calibrated or the last attempted calibration for this channel failed. If the last calibration failed, this tag is cleared, that is, set to 0, when power is cycled to the module.	• 0 = Calibration did not fail • 1 = Calibration failure
Ch[x].Calibrating	BOOL	Indicates the channel is currently being calibrated.	• 0 = Channel is not being calibrated • 1 = Channel is being calibrated
Ch[x].CalGoodLowRef	BOOL	Indicates that a valid Low Reference value has been received on the channel.	• 0 = Valid Low Reference value has not been received on this channel • 1 = Valid Low Reference value has been received on this channel
Ch[x].CalBadLowRef	BOOL	Indicates that invalid Low Reference data has been received on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid Low Reference signal, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed or the module is Reset or RIUP'ed.	• 0 = Invalid Low Reference value has not been received on this channel • 1 = Invalid Low Reference value has been received on this channel

Table 37 - 1756-OF8I, 1756-OF8IK Module - Input Tags (Continued)

Tag Name	Data Type	Definition	Valid Values
Ch[x].CalGoodHighRef	BOOL	Indicates that a valid High Reference value has been received on this channel.	• 0 = Valid High Reference value has not been received on this channel • 1 = Valid High Reference value has been received on this channel
Ch[x].CalBadHighRef	BOOL	Indicates that an invalid High Reference value has been received on this channel. You must correct this condition to successfully calibrate the module. If calibration is aborted with an invalid High Reference value, the *I.Ch[x].CalibrationFault* tag is set for this channel until a successful calibration is performed or the module is Reset or RIUP'ed.	• 0 = Invalid High Reference value has not been received on this channel • 1 = Invalid High Reference value has been received on this channel
Ch[x].CalSuccessful	BOOL	Indicates calibration on this channel is complete and the Calibrating state has been exited. This tag remains set after valid calibration as long as connection is open.	• 0 = Calibration was not successful • 1 = Calibration was successful and calibrating state has been exited.
Ch[x].Data	REAL	Output Data Echo data in scaled Engineering units.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.
Fault	DINT	Standard Analog Fault mask – controller sets all 32 bits on connection loss.	• 0000_0000= Connection is good • FFFF_FFFF Hex = Connection has failed
OwnerActive	BOOL	Owner Active—Indicates that the output has a controlling owner.	B4
OwnerID	BOOL	Owner ID—Indicates which owner is active (controlling): 0 = Owner A 1 = Owner B	B5
OwnerAConnected	BOOL	Owner A Connected—Indicates that Owner A is connected.	B6
OwnerAClaim	BOOL	Owner A Claim—Indicates that Owner A is claiming outputs (COO).	B7
OwnerAReady	BOOL	Owner A Ready—Indicates that Owner A is Ready to claim outputs (ROO).	B8
OwnerBConnected	BOOL	Owner B Connected—Indicates that Owner B is connected.	B9
OwnerBClaim	BOOL	Owner B Claim—Indicates that Owner B is claiming outputs (COO).	B10
OwnerBReady	BOOL	Owner B Ready—Indicates that Owner B is Ready to claim outputs (ROO).	B11
RollingTimestamp	DINT	16-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID instruction to automatically calculate sample deltas. For more information on the Rolling Timestamp, see page 20.	0…32,767 ms where 1 ms = 1 count
Timestamp	DINT[2]	64-bit timestamp value that indicates when any of the 8 channels were last updated with new Output Data. This value is provided in terms of CIPSync time.	Timestamp data

Output Tags

Table 38 describes the Output tags associated with the module.

Table 38 - 1756-OF8I, 1756-OF8IK Module - Output Tags

Tag Name	Data Type	Definition	Valid Values
Ch[x].LLimitUnlatch	BOOL	Unlatches a latched Low Limit alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Low Limit alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Low Limit alarm unlatching.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
Ch[x].HLimitUnlatch	BOOL	Unlatches a latched High Limit alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the High Limit alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the High Limit alarm unlatching.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
Ch[x].RampAlarmUnlatch	BOOL	Unlatches a latched Ramp alarm at the first instance of the bit transitioning from 0 to 1. For example, if the controller sends data for this tag in successive instances as 0, 1, 1, 1, 1, the module unlatches the Ramp alarm when it receives the first 1. The following instances of this tag value being 1 do not impact the Ramp alarm unlatching.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
Ch[x].Calibrate	BOOL	Initiates the Calibration process. This tag must remain set until a valid Low Reference and High Reference values are sent to the channel.	• 0 = Calibration process is not started (default) • 1 = Calibration process is started
Ch[x].CalOutputLowRef	BOOL	When set, the channel produces the Low Calibration Reference Point for the current *C.Ch[x].OutputRange* tag value.	• 0 = Do not output Cal Low Reference • 1 = Output Calibration Low Reference Do not set this tag and the CalOutputHighRef tag to 1 simultaneously.
Ch[x].CalOutputHighRef	BOOL	When set, the channel produces the High Calibration Reference Point for the current *C.Ch[x].OutputRange* tag value.	• 0 = Do not Output Cal High Reference • 1 = Output Calibration High Reference Signal Do not set this tag and the CalOutputLowRef tag to 1 simultaneously.
Ch[x].CalLowRefPassed	BOOL	Data value change that indicates that the *O.Ch[x].Data* tag contains the recorded Low Reference value for the channel that is used by the module in Calibration.	• 0 = Not sending Recorded Cal Low Ref • 1 = Sending Recorded Cal Low Reference in Output Data for Calibration Verification
Ch[x].CalHighRefPassed	BOOL	Data value change that indicates that the *O.Ch[x].Data* tag contains the recorded High Reference value for the channel that is used by the module in Calibration.	• 0 = Not sending Cal High Reference • 1 = Sending recorded Calibration High Reference Signal in Output Data for Calibration Verification
Ch[x].CalFinishCalibration	BOOL	Data value change that triggers the channel to complete the Calibration procedure, applying the Valid Low and High References received. Channel exits the Calibration state if successful.	• 0 = Channel not triggered to complete the calibration procedure • 1 = Channel triggered to complete the calibration procedure
Ch[x].Data	REAL	Channel data in scaled Engineering Units.	Any positive or negative value. Determined by how you set the scaling parameters on the channel. For more information, see Scaling on page 29.

Redundant Owner Configuration Tags

The redundant owner configuration tags are identical to the existing 1756-OF8I, 1756-OF8IK configuration.

Redundant Owner Input Tag Layout

We added eight Input tags to the existing Input data layout. The bit tag field, *PartnerBits*, increased from 2 bits to 10 bits to cover OwnerActive, Owner ID, and Active/Claim/Ready status for the A and B controllers.

Table 39 - New Redundant Input Tag Description – 1756-OF8I, 1756-OF8IK

Field	Data Type	Legal Values	Usage
OwnerActive	BOOL	B4	The Output has a Controlling Owner
OwnerID	BOOL	B5	Which Owner is Active (Controlling): 0 = Owner A 1 = Owner B
OwnerAConnected	BOOL	B6	Owner A is Connected.
OwnerAClaim	BOOL	B7	Owner A is claiming Outputs (COO).
OwnerAReady	BOOL	B8	Owner A is Ready to claim Outputs (ROO).
OwnerBConnected	BOOL	B9	Owner B is Connected.
OwnerBClaim	BOOL	B10	Owner B is claiming Outputs (COO).
OwnerBReady	BOOL	B11	Owner B is Ready to claim Outputs (ROO).

Redundant Owner Output Tag Layout

We added two Input tags in the Output data: a BOOL to reflect the COO bit and another for the ROO bit.

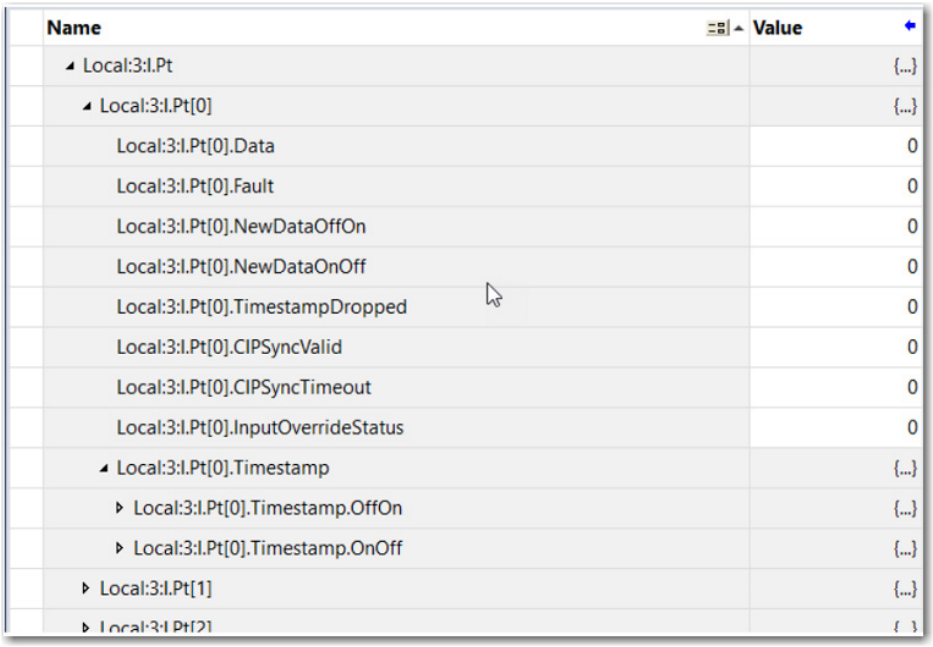
Table 40 - New Redundant Output Tag Description – 1756-OF8I, 1756-OF8IK

Field	Data Type	Legal Values	Usage
OwnerClaim	BOOL	B0 0 = Not Requesting Ownership 1 = Claim Ownership	When set, indicates that the controller wants to Claim Ownership of the redundant connection and have its outputs actively used. • If both Redundant Owners have COO set, the last originator application that transitioned its COO flag from reset to set shall be the owner. **NOTE:** Only a Rx'd 0 to a 1 and not just the receipt of a new connection is considered such a transition. • If neither Redundant Owner has COO set, then the highest ROO becomes Owner.
OwnerReady	BOOL	B1 0 = Not Ready to Own 1 = Ready to Own	Indicates the controller's readiness for output ownership. A value of 1 indicates ready while 0 indicates the controller is not ready to own the outputs. • If neither controller has the COO bit set, the ROO determines the current owner. • If both controllers have COO=0 and ROO=0, then the outputs go to IDLE (Program mode). • If both controllers have COO=0 and ROO=1, OwnerA will be active.

Array Data Structures

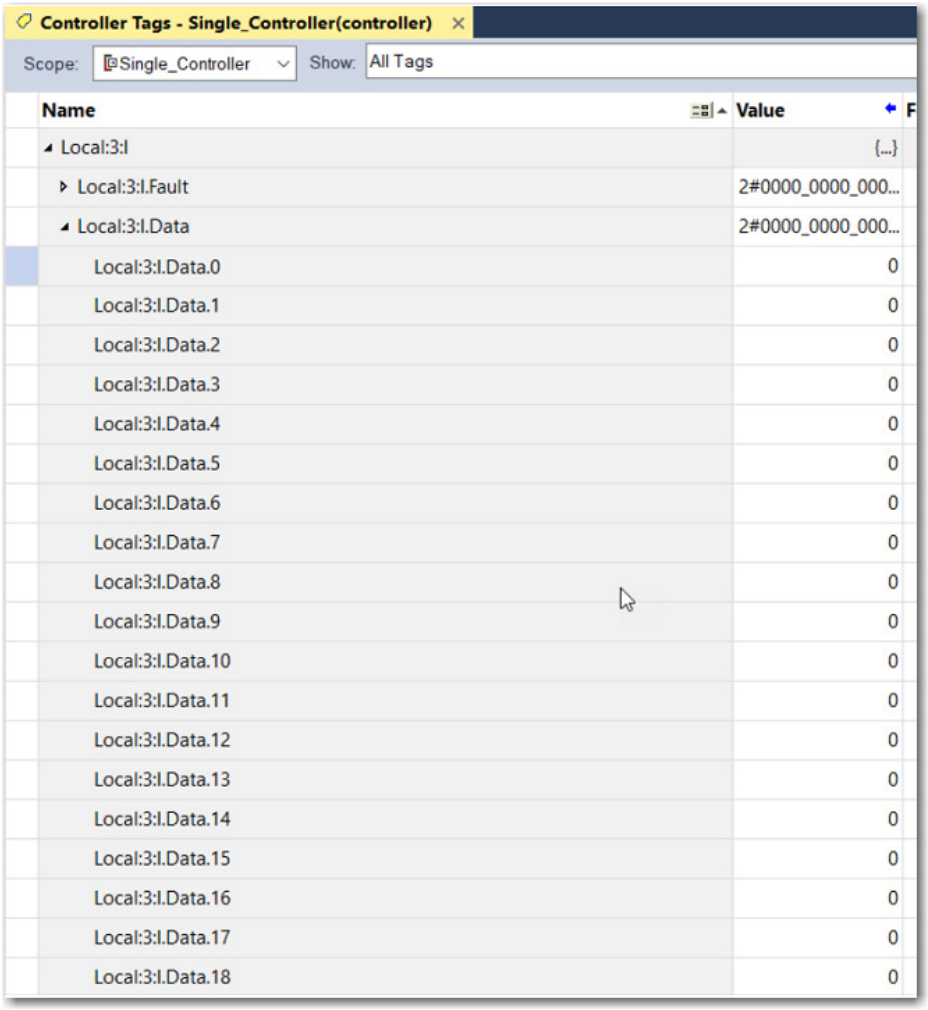
Fast digital I/O modules use an array data structure. In this type of structure, all the tags for a particular point are organized under that point. For example, in Figure 34, all of the tags that appear under point 0 also appear under points 1...15 for the input module in slot 1. With this structure, you can copy or access all of the data for a particular point by simply referencing or copying the point or alias for the point, such as Pt[3] or PressureValveTank3.

Figure 34 - Array Data Structure



Other digital I/O modules use a flat data structure. In this type of structure, only one instance of a tag exists for a module. For example, in Figure 35, only one instance of each tag appears under the input module in slot 3. To reference or copy data for an individual point, you specify the tag name followed by a bit number, such as Data.0 or EventOverflow.3. Unlike an array structure where all the data for a point can be accessed via a single tag reference, a flat structure requires multiple tag references to access all the data for a point.

Figure 35 - Flat Data Structure



The 1756-OF8I, 1756-OF8IK module uses either type of data structure depending on how you configure the module. For more information, see page 174.

Notes:

Choose the Correct Power Supply

Power-sizing Chart

To maintain an adequate power supply, you can determine the power that modules in a ControlLogix® chassis consume.

An interactive spreadsheet is available that lets you enter a chassis configuration and automatically calculates the total power supply consumption. The total power supply consumption cannot exceed 75 W @ 60 °C (140 °F).

See the configuration spreadsheet in the Knowledgebase article *Sizing the ControlLogix Power Supply*.

The 5.1V DC and 24V DC currents are used together to calculate the maximum backplane power dissipation. The following table lists the current draw of each module.

Cat. No.	Current Draw @ 5.1V DC	Current Draw @ 24V DC
1756-IF8I, 1756-IF8IK	200 mA(1)	• Voltage/Non-sourcing Current mode: 150 mA • Sourcing Current mode: 400 mA
1756-IRT8I, 1756-IRT8IK	Series B, 210 mA(2) Series A, 200 mA	150 mA
1756-IR12, 1756-IR12K	Series B, 210 mA(2) Series A, 200 mA	70 mA
1756-IT16, 1756-IT16K	Series B, 210 mA(2) Series A, 200 mA	80 mA
1756-OF8I, 1756-OF8IK	200 mA(3)	• Voltage or Current mode with 250 Ω loads = 220 mA • Current mode with 500 Ω loads = 275 mA • Current mode with 750 Ω loads = 340 mA • Current mode with 1000 Ω loads = 385 mA

(1) Firmware revision 3.011 reduces the processor clock speed to 360 MHz and reduces the nominal current consumption by 10...15 mA.
(2) 210 mA is the worst case current rating per test results. The processor clock speed of 360 MHz now reduces nominal current consumption.
(3) Firmware revision 4.011 reduces the processor clock speed to 360 MHz and reduces the nominal current consumption by 10...15 mA.

Use the following table to check power supply consumption.

Slot Number	Module Cat. No.	Current @ 5.1V DC (mA)		Power @ 5.1V DC (Watts)	Current @ 24V DC (mA)		Power @ 24V DC (Watts)
0			x 5.1V =			x 24V =	
1			x 5.1V =			x 24V =	
2			x 5.1V =			x 24V =	
3			x 5.1V =			x 24V =	
4			x 5.1V =			x 24V =	
5			x 5.1V =			x 24V =	
6			x 5.1V =			x 24V =	
7			x 5.1V =			x 24V =	
8			x 5.1V =			x 24V =	
9			x 5.1V =			x 24V =	
10			x 5.1V =			x 24V =	
11			x 5.1V =			x 24V =	
12			x 5.1V =			x 24V =	
13			x 5.1V =			x 24V =	
14			x 5.1V =			x 24V =	
15			x 5.1V =			x 24V =	
16			x 5.1V =			x 24V =	
	TOTALS	mA		W	mA		W

Do not exceed the 5.1V DC current of 10 A for the 1756-Px72 power supply or 13 A for the 1756-Px75 power supply.

1492 Analog Interface Modules

As an alternative to buying RTBs and connecting the wires yourself, you can buy a wiring system that connects to I/O modules through pre-wired and pre-tested cables.

ATTENTION: The ControlLogix® system has been agency certified using only the ControlLogix RTBs (catalog numbers 1756-TBCH, 1756-TBNH, 1756-TBSH and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application specific approval by the certifying agency.

The following table lists the analog interface modules (AIFMs) available for use with the ControlLogix eight-channel analog I/O modules.

IMPORTANT You can use the 6-channel AIFMs, for example, 1492-AIFM6S-3, listed with 8-channel analog I/O modules.

We **recommend** that you use the 8-channel AIFMs, for example, 1492-AIFM8S-3, in your application whenever possible.

Module Cat. No.	Operating Mode	AIFM Cat. No. Fixed Terminal Block	AIFM Cat. No. RTB Socket Assembly	Pre-wired Cable Cat. No. where *x* = Cable Length
1756-IF8I	Current (Internal or External Source Loop Current)	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYA
	Current (External Loop Power only)	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYA
		1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABLExYA 1492-ACABLExYE
	Voltage	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYB
		1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABLExYB
1756-IRT8I	RTD	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYF
		1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABLExYF
	Thermocouple	1492-AIFM8TC-3	1492-RAIFM8TC-3	1492-ACABLExYC
		1492-AIFM6TC-3	1492-RAIFM6TC-3	1492-ACABLExYC
1756-OF8I	Current	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYA
		1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABLExYA
	Voltage	1492-AIFM8S-3	1492-RAIFM8S-3	1492-ACABLExYB
		1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABLExYB

Notes:

History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

1756-UM054OF-EN-P, November 2021

Change
Added catalog numbers with conformal coating
Updated screen shots from the Studio 5000 Logix Designer® application
Added 1756-IF6CIS module information
Updated tag names for 1756-IF8I and 1756-OF8I modules

1756-UM054OE-EN-P, December 2017

Change
Added information about how to configure the 1756-OF8I redundant owner

1756-UM054OD-EN-P, April 2016

Change
Added section Elegant Migration Emulation Mode
Updated 1756-IF8I Notch Filter Settings
Update Module Input Ranges
Updated 1756-IRT8I Notch Filter Settings
Updated 1756-OF8I Module Fault and Status Reporting
Updated 1756-IF8I Module - Configuration Tags Ch[x].ProcessAlarmLatch and Ch[x].RateAlarmLatch
Updated 1756-IF8I Module - Input Tags CIPSyncValid
Updated 1756-IRT8I Module - Configuration Tags Ch[x].ProcessAlarmLatch and Ch[x].RateAlarmLatch

1756-UM054OC-EN-P, June 2015

Change
Added content throughout for new 1756-IR12 and 1756-IT16 modules

1756-UM054OB-EN-P, January 2015

Change
Updated Sensor Offset and Channel Offset features

Notes:

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

ControlLogix AC Digital I/O Modules

Catalog Numbers 1756-IA8D, 1756-IA8DK, 1756-IA16, 1756-IA16K, 1756-IA16I, 1756-IA16IK, 1756-IA32, 1756-IA32K, 1756-IM16I, 1756-IM16IK, 1756-IN16, 1756-IN16K, 1756-OA8D, 1756-OA8, 1756-OA8K, 1756-OA8E, 1756-OA8EK, 1756-OA16, 1756-OA16K, 1756-OA16I, 1756-OA16IK, 1756-ON8, 1756-ON8K

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ControlLogix® digital I/O modules are input and output modules that provide On/Off detection and actuation. By using the Producer/Consumer network model, digital I/O modules can produce information when needed while providing additional system functions.

The catalog numbers of the conformally coated products include the designation 'K' in the last position before the series identifier.

Summary of Changes

This publication contains the following changes.

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Rockwell Automation

ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

설치 , 조정 , 가동 , 사용 , 조립 , 분해 , 유지보수 등 모든 작업은 관련 규정에 따라 적절한 교육을 받은 사용자를 통해서만 수행해야 합니다 .

본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於 「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安裝、調整、交付使用、使用、組裝、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

ATTENTION: This equipment is certified for use only within the surrounding air temperature range of 0…60 °C (32…140 °F). The equipment must not be used outside of this range.
In case of malfunction or damage, make no attempt at repair. Return the module to the manufacturer for repair. Do not dismantle the module.
Use only a soft dry anti-static cloth to wipe down equipment. Do not use any cleaning agents.

Environment and Enclosure

ATTENTION: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in EN/IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.
This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.
This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to help prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to help prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.
In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA Standard 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Removal and Insertion Under Power (RIUP)

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electric arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts can create electrical resistance that can affect module operation.

WARNING: When you connect or disconnect the removable terminal block (RTB) with field-side power applied, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

ATTENTION: Wire conductor and insulation ratings shall support minimum temperature rating of 105 °C (221 °F).
If multiple power sources are used, do not exceed the specified isolation voltage.
When using the 1756-TBNH, do not wire more than two
0.33…1.3 mm^2 (22…16 AWG) conductors on any terminal.
Use only the same size wires with no intermixing of solid and stranded wire types.
When using the 1756-TBSH, do not wire more than one 0.33…2.1 mm2 (22…14 AWG) conductor on any terminal.

IMPORTANT Any illustrations, charts, sample programs, and layout examples that are shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements that are associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use based on the examples that are shown in this publication.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

UK and European Hazardous Location Approval

The following applies to products marked Ⓔx, II 3 G. Such modules:

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection for the catalog numbers 1756-ON8 and 1756-ON8K is Ex ec IIC T4 Gc. Equipment protection by increased safety "e".
- The type of protection for the catalog numbers 1756-IN16 and 1756-IN16K is Ex ec IIC T3 Gc. Equipment protection by increased safety "e".
- Equipment protection by increased safety "e", reference certificate number UL22ATEX2820X and UL22UKEX2602X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

IEC Hazardous Location Approval

The following applies to products with IECEx certification.

- Such products are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection for catalog numbers 1756-ON8 and 1756-ON8K is Ex ec IIC T4 Gc. Equipment protection by increased safety "e".
- The type of protection for catalog numbers 1756-IN16 and 1756-IN16K is Ex ec IIC T3 Gc. Equipment protection by increased safety "e".
- IECEx certificate number IECEx UL 22.0065X.

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an UKEX/ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Any external connections that mate to this equipment shall be secured by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Equipment shall not be disconnected unless power has been removed or the area is known to be nonhazardous.
- Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage at the supply terminals to the equipment.
- This equipment must be used only with UKEX/ATEX/IECEx certified Rockwell Automation® backplanes.
- The instructions in the user manual shall be observed.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.

Installation Requirements

Before you install the module, you must complete these steps.

1. Install a 1756 ControlLogix chassis.
2. Install a 1756 ControlLogix power supply.

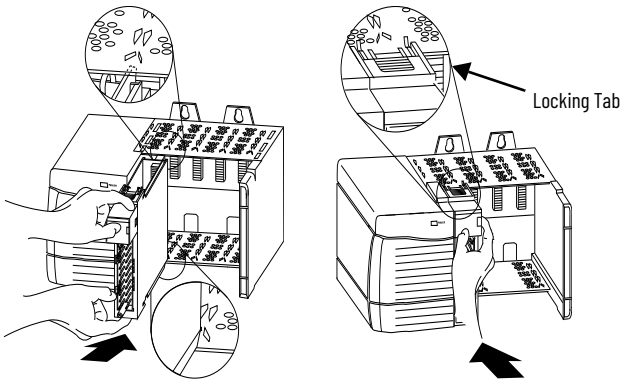
Install the Module

You can install or remove a module while chassis power is applied.

ATTENTION: The module is designed to support removal and insertion under power (RIUP). However, when you remove or insert a removable terminal block (RTB) with field-side power applied, unintended machine motion or loss of process control can occur. Exercise extreme caution when using this feature. We recommend that you remove field-side power before installing the RTB onto the module.

SHOCK HAZARD: If the RTB is installed onto the module while the field-side power is applied, the RTB is electrically live. Do not touch the RTB terminals. Failure to observe this caution can result in personal injury.

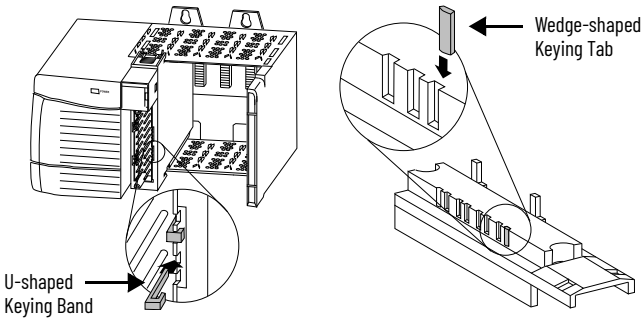
Slide the module into the slot in the chassis until the locking tabs click.



Key the Removable Terminal Block

Key the RTB to help prevent inadvertently connecting the incorrect RTB to your module.

1. Push the U-shaped band onto the module until the band snaps into place.
2. Insert wedge-shaped tabs into positions on the RTB that correspond to unkeyed module positions on the module until they stop.



Connect Wiring

You can use an RTB or a Bulletin 1492 prewired interface module (IFM) to connect wires to your module.

If you're using an RTB, see Recommendations for Wiring Your RTB, to connect wires to the RTB. IFMs are prewired before shipping.

WARNING: If you connect or disconnect wiring while the field-side power is on, an electric arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

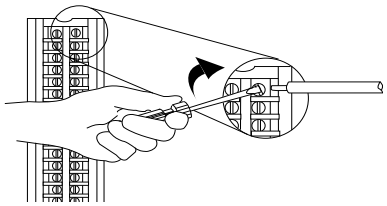
ATTENTION: If multiple power sources are used, do not exceed the specified isolation voltage.

ATTENTION: When using the 1756-TBNH, do not wire more than two 0.33...2.1 mm2 (22...14 AWG) conductors on any single terminal. Use only the same size wires with no intermixing of solid and stranded wire types.
When using the 1756-TBSH, do not wire more than one conductor on any single terminal.

ATTENTION: The ControlLogix system has been agency certified using only the ControlLogix RTBs (1756-TBNH and 1756-TBSH). Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application-specific approval by the certifying agency.

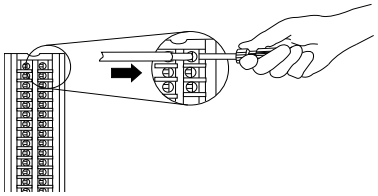
Wire a Cage Clamp-style RTB

3. Insert the wire into the terminal.
4. Turn the screw clockwise to close the terminal on the wire.



Wire a Spring Clamp

1. Insert the screwdriver into the outer hole of the RTB.
2. Insert the wire into the open terminal and remove the screwdriver.



Recommendations for Wiring Your RTB

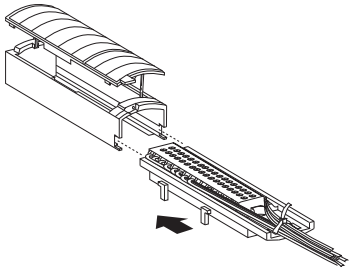
We recommend that you follow these guidelines when wiring your RTB:

- Begin wiring the RTB at the bottom terminals and move up.
- Use a tie to secure the wires in the strain relief (bottom) area of the RTB.
- Order and use an extended-depth housing (catalog number 1756-TBE) for applications that require heavy gauge wiring.

Assemble the RTB and the Housing

A removable housing covers the wired RTB to help protect the wiring connections when the RTB is seated on the module.

1. Align the grooves at the bottom of each side of the housing with the side edges of the RTB.
2. Slide the RTB into the housing until it snaps into place.



IMPORTANT If additional wire routing space is required for your application, use the extended-depth housing, catalog number 1756-TBE.

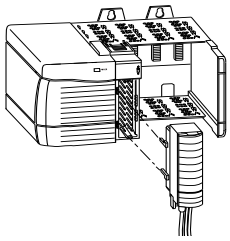
The housings that are shown are used with a spring clamp RTB, but the capacity for each remains the same regardless of RTB type.

Install the Removable Terminal Block

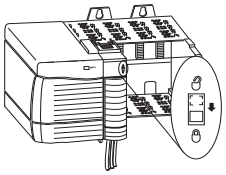
Follow these steps to install the RTB onto the module to connect the wiring.

WARNING: When you connect or disconnect the removable terminal block (RTB) with field-side power applied, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify the following:
   - Field-side wiring of the RTB is complete.
   - The RTB housing is snapped into place on the RTB.
   - The RTB housing door is closed.
   - The locking tab at the top of the module is unlocked.
2. Align the top, bottom, and left side guides of the RTB with the guides on the module.



3. Press quickly and evenly to seat the RTB on the module until the latches snap into place.
4. Slide the locking tab down to lock the RTB onto the module.



Specifications

1756-IA8D, 1756-IA8DK, 1756-IA16, 1756-IA16K, 1756-IA32, 1756-IA32K

Attribute	1756-IA8D, 1756-IA8DK	1756-IA16, 1756-IA16K	1756-IA32, 1756-IA32K
Temperature, operating • IEC 60068-2-1 (Test Ae, Operating Cold) • IEC 60068-2-2 (Test Be, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ 60 °C (32 °F ≤ Ta ≤ 140 °F)		
Corrosive Atmosphere(1) ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants - Gases Severity Level CX(2) per IEC 60721-3-3:2019, Chemically Active Substances		
Temperature, surrounding air, max	60 °C (140 °F)		
Enclosure type rating	None (open-style)		
Voltage and current ratings			
Backplane	• 5.1V DC, 100 mA • 24V DC, 3 mA	• 5.1V DC, 100 mA • 24V DC, 2 mA	• 5.1V DC, 165 mA • 24V DC, 2 mA
Inputs	120V AC, 50/60 Hz, 16 mA	120V AC, 50/60 Hz, 13 mA	74…132V AC, 50/60 Hz, 15 mA
Isolation voltage	• 125V (continuous), basic insulation type, inputs to backplane • No isolation between individual inputs		• 250V (continuous), basic insulation type, inputs to backplane • 125V (continuous), basic insulation type, input group to group • No isolation between individual inputs
Wire size	0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire that is rated at 90 °C (194 °F) or greater, 1.2 mm (3/64 in.) insulation max		
Wiring category(3)	1 - on signal ports		
North American temperature code	T4A		

(1) Only applicable to modules that end with a "K" or "XT".

(2) Up to 9.6 microns per year, corrosion rate of copper.

(3) Use this Conductor Category information for planning conductor routing. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

1756-IA16I, 1756-IA16IK, 1756-IM16I, 1756-IM16IK, 1756-OA8E, 1756-OA8EK, 1756-OA16I, 1756-OA16IK

Attribute	1756-IA16I, 1756-IA16IK	1756-IM16I, 1756-IM16IK	1756-OA8E, 1756-OA8EK	1756-OA16I, 1756-OA16IK
Temperature, operating • IEC 60068-2-1 (Test Ae, Operating Cold) • IEC 60068-2-2 (Test Be, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ 60 °C (32 °F ≤ Ta ≤ 140 °F)			
Corrosive Atmosphere(1) ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants - Gases Severity Level CX(2) per IEC 60721-3-3:2019, Chemically Active Substances			
Temperature, surrounding air, max	60 °C (140 °F)			
Enclosure type rating	None (open-style)			
Voltage and current ratings				
Backplane	• 5.1V DC, 125 mA • 24V DC, 3 mA	• 100 mA @ 5.1V DC • 3 mA @ 24V DC	• 200 mA @ 5.1V DC • 250 mA @ 24V DC	• 300 mA @ 5.1V DC • 2.5 mA @ 24V DC
Inputs	120V AC, 50/60 Hz, 15 mA	240V AC 50/60 HZ, 13 mA	–	–
Output	–	–	120V AC 50/60HZ, 2 A pilot duty	120/240V AC 50/60 HZ, 2 A pilot duty
Isolation voltage	125V (continuous), basic insulation type, inputs to backplane, and input to input	250V (continuous), basic insulation type, inputs to backplane, and input to input	• 125V (continuous), basic insulation type, outputs to backplane • No isolation between individual outputs	250V (continuous), basic insulation type, outputs to backplane, and output to output
Wire size	0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater, 1.2 mm (3/64 in.) insulation max			
Wiring category(3)	1 - on signal ports			
North American temperature code	T4A	T4	T4A	T4A

(1) Only applicable to modules that end with a "K" or "XT".

(2) Up to 9.6 microns per year, corrosion rate of copper.

(3) Use this Conductor Category information for planning conductor routing. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

1756-IN16, 1756-IN16K, 1756-ON8, 1756-ON8K, 1756-OA8, 1756-OA8K, 1756-OA8D

Attribute	1756-IN16, 1756-IN16K	1756-ON8, 1756-ON8K	1756-OA8, 1756-OA8K	1756-OA8D
Temperature, operating • IEC 60068-2-1 (Test Ae, Operating Cold) • IEC 60068-2-2 (Test Be, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C ≤ Ta ≤ 60 °C (32 °F ≤ Ta ≤ 140 °F)			
Corrosive Atmosphere(1) ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants - Gases Severity Level CX (2)per IEC 60721-3-3:2019, Chemically Active Substances			
Temperature, surrounding air, max	60 °C (140 °F)			
Enclosure type rating	None (open-style)			
Voltage and current ratings				
Backplane	• 5.1V DC, 135 mA • 24V DC, 2 mA	• 5.1V DC, 200 mA • 24V DC, 2 mA	• 5.1V DC, 200 mA • 24V DC, 2 mA	• 5.1V DC, 175 mA • 24V DC, 250 mA
Inputs	10…30V AC, 50/60 Hz 25 mA max	–	–	–
Output	–	10…30V AC, 50/60Hz, 2 A pilot duty, Current per output 5 A/4 A 30 °C (86 °F)/60 °C (140 °F), Current per module, max	120/240V AC, 50/60 Hz, 2 A pilot duty	120V AC, 50/60 Hz, 1 A, 8 A surge
Isolation voltage	• 250V (continuous), basic insulation type, channels to backplane • No isolation between individual channels		• 250V (continuous), basic insulation type, outputs to backplane • No isolation between individual outputs	• 125V (continuous), basic insulation type, outputs to backplane • No isolation between individual outputs
Wire size	1756-TBNH • Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F) or greater, 1.2 mm (3/64 in.) insulation max • Double wire connection: 0.33…1.3 mm^2 (22…16 AWG) solid or stranded copper wire rated at 105 °C (221 °F) or greater, 1.2 mm (3/64 in.) insulation max 1756-TBSH • Single wire connection: 0.33…2.1 mm^2 (22…14 AWG) solid or stranded shielded copper wire rated at 105 °C (221 °F) or greater, 1.2 mm (3/64 in.) insulation max		0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater, 1.2 mm (3/64 in.) insulation max	
Wiring category(3)	1 - on signal ports			
Terminal block torque	1756-TBNH 0.36 N•m (12 lb•in)			
North American temp code	T3C	T4A		
ATEX/IECEX temperature code	T3	T4	–	–

(1) Only applicable to modules that end with a "K" or "XT".
(2) Up to 9.6 microns per year, corrosion rate of copper.
(3) Use this Conductor Category information for planning conductor routing. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

1756-OA16, 1756-OA16K

Attribute	1756-OA16, 1756-OA16K
Temperature, operating IEC 60068-2-1 (Test Ae, Operating Cold), IEC 60068-2-2 (Test Be, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Corrosive Atmosphere(1) ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3 per ANSI/ISA 71.04-2013, Airborne Contaminants - Gases Severity Level CX (2)per IEC 60721-3-3:2019, Chemically Active Substances
Temperature, surrounding air, max	60 °C (140 °F)
Enclosure type rating	None (open style)
Voltage and current ratings	
Backplane	• 5.1V DC, 400 mA • 24V DC, 2 mA
Outputs	120/240V AC, 50/60 Hz, 0.5 A pilot duty
Isolation voltage	250V (continuous), basic insulation type, outputs to backplane
Wire size	0.33…2.1 mm^2 (22…14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater, 1.2 mm^2 (3/64 in.) insulation max
Wiring category(3)	1 - on signal ports
Terminal block torque	1756-TBNH 0.36 N•m (12 lb•in)
North American temperature code	T4

(1) Only applicable to modules that end with a "K" or "XT".
(2) Up to 9.6 microns per year, corrosion rate of copper.
(3) Use this Conductor Category information for planning conductor routing. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Additional Resources

Resource	Description
ControlLogix I/O Modules Specifications Technical Data, publication 1756-TD002	Provides specifications, wiring diagrams, and schematics for ControlLogix I/O modules.
ControlLogix Digital I/O Modules User Manual, publication 1756-UM058	Provides installation, configuration, operation, and maintenance information for ControlLogix digital I/O modules.
ControlLogix Power Supply Installation Instructions, publication 1756-IN619	Describes how to install a ControlLogix power supply.
ControlLogix Redundant Power Supply Installation Instructions, publication 1756-IN620	Describes how to install redundant ControlLogix power supplies.
ControlLogix Chassis Installation Instructions, publication 1756-IN621	Describes how to install a ControlLogix chassis.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

Notes:

Notes:

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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ControlLogix Digital I/O Modules

Catalog Numbers 1756-IA8D, 1756-IA16, 1756-IA16K, 1756-IA16I, 1756-IA16IK, 1756-IA32, 1756-IA32K, 1756-IB16, 1756-IB16K, 1756-IB16D, 1756-IB16DK, 1756-IB16I, 1756-IB16IK, 1756-IB16IF, 1756-IB16IFK, 1756-IB16XT, 1756-IB32, 1756-IB32K, 1756-IB32XT, 1756-IC16, 1756-IG16, 1756-IG16K, 1756-IH16I, 1756-IH16IK, 1756-IM16I, 1756-IM16IK, 1756-IN16, 1756-IN16K, 1756-IV16, 1756-IV16K, 1756-IV32, 1756-IV32K, 1756-OA8, 1756-OA8D, 1756-OA8E, 1756-OA16, 1756-OA16K, 1756-OA16I, 1756-OA16IK, 1756-OB8, 1756-OB8K, 1756-OB8EI, 1756-OB8EIK, 1756-OB16D, 1756-OB16DK, 1756-OB16E, 1756-OB16EK, 1756-OB16I, 1756-OB16IEF, 1756-OB16IEFK, 1756-OB16IEFS, 1756-OB16IEFSK, 1756-OB16IS, 1756-OB32, 1756-OB32K, 1756-OB32XT, 1756-OC8, 1756-OC8K, 1756-OG16, 1756-OG16K, 1756-OH8I, 1756-ON8, 1756-ON8K, 1756-OV16E, 1756-OV32E, 1756-OV32EK, 1756-OW16I, 1756-OW16IK, 1756-OX8I, 1756-OX8IK

Allen-Bradley

by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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About This Publication

This manual describes how to install, configure, and troubleshoot your ControlLogix® digital I/O modules. There is also a complete listing of digital input and output modules, including specifications and wiring diagrams. You must be able to program and operate a ControlLogix controller to use your digital I/O module efficiently.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication are not in alignment with the movement toward inclusive language in technology. We are proactively collaborating with industry peers to find alternatives to such terms and making changes to our products and content. Please excuse the use of such terms in our content while we implement these changes.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Added missing K variants to the IFMs and Prewired Cables table	166
Added catalog numbers 1756-IB16XT, 1756-IB32XT, and 1756-OB32XT	Throughout
This publication was reformatted and updated to the most current template	Throughout

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix I/O Modules Specifications Technical Data, publication 1756-TD002	Provides specifications for ControlLogix I/O modules.
ControlLogix Peer I/O Control Application Technique, publication 1756-AT016	Describes typical peer control applications and provides details about how to configure I/O modules for peer control operation.
ControlLogix DC Digital I/O Modules Installation Instructions, publication 1756-IN062	Describes how to install and wire the ControlLogix DC digital I/O modules.
ControlLogix AC Digital I/O Modules Installation Instructions, publication 1756-IN064	Describes how to install and wire the ControlLogix AC digital I/O modules.
ControlLogix System User Manual, publication 1756-UM543	Describes how to install, configure, program, and operate a ControlLogix system.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Notes:

ControlLogix Digital I/O Modules

ControlLogix® digital I/O modules are input and output modules that provide On/Off detection and actuation. By using the Producer/Consumer network model, digital I/O modules can produce information when needed while providing additional system functions.

About Digital I/O Modules

ControlLogix modules mount in a ControlLogix chassis and require either a removable terminal block (RTB) or a Bulletin 1492 wiring interface module (IFM) to connect all field-side wiring.

IMPORTANT	The ControlLogix system has been agency certified using only the ControlLogix RTB catalog numbers 1756-TBCH, 1756-TBCHXT, 1756-TBNH, 1756-TBNHXT, 1756-TBSH, 1756-TBSHXT, 1756-TBS6H, and 1756-TBS6HXT. Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application-specific approval by the certifying agency.

Before you install and use your module, you must do the following:

- Install and ground a 1756 chassis and power supply.
- Order and receive an RTB or IFM and its components for your application.

IMPORTANT	RTBs and IFMs are not included with your module purchase.

Table 1 - Types of ControlLogix Digital I/O Modules

Digital I/O Type	Description
Diagnostic	These modules provide diagnostic features to the point level. These modules have a **D** at the end of the catalog number.
Electronic fusing	These modules have internal electronic fusing to help prevent too much current from flowing through the module. These modules have an **E** at the end of the catalog number.
Individually isolated	These modules have individually isolated inputs or outputs. These modules have an **I** at the end of the catalog number.
Fast	These modules provide fast response times. These modules have an **F** at the end of the catalog number.
Conformal coated	These modules provide extended protection in harsh, corrosive environments. These modules have a **K** or an **XT** at the end of the catalog number.

IMPORTANT	When a ControlLogix product that is rated for harsh environments (corrosive atmosphere, extended temperature, etc.) is used in a system with other ControlLogix products that have lower specification values, the system is derated to the lowest common value. **EXAMPLE:** If the maximum operating temperature specification found in the Technical Data for your ControlLogix-XT™ module is 70 °C (158 °F) and you pair it with a ControlLogix chassis that is temperature rated to 60 °C (140 °F), your system is derated to 60 °C (140 °F). To ensure that your system is equipped for harsh environments, compare the corrosive atmosphere, temperature, and other specifications found in the Technical Data publication for each product.

Table 2 - ControlLogix Digital I/O Modules

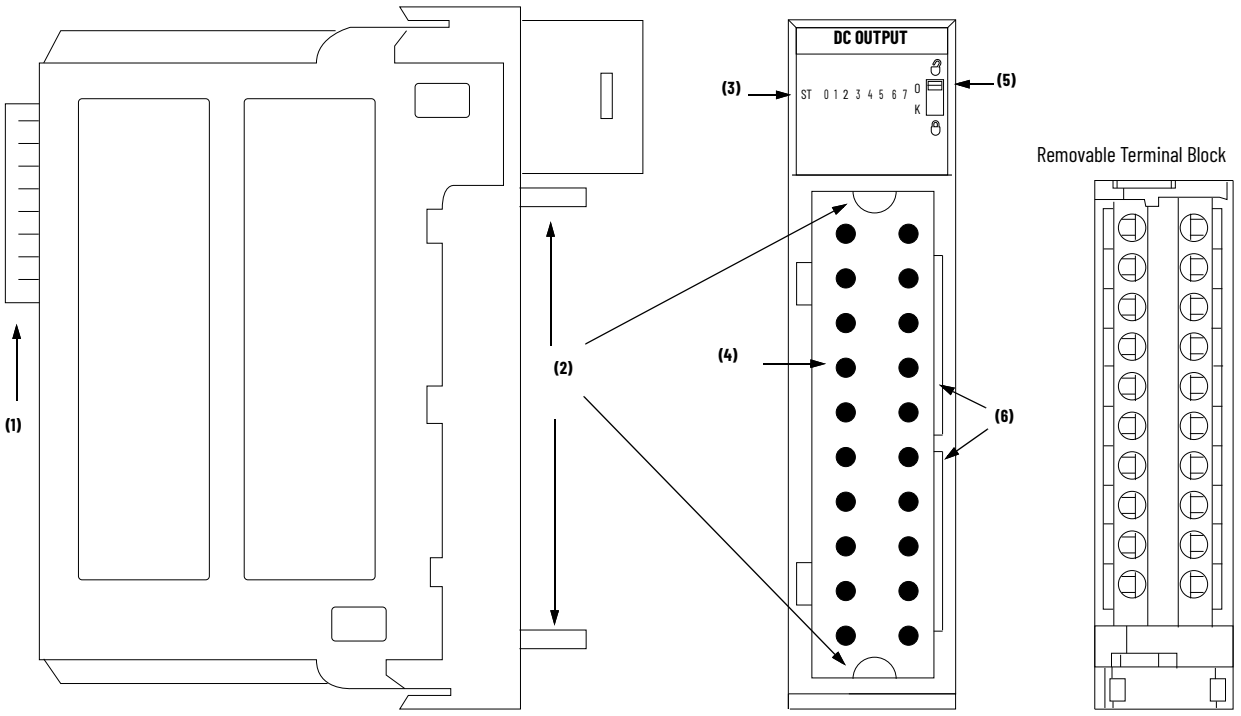
Cat. No.	Description	Page
1756-IA8D	79...132V AC 8-point diagnostic input module	96
1756-IA16, 1756-IA16K	74...132V AC 16-point input module	97
1756-IA16I, 1756-IA16IK	79...132V AC 16-point isolated input module	97
1756-IA32, 1756-IA32K	74...132V AC 32-point input module	98
1756-IB16, 1756-IB16K, 1756-IB16XT	10...31.2V DC 16-point input module	98
1756-IB16D, 1756-IB16DK	10...30V DC diagnostic input module	99
1756-IB16I, 1756-IB16IK	10...30V DC 16-point, isolated input module	100
1756-IB16IF, 1756-IB16IFK	10...30V DC, 16-point, isolated, fast peer control input module	101
1756-IB32, 1756-IB32K, 1756-IB32XT	10...31.2V DC 32-point input module	102
1756-IC16	30...60V DC 16-point input module	102
1756-IG16, 1756-IG16K	Transistor-transistor logic (TTL) input module	103
1756-IH16I, 1756-IH16IK	90...146V DC 16-point isolated input module	104
1756-IM16I, 1756-IM16IK	159...265V AC 16-point isolated input module	104
1756-IN16, 1756-IN16K	10...30V AC 16-point input module	105
1756-IV16, 1756-IV16K	10...30V DC 16-point sourcing current input module	105
1756-IV32, 1756-IV32K	10...30V DC 32-point sourcing current input module	106
1756-OA8	74...265V AC 8-point output module	106
1756-OA8D	74...132V AC 8-point diagnostic output module	107
1756-OA8E	74...132V AC 8-point electronically fused output module	107
1756-OA16, 1756-OA16K	74... 265V AC 16-point output module	108
1756-OA16I, 1756-OA16IK	74...265V AC 16-point isolated output module	109
1756-OB8, 1756-OB8K	10...30V DC 8-point output module	110
1756-OB8EI, 1756-OB8EIK	10...30V DC 8-point electronically fused, isolated output module	111
1756-OB16D, 1756-OB16DK	19.2...30V DC 16-point diagnostic output module	111
1756-OB16E, 1756-OB16EK	10...31.2V DC 16-point electronically fused output module	112
1756-OB16I	10...30V DC 16-point isolated output module	112
1756-OB16IEF, 1756-OB16IEFK	10...30V DC, 16-point, isolated, fast peer control output module	113
1756-OB16IEFS, 1756-OB16IEFSK	10...30V DC, 16-point, isolated, fast, scheduled per point output module	113
1756-OB16IS	10...30V DC scheduled, isolated output module	114
1756-OB32, 1756-OB32K, 1756-OB32XT	10...31.2V DC 32-point output module	114
1756-OC8, 1756-OC8K	30...60V DC 8-point output module	115
1756-OG16, 1756-OG16K	Transistor-transistor logic (TTL) output module	116
1756-OH8I	90...146V DC 8-point isolated output module	117
1756-ON8, 1756-ON8K	10...30V AC 8-point output module	117
1756-OV16E	10...30V DC 16-point electronically fused, sinking current output module	118
1756-OV32E, 1756-OV32EK	10...30V DC 32-point electronically fused, sinking current output module	118
1756-OW16I, 1756-OW16IK	10...265V, 5-150V DC 16-point isolated contact module	119
1756-OX8I, 1756-OX8IK	10...265V, 5-150V DC 8-point isolated contact module	119

IMPORTANT ControlLogix Digital I/O Modules that have an **XT** at the end of the catalog number are shipped in packaging that provides a degree of protection from corrosive atmospheres.

Once the factory packaging seal is broken, the module and the corresponding ControlLogix-XT Removable Terminal Block (RTB) must remain installed at all times, and the RTB door must remain closed, for the product to maintain its corrosive atmosphere rating.

If maintenance is required, you can open the RTB door or remove the module or RTB. Close the RTB door or reinstall the module or RTB after temporary access is complete.

Figure 1 - Parts Illustration



Note No.	Description
1	**Backplane Connector**—Interface for the ControlLogix system that connects the module to the backplane.
2	**Top and bottom guides**—Guides assist in seating the RTB or IFM onto the module.
3	**Status indicators**—Indicators display the status of communication, module health, and input/output devices. Indicators help in troubleshooting anomalies.
4	**Connector pins**—Input/output, power, and grounding connections are made to the module through these pins with the use of an RTB or IFM.
5	**Locking tab**—The locking tab anchors the RTB or IFM on the module, maintaining wiring connections.
6	**Slots for keying**—Mechanically keys the RTB to help prevent making the wrong wire connections to your module.

Available Features

The table below lists several features available on ControlLogix digital I/O modules.

Table 3 - Digital I/O Module Features

Feature	Description
Removal and Insertion Under Power (RIUP)	You can remove and insert modules and removable terminal blocks (RTB) while power is applied.
Producer/Consumer communication	This communication method is an intelligent data exchange between modules and other system devices in which each module produces data without first being polled.
System time stamp of data	A 64-bit system clock places a time stamp on the transfer of data between the module and its owner-controller.
Module-level fault reporting and field-side diagnostic detection	Fault and diagnostic detection capabilities to help you effectively and efficiently use your module and troubleshoot your application.
Agency Certification	Class 1, Division 2 agency certification for any application that requires approval.

Module Identification and Status Information

Each ControlLogix I/O module maintains specific identification information that separates it from all other modules. This information assists you in tracking all the components of your system.

For example, you can track module identification information to know which modules are in any ControlLogix chassis at any time. While retrieving module identity, you can also retrieve module status.

Item	Description
Product type	Module product type, such as digital I/O or analog I/O
Product code	Module catalog number
Major revision	Module major revision number
Minor revision	Module minor revision number
Status	Module status, including these items: • Controller ownership • Whether the module has been configured • Device-specific status, such as the following: – Self-test – Update in progress – Communications fault – Not owned (outputs in Program mode) – Internal fault (needs update) – Run mode – Program mode (outputs only) • Minor recoverable fault • Minor unrecoverable fault • Major recoverable fault • Major nonrecoverable fault
Vendor	Module manufacturer vendor, such as Allen-Bradley
Serial number	Module serial number
Length of ASCII text string	Number of characters in module text string
ASCII text string	Module ASCII text string description

IMPORTANT You must perform a WHO service to retrieve this information. For more information, see See Perform a WHO to Retrieve Module Identification and Status on page 155.

Module Definitions, Communication, or Connection Formats

The initial configuration of a module requires you to choose a module definition or a communication or connection format. The term that is used depends on the Add-on Profile (AOP) for your module. Earlier AOPs use communication formats, later AOPs use connection formats, and the newest AOPs use module definitions.

A module definition or communication or connection format determines the following:

- Available configuration options
- Type of data that is transferred between the module and its owner-controller
- Which tags are generated when the configuration is complete

IMPORTANT	Communication formats cannot be changed whether online or offline after a program is downloaded to the controller. However, connection formats can be changed when offline after a program is downloaded to the controller.

The communication or connection format also defines the connection between the controller writing the configuration and the module. The number and type of choices varies depending on what module you are using and whether it is in a local or remote chassis.

When you choose a Listen-only format, only the General and Connection tabs appear when you view module properties in Logix Designer application. Controllers that want to listen to a module, but not own it, use a Listen-only format.

For more information on configuration options for module definitions, communication, or connection formats, see Module Definitions, Communication, or Connection Formats on page 15.

Ownership

I/O modules in a ControlLogix system can be owned by a Logix 5000® controller. An owner-controller fulfills these functions:

- Stores configuration data for every module that it owns
- Sends I/O modules configuration data to define module behavior and begin module operation with the control system
- Resides in a local or remote chassis in regard to the I/O module position

Each ControlLogix I/O module must continuously maintain communication with its owner-controller to operate normally.

Typically, each module in the system has only one owner-controller. Input modules can have multiple owner-controllers. Output modules, however, are limited to a single owner-controller.

For more information about using multiple owner-controllers, see Configuration Changes in an Input Module with Multiple Owners on page 17.

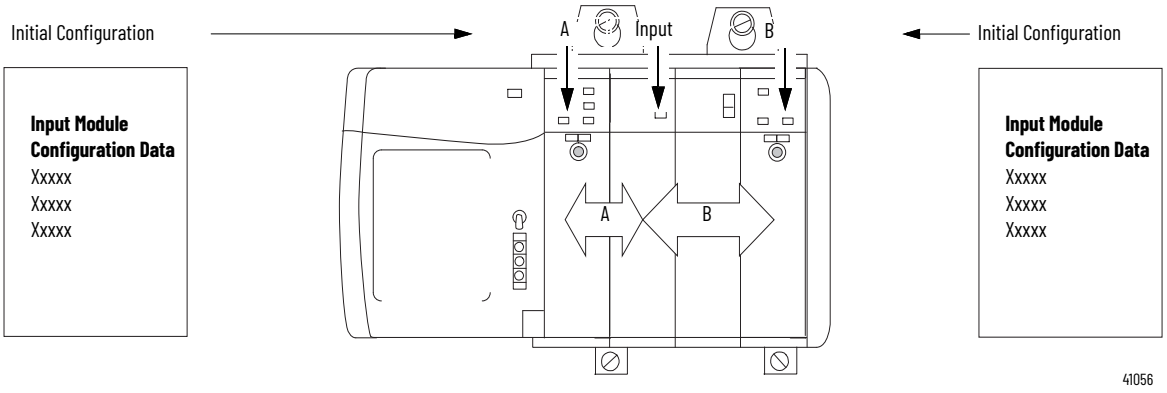
Multiple Owner-Controllers of Input Modules

If a connection is lost between an owner-controller and a module, the connection is also lost between any controllers listening to that module. As a result, the ControlLogix system lets you define more than one owner-controller for most input modules. Input modules that have Output tags do not allow more than one owner-controller.

IMPORTANT	Only input modules can have multiple owner-controllers. If multiple owner-controllers are connected to the same input module, they must maintain identical configurations for that module.

In the figure below, controller A and controller B both have been configured to be owner-controllers of the same input module.

Figure 2 - Identical Owner-Controller Configurations for Input Module



As soon as a controller receives its user program, it tries to establish a connection with the input module. A connection is established with the controller whose configuration data arrives first. When the second controller's configuration data arrives, the module compares it to its current configuration data, which was received and accepted from the first controller.

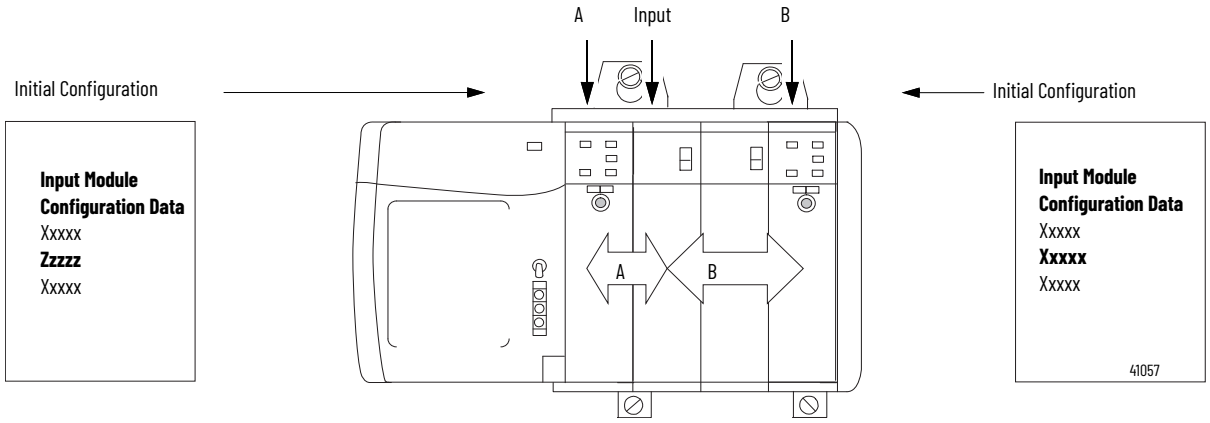
If the configuration data sent by the second controller matches the data sent by the first controller, that connection is also accepted. If any parameter of the second configuration data differs from the first, the module rejects the connection and the user is informed by an error in the software or via program logic.

The advantage of multiple owners over a Listen-only connection is that either of the controllers can break the connection to the module, and the module continues to operate and multicast data to the system through the connection maintained by the other controller.

Configuration Changes in an Input Module with Multiple Owners

You must be careful when changing the configuration data of an input module in a multiple owner scenario. If the configuration data is changed in owner A and sent to the module, that configuration data is accepted as the new configuration for the module. Owner B continues to listen unaware that any changes have been made in the behavior of the input module, as illustrated.

Figure 3 - Module Configuration Changes with Multiple Owners



IMPORTANT	A message in Logix Designer application alerts you to the possibility of a multiple owner-controller situation and lets you inhibit the connection before changing the module configuration. When changing the configuration for a module with multiple owners, we recommend that you inhibit the connection.

1756-OB16IEF Redundant Owner

Redundant ownership lets a single controller use redundant network paths to communicate with a single output or lets two separate controllers coordinate to control the output.

See Table 34 for a list of digital input modules that do not support multiple module owners.

Listen-only Mode

Any controller in the system can listen to the data from any I/O module, such as input data, echoed output data, or echoed diagnostic information. Even if a controller does not own a module, or hold the module configuration data, the controller can still listen to the module.

During the module configuration process, you can specify one of several Listen modes. For more information, see Module Definitions, Communication, or Connection Formats on page 15.

Choosing a Listen mode lets the controller and module establish communication without the controller sending any configuration data. In this instance, another controller owns the module being listened to.

IMPORTANT	In Listen-only mode, controllers continue to receive data multicast from the I/O module as long as the connection between the owner-controller and I/O module is maintained. If the connection between the owner-controller and module is broken, the module stops multicasting data and connections to all listening controllers are also broken.

Connections

With ControlLogix I/O modules, a connection is the data transfer link between a controller and an I/O module. A connection can be one of these types:

- Direct
- Rack-optimized

This table lists the advantages and disadvantages of each connection type.

Connection Type	Advantages	Disadvantages
Direct	All input and data echo information is transferred, including diagnostic information and fusing data.	With more data transferring over the network, your system does not operate as efficiently as with rack connections.
Rack-optimized	Connection usage is economized. The owner-controller has a single RPI value for each connection.	Input and data echo information is limited to general faults and data.

Direct Connections

A direct connection is a real-time data transfer link between the controller and the device that occupies the slot that the configuration data references. When module configuration data is downloaded to an owner-controller, the controller attempts to establish a direct connection to each of the modules that is referenced by the data.

If a controller has configuration data referencing a slot in the control system, the controller periodically checks for the presence of a device there. When the presence of a device is detected there, the controller automatically sends the configuration data.

If the data is appropriate to the module found in the slot, a connection is made and operation begins. If the configuration data is not appropriate, the data is rejected and an error message appears in the software. In this case, the configuration data can be inappropriate for any of a number of reasons. For example, module configuration data may be appropriate except for a mismatch in electronic keying that helps prevent normal operation.

The controller maintains and monitors its connection with a module. Any break in the connection causes the controller to set fault status bits in the data area associated with the module. Breaks in the connection can be caused by a module fault or the removal of the module from the chassis while under power. Logix Designer application monitors fault status bits to annunciate module failures.

Rack-optimized Connections

When a digital I/O module is in a remote chassis with respect to its owner-controller, you may be able to choose Rack Optimization or Listen-only Rack Optimization during module configuration. The option that you choose depends on the communication module configuration. If the communication module uses Listen-only Rack Optimization, then the I/O module must also use Listen-only Rack Optimization.

A rack-optimized connection economizes bandwidth between owner-controllers and digital I/O modules in the remote chassis. Rather than having several direct connections with individual RPI values, an owner-controller has a single rack connection with a single RPI value. That RPI value accommodates all digital I/O modules in the remote chassis.

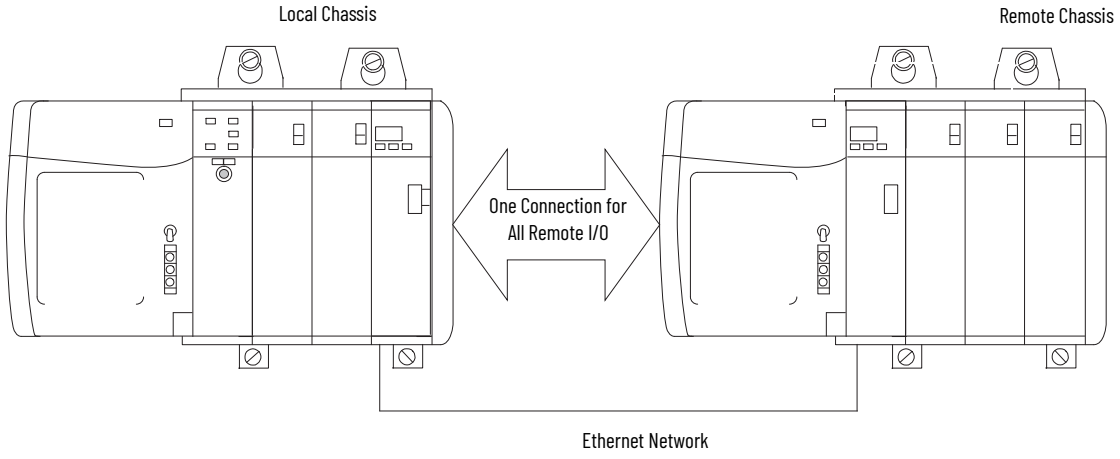
IMPORTANT	Because rack-optimized connections are applicable only in applications that use a remote chassis, you must configure the communication format, as described in Chapter 4, for both the remote I/O module and the remote 1756-CNB module or EtherNet/IP™ module. Make sure you configure both modules for rack optimization. If you choose another communication format for each module, the controller makes two connections to the same chassis (one for each format) and the same data travels across the Ethernet network. If you use rack optimization for both modules, you preserve bandwidth and configure your system to operate more efficiently.

The input, or data echo, information is limited to general faults and data. No additional status, such as diagnostic information, is available.

IMPORTANT	Each controller can establish connections in any combination of direct or rack-optimized. In other words, you can use a rack-optimized connection between an owner-controller and multiple remote I/O modules while simultaneously using a direct connection between that same controller and any other I/O modules in the same remote chassis.

This figure shows how a rack-optimized connection eliminates the need for three separate connections. The owner-controller in the local chassis communicates with all the I/O modules in the remote chassis but uses only one connection. The EtherNet communication module sends data from the modules simultaneously at the RPI.

Figure 4 - Rack-optimized Connection



Recommendations for Rack-optimized Connections

We recommend that you use a rack-optimized connection for these applications:

- Standard digital I/O modules
- Non-fused digital output modules
- Owner-controllers running low on connections

IMPORTANT	Rack-optimized connections are available only to digital I/O modules. However, do not use a rack-optimized connection for diagnostic I/O modules or fused output modules. Diagnostic and fused output data is not transferred over a rack-optimized connection. This defeats the purpose of using those modules.

Internal Module Operation

ControlLogix I/O modules experience signal propagation delays that must be accounted for during operation. Some of these delays are user-configurable, and some are inherent to the module hardware.

For example, there is a small delay, typically less than 1 ms, between when a signal is applied at the RTB of a ControlLogix input module and when a signal is sent to the system over the backplane. This time reflects a filter time of 0 ms for a DC input.

This section offers an explanation of the time limitations with ControlLogix I/O modules.

Input Module Operation

In traditional I/O systems, controllers poll input modules to obtain their input status. In the ControlLogix system, a controller does not poll digital input modules. Instead, the modules multicast their data either upon change of state (COS) or requested packet interval (RPI). The frequency depends on the options that are chosen during configuration and whether the input module is local or remote. This method of communication uses the Producer/Consumer model. The input module is the producer of input data and the controller is the consumer of the data.

All ControlLogix inputs are updated asynchronously in relation to the controller's task execution. In other words, an input may be updated in the controller at any time during the controller's execution of the tasks it is configured to run. The input device determines when the input is sent based on its configuration.

The behavior of an input module also varies depending upon whether it operates in the local chassis or in a remote chassis. The following sections detail the differences in data transfers between local and remote installations.

Input Modules

As shown in the illustration, ControlLogix input modules receive a signal at the RTB and process it internally through hardware, filters, and an ASIC scan before sending a signal to the backplane via the requested packet interval (RPI) or at a Change of State (COS) occurrence. The RPI is a configured interval of time that determines when module data is sent to the controller.

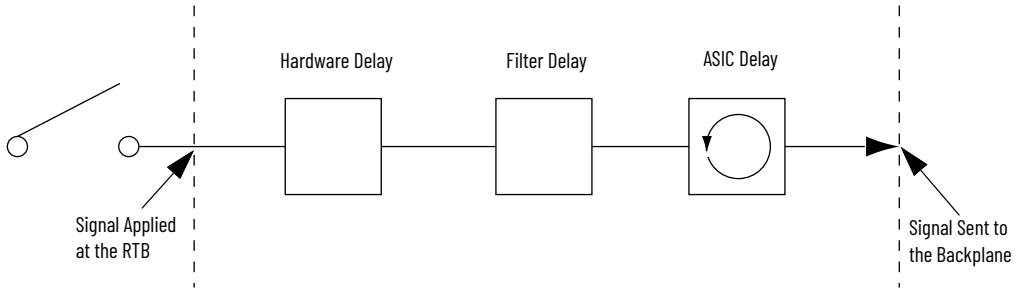


Table 4 - Delay Factors that Affect Signal Propagation

Delay	Description
Hardware	How the module is configured and the variance between the type of modules affects how the signal is processed.
Filter	User configuration varies between modules, thus affecting the signal propagation.
ASIC	ASIC scan = 200 µs.

EXAMPLE

A typical delay time can be estimated despite the number of factors that can contribute. For example, if you are turning on a 1756-IB16 or 1756-IB16K module at 24V DC in 25 °C (77 °F) conditions, the signal propagation delay is affected by these factors:

- Hardware delay to energize the input (typically 290 µs on the 1756-IB16 module)
- User-configurable filter time of 0 ms, 1 ms, or 2 ms
- ASIC scan of 200 µs

In the worst case scenario with a filter time of 0 ms, the 1756-IB16 or 1756-IB16K module has a 490 µs signal propagation delay.

These times are not guaranteed. For nominal and maximum delay times for each module, see the 1756 ControlLogix I/O Modules Specifications Technical Data, publication 1756-TD002.

Input Modules in a Remote Chassis

If an input module physically resides in a chassis other than where the owner-controller resides, the role of the RPI and the module COS behavior changes slightly with respect to getting data to the owner.

The RPI and COS behavior still define when the module multicasts data within its own chassis, as described in the previous section. But, only the value of the RPI determines when the owner-controller receives it over the network.

RPI

The RPI defines the slowest rate at which a module multicasts its data to the owner-controller. The time ranges from 200 µs...750 ms and is sent to the module with all other configuration parameters. When the specified time frame elapses, the module multicasts data. This is also called a cyclic update.

COS

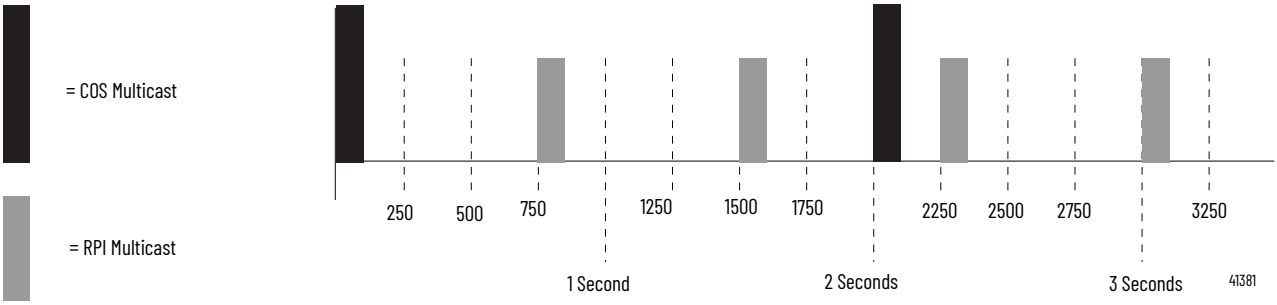
COS instructs the module to transfer data whenever a specified input point transitions from On to Off or Off to On. The transition is referred to as a change of state.

IMPORTANT	The module COS feature defaults to Enabled for both On-to-Off and Off-to-On.

COS configuration occurs on a per-point basis, but all module data is multicast when any point enabled for COS changes state. COS is more efficient than RPI because it multicasts data only when a change occurs.

IMPORTANT	You must specify an RPI regardless of whether you enable COS. If a change does not occur within the RPI time frame, the module still multicasts data at the rate specified by the RPI.

For example, if an input is changing state consistently every 2 seconds and the RPI is set at 750 ms, the data transfer looks like the illustration.



Because the RPI and COS functions are asynchronous to the program scan, it is possible for an input to change state during program scan execution. The point must be buffered to help prevent this from occurring. To buffer the point, you can copy the input data from your input tags to another structure and use the data from there.

To minimize traffic and conserve bandwidth, use a larger RPI value if COS is enabled and the module is in the same chassis as its owner-controller.

Trigger Event Tasks

When configured, ControlLogix digital input modules can trigger an event task. The event task lets you execute a section of logic immediately when an event, or receipt of new data, occurs.

Your ControlLogix digital I/O module can trigger event tasks whenever module input data changes state. Refer to these considerations when using a digital input module to trigger an event task:

- Only one input module can trigger a specific event task.
- Input modules trigger the event task based on the module COS configuration. The COS configuration defines which points prompt the module to produce data if they turn On or Off. This production of data triggers the event task.
- Typically, enable COS for only one point on the module. If you enable COS for multiple points, a task overlap of the event task may occur.

For more information on event tasks, refer to the Logix 5000 Controllers Tasks, Programs, and Routines Programming Manual, publication 1756-PM005.

Input Modules in a Remote Chassis

If an input module physically resides in a chassis other than where the owner-controller resides, the role of the RPI and the module COS behavior changes slightly with respect to getting data to the owner.

The RPI and COS behavior still define when the module multicasts data within its own chassis, as described in the previous section. But, only the value of the RPI determines when the owner-controller receives it over the network.

Remote Input Modules Connected Via the EtherNet/IP Network

When remote digital input modules are connected to the owner-controller via an EtherNet/IP network, data is transferred to the owner-controller at these times:

- At the RPI, the module produces data within its own chassis.
- At the COS (if enabled), the 1756 EtherNet/IP communication module in the remote chassis immediately sends the module data over the network to the owner-controller as long as it has not sent data within a time frame that is one-quarter the value of the digital input module RPI. This helps prevent flooding the network with data.

  For example, if a digital input module uses an RPI = 100 ms, the EtherNet/IP module sends module data immediately on receiving it if another data packet was not sent within the last 25 ms.

For more information about specifying an RPI rate, see the Logix5000 Controllers Design Considerations Reference Manual, publication 1756-RM094.

Output Module Operation

An owner-controller sends output data to an output module when either one of two things occurs:

- At the end of every one of its tasks (local chassis only)
- At the rate specified in the module RPI

When an output module resides in a remote chassis with respect to the owner-controller, the owner-controller sends data to the output module **only** at the RPI rate that is specified for the module. Updates are not performed at the end of the owner-controller's tasks.

Whenever the module receives data from the controller, it immediately multicasts the output commands it received to the rest of the system. The actual output data is echoed by the output module as input data and multicast back out onto the network. This is called output data echo.

IMPORTANT	In this Producer/Consumer model, the output module is the consumer of the controller's output data and the producer of the data echo.

Output Modules

ControlLogix output modules receive a signal from the controller and process it internally via hardware and an ASIC scan before sending a signal to the output device via the RTB.

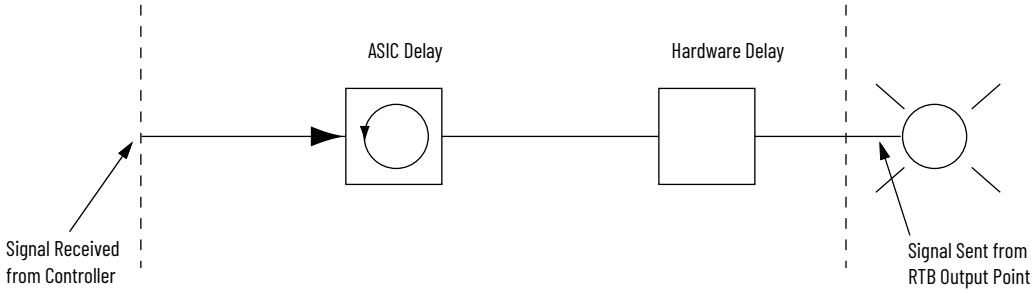


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Table 5 - Delay Factors that Affect Signal Propagation

Delay	Description
Hardware	How the module is configured and the variance between the type of modules affects how the signal is processed.
ASIC	ASIC scan = 200 µs.

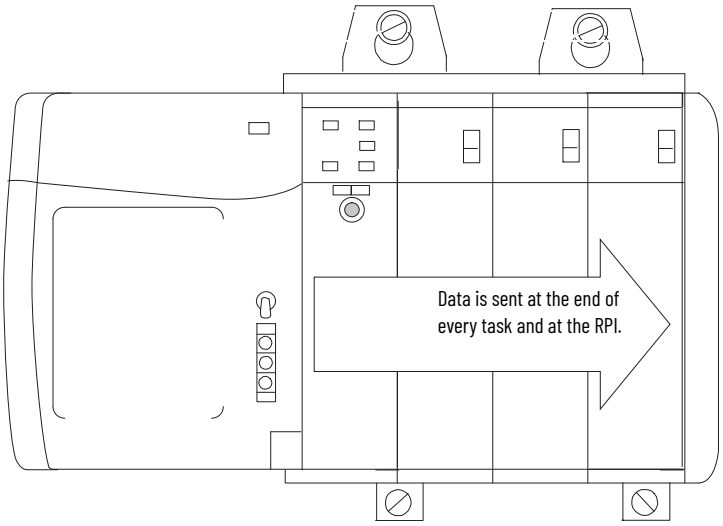
EXAMPLE	A typical delay time can be estimated despite the number of factors that can contribute. For example, if you are turning on a 1756-OB16E module at 24V DC in 25 °C (77 °F) conditions, the signal propagation delay is affected by these factors: • Hardware delay to energize the output (typically 70 µs on the 1756-OB16E module) • ASIC scan of 200 µs In the worst case scenario with a filter time of 0 ms, the 1756-OB16E module has a 270 µs signal propagation delay. These times are not guaranteed. See Chapter 6 for nominal and maximum delay times for each module.

Output Modules in a Local Chassis

The owner-controller updates ControlLogix digital output modules in the local chassis at the end of every task and at the RPI.

When you specify an RPI value for a digital output module, you instruct the owner-controller when to broadcast the output data to the module. If the module resides in the same chassis as the owner-controller, the module receives the data almost immediately after the owner-controller sends it. Backplane transfer times are small.

Figure 5 - Local Output Modules



Depending on the value of the RPI with respect to the length of the program scan, the output module can receive and echo data multiple times during one program scan.

Output Modules in a Remote Chassis

If an output module physically resides in a chassis other than that of the owner-controller, the owner-controller normally sends data to the output module at the RPI rate specified. Updates are not performed at the end of the controller's tasks.

In addition, the role of the RPI for a remote output module changes slightly with respect to getting data from the owner-controller.

Remote Output Modules Connected Via the EtherNet/IP Network

When remote digital output modules are connected to the owner-controller via an EtherNet/IP network, the controller sends output data at these times:

- When the RPI timer expires
- When an Immediate Output (IOT) instruction, if programmed, is executed

  An IOT sends data immediately and resets the RPI timer.
- When a new schedule is created for a 1756-OB16IEFS module from the motion planner for a cam that has been armed by an MAOC instruction

Because the 1756-OB16IEFS module is the only 1756 module that can be used in a remote chassis with the MAOC instruction, it is the only module that receives output data in this scenario.

Common Digital I/O Module Features

The 1756 digital I/O modules support these features.

1756 I/O Module Features

Module Type	Features
1756 digital AC input modules	• Change of state: Software configurable • Timestamp of inputs: ±200 µs • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical
1756 digital AC output modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Fault states per point: Hold last state, on or off (off is default) • States in Program mode per point: Hold last state, on or off (off is default) • Fusing: – 1756-OA8D, 1756-OA8E: Electronically fused per point – 1756-OA16: Mechanically fused/group, 3.15 A @ 250V AC slow blow, 1500 A interruption current, Littelfuse p/n H2153.15 – All other modules: Not protected. A fused IFM is recommended to protect outputs (see publication 1492-TD008) • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical
1756 digital DC input modules	• Reverse polarity protection: All modules except 1756-IG16 and 1756-IG16K modules • Change of state: Software configurable • Timestamp of inputs: – ±100 µs for sequence of events modules(1) – ±200 µs for all other modules • Module keying: Electronic, software configurable • RTB Keying: User-defined mechanical
1756 digital DC output modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Fault states per point: Hold last state, on or off (off is default) • States in Program mode per point: Hold last state, on or off (off is default) • Fusing: – 1756-OB8EI, 1756-OB16D, 1756-OB16E, 1756-OB16IEF, 1756-OB16IEFS, 1756-OV16E, 1756-OV32E: Electronically fused per point – All other modules not protected. A fused IFM is recommended to protect outputs. See publication 1492-TD008. • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical
1756 digital contact modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Configurable fault states per point: Hold last state, on or off (off is default) • Configurable states in Program mode per point: Hold last state, on or off (off is default) • Fusing: Not protected. A fused IFM is recommended to protect outputs (See publication 1492-TD008) • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical

(1) For details, see the ControlLogix Sequence of Events Module Installation Instructions, publication 1756-IN592, and the ControlLogix Sequence of Events Module User Manual, publication 1756-UM528.

IMPORTANT For the latest I/O module specifications, see the 1756 ControlLogix I/O Modules Technical Specifications, publication 1756-TD002.

Removal and Insertion Under Power

All ControlLogix I/O modules may be inserted and removed from the chassis while power is applied. This feature enables greater availability of the overall control system. While the module is being removed or inserted, there is no additional disruption to the rest of the control process. This helps prevent an entire production line from having to be shut down.

Module Fault Reporting

ControlLogix digital I/O modules provide both hardware and software indication when a module fault has occurred. Each fault status indicator and Logix Designer application graphically display this fault and include a fault message describing the nature of the fault. This feature lets you determine how your module has been affected and what action to take to resume normal operation.

The 1756-OB16IEF module extends this feature by enabling you to define the duration of time before the module transitions to On or Off after a fault occurs. For more information, see Programmable Fault State Delay on page 55.

Software Configurable

Logix Designer application provides an interface to configure each module. All module features are enabled or disabled through the I/O configuration within the software.

You can also use the software to retrieve this information from any module in the system:

- Serial number
- Firmware revision information
- Product code
- Vendor
- Error and fault information
- Diagnostic counters

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device that is defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared.

Table 6 - Electronic Keying

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The Electronic Keying options below are available.

Table 7 - Electronic Keying Options

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has these characteristics: • Same catalog number • Same or higher Major Revision • Minor Revision as follows: • If the Major Revision is the same, the Minor Revision must be the same or higher. • If the Major Revision is higher, the Minor Revision can be any number.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **ATTENTION**: Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We **strongly recommend** that you **do not use** Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT	Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken. If an I/O connection to a device is interrupted, the result can be a loss of data.

For more detailed information about Electronic Keying, see Electronic Keying in Logix5000™ Control Systems Application Technique, publication LOGIX-AT001.

Module Inhibiting

Module inhibiting lets you indefinitely suspend a connection between an owner-controller and a digital I/O module without having to remove the module from the configuration. This process lets you temporarily disable communication to a module, such as to perform maintenance. You can use module inhibiting in these ways:

- You write a configuration for an I/O module but inhibit the module to help prevent it from communicating with the owner-controller. In this case, the owner does not establish a connection and the configuration is not sent to the module until the connection is uninhibited.
- In your application, a controller already owns a module, has downloaded the configuration to the module, and is exchanging data over the connection between the devices. In this case, you can inhibit the module and the owner-controller behaves as if the connection to the module does not exist.

IMPORTANT	Whenever you inhibit an output module, it enters Program mode, and all outputs change to the state configured for Program mode. For example, if an output module is configured so that the state of the outputs transition to zero during Program mode, whenever that module is inhibited, outputs transition to zero.

You may need to use module inhibiting in these instances:

- Multiple controllers own the same digital input module. A change is required in the module configuration. However, the change must be made to the program in all controllers. In this case, you follow these steps.
  a. Inhibit the module.
  b. Change configuration in all controllers.
  c. Uninhibit the module.
- You want to upgrade a digital I/O module. We recommend you use this procedure.
  a. Inhibit the module.
  b. Perform the upgrade.
  c. Uninhibit the module.
- You are using a program that includes a module that you do not physically possess yet, and you do not want the controller to continually look for a module that does not yet exist. In this case, you can inhibit the module in your program until it physically resides in the proper slot.

Producer/Consumer Communication

By using Producer/Consumer communication, ControlLogix I/O modules can produce data without first being polled by a controller. The modules produce the data and any other owner-controller device can decide to consume it.

For example, an input module produces data and any number of processors can consume the data at the same time. This eliminates the need for one processor to send the data to another processor. For more information about this process, see Input Module Operation on page 21.

Status Indicator Information

Each ControlLogix digital I/O module has a status indicator on the front of the module that lets you check the health and operational status of a module. The status indicator displays vary for each module.

Table 8 - Status Indicator Displays

Status	Description
I/O status ST	This yellow display indicates the On/Off state of the field device. **IMPORTANT:** For the 1756-OA8D and 1756-OA8E modules, the I/O status indicator does not illuminate without field power applied.
Module status OK	This green display indicates the module communication status.
Fault status FLT	This display is only found on some modules and indicates the presence or absence of various faults.
Fuse status Fuse	This display is only found on electronically fused modules and indicates the state of the module fuse.

See Status Indicators on page 89 for examples of status indicators on ControlLogix digital I/O modules.

Use the System Clock to Timestamp Inputs and Schedule

This section describes how to use CST timestamps in standard and diagnostic I/O modules and the CIP Sync™ timestamps in fast I/O modules.

Use Coordinated System Time with Standard and Diagnostic I/O Modules

Time masters generate a 64-bit coordinated system time (CST) for their respective chassis.

You can configure your digital input modules to access the CST and timestamp input data with a relative time reference of when that input data changes state.

IMPORTANT	Because only one CST value is returned to the controller when any input point changes state, we recommend that you use timestamping on only one input point per module.

Table 9 - How to use CST timestamps

Topic	Description
Timestamping for a sequence of events	The CST can be used to establish a sequence of events occurring at a particular input module point by timestamping the input data. To determine a sequence of events, you must do the following: • Set the communication format of the input module to CST Timestamped Input Data. • Enable COS for the input point where a sequence occurs, and disable COS for all other points on the module.
	If you decide to configure multiple input points for COS, your module generates a unique CST each time any of those input points change state, as long as the changes do not occur within 500 µs of each other. If multiple input points configured for COS change state within 500 µs of each other, a single CST value is generated for all making it appear that they changed at exactly the same time.
Timestamping in conjunction with scheduled outputs	Timestamping can be used in conjunction with the scheduled outputs feature, so that after input data changes state and a timestamp occurs, an output point actuates at some configured time in the future. You can schedule outputs up to 16 seconds into the future. When you use timestamping of inputs and scheduled outputs, you must do the following: • Choose a communication or connection format for each input and output module that enables timestamping. For more information, see Module Definitions, Communication, or Connection Formats on page 15. • Have a time master in the same chassis as both I/O modules. • Disable COS for all input points on the input module except the point being timestamped.
	For scheduled outputs to work most effectively, remember these items: • The time to schedule outputs to transition in the future must account for any controller, backplane, and network delays. • The I/O modules must reside in the same rack as the time master.

Use CIP Sync Time with Fast I/O Modules

The 1756-IB16IF, 1756-OB16IEF, and 1756-OB16IEFS modules use CIP Sync for both timestamps and scheduling.

CIP Sync is a CIP™ implementation of the IEEE 1588 PTP (Precision Time Protocol). CIP Sync provides accurate real-time (Real-World Time) or Universal Coordinated Time (UTC) synchronization of controllers and devices that are connected over CIP networks. This technology supports highly distributed applications that require timestamping, sequence of events recording, distributed motion control, and increased control coordination.

The 1756-IB16IF, 1756-OB16IEF, and 1756-OB16IEFS modules are CIP Sync slave-only devices. There must be another module on the network that functions as a master clock. For more information on how to use CIP Sync technology, see the Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003.

Fast I/O modules can be used to capture timestamps and schedule outputs like CST-based modules while providing these advantages:

- Fast I/O modules have much higher precision than CST-based modules.
- Inputs are timestamped by point, so multiple inputs can be configured for COS without losing timestamp data.
- CIP Sync is system-wide, so timestamp and schedule values are consistent across all modules in the system. For instance, using 1756-IB16IF input timestamps to schedule outputs on a 1756-OB16IEF module means that the controller, input module, and output module are not restricted to the same chassis as is the case with CST-based I/O.
- Output modules use all 64 bits of the timestamp to schedule, so there are no limits on schedule ranges.

Mixing CST and CIP Sync Modules in a ControlLogix System

CST is automatically enabled for each chassis that has been configured to use CIP Sync. Therefore, it is possible to include modules that use CST for their time base into systems that have been configured to use CIP Sync. Also, there is a direct correlation between CIP Sync system time and the local chassis CST time.

The CIP Sync system time and local chassis CST time are related by this equation:

CIP Sync system time = CST time + offset

The offset in the equation is a value unique to each chassis and can be obtained by using one of these methods:

- CSTOffset from the WallClockTime (WCT) object of a controller in the chassis
- SystemOffset from the Time Synchronize object of a controller in the chassis
- LocalClockOffset returned in an I/O connection from a CIP Sync capable module in the chassis

This relationship enables CST and CIP Sync-based I/O to interoperate as long as the offset in the chassis containing the CST-based module is accessible.

Input Module Features

ControlLogix digital input modules interface to sensing devices and detect whether they are On or Off.

ControlLogix input modules convert AC or DC On/Off signals from user devices to appropriate logic level for use within the processor. Typical input devices include the following:

- Proximity switches
- Limit switches
- Selector switches
- Float switches
- Push-button switches

When designing systems with ControlLogix input modules, consider these factors:

- Voltage necessary for your application
- Current leakage
- Whether you need a solid-state device
- Whether your application uses sinking or sourcing wiring

Data Transfer on Either Cyclic Time or Change of State (COS)

Digital input modules always send data at the RPI, but they send data at a change of state only if the COS feature is enabled. COS is more efficient than RPI because it multicasts data only when a change occurs.

The table describes the two ways that a module sends data to the owner-controller.

Table 10 -

Method	Description
RPI	A user-defined rate at which the module updates the information sent to its owner-controller. This is also known as Cyclic Data Transfer.
COS	Configurable feature that, when enabled, instructs the module to update its owner-controller with new data whenever a specified input point transitions from On to Off and Off to On. The data is sent at the RPI rate when there is no change of state. By default, this setting is always enabled for input modules.

Isolated and Nonisolated Varieties of Input Modules

ControlLogix input modules provide isolated or nonisolated wiring options. Some applications require power for the I/O circuits to originate on separate, isolated power sources. Because these conditions require separate commons for each channel, some input modules use individual isolation, or point-to-point isolation so if one point faults, the others continue to operate.

Other types of isolation available with ControlLogix input modules are channel-to-channel isolation and no isolation. Your application determines what type of isolation is necessary and which input module to use.

Multiple Input Point Densities

ControlLogix input modules use either 8-, 16-, or 32-point densities for greater flexibility in your application. A point is the termination where a wire attaches to the input module from a field device. The module receives information from the device to this designated point, thus signaling when activity occurs.

RPI

The Connection tab on the Module Properties dialog box lets you enter an RPI. The RPI guarantees the slowest rate at which data is multicast.

The actual data transfer rate of the module can be faster than the RPI setting. But, the RPI provides a defined, maximum period of time when data is transferred to the owner-controller.

For more information on configuring this feature, see Chapter X - Configure Digital I/O Modules.

Change of State

The Point column on the left side of the Configuration tab lets you set whether a COS occurs when a field device transitions from Off to On or On to Off.

For more information on configuring this feature, see Chapter X - Configure Digital I/O Modules.

Software Configurable Filter Times

On-to-Off and Off-to-On filter times can be adjusted through Logix Designer application for all ControlLogix input modules. These filters improve noise immunity within a signal. A larger filter value affects the length of delay times for signals from these modules.

IMPORTANT	Input filters on the 1756-IB16IF module function differently than other digital I/O modules. For information about input filters on the 1756-IB16IF module, see Fast Input Module Tags on page 125.

For more information on configuring this feature, see Chapter X - Configure Digital I/O Modules.

Output Module Features

ControlLogix output modules can be used to drive various output devices. Typical output devices compatible with ControlLogix outputs include these items:

- Motor starters
- Solenoids
- Indicators

Follow these guidelines when designing a system:

- Make sure that the ControlLogix outputs can supply the necessary surge and continuous current for proper operation.
- Make sure that the surge and continuous current are not exceeded. Damage to the module could result.

When sizing output loads, refer to the documentation supplied with the output device for the surge and continuous current needed to operate the device.

The ControlLogix standard digital outputs are capable of directly driving the ControlLogix standard digital inputs. The exceptions are the AC and DC diagnostic input modules. When diagnostics are used, a shunt resistor is required for leakage current.

For information on the compatibility of motor starters with ControlLogix output modules, see Appendix D.

Output Data Echo

During normal operation, when a controller sends out an output command to the ControlLogix system, the output module that is targeted for that command returns the commanded state of the output to the system. This process verifies that the module has received the command and tried to execute it.

Other devices can use this broadcast signal through a Listen-only connection to determine the desired state of the output without having to interrogate the owner-controller.

Monitor Fault Bits

The output data echo only matches the commanded state of the outputs if the module is operating under normal conditions. If there is an anomaly with the module, the commanded state and the output data echo may not match.

You can monitor the fault bits for your output points for fault conditions. If a fault occurs, the fault bit is set and your program alerts you to the condition. In this case, the output data echo may not match the commanded state of the outputs.

If there is a mismatch between the commanded state of the outputs and the output data echo, check your output module for these conditions:

- Communication fault.
- Connection is inhibited.
- Blown fuse—The module does not turn on an output if an overload or short circuit is detected.
- (1756-OA8D and 1756-OA8E only) Loss of field power—The module does not turn on an output unless AC power is detected.

Redundant Owner, but this controller is not the Active owner.

Isolated and Nonisolated Varieties of Output Modules

As with input modules, ControlLogix output modules provide isolated or nonisolated wiring options. I/O modules provide point-to-point, group-to-group, or channel-to-channel wiring isolation. Your specific application determines what type of isolation is necessary and which output module to use.

IMPORTANT	Although some ControlLogix I/O modules provide nonisolated, field-side wiring options, each I/O module maintains internal electrical isolation between the system side and field side.

Time-scheduled Output Control

Time-scheduled output control is available for these modules:

- 1756-OB16IS—Provides time-scheduled output control in CST time for outputs 0…7. Enables schedules with a minimum interval of 100 µs.
- 1756-OB16IEFS—Provides time-scheduled output control in CIP Sync time for outputs 0…15. Enables schedules with a minimum interval of 5 µs.

By using the time-scheduled output control feature, the module can turn the outputs On or Off at a scheduled time. You can set the time for the output to turn On or Off in program logic. The modules manage the time locally, so that the output is turned On or Off at the specified time.

MAOC Instructions with Time-scheduled Output Control

The Motion Axis Output Cam (MAOC) instruction provides position-based control of outputs by using position and velocity information of any motion axis. When the 1756-OB16IS or 1756-OB16IEFS module is specified as the output destination for the MAOC instruction, the MAOC instruction automatically handles time-based scheduling for outputs. The benefit of using output scheduling in this manner is that the resolution of the output control is improved from the motion coarse update rate (typically 1…32 ms) to 100 µs for outputs 0…7 on the 1756-OB16IS module and 10 µs for outputs 0…15 on the 1756-OB16IEFS module.

You can also use outputs 8…15 on the 1756-OB16IS module with the MAOC instruction. However, only outputs 0…7 have 100 µs resolution. Outputs 8…15 are updated at the motion coarse update rate.

IMPORTANT	The 1756-OB16IS Scheduled Output Module can be associated with one MAOC axis/execution target only.

For more information about using the MAOC instruction with scheduled output modules, refer to the Position-based Output Control with the MAOC Instruction Application Technique, publication 1756-AT017.

Module Major Revision Considerations with Timestamping

When using timestamping for inputs or diagnostic timestamping of I/O modules, these conditions can occur depending on the major revision of the module:

- If the module has a Major Revision = 1 (unless a 1756-IB16IF, 1756-IB16ISOE, or 1756-IH16ISOE module), it always returns a positive timestamping value.
- If the module has a Major Revision > 2 or is a 1756-IB16IF, 1756-IB16ISOE, or 1756-IH16ISOE module, it returns a negative timestamping value until the module is synchronized with the owner-controller and the first change of state condition occurs.

Use the Module Properties dialog box in Logix Designer application to determine if the module has been synchronized with the owner-controller and whether the controller is synchronized with the CST. For more information on synchronizing owner-controllers and modules with the CST, see the ControlLogix System User Manual, publication 1756-UM001.

Configurable Point-level Output States

Individual outputs can be configured to unique output states if the module goes into Program mode or Fault mode.

IMPORTANT	Whenever you inhibit an output module, it enters Program mode, and all outputs change to the state configured for Program mode. For example, if an output module is configured so that the states of outputs turn Off during Program mode, whenever that module is inhibited, outputs turn Off.

For more information on configuring this feature, see page 70.

Electronic Fusing

Some digital outputs have internal electronic or mechanical fusing to help prevent too much current from flowing through the module. This feature protects the module from electrical damage. Other modules require external fusing.

Modules that use electronic fusing are fused on either a per point basis or per group basis to protect output points from the surge of too much current. If too much current begins to flow through a point, the fuse is tripped and a point-level fault is sent to the controller. A corresponding tag can be examined in the event of a fault. For more information about fault tags, see Appendix A.

These modules use electronic fusing:

- 1756-OA8E
- 1756-OB8EI
- 1756-OA8D
- 1756-OB16D
- 1756-OB16E
- 1756-OV16E
- 1756-OV32E
- 1756-OB16IEF
- 1756-OB16IEFS

Refer to this table to determine what fuse to use in your application. If your module does not support fusing, you can use a fused IFM to protect outputs. See publication 1492-TD008.

Table 11 - Recommended Fuses

Circuit Type	Cat. No.	Fusing on the module	Recommended Fuse	Fuse Supplier
AC	1756-OA8[1]	None—Fused IFM can be used to protect outputs	5x20mm 6.3 A Medium lag	SAN-O Industry Corp. (SOC) PN MT 4-6.3A
	1756-OA8D[2][3]	Yes—Fused on a per point basis	Electronically fused	
	1756-OA8E[2][3]			
	1756-OA16[1][4][5]	Yes—Fused on a per group basis	5x20mm 3.15 A Slo-Blow 1500 A Interruption current	Littelfuse p/n H2153.15
	1756-OA16I[1]	None—Fused IFM can be used to protect outputs	5x20mm 6.3 A Medium lag	SOC p/n MT 4-6.3A
	1756-ON8			
DC	1756-OB8[6]	None—Fused IFM can be used to protect outputs	5x20mm 4 A Quick acting	SOC p/n MQ2-4A
	1756-OB8EI[6]			
	1756-OB8EI[2][3][6]	Yes—Fused on a per point basis	Electronically fused	
	1756-OB16D[2][3][7]			
	1756-OB16E[2][5][6]	Yes—Fused on a per group basis		
	1756-OB16I[6][8]	None—Fused IFM can be used to protect outputs	5x20mm 4 A Quick acting	SOC p/n MQ2-4A
	1756-OB16IEF[2][3][6]	Yes—Fused on a per point basis	Electronically fused	
	1756-OB16IEFS[2][3][6]			
	1756-OB16IS[6][8]	None—Fused IFM can be used to protect outputs	5x20mm 4 A Quick acting	SOC p/n MQ2-4A
	1756-OB32[6][8]		5x20mm 800 mA	Littelfuse p/n SP001.1003 or Schurter p/n 216.800
	1756-OC8[6]		5x20mm 4 A Quick acting	SOC p/n MQ2-4A
	1756-OG16[6]			
	1756-OH8I[6][8]			
	1756-OV16E[2][5][6]	Yes—Fused on a per group basis	Electronically fused	
	1756-OV32E[2][5][6]			
Relay	1756-OW16I[8]	None—Fused IFM can be used to protect outputs	5x20mm 6.3 A Medium lag	SOC p/n MT 4-6.3A
	1756-OX8I[8]			

(1) For voltages above 132V AC, the Interface Modules (IFM) are not an acceptable means to provide external fusing. A rated terminal block for the intended application must be used.
(2) Electronic protection is not intended to replace fuses, circuit breakers, or other code-required wiring protection devices.
(3) The electronic protection of this module has been designed to provide protection for the module from short-circuit conditions. The protection is based on a thermal cut-out principle. In the event of a short-circuit condition on an output channel, that channel limits the current within milliseconds after its thermal cut-out temperature has been reached. All other channels with a NUT of that group continue to operate as directed by the module master (CPU, bridge, and so forth).
(4) A fuse is provided on each common of this module for a total of two fuses. The fuses are designed to protect the module from short circuit conditions. The fuse does not provide overload protection. In the event of an overload on an output channel, it is likely that the fuse does not blow and the output device associated with that channel is damaged. To provide overload protection for your application, install user-supplied fuses externally.
(5) If a short circuit condition occurs on any channel within this module group, the entire group is turned Off.
(6) The module does not provide protection against reverse polarity wiring or wiring to AC power sources.
(7) The electronic protection of this module has been designed to provide protection for the module from short-circuit conditions. The protection is based on a thermal cut-out principle. In the event of a short-circuit condition on an output channel, that channel limits the current within milliseconds after its thermal cut-out temperature has been reached. Other channels could produce a false error on the output verify fault signal due to the supply dropping below the minimum detect level of 19.2V DC. The output channels that are affected by this phenomenon continues to operate as directed by the module master (CPU, bridge, and so forth). What this means is that the output verify fault signals of the other channels must be checked and reset if a short-circuit on one channel occurs.
(8) The recommended fuse for this module has been sized to provide short circuit protection for wiring only to external loads. In the event of a short circuit on an output channel, it is likely that the transistor or relay associated with that channel is damaged and the module can be replaced or a spare output channel used for the load. The fuse does not provide overload protection. In the event of an overload on an output channel, it is likely that the fuse does not blow and the transistor or relay associated with that channel is damaged. To provide overload protection for your application, user supplied fuse can be installed externally and properly sized to match the individual load characteristics.

You can reset an electronic fuse through the Logix Designer application during online monitoring or through program logic running on a controller. If your module uses point-level fusing, you can reset a fuse with a CIP Generic message instruction, as described on Reset a Fuse, Perform Pulse Test, and Reset Latched Diagnostics on page 154.

Field Power Loss Detection

For the standard digital output modules, the Field Power Loss detection feature is found on the **1756-OA8E module only**. When field power to the module is lost, or zero cross cannot be detected, a point-level fault is sent to the controller to identify the exact point faulted.

IMPORTANT	Only enable Field Power Loss detection for points that are in use. If this feature is enabled for points that are not in use, you receive faults for those points during operation.

This feature has a corresponding tag that can be examined in the user program in the event of a fault. For information on these tags, see Appendix A.

Diagnostic Latch of Information

The diagnostic latch feature is available for the **1756-OA8E modules only**. Diagnostic latching lets this module latch a fault in the set position once it has been triggered, even if the error condition causing the fault to occur disappears.

Notes:

Digital Diagnostic Module Features

Common Diagnostic Features

Below are features common to all ControlLogix® digital diagnostic I/O modules. Diagnostic I/O Modules also have the common features described in Common Digital I/O Module Features.

- Diagnostic Timestamp
- 8-Point AC/16-Point DC
- Point-level Fault Reporting
- Diagnostic Latch of Information

Diagnostic Timestamp

Diagnostic I/O modules can timestamp the time when a fault occurs or when it clears. This feature provides greater accuracy and flexibility in running applications. Modules use the ControlLogix system clock from a local controller to generate timestamps.

To use diagnostic timestamps, you must choose the appropriate communication format during initial configuration. To configure features

8-Point AC/16-Point DC

Diagnostic I/O modules provide various grouping of points on different modules. The eight-point AC modules and 16-point DC modules provide additional flexibility when designing module applications. The greater number of points lets more field devices be attached to I/O modules to boost efficiency.

Point-level Fault Reporting

Diagnostic I/O modules set bits to indicate when a fault has occurred on a point-by-point basis. These fault conditions generate their own unique fault bits.

Table 12 - Unique Fault Bits for I/O Points

Input Points	Output Points
These conditions can set a fault bit for an input point: • Open wire • Field power loss (1756-IA8D only)	These conditions can set a fault bit for an output point: • Fuse blown • No load • Output verify • Field power loss (1756-IA8D only)

Using these bits in tandem with data echo and manually performing a pulse test can help to further isolate the fault.

Table 13 - 1756-OA8D Point-level Fault Scenarios

Ladder commands output to be On	Ladder commands output to be Off	Possible cause of fault
1. Output Data Echo returns the state of the output as Off. 2. Fuse Blown bit is set.	1. Output Data Echo returns the state of the output as Off.(1) 2. Pulse Test fails.	Output is shorted to L2.
1. Output Data Echo returns the state of the output as On. 2. Pulse Test fails.(2)	1. Output Data Echo returns the state of the output as Off. 2. No Load bit is off.	No Load or output is shorted to L1.
1. Output Data Echo returns the state of the output as Off. 2. No Load shows a fault. 3. Field Power Loss shows a fault. 4. Pulse Test fails.	1. Output Data Echo returns the state of the output as Off. 2. No Load bit is set. 3. Field Power Loss is set. 4. Pulse Test fails.	L1 or L2 are disconnected or outside the 47...63 Hz frequency range.
1. Output Data Echo returns the state of the output as On.(3) 2. Output Verify bit is set.(4)	1. Data Echo returns the state of the output as Off. 2. Pulse Test fails.	Hardware point damage.(5)

(1) It is not possible to create a Fuse Blown fault in the Off state. If a short-circuit occurs, the output point is turned Off and the fault appears in the Off state until the point is reset.
(2) When pulse test is executed, it is normal operation to see a momentary pulsation on the module display.
(3) The output cannot turn On due to hardware point damage.
(4) Depending on the characteristics of an applied short-circuit, an output verify fault could be set until the short-circuit is detected by the module and the output is turned Off.
(5) During normal operating conditions, hardware damage is not possible. An output shorted to L2 may temporarily cause a hardware point fault. See output shorted to L2 as a possible cause.

This table lists possible diagnostic faults on the 1756-OB16D module.

Table 14 - 1756-OB16D Point-level Fault Scenarios

Ladder commands output to be On	Ladder commands output to be Off	Possible cause of fault
1. Output Data Echo returns the state of the output as Off. 2. Fuse Blown bit is set.(1)	1. Output Data Echo returns the state of the output as Off.(2) 2. Pulse Test fails.(3)	Output is shorted to GND.
1. Output Data Echo returns the state of the output as On. 2. Pulse Test fails	1. Output Data Echo returns the state of the output as Off. 2. No Load bit is set. 3. Pulse Test passes.	One of the following could be the cause. 1. No Load. 2. Output shorted to DC+. 3. No power at module.
1. Output Data Echo returns the state of the output as On.(4) 2. Output Verify sets a bit.(5)	1. Output Data Echo returns the state of the output as Off. 2. Pulse Test fails.	Hardware point damage.(6)

(1) The electronic protection of this module has been designed to provide protection for the module from short-circuit conditions. The protection is based on a thermal cutout principal. In the event of a short-circuit condition on an output channel, that channel limits the current within milliseconds after its thermal cutout temperature has been reached. Other channels could produce a false error on the output verify fault signal due to the supply dropping below the minimum detect level of 19.2V DC. The output channels that are affected by this phenomenon continues to operate as directed by the module master (CPU, bridge, and so forth). What this means is that the output verify fault signals of the other channels must be checked and reset if a short-circuit on one channel occurs.
(2) It is not possible to create a Fuse Blown fault in the Off state. If a short-circuit occurs, the point is turned Off and the fault appears in the Off state until that point is reset.
(3) When the pulse test is executed, it is normal operation to see a momentary pulsation on the module display.
(4) The output cannot turn On due to hardware point damage.
(5) Depending on the characteristics of an applied short-circuit, an output verify fault could be set until the short-circuit is detected by the module and the output is turned Off.
(6) During normal operating conditions, hardware damage is not possible. An output shorted to GND may temporarily cause a hardware point fault. See output shorted to GND as a possible cause.

Diagnostic Latch of Information

Diagnostic latching lets diagnostic I/O modules latch a fault in the set position once it has been triggered, even if the error condition causing the fault to occur disappears.

Diagnostic Input Module Features

When designing systems with ControlLogix diagnostic input modules, consider these factors:

- Voltage necessary for your application
- Current leakage
- Whether you need a solid-state device
- Whether your application must use sinking or sourcing wiring

Fault and Status Reporting between Input Modules and Controllers

ControlLogix diagnostic digital input modules multicast fault and status data to any owner-controller or listening controller. All diagnostic input modules maintain a module-fault word, the highest level of fault reporting. Some modules use additional words to indicate fault conditions.

Table 15 lists the fault words and the associated tags that can be examined in program logic to indicate when a fault has occurred for a diagnostic input module.

Table 15 - Fault Words on Diagnostic Input Modules

Word	Tag Name	Description
Module-fault	Fault	Provides fault summary reporting. Available on all digital input modules.
Field Power Loss	FieldPwrLoss	Indicates loss of field power to a group on the module. Available on the **1756-IA8D only**. For more information, see Field Power Loss Detection on page 43.
Open Wire	OpenWire	Indicates the loss of a wire from a point on the module. For more information, see Open Wire Detection on page 42.

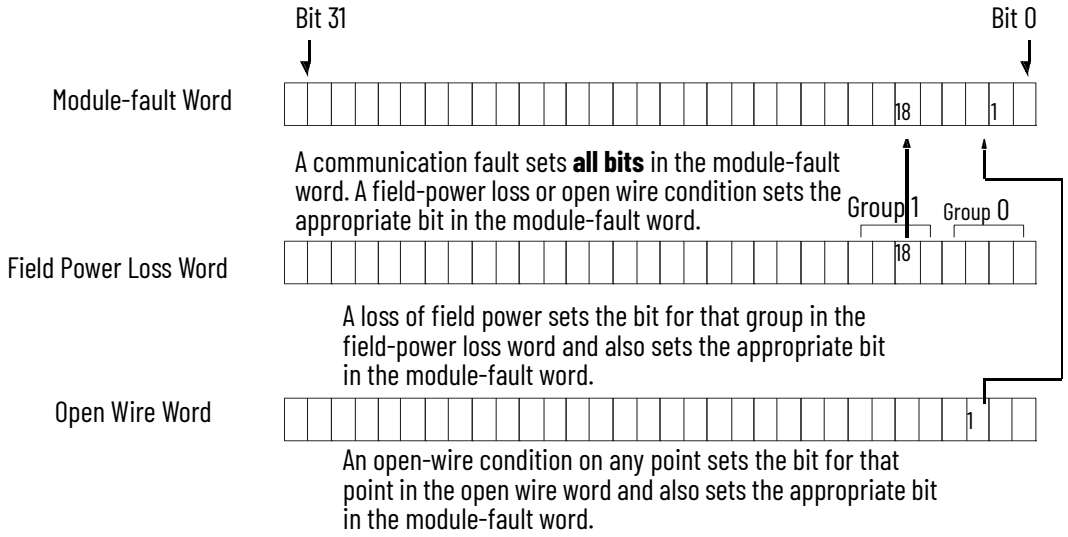
All words are 32 bit, although only the number of bits appropriate for each module's density are used. For example, the 1756-IA16I module has a module-fault word of 32 bits. But, because this is a 16-point module, only the first 16 bits (0...15) are used in the module-fault word.

Fault bits in the field-power loss word and open wire word are logically entered into the module-fault word. Depending on the module type, a bit set in the module-fault word can mean multiple things, as indicated in the table.

Table 16 - Bits Set in Module-fault Word

Condition	Bits Set
Communications fault	All 32 bits are set to 1, regardless of the module's density.
Field-power loss	Only the bit affected is set to 1.
Open wire	

This illustration provides an overview of the fault reporting process for digital input modules.



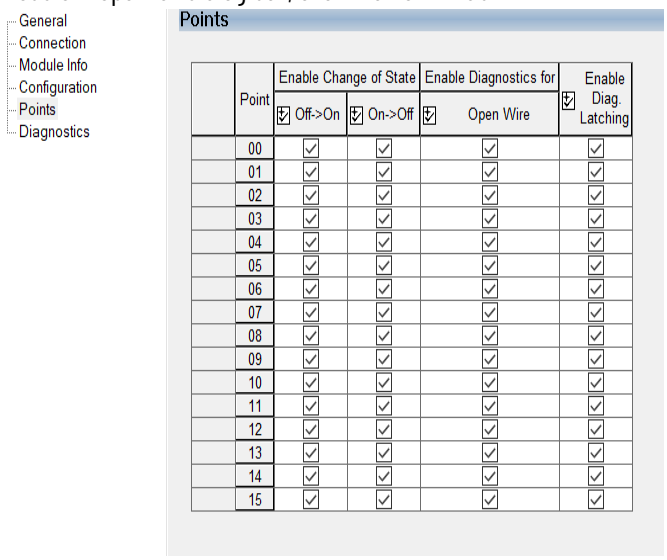
Diagnostic Change of State for Input Modules

If the diagnostic change of state feature is enabled, a diagnostic input module sends new data to the owner-controller when one of the events that are described in the table occurs.

Event	Description
RPI	A user-defined rate at which the module updates the information sent to its owner-controller. This is also known as Cyclic Data Transfer.
Change of State	Configurable feature that, when enabled, instructs the module to update its owner-controller with new data whenever a specified input point transitions from On to Off and Off to On. The data is sent at the RPI rate where there is no change of state. By default, this setting is always enabled for input modules.
Diagnostic Change of State	Information updates when any change in the diagnostics for an input module occurs.

Although the RPI occurs continuously, the COS feature lets you decide whether changes in a module's diagnostic detection cause the module to send real-time data to the owner-controller.

1. On the Module Properties dialog box, click the Points tab.



2. Do the following in the Enable Change of State column:
   - To enable the input module to send new data to the owner-controller at the RPI, on input COS if it is enabled, and if a diagnostic fault occurs, check the corresponding Off ? On or On ?Off checkbox for a point.
   - To disable the feature, clear the corresponding checkbox for a point. Real-time data is not sent when a diagnostic fault occurs but is still sent at the specified RPI or on input COS if it is enabled.
3. Click OK.

Open Wire Detection

Open Wire is used to verify that the field wiring is connected to the module. The field device must provide a minimum leakage current to function properly.

A leakage resistor must be placed across the contacts of an input device. The resulting current is then expected to exist when the input is open. For more information, see each module's specifications in Chapter 6.

When an Open Wire condition is detected, a point-level fault is sent to the controller to identify the exact point fault. This feature has a corresponding tag that can be examined in the user program in the event of a fault.

Field Power Loss Detection

For the standard digital output modules, the Field Power Loss detection feature is found on the **1756-IA8D module only**. When field power to the module is lost, or zero cross cannot be detected, a point-level fault is sent to the controller to identify the exact point faulted.

IMPORTANT	Only enable Field Power Loss detection for points that are in use. If this feature is enabled for points that are not in use, you receive faults for those points during operation.

This feature has a corresponding tag that can be examined in the user program in the event of a fault. For information on these tags, see Chapter 5.

Diagnostic Output Module Features

ControlLogix diagnostic output modules are capable of directly driving the ControlLogix diagnostic digital inputs. When diagnostics are used, a shunt resistor is required for leakage current.

For more information on the compatibility of motor starters with ControlLogix output modules, see Appendix D.

Field Wiring Options

As with diagnostic input modules, ControlLogix diagnostic output modules provide isolated or nonisolated wiring options. I/O modules provide point-to-point, group-to-group, or channel-to-channel wiring isolation.

Your specific application determines what type of isolation is necessary and which output module to use.

IMPORTANT	Although some ControlLogix diagnostic I/O modules provide nonisolated field-side wiring options, each I/O module maintains internal electrical isolation between the system side and field side.

Pulse Test

Pulse test is a feature found on diagnostic output modules that can verify output-circuit functionality without actually changing the state of the output load device. A short pulse is sent to the targeted output circuit. The circuit responds as if a real change of state command was issued, but the load device does not transition.

See See Reset a Fuse, Perform Pulse Test, and Reset Latched Diagnostics on page 154 for instructions on performing a pulse test with a CIP Generic Message instruction.

Consider the following when using the pulse test:

- Only use the test when the output state does not transition for long periods of time. Normal diagnostics catch faults if the outputs are transitioning regularly.
- When first performing the pulse test, verify that the load does not transition. Be at the actual load while the test is performed.

This table explains how a pulse test can be used to perform a preemptive diagnosis of possible future module conditions.

Table 17 - Pulse Test Descriptions

Objective	Pulse Test Description
Detect a blown fuse before it happens	The Blown Fuse diagnostic can be used only when an output module is in the On state. However, you can use a pulse test when an output module is in an Off state to determine whether operating conditions may cause a blown fuse. When you perform a pulse test on a module in the Off state, the output point is commanded to be On briefly. Although no diagnostic bits are set in the output data echo, the pulse test reports a failure if the conditions when the point is On indicate a blown fuse may occur. See Point-level Fault Reporting on page 39.
	IMPORTANT The pulse test does not guarantee failure of a fuse when the output point turns On. It merely indicates that a blown fuse is possible.
Detect a No Load condition with an output On	No Load detection can only detect a fault when an output point is in the Off state. However, you can use a pulse test when an output module is in an On state to determine whether operating conditions for a point may cause a No Load condition. If you perform a pulse test on an output point while it is in the On state, the output point is commanded to be Off briefly. The pulse test reports a failure because conditions when the point is Off indicate the possible absence of a field device; in this case, though, the No Load bit is not set. See Point-level Fault Reporting on page 39.
	IMPORTANT The Pulse Test does not guarantee the absence of a load. It merely indicates that a No Load condition is possible.

Diagnostic Change of State for Output Modules

If the Diagnostic Change of State feature is enabled, a diagnostic output module sends new data to the owner-controller when one of the events that are described in Table 18 occurs.

Table 18 - Diagnostic Change of State Events

Event	Description
Receipt of output data	Output module sends data when it echoes back to the owner-controller.
Diagnostic change of state	Output module sends data when any change in the diagnostics output point occurs.

Unlike diagnostic input modules, this feature cannot be disabled for diagnostic output modules. There is no Enable Change of State for Diagnostic Transitions checkbox on the Configuration tab to check or clear for diagnostic output modules.

Fault and Status Reporting Between Output Modules and Controllers

ControlLogix diagnostic digital output modules multicast fault and status data to any owner-controller or listening controller. Like input modules, output modules maintain a module-fault word, the highest level of fault reporting. However, some output modules use additional words to indicate fault conditions.

The table lists the fault words and the associated tags that can be examined in program logic to indicate when a fault has occurred for a diagnostic output module.

Table 19 - Fault Words on Diagnostic Output Modules

Word	Tag Name	Description
Module-fault	Fault	Provides fault summary reporting. Available on all digital output modules.
Fuse Blown	FuseBlown	Indicates a blown fuse for a point on the module. For more information, see For more information, see Electronic Fusing on page 35.
No Load	NoLoad	Indicates a loss of a load from a point on the module. For more information, see No Load Detection on page 46.
Output Verify	OutputVerify	Indicates when an output is not performing as commanded by the owner-controller. For more information, see Field-side Output Verification on page 46.

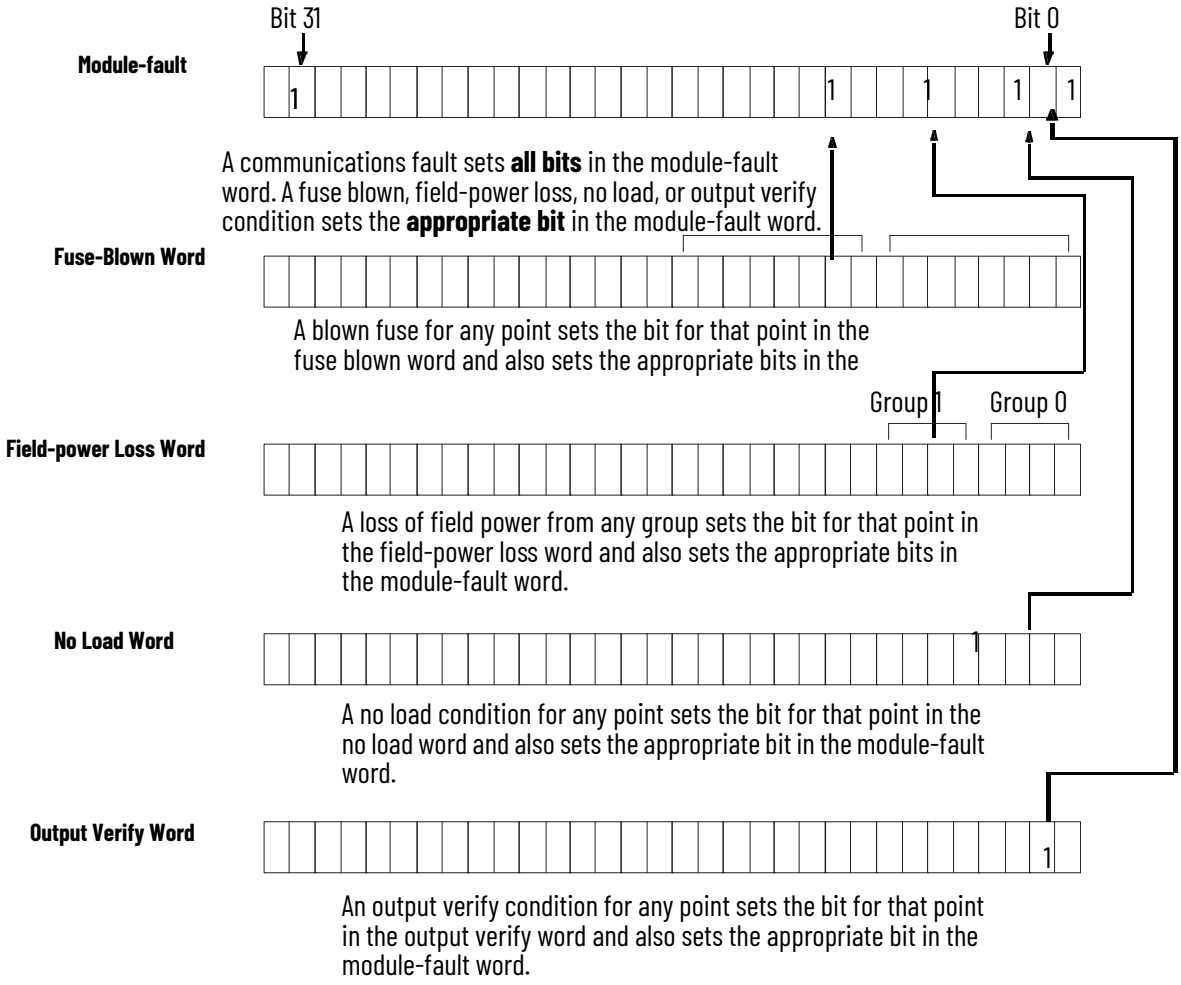
All words are 32 bit, although only the number of bits appropriate for each module's density are used. For example, the 1756-OB8 module has a module-fault word of 32 bits. But, because the module is an 8-point module, only the first 8 bits (0...7) are used in the module-fault word.

Fault bits in the fuse blown word, field-power loss word, no load word, and output verify word are logically entered into the module-fault word. Depending on the module type, a bit set in the module-fault word can mean multiple things, as indicated in the table.

Table 20 - Bits Set in Module-fault Word

Condition	Bits Set
Communication fault	All 32 bits are set to 1, regardless of the module's density.
Fuse blown	Only the bit affected is set to 1.
Field-power loss	
No load	
Output verify	

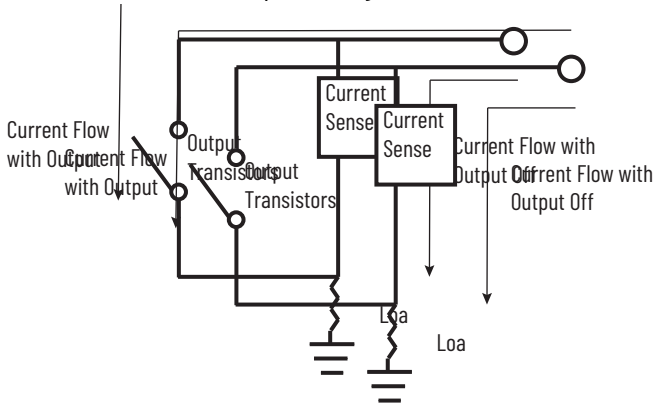
This illustration provides an overview of the fault reporting process for digital output modules.



No Load Detection

For each output point, no load detection senses the absence of field wiring or a missing load from each output point in the Off state only.

The output circuit on a diagnostic output module has a current sensing opto-isolator used in parallel with the output transistor. Current flows through this sensing circuit only when the output is Off, as shown in the simplified diagram.



Diagnostic output modules list a minimum load current specification (1756-OA8D = 10 mA & 1756-OB16D = 3 mA). In the On state, the module must be connected to a load that draws a minimum current equal to these values.

If a connected load is sized in accordance with the minimum load current specification, diagnostic output modules are capable of sensing current through the opto-isolator and the load when the output point is Off.

For more information on configuring this feature, see Chapter 4.

Field-side Output Verification

Field-side output verification informs you that logic-side instructions consumed by the module are accurately represented on the power side of a switching device. For each output point, this feature confirms that the output is On when it is commanded to be On.

The diagnostic output module can tell a controller that it received a command and whether the field-side device that is connected to the module has executed the command. For example, in applications that must verify that the module has accurately followed the processor's instructions, the module samples the field-side state and compares it to the system-side state.

This feature has a corresponding tag that can be examined in the user program in the event of a fault. For more information on these tags, see Appendix A.

If an output cannot be verified, a point-level fault is sent to the controller.

For more information on configuring this feature, see Chapter 4.

Fast Digital Module Features

Fast Module Features

Module features include all the common features that are described in Chapter 1, as well the extended capabilities described within this chapter.

For higher-speed control, the 1756-OB16IEF output module can be configured to receive input status over the backplane directly from the 1756-IB16IF input module or 1756-LSC8XIB8I counter module without controller processing. This feature, know as peer ownership, is described in the ControlLogix® Peer Ownership Application Technique, publication 1756-AT016.

IMPORTANT To configure the modules, you must have the following:

- The 1756-OB16IEF and 1756-OB16IEFS modules requires Studio 5000® environment, version 21.00.00 or later.
- The Add-on Profile (AOP) for each module available for download at rok.auto/pcdc

Response Time

This table indicates the screw-to-backplane response time of fast input and fast output modules.

Table 21 - Input and Output Response Time

Delay	Response Time
Fast Input Modules	
Total On/Off delay (screw to backplane)	14 µs nom/23 µs max + user-configurable filter time
Hardware delay	< 1 µs nom, 2 µs max
Firmware delay	13 µs nom, 21 µs max
User-configurable filter time	0...30,000 µs
Fast Output Modules	
Total On/Off delay (screw to backplane)	14 µs nom/23 µs max
Hardware delay	< 1 µs nom, 2 µs max
Firmware delay	13 µs nom, 21 µs max

Fast Input Module Features

Follow these guidelines when designing a system:

- Make sure that the ControlLogix outputs can supply the necessary surge and continuous current for proper operation.
- Make sure that the surge and continuous current are not exceeded. Damage to the module could result.

Pulse Capture

The 1756-IB16IF fast input module can be used to detect or latch short-duration pulses. The module can detect incoming pulses with a duration as short as 10 µs if the frequency is under 4 kHz (period of 250 µs).

When the module detects a short-duration pulse at an input point, it sets the corresponding bit for the Pt[*x*].NewDataOffOn or Pt[*x*].NewDataOnOff input tag. This bit remains latched until acknowledged. As a result, you can use this bit to detect a transition that is too fast to be detected by the program scan. You can also determine how rapid the transition was by configuring the module to latch timestamps for the point, as described in Per Point Timestamping and Change of State on page 51.

To acknowledge the last captured pulse and reset the pulse latch, you set the rising edge of the corresponding bit in these output tags:

- Pt[*x*].NewDataOffOnAck—Acknowledges that the input point has transitioned to an On state and resets the pulse latch.
- Pt[*x*].NewDataOnOffAck—Acknowledges that the input point has transitioned to an Off state and resets the pulse latch.

You can change output tag values in program logic while normal module operation continues or through the Logix Designer application tag editor. For more information about module tags, refer to Appendix A.

Once a pulse latch is reset for an input point, the next pulse at that point sets the corresponding bit in the Pt[x].NewDataOffOn or Pt[x].NewDataOnOff input tags.

Dedicated Connection for Event Tasks

The 1756-IB16IF input module can initiate an event task over a dedicated second connection in response to four user-defined input patterns. You can define these patterns in real time during a control process by using these output tags:

- Event[*x*].Mask—Defines which input points trigger the event task.
- Event[*x*].Value—Defines whether the masked input points must be in the On or Off state before the event task is triggered.

Each pattern can use any of the module's 16 input points, as shown in the tables below.

In example pattern 1, the input module triggers the event task when input points 0...7 are in the On state.

Table 22 - Example Pattern 1

Output Tag	Bit Position															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event[*x*].Mask	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Event[*x*].Value	1	1	1	1	1	1	1	1	x	x	x	x	x	x	x	x

In example pattern 2, the input module triggers the event task when input points 0...7 are in the Off state.

Table 23 - Example Pattern 2

Output Tag	Bit Position															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event[*x*].Mask	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Event[*x*].Value	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x	x

In example pattern 3, the input module triggers the event task when input points 4, 6, 8, and 10 are in the On state.

Table 24 - Example Pattern 3

Output Tag	Bit Position															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event[*x*].Mask	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0
Event[*x*].Value	x	x	x	x	1	x	1	x	1	x	1	x	x	x	x	x

In example pattern 4, the input module triggers the event task when input points 0...3 are in the On state, and input points 12...15 are in the Off state.

Table 25 - Example Pattern 4

Output Tag	Bit Position															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event[*x*].Mask	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1
Event[*x*].Value	1	1	1	1	x	x	x	x	x	x	x	x	0	0	0	0

Once you define a pattern, you can disable an event from being triggered without clearing its output data by using the Event[*x*].Disarm output tag.

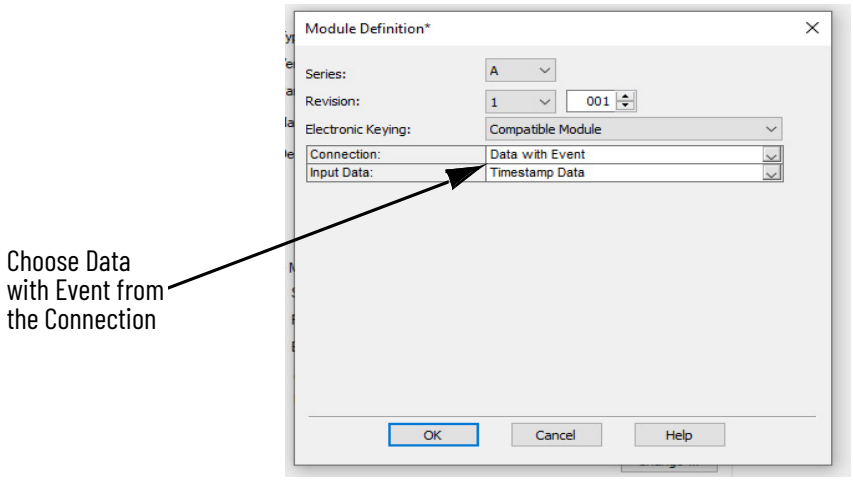
IMPORTANT All event masks and event values must be defined in the output tags of the module.

You can change output tag values in program logic while normal module operation continues or through the Logix Designer application tag editor. For more information about module tags, refer to Appendix A.

To use a dedicated connection to trigger event tasks, you must set the module's connection format to Data with Event, as shown in Figure 6. For more information about connection formats, see Module Definitions, Communication, or Connection Formats on page 15.

You can change the connection format at any time after creating a module except when you are online. The AOP applies all the configuration data that is required for the new connection format.

Figure 6 - Event Connection Format



When you choose the Data with Event connection format, the following occurs:

- A second connection dedicated to event data only is established with the module. This dedicated event connection reduces controller overhead when using inputs or input patterns to trigger event tasks in the controller.

A new set of event tags is created, as described in Table 49 on page 123.

Fault and Status Reporting between Input Modules and Controllers

ControlLogix fast input modules multicast fault and status data to any owner-controller or listening controller. All input modules maintain a Module Fault word, the highest level of fault reporting. Modules configured to use the Data with Event connection format also maintain an Event Fault word to report on the status of an event connection.

This lists the fault words and associated tags that you can examine in program logic to indicate when a fault or event has occurred for a fast input module.

Table 26 - Fault Words on Fast Input Modules

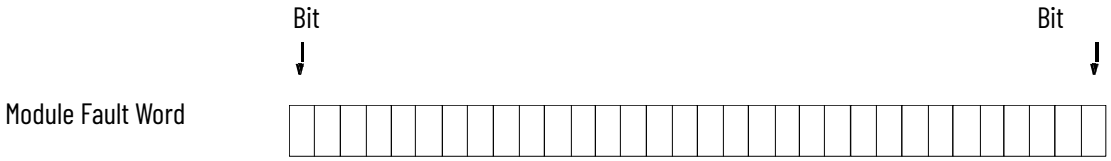
Word	Input Tag Name	Description
Module Fault	I:Fault	Provides fault summary reporting. Available on all digital input modules.
Event Fault	E:Fault	Provides fault summary reporting. Available on all digital input modules that use the Data with Event or Listen Only with Event connection format.

All words are 32 bit, although only the number of bits appropriate for each module's density are used. For example, the 1756-IB16IF module has a Module Fault word of 32 bits.

Table 27 - Bits Set in Module Fault Word

Condition	Bits Set
Communication fault	All 32 bits are set to 1, regardless of the module's density.

This illustration offers an overview of the fault reporting process on ControlLogix fast digital input modules.



A communication fault sets all 32 bits in the Module Fault word.

Per Point Timestamping and Change of State

With per point timestamping, each input point on the module records timestamps in CIP Sync™ format at these speeds:

- ± 4 µs for inputs < 4 kHz
- ± 13 µs for inputs > 4 kHz

IMPORTANT	Timestamping functions only in a CIP Sync system. If you are using change of state (COS) in a system using Coordinated System Time (CST), all timestamp values and the GrandMasterClockID input tag are set to zero. To set up CIP Sync time synchronization on the local controller, use the Date/Time tab in the controller properties. For more information about CIP Sync configuration, refer to the Integrated Architecture® and CIP Sync Configuration Application Technique, publication IA-AT003.

You can configure an input point to record a timestamp when the point transitions from On to Off, Off to On, or in both directions. By default, all points are configured to record a timestamp in both directions.

You can also configure the module to latch timestamps for an input point's last transition. When latching is enabled for a specific point, the point records a timestamp in the Pt[*x*].Timestamp.OffOn or Pt[*x*].Timestamp.OnOff input tags. The timestamp remains latched, and no new timestamps are recorded for the input point until the timestamp is acknowledged and reset. As a result, you can use the timestamp to determine the speed of a transition that is too fast to be detected by the program scan.

To acknowledge a transition and reset a timestamp latch, you set the corresponding bit in these output tags:

- Pt[*x*].NewDataOffOnAck—Acknowledges that the input point has transitioned to an On state and resets the timestamp latch.
- Pt[*x*].NewDataOnOffAck—Acknowledges that the input point has transitioned to an Off state and resets the timestamp latch.

The Pt[*x*].TimestampDropped input tag indicates whether a new timestamp has not been recorded because a previous timestamp was either latched or unacknowledged.

Once a timestamp latch is reset for an input point, a new timestamp may be recorded in the Pt[*x*].Timestamp.OffOn or Pt[*x*].Timestamp.OnOff input tags upon the next transition.

You can configure per point timestamping in three ways:

- Timestamping enabled without latching (default configuration)
- Timestamping enabled with latching
- Timestamping disabled

For more information on configuring this feature, see Per Point Timestamping and Change of State on page 51

Software Configurable Filter Times

To account for hard contact bounce, you can configure Off-to-On and On-to-Off input filter times of 0...30,000 µs in the Logix Designer application. These filters define how long an input transition must remain in the new state before the module considers the transition valid.

When an input transition occurs, the module timestamps the transition on the edge of the transition and stores timestamp data for the transition. The module then monitors the input for the duration of the filter time to verify that the input remains in the new state:

- If the input remains in the new state for a time period equal to the filter time, the input is recognized and recorded. The module sends timestamp data for the transition and the input's On/Off state to the controller.
- If the input changes state again before the duration of the filter time has elapsed, the module continues to scan that input for up to 10x the filter time. During this continued scan period, one of these events occurs:
  - In the time period that is 10x the duration of the filter time, the input returns to the transitioned state for the duration of the filter time. In this case, the module sends timestamp data from the initial transition to the controller.
  - In the time period that is 10x the duration of the filter time, the input never remains in the transitioned state for the duration of the filter time. In this case, the input is recognized, but the module does not consider the original transition valid and drops the timestamp.

EXAMPLE A 1756-IB16IF module is configured for a 2 ms filter time for Off-to-On transitions. In this example, three possible scenarios can result after an input transitions from Off to On:

- **Scenario 1**—The input turns On and remains On for the full 2 ms filter time. The module considers the transition valid and sends the data recorded at the transition to the controller (Figure 7 on page 52).
- **Scenario 2**—The input turns On but turns Off before the 2 ms filter time elapses. The module continues to monitor the input for 10x the duration of the filter time. Within that time period, the input turns On again and remains On for at least 2 ms. The module considers the transition valid and sends the data timestamped at the original transition to the controller (Figure 8 on page 53).
- **Scenario 3**—The input turns On but turns Off before the 2 ms filter time elapses. The module continues to monitor the input for 10x the duration of the filter time. Within that time period, the input never remains On for at least 2 ms. The module considers the transition invalid and drops the data timestamped at the original transition (Figure 9 on page 53).

Figure 7 - Valid Transition with No Bounce

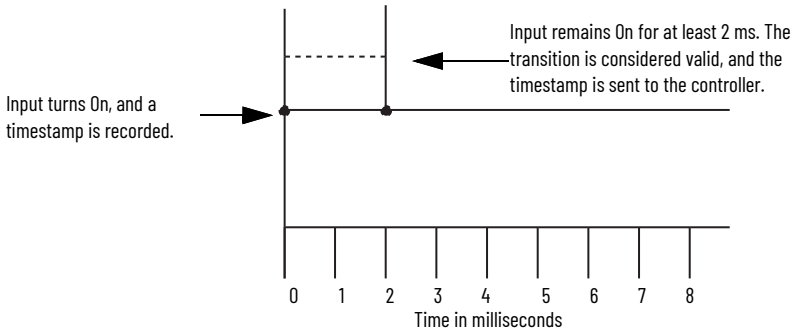


Figure 8 - Transition Valid with Bounce

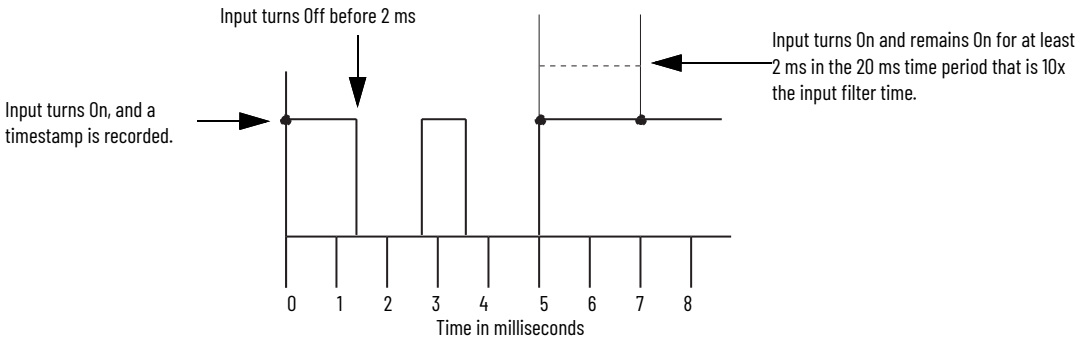
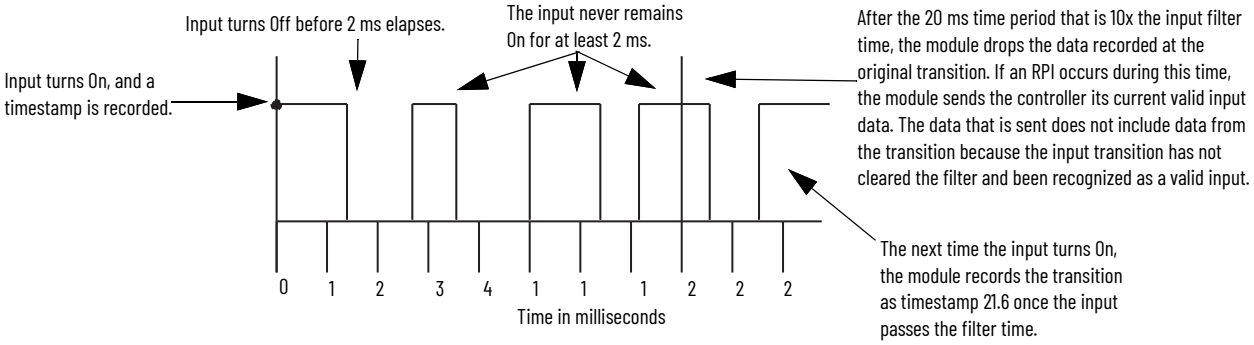


Figure 9 - Invalid Transition



For more information on configuring this feature, see Software Configurable Filter Times on page 52.

Fast Output Module Features

ControlLogix fast output modules can be used to drive a variety of output devices. Typical output devices compatible with ControlLogix outputs include these items:

- Solenoids
- Indicators

Follow these guidelines when designing a system:

- Make sure that the ControlLogix outputs can supply the necessary surge and continuous current for proper operation.
- Make sure that the surge and continuous current are not exceeded. Damage to the module could result.
- When sizing output loads, refer to the documentation supplied with the output device for the surge and continuous current needed to operate the device.
- Outputs on fast output modules can be directly wired to inputs on fast input modules.

Fault and Status Reporting between Output Modules and Controllers

ControlLogix fast digital output modules multicast fault and status data to any owner-controller or listening controller. Like input modules, output modules maintain a Module Fault word, the highest level of fault reporting. However, output modules use an additional word to indicate a fault condition.

Table 28 lists the fault word and the associated tag that you can examine in program logic to indicate when a fault has occurred for a fast output module.

Table 28 - Fault Words on Fast Output Modules

Word	Input Tag Name	Description
Module Fault	I:Fault	Provides fault summary reporting. Available on all digital output modules.

All words are 32 bit, although only the number of bits appropriate for each module's density are used. For example, the 1756-OB16IEF module has a Module Fault word of 32 bits. But, because the module is a 16-point module, only the first 16 bits (0...15) are used in the Module Fault word.

Bits set in the FuseBlown tag are logically entered into the Module Fault word. Depending on the module type, a bit set in the Module Fault word can mean multiple things, as indicated in the table.

Table 29 - Bits Set in Module Fault Word

Condition	Bit set
Communication fault	All 32 bits are set to 1, regardless of the module's density.
Fuse blown	Only the bit affected is set to 1.

This illustration provides an overview of the fault reporting process for digital output modules.

Bits set for the Fault input tag indicate I/O data may be incorrect due to a fault due to one of these conditions:

- FuseBlown = 1
- PWMCycleTime outside the valid range of 0.001...3600.0 seconds
- PWMOnTime outside the valid range of 0.0002...3600.0 seconds or 0...100 percent

PWMCycleTime ≤ PWMOnTime

Programmable Fault State Delay

You can define these states for an output point that is in Fault mode due to a communication failure:

- Duration—Defines the length of time that the output remains in the Fault mode state before transitioning to a final state of On or Off. By default, the output remains in the Fault mode state as long as the fault condition persists.
- Final state—Defines whether the output transitions to the On or Off state after the duration of the Fault mode state elapses. By default, the output transitions to the Off state.

EXAMPLE	You define a duration of 1 second and a final state of On for an output point. If a fault occurs at that point, the output remains in its Fault mode state (Off, On, or Hold) for 1 second before transitioning to the On state.

IMPORTANT	If a connection is re-established after an output point goes into Fault mode but before the duration time elapses, the settings you specify for the duration and final state no longer apply. For example, if you specify a 10 second duration and a final state of Off, and the fault ends in 3 seconds, the output point never transitions to the final state of Off.

For more information about defining a Fault mode state, refer to Configurable Point-level Output States on page 35.

For more information on configuring this feature, see page 70.

Pulse-width Modulation

Pulse-width modulation (PWM) provides precise, onboard control of an output's pulse train with no program variability. To configure a PWM signal, you define two real-time values for the pulse train in the module's output tags:

- Cycle time—The duration of a pulse cycle in seconds from 1 ms...1 hour.
- On time—The pulse width, or length of time that a pulse is active within a cycle from 200 µs...1 hour. You can define the On time in seconds or as 0...100 percent of the cycle time. You may want to use a steady-state On time, such as for gluing applications, or a dynamic On time that is defined by program logic.

If the cycle time or On time is outside the valid range for an output, the corresponding bit in the Fault input tag is set and the module responds as described.

Condition	Result
PWMCycleTime < minimum of 1 ms	PWMCycleTime = 1 ms
PWMCycleTime > maximum of 1 hour	PWMCycleTime = 1 hour
PWMCycleTime ≤ PWMOnTime	Output is always On
PWMOnTime < minimum of 200 µs	Output is always Off
PWMOnTime > maximum of 1 hour	PWMOnTime = 1 hour

If the cycle time or On time value changes while the output is generating a PWM signal, the changes are not applied until the next cycle of the PWM output. For instance, if the cycle time is erroneously set to an hour, a new cycle time does not go into effect until the last cycle of the

hour is complete. To trigger the PWM output to restart immediately with a new cycle time or On time, turn the output Off and then back On.

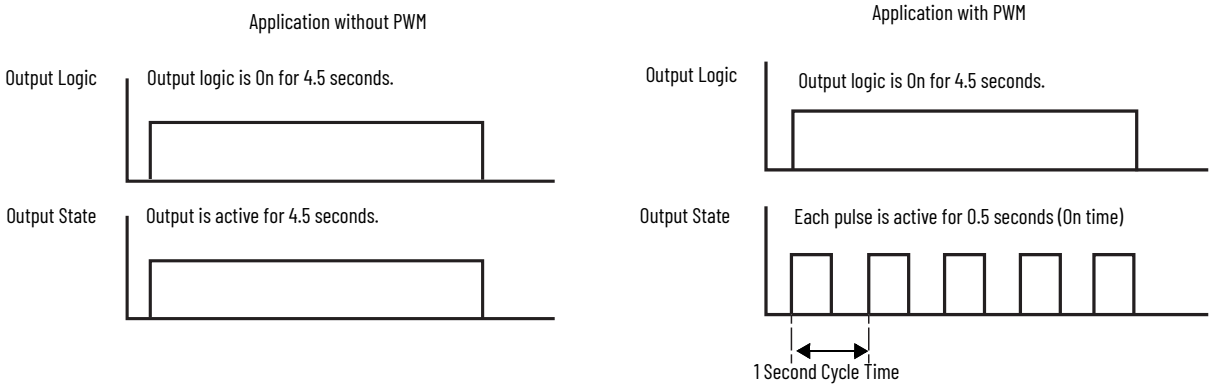
EXAMPLE	If PWMOnTime is 0.1 second and PWMCycleTime is 1.0 second and the PWMCycleTime is changed to 0.5 second just after the output turns On, the output stays on for 0.1 second and then turns Off for 0.9 seconds to complete the cycle before the new 0.5 second cycle begins.

IMPORTANT	Before PWM functions, you must enable PWM during configuration and define the PWM cycle time and On time in the PWMCycleTime and PWMOnTime output tags. If PWM is enabled (PWMEnable = 1) and the output is instructed to turn On (Data = 1), the output generates a PWM signal.

The figure below compares two applications in which the output is instructed to turn On for 4.5 seconds:

- In the application without PWM, a single pulse is generated. The pulse remains active for the same length of time the Data output tag is On (4.5 seconds).
- In the application with PWM, a series of pulses is generated. Each pulse is active for a configured On time of 0.5 seconds or 50% of the 1 second cycle time. The Data output tag is On for 4.5 seconds

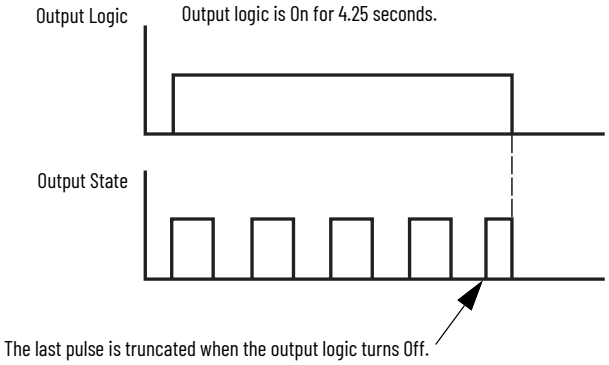
Figure 10 - PWM Timing



By default, PWM is configured to continue the output pulse train until the output logic turns Off. When the output logic turns Off, the output pulse train immediately stops.

EXAMPLE	In this figure, the output logic is On for 4.25 seconds and then turns Off in the middle of the last pulse. Even though the PWM On time is configured for 0.5 seconds, the last pulse is only active for 0.25 seconds because it is truncated when the output logic turns Off.

Figure 11 - PWM with Truncated Pulse



IMPORTANT	The Program and Fault mode states that are configured for the module override the PWM output state unless the point is configured to hold the last state while in Program or Fault mode. If a point is configured to hold the last state and the output is currently On, the output continues to use PWM until the PWM cycle limit is reached, the module transitions out of Program or Fault mode, or a final fault state goes into effect. For more information, see the following: • Configurable Point-level Output States on page 35 • Programmable Fault State Delay on page 55 • Cycle Limit and Execute All Cycles on page 57

You can modify the default PWM configuration for each of a module's 16 outputs for further control of an output's pulse train, as described in Configure Pulse-width Modulation on page 83.

Configuration options include the following:

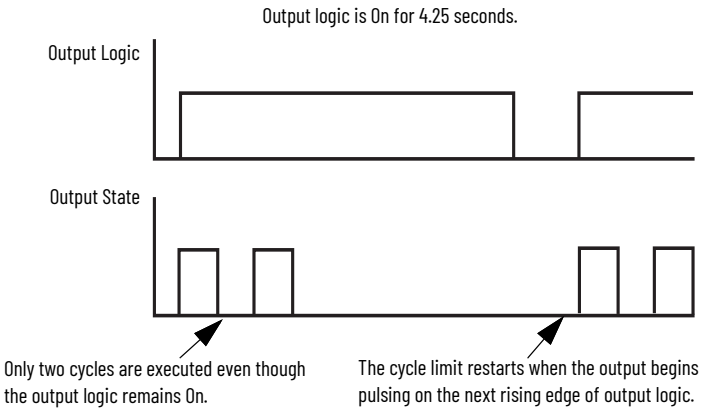
- Cycle Limit and Execute All Cycles on page 57
- Minimum On Time, Extend Cycle, and Stagger Output on page 59

Cycle Limit and Execute All Cycles

You can limit the number of pulse cycles that occur while an output is On. This feature is useful when you want to apply a level of output control when a process is stopped. For example, in a gluing application, you may want to apply four drops of glue to a product when the product is within a fixed window on a conveyor belt. By configuring a cycle limit of four, you can make sure that only 4 drops of glue are applied even if the conveyor belt stops with the product in the window. Controlling the process with the Cycle Limit feature eliminates the need to write complex logic to detect a stopped conveyor belt.

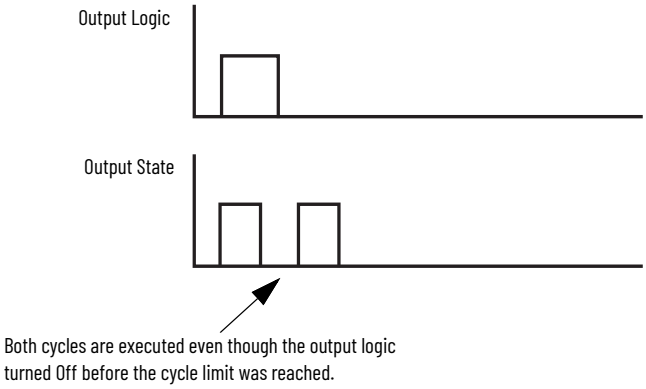
This figure shows a PWM pulse train that is configured with a cycle limit of 2. The PWMCycleLimitDone input tag indicates when the PWM cycle limit has been reached. The corresponding bit is reset upon the next rising edge of the output that restarts PWM.

Figure 12 - PWM Cycle Limit



If the output logic turns Off before the cycle limit is reached, you can configure the pulse cycles to continue until the cycle limit is reached by enabling the Execute All Cycles option. Figure 13 shows a cycle limit of 2 with the Execute All Cycles option enabled.

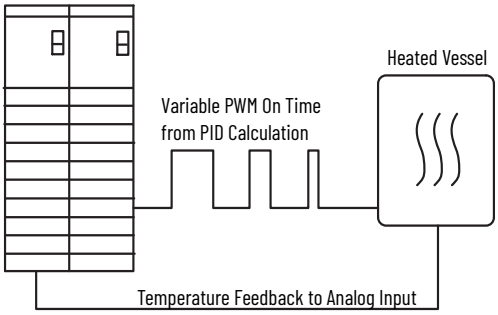
Figure 13 - PWM Cycle Limit with Execute All Cycles Option



Minimum On Time, Extend Cycle, and Stagger Output

The Minimum On Time, Extend Cycle, and Stagger Output configuration options are useful in time-proportional control applications, such as temperature control. In these applications, PID calculations compare the actual temperature to the desired setpoint and vary the PWM On time to a heating element in real time to regulate temperature as it approaches the setpoint, as shown in Figure 14.

Figure 14 - PWM for Time Proportioned Control



In this type of application, the Minimum On Time, Extend Cycle, and Stagger Output configuration options provide these benefits:

- **Minimum On Time and Extend Cycle**—Ensures that output devices that require a minimum time to turn On or that cannot react to a short pulse cycle can react with any given PWM On time calculation rather than not turning On.

  To ensure that the output device turns On when the calculated On time is less than the minimum On time, you must enable the Extend Cycle option. When Extend Cycle is enabled, the cycle time is extended proportionately up to 10 times the calculated On time while taking into account the minimum On time.

EXAMPLE	A solenoid requires at least 40 ms to turn On. During configuration, you enable the output for PWM, specify a minimum On time of 40 ms, and enable the Extend Cycle option. If the calculated On time in the PWMOnTime output tag drops below the 40 ms minimum On time, the module automatically extends the On time to 40 ms and proportionally extends the cycle time in the PWMCycleTime output tag. If the On time drops below 4 ms, the output turns Off because the cycle cannot extend beyond 10 times the 40 ms On time.

  If Extend Cycle is not enabled and the calculated On time is less than the minimum On time, the output of the module does not energize.

- **Stagger Output**—Mitigates the power surge from outputs that drive high-power loads by helping prevent the outputs from turning On simultaneously. Enabling the Stagger Output option for multiple output points addresses surges by staggering the leading edge of those outputs (Figure 15). When the Stagger Output feature is not enabled, output points turn On immediately at the start of the cycle (Figure 16).

  The stagger time for an output is calculated when the output turns On. If the On time and cycle times are changed by large amounts while the output is On, the stagger times may begin to overlap.

  If the cumulative On time of staggered outputs is less than the cycle, each new On transition is staggered to begin 50 µs after the prior staggered output turns Off.

Figure 15 - Outputs with Staggering

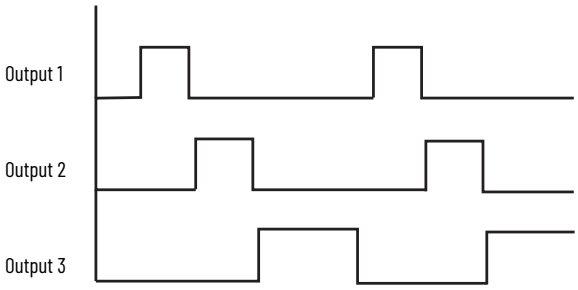
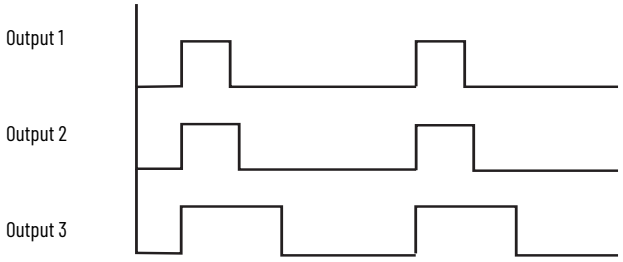


Figure 16 - Outputs without Staggering



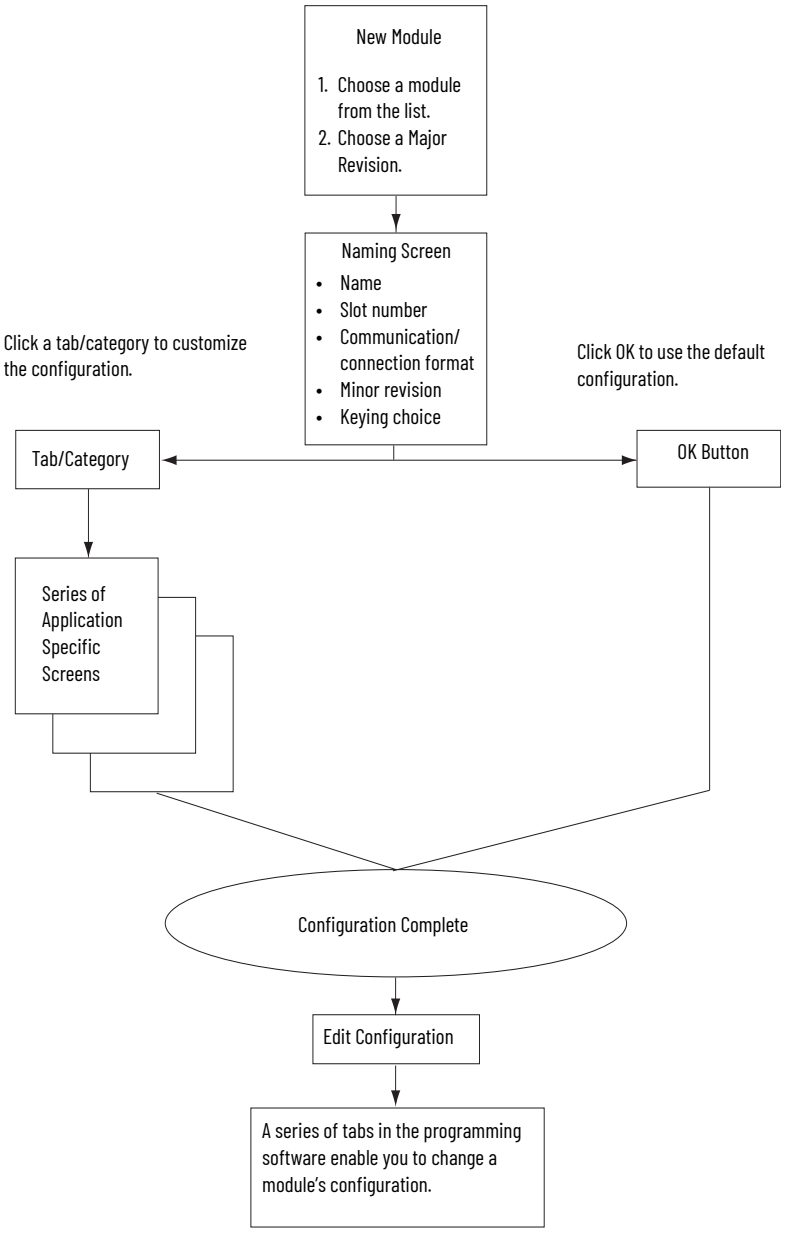
Configure Digital I/O Modules

You must configure your module upon installation. The module does not work until it has been configured. In most cases, you use the Studio 5000 Logix Designer® application to complete the configuration. The application uses default configurations, such as RPI and filter times, to get your I/O module to communicate with its owner-controller. You can edit the default configuration as needed from the Module Properties dialog box.

Configure ControlLogix Digital I/O Modules

Follow these steps to configure a ControlLogix® digital I/O module with the Logix Designer application.

1. Create a new module.
2. Accept or customize the default configuration for the module.
3. Edit the configuration as changes are needed.



Create a New Module

Before creating a module, make sure you complete these procedures in the Logix Designer application:

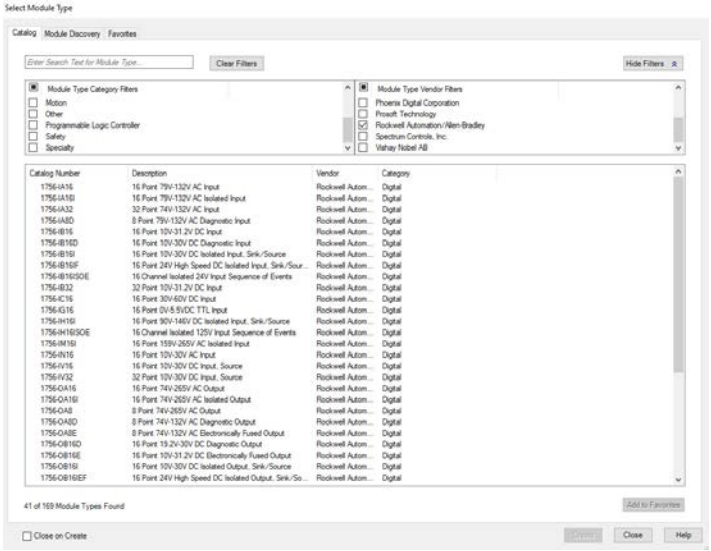
- Create a controller project.
- If you plan to add the I/O module to a remote chassis, add EtherNet/IP™ communication modules to both the local and remote chassis in the I/O Configuration tree.
  - For more information on ControlLogix EtherNet/IP modules, see EtherNet/IP Modules in the Logix 5000® Control Systems User Manual, publication ENET-UM001.

IMPORTANT The Studio 5000® environment lets you add I/O modules online. When using a previous version, you must be offline to create a module.

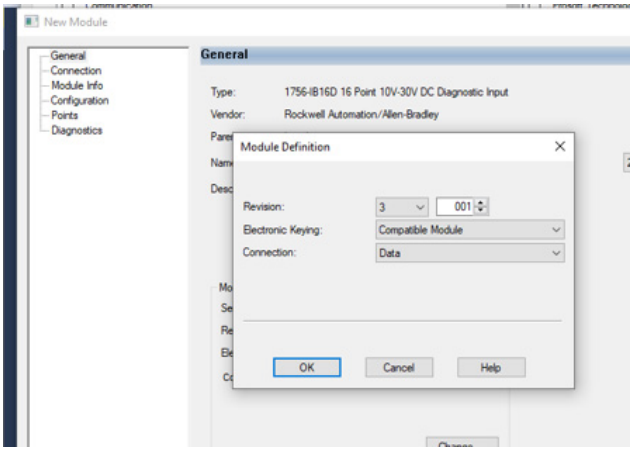
Follow these steps to add a local or remote I/O module.

1. To add an I/O module to a local chassis, right-click the I/O Configuration folder and choose New Module.

   To add an I/O module to a remote chassis, right-click the remote communication module, and choose New Module.
2. On the Select Module Type dialog box, select the digital module to create, and then click Create.



3. On the Select Major Revision dialog box, click OK to accept the default major revision.

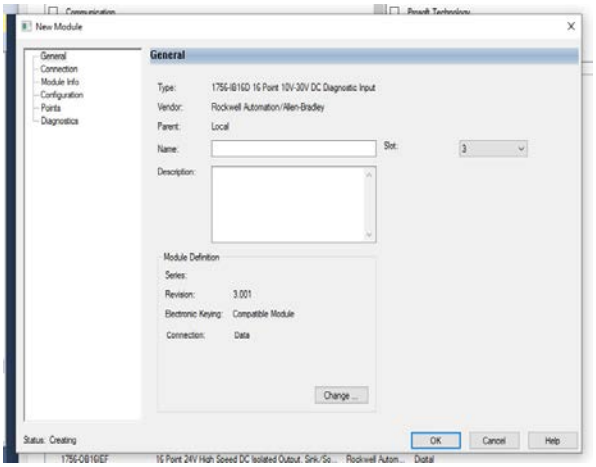


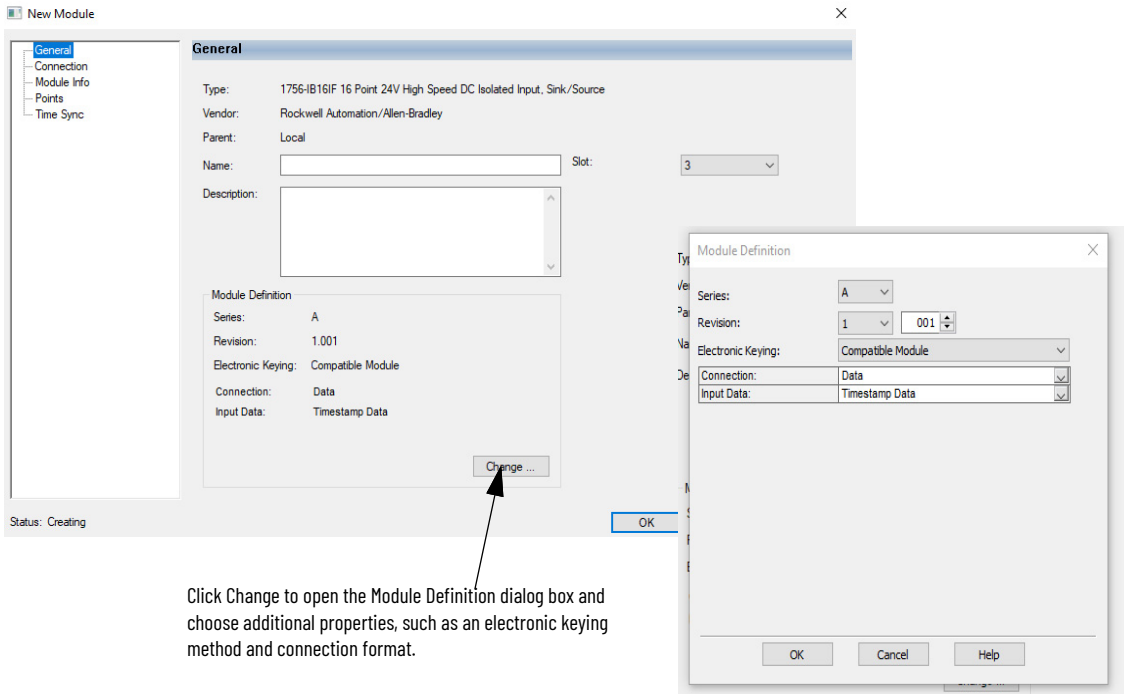
4. On the New Module dialog box, complete the fields and click OK.

For information about how to choose an electronic keying method, see Electronic Keying on page 27.

For information about how to choose a communication format or connection type, see Communication Formats, Connection Formats, and Module Definitions on page 64.

The fields on the New Module dialog box vary depending on the catalog number of your I/O module.





Click Change to open the Module Definition dialog box and choose additional properties, such as an electronic keying method and connection format.

Communication Formats, Connection Formats, and Module Definitions

These are the communication formats and module definitions for Input and Output modules.

Table 30 - Communication Formats — Input Module

Communication Format	Data Return	Module
Input Data	Module returns only general fault and input data.	1756-IA16, 1756-IA16K, 1756-IA16I, 1756-IA16IK, 1756-IA32, 1756-IA32K, 1756-IB16I, 1756-IB16IK, 1756-IB16, 1756-IB16K, 1756-IB16XT, 1756-IB32, 1756-IB32K, 1756-IB32XT, 1756-IC16, 1756-IG16, 1756-IG16K, 1756-IH16I, 1756-IH16IK, 1756-IM16I, 1756-IM16IK, 1756-IN16, 1756-IN16K, 1756-IV16, 1756-IV16K, 1756-IV32, 1756-IV32K
CST Timestamped Input Data	Module returns input data with the value of the system clock from its local chassis when the input data changes.	
Rack Optimization	The Ethernet bridge module collects all digital input words in the remote chassis and sends them to the controller as a single rack image. This connection type limits the status and diagnostic information available.	
Listen Only—Input Data	These formats have the same definition as the similarly named options above except that they are Listen-only connections.	
Listen Only—CST Timestamped Input Data		
Listen Only—Rack Optimization		
Full Diagnostic Input Data	Module returns input data, the value of the system clock from its local chassis when the input data changes, and diagnostic data.	1756-IA8D, 1756-IB16D
Listen Only—Full Diagnostic Input Data	This format has the same definition as Full diagnostic input data except that it is a Listen-only connection.	1756-IA8D, 1756-IB16D

Table 31 - Module Definitions — Input Module

Connection	Input Data	Data Return	Module
Data	Timestamp Data	Module returns input data with COS timestamps in CIP Sync® system time. To configure per point timestamping, see page 80.	1756-IB16IF
	Data	Module returns input data without COS timestamps, useful when the highest possible throughput is required.	
Data with Event	Timestamp Data	Results in two input connections: Connection to return input data with COS timestamps in CIP Sync system time. Connection to initiate event tasks. See Dedicated Connection for Event Tasks on page 48.	
Listen Only	Timestamp Data	These formats have the same definition as those above except that they are Listen-only connections.	
	Data		
Listen Only with Event	Timestamp Data		

Table 32 - Communication Formats — Output Module

Communication Format	Data Return	Module	Communication Format
Output Data	The owner-controller sends the module only output data.	1756-OA8, 1756-OA16I, 1756-OB8, 1756-OB16I, 1756-OB16IS[1], 1756-OB32, 1756-OC8, 1756-OG16, 1756-OH8I, 1756-ON8, 1756-OW16I, 1756-OX8I	Output Data
Scheduled Output Data	The owner-controller sends the module output data and a CST timestamp value		Scheduled Output Data
Rack Optimization	The owner-controller sends all digital output words to the remote chassis as a single rack image.		Rack Optimization
Listen Only—Output Data	These formats have the same definition as those above except that they are Listen-only connections.		Listen Only—Output Data
Listen Only—Rack Optimization			Listen Only—Rack Optimization
CST Timestamped Fuse Data—Output Data	The owner-controller sends the module only output data. The module returns Fuse Blown status with the value of the system clock (from its local chassis) when the fuse is either blown or reset.	1756-OA16, 1756-OA8E, 1756-OB16E, 1756-OB8EI, 1756-OV16E, 1756-OV32E	CST Timestamped Fuse Data—Output Data
CST Timestamped Fuse Data—Scheduled Output Data	The owner-controller sends the module output data and a CST timestamp value. The module returns Fuse Blown status with the value of the system clock (from its local chassis) when the fuse is either blown or reset.		CST Timestamped Fuse Data—Scheduled Output Data
Listen Only - CST Timestamped Fuse Data—Output Data	This choice has the same definition as CST timestamped fuse data - output data except that it is a Listen-only connection.		Listen Only - CST Timestamped Fuse Data—Output Data
Full Diagnostics—Output Data	The owner-controller sends the module only output data. The module returns diagnostic data and a timestamp of diagnostics.	1756-OA8D, 1756-OB16D	Full Diagnostics—Output Data
Full Diagnostics—Scheduled Output Data	The owner-controller sends the module output data and a CST timestamp value. The module returns diagnostic data and a timestamp of diagnostics.		Full Diagnostics—Scheduled Output Data
Listen Only—Full Diagnostics—Output Data	This format has the same definition as Full diagnostics - output data except that it is a Listen-only connection.		Listen Only—Full Diagnostics—Output Data

(1) The 1756-OB16IS module does not support the Rack optimization, Listen only—rack optimization and Scheduled output data communication formats.

Table 33 - Module Definitions — Output Module

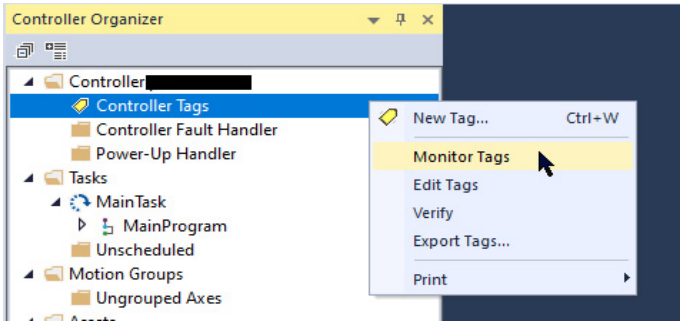
Connection	Output Data	Data Return	Module
Data	Data	The owner-controller sends the module only output data.	1756-OB16IEF, 1756-OB16IEFS
	Scheduled Per Module	The owner-controller sends the module output data and a CIP Sync timestamp value.	1756-OB16IEF
	Scheduled Per Point	The owner-controller sends output data and a CIP Sync timestamp value to points configured for scheduling.	1756-OB16IEFS
Listen Only	None	Establishes a Listen-only connection with no data.	1756-OB16IEF, 1756-OB16IEFS
Peer Input with Data	Data with Peer	Establishes a Listen-only connection to input peer modules. See the Peer Ownership Application Technique, publication 1756-AT016.	1756-OB16IEF

View and Change Module Tags

When you create a module, a set of tags is created by the ControlLogix system that can be viewed in the Tag Editor of the Logix Designer application. Each configured feature on your module has a unique tag that can be used in the controller's program logic.

Follow these steps to access a module's tags.

1. On the Controller Organizer, expand the Controller folder, right-click Controller Tags, and choose Monitor Tags.



   The Controller Tags dialog box appears with data.

2. Expand the slot number of the module for which to view information.

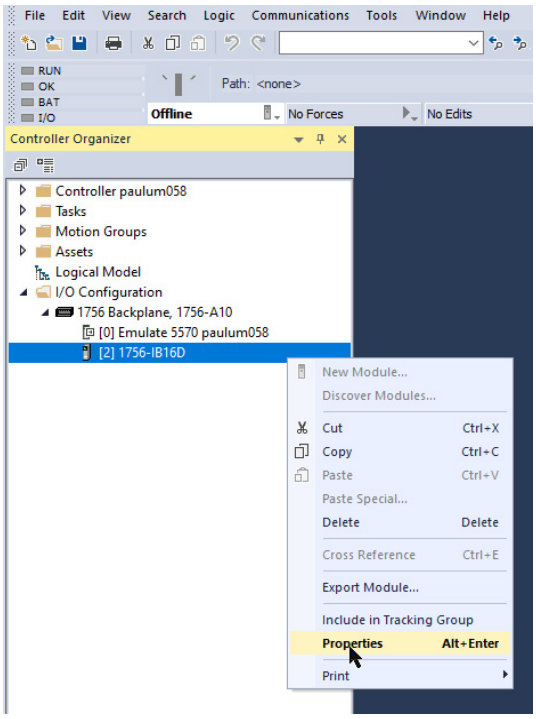
   See Appendix A for details on viewing and changing a module's configuration tags.

Edit the Configuration

After you add a module to the I/O configuration in the Logix Designer application, you can review and edit the configuration. You can also download the data to the controller while online. This is called dynamic reconfiguration.

Follow these steps to edit a module's configuration.

1. On the Controller Organizer, right-click an I/O module and choose Properties.



2. On the Module Properties dialog box, click the tab/category corresponding to the feature to modify, and then click OK:
   - To configure connection properties between the module and the controller, see page 67.
   - To configure features common to all modules, see Chapter 1.
   - To configure features specific to diagnostic modules, see Chapter 2.
   - To configure features specific to fast modules, see Chapter 3.

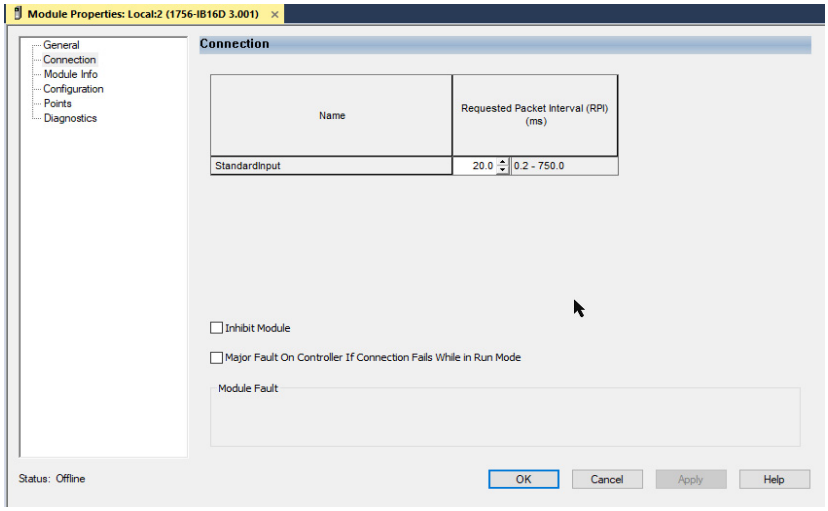
Connection Properties

Connection properties define controller-to-module behavior. When defining connection properties, you can do the following:

- Select a requested packet interval (RPI) to set a defined, maximum period of time when data is transferred to the owner-controller
- Choose to inhibit the module
- Configure the controller so that a loss of connection to this module causes a major fault
- View information about the condition of the connection between the module and the controller

Follow these steps to configure connection properties.

1. On the Module Properties dialog box, click the Connection tab/category.

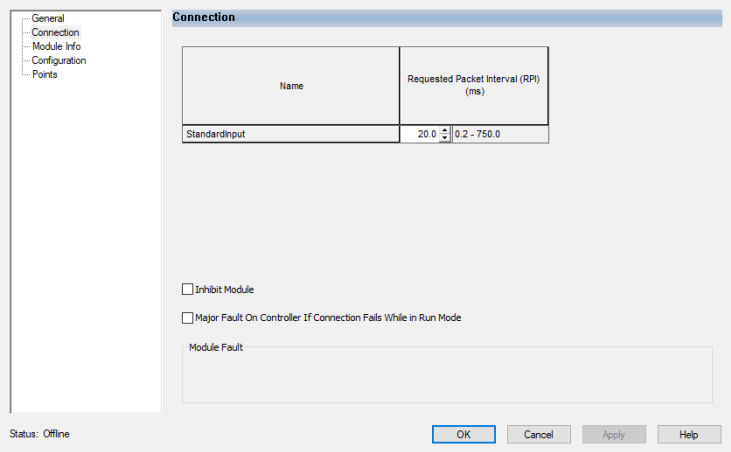


2. Complete the fields as described and click OK.

Field	Description
Requested Packet Interval (RPI)	Enter an RPI value or use the default. See RPI for more information.
Inhibit module	Check the box to help prevent communication between the owner-controller and the module. This option enables maintenance of the module without faults being reported to the controller. See Module Inhibiting for more information.
Major fault On Controller If Connection Fails While in Run Mode	Check the box to create a major fault if there is a connection failure with the module while in Run mode. For important information on this checkbox, see the Logix 5000 Controllers Information and Status Programming Manual, publication 1756-PM015.
Module Fault	The fault box is empty if you are offline. The type of connection fault appears in the text box if a fault occurs when the module is online.

Configure Input Modules

Follow these steps to set an RPI value.

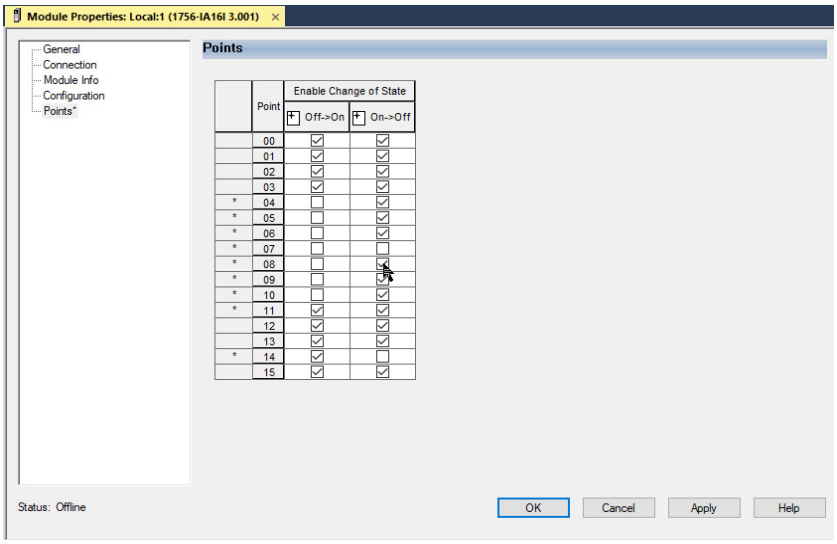


1. On the Module Properties dialog box, click the Connection tab.
2. In the Requested Packet Interval (RPI) field, enter an RPI value.
3. Click OK.

Enable COS

Follow these steps to enable or disable COS.

1. On the Module Properties dialog box, click the Points tab.

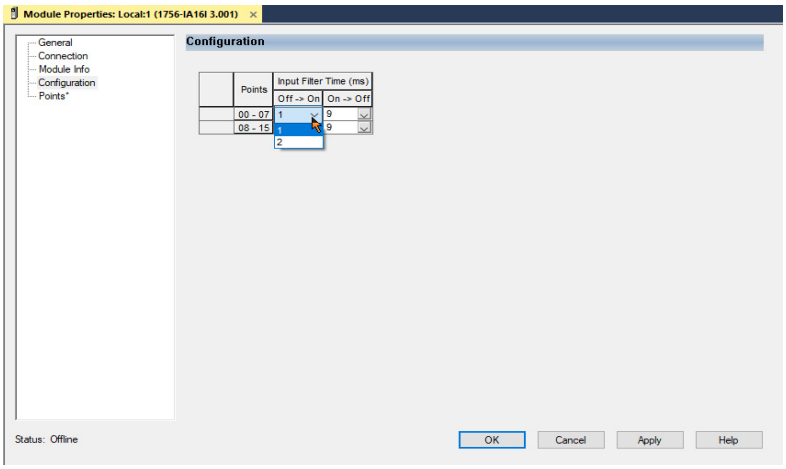


2. Do one of the following in the Enable Change of State columns:
   - To enable COS for a point, check the corresponding Off to On or On to Off checkbox.
   - To disable COS for a point, clear the corresponding Off to On or On to Off checkbox.
3. Click OK.

Configure Input Filter Times

Follow these steps to configure the input filter time.

1. On the right side of the Configuration tab, choose the input filter times from the Off ? On and On ? Off dropdown menus.

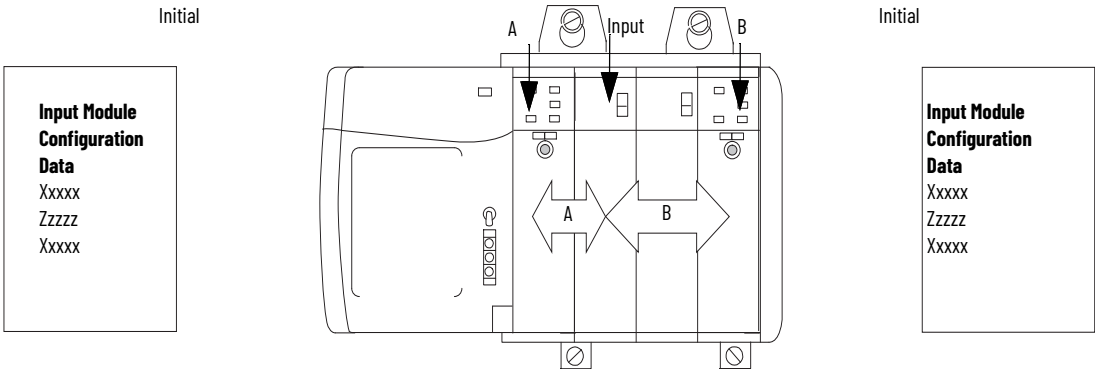


2. Click OK.

Configure Input Module with Multiple Owners

Be careful when changing the configuration data of an input module in a multiple owner scenario. If the configuration data is changed in owner A and sent to the module, that data is accepted as the new configuration for the module. Owner B continues to listen unaware that any changes have been made in the behavior of the input module, as illustrated.

Figure 17 - Module Configuration Changes with Multiple Owners



IMPORTANT A message in the Logix Designer application alerts you to the possibility of a multiple owner-controller situation and lets you inhibit the connection before changing the module configuration. We recommend inhibiting the connection when changing the configuration of a module with multiple owners.

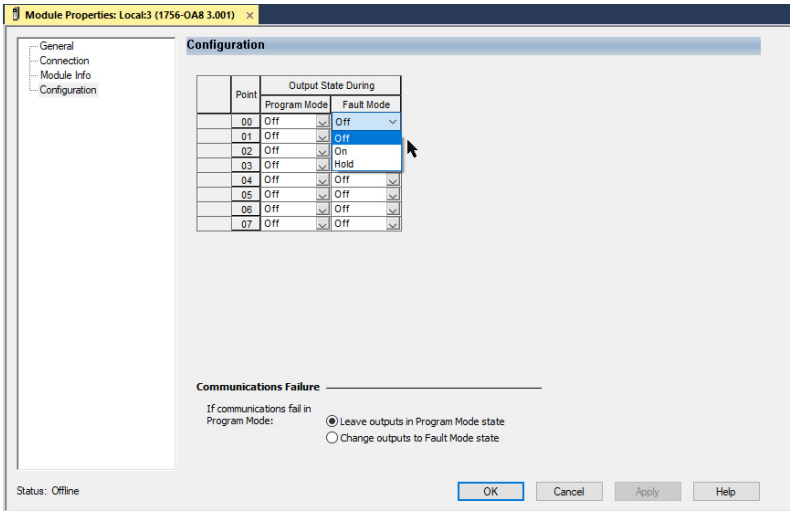
To help prevent other owner-controllers from receiving potentially erroneous data, use these steps when changing the configuration of a module in a multiple owner scenario while online.

1. For each owner-controller, inhibit the connection to the module either on the Connection tab or the message dialog box regarding the multiple owner condition.
2. Make the appropriate configuration data changes in the software. For more information about using the Logix Designer application to change the configuration, see Chapter 4.
3. Repeat step 1 and step 2 for all owner-controllers, making the same changes in each.
4. Clear the Inhibit checkbox in each owner-controller configuration.

Configure Output Modules

Follow these steps to configure an output state.

1. On the Module Properties dialog box, click the Configuration tab.

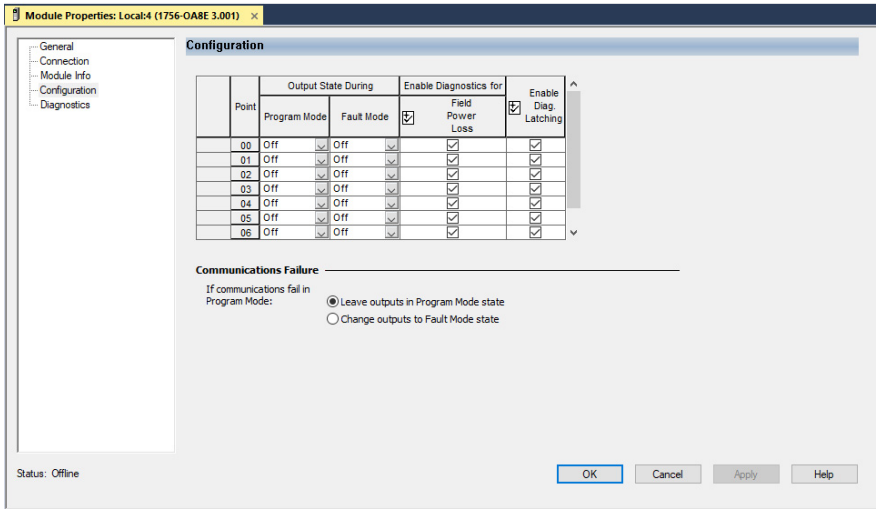


2. From the Program Mode dropdown menu, choose whether the output state of the module is On or Off during Program mode:
   - On
   - Off
   - Hold (Retain current output state)
3. From the Fault Mode dropdown menu, choose the output state of the module during Fault mode:
   - On
   - Off
   - Hold (Retain current output state)
4. Click OK.

Enable or Disable Field Power Loss (1756-OA8E only)

Follow these steps to enable or disable diagnostics for field power loss.

1. On the Module Properties dialog box, click the Configuration tab.

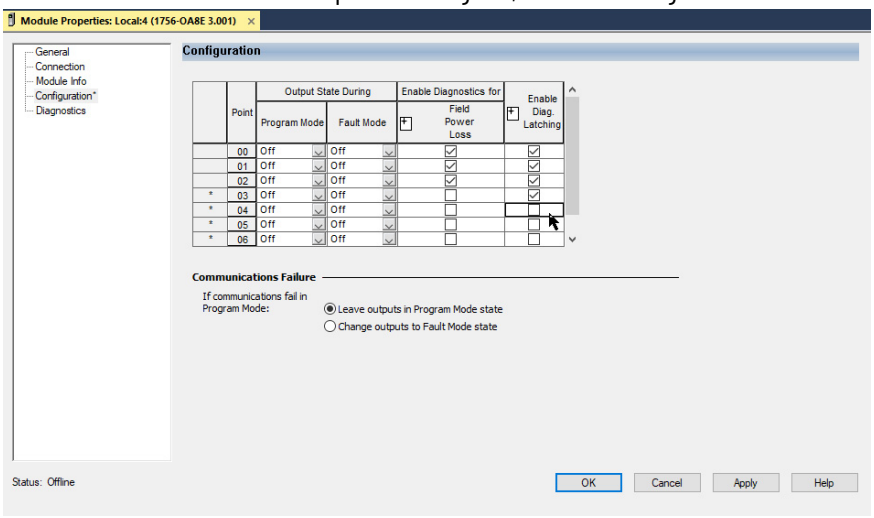


2. In the Enable Diagnostics for Field Power Loss column:
   - To enable detection for a specific point, select the corresponding checkbox.
   - To disable detection for a specific point, clear the corresponding checkbox.
3. Click OK.

Enable or Disable Diagnostic Latch of Information (1756-OA8E only)

Follow these steps to enable diagnostic latch of information.

1. On the Module Properties dialog box, click the Configuration tab.



2. Do one of the following in Enable Diag. Latching column:
   - To enable diagnostic latching for a specific point, check the corresponding checkbox.
   - To disable diagnostic latching for a specific point, clear the corresponding checkbox.
3. Click OK.

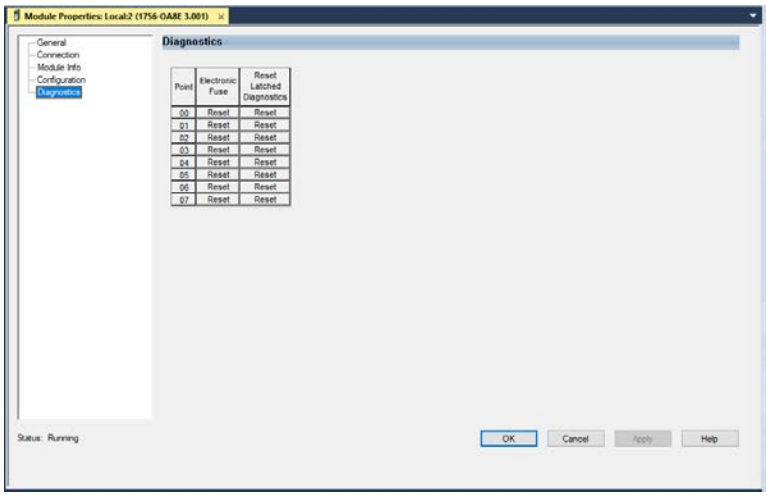
Reset Latched Fault (OA8E only)

Latched diagnostic features can be cleared by using these methods:

- Reset Diagnostic Latch service
- Software reset during online monitoring
- Cycling power to the module

Follow these steps to a reset a latched fault through the Logix Designer application during online monitoring.

1. On the Modules Properties screen, click the Diagnostics tab.

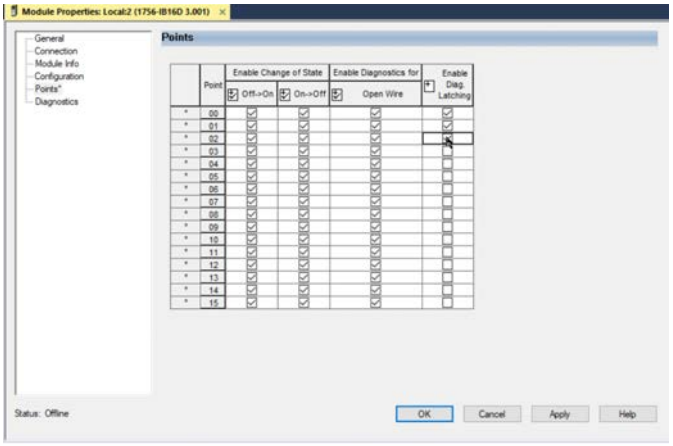


2. In the Reset Latched Diagnostics column, click Reset next to the output point for which to reset a latched fault.
3. Click OK.

Configure Diagnostic Modules

Follow these steps to enable or disable diagnostic latching.

1. On the Module Properties dialog box, click the Points tab.



2. Do one of the following in the Enable Diag. Latching column:
   - To enable diagnostic latching for a specific point, check the corresponding checkbox.
   - To disable diagnostic latching for a specific point, clear the corresponding checkbox.
3. Click OK.

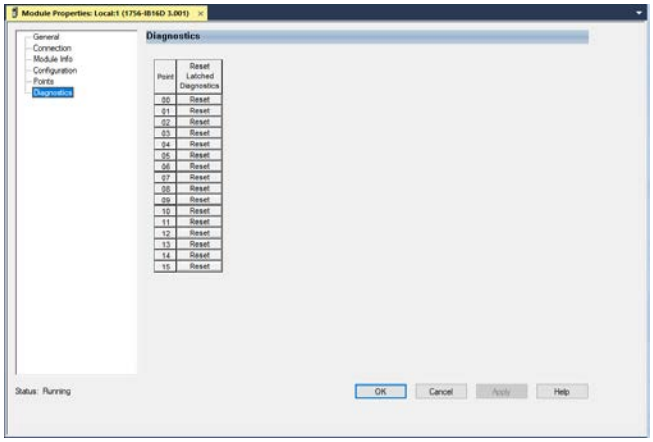
Latched diagnostic features can be cleared by using these methods:

- Reset Diagnostic Latch service
- Software reset during online monitoring
- Cycling power to the module

Reset Latched Fault

Follow these steps to reset a latched fault through the Logix Designer application during online monitoring.

1. On the Modules Properties screen, click the Diagnostics tab.



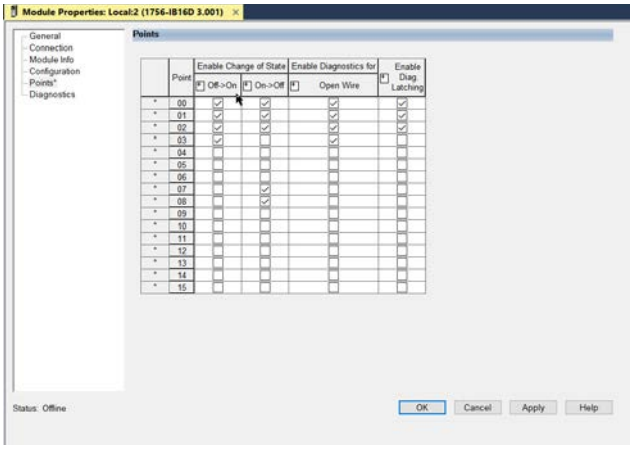
2. Click Reset next to the point for which to reset a latched fault.

Click OK.

Configure Diagnostic Input Modules

Follow these steps to enable COS for diagnostic input modules.

1. On the Module Properties dialog box, click the Points tab.

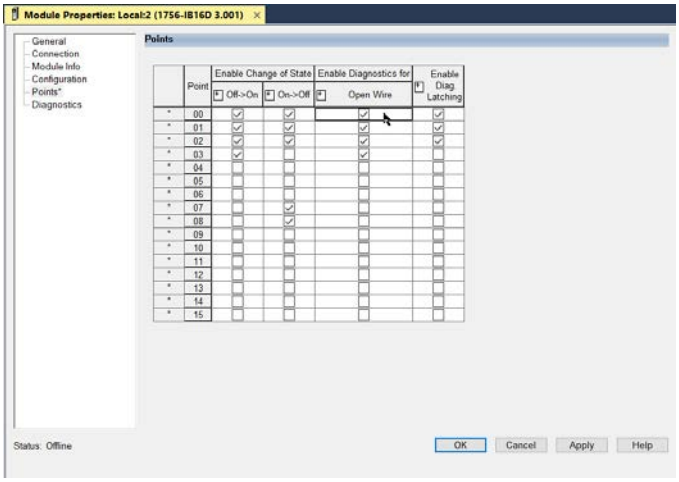


2. Do the following in the Enable Change of State column:
   - To enable the input module to send new data to the owner-controller at the RPI, on input COS if it is enabled, and if a diagnostic fault occurs, check the corresponding Off ? On or On ?Off checkbox for a point.
   - To disable the feature, clear the corresponding checkbox for a point.
   - Real-time data is not sent when a diagnostic fault occurs but is still sent at the specified RPI or on input COS if it is enabled.
3. Click OK.

Configure Open Wire Detection

Follow these steps to configure open wire detection.

1. On the Module Properties dialog box, click the Points tab.

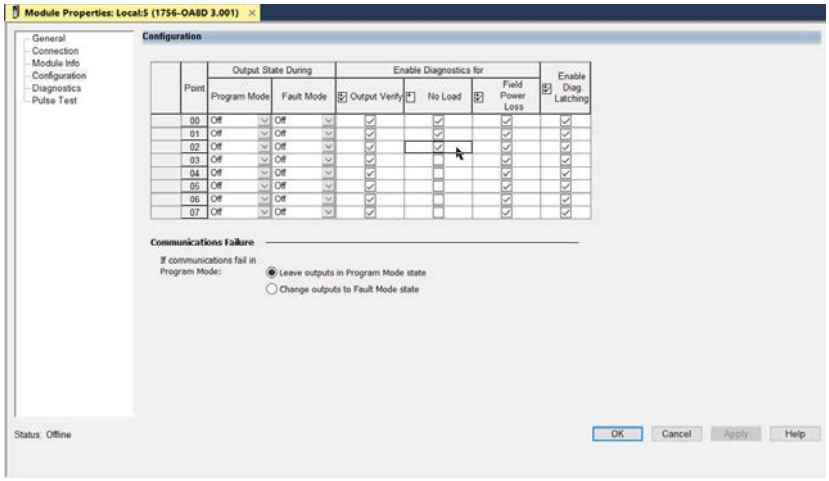


2. Do one of the following in the Open Wire (middle) column:
   - To enable the open wire detection for a specific point, check the corresponding checkbox.
   - To disable open wire detection for a specific point, clear the corresponding checkbox.
3. Click OK.

Configure Diagnostic Output Modules

Follow these steps to enable no load detection.

1. On the Module Properties dialog box, click the Configuration tab.



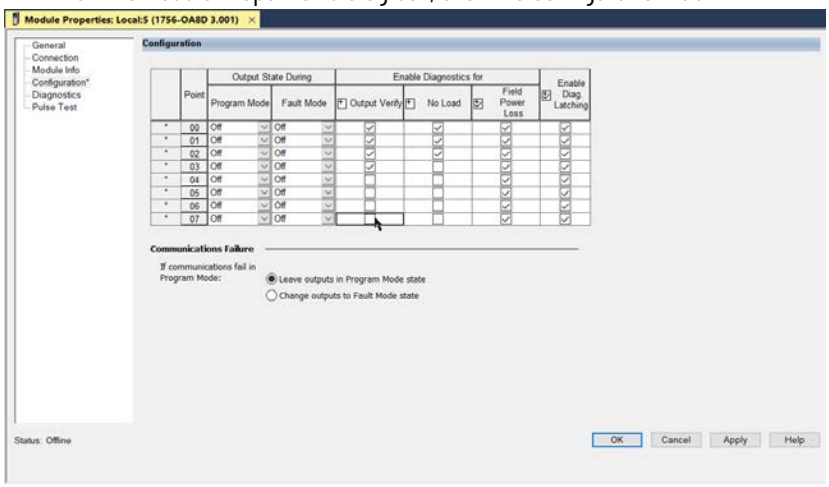
2. Do one of the following in the No Load column:
   - To enable the feature for a specific point, check the corresponding checkbox.
   - To disable the feature for a specific point, clear the corresponding checkbox.
3. Click OK.

This feature has a corresponding tag that can be examined in the user program in the event of a fault. For more information on these tags, see Appendix A.

Enable Field-side Output Verification

Follow these steps to enable the field-side output verification.

1. On the Module Properties dialog box, click the Configuration tab.



2. Do one of the following in the Output Verify column:
   - To enable the feature for a specific point, check the corresponding checkbox.
   - To disable the feature for a specific point, clear the corresponding checkbox.
3. Click OK.

About Redundant Owners

Redundant ownership lets a single controller use redundant network paths to communicate with a single output or lets two separate controllers coordinate to control the output.

To enable Redundant Ownership mode in the output module, each connection to the output module is via a redundant owner module definition. In the module definition, you select between Redundant Output Owner A and Redundant Output Owner B. Each pair of connections must have an A and a B requested—that is, if the first is A, the second must be B.

If the second connection does not pair with the original connection, it is rejected with a general status = 0x01 and extended status = 0x031D. All other aspects of configuration between the two connections must be identical.

After the connection is established, a redundant owner uses the Claim Owner Output (COO) tag to indicate that it is ready for ownership of the outputs. The Ready Owner Output (ROO) tag indicates that an owner is ready to take ownership if needed. The ROO is implemented as a single bit, OwnerReady, as this implementation is intended for only two controllers.

When the OwnerClaim bit is set, it indicates that the controller wants to claim ownership of the redundant connection and have its outputs actively used. If both redundant owners have COO set, the last originator application that transitioned its COO flag from cleared to set is the owner.

Only a received 0-to-1 transition, and not simply the receipt of a new connection, is considered such a transition for ownership.

If neither redundant owner has OwnerClaim set, then the controller that has the OwnerReady bit set becomes the owner. If neither controller has OwnerClaim set and both have OwnerReady set, owner A becomes the owner. If both controllers have OwnerClaim=0 and OwnerReady=0, then the outputs go to IDLE (Program mode).

Finally, the Input data adds status fields that indicate if the output module has an active owner (OwnerActive) and for which controller, A or B (OwnerID). For each of owner A and B, three status fields indicate if the controller is connected (OwnerAConnected/OwnerBConnected) and echo the output values received for each owner via OwnerAClaim/OwnerBClaim and OwnerAReady/OwnerBReady, respectively.

Requirements

You must use output modules that support Redundant Owner connections:

- 1756-OB16IEF output module Peer Ownership and Scheduled Output are **not** supported
- Any Allen-Bradley 1756 input module that supports multiple owners

Redundant owner supports these ControlLogix 1756 Ethernet modules:

- 1756-EN2T
- 1756-EN2TP
- 1756-EN2TR
- 1756-EN2F
- 1756-EN4TR

Restrictions

The redundant owner solution uses two connections for every I/O module–one for each of the redundant connections. Each connection is shown in the Studio 5000 Logix Designer® I/O Configuration–two entries for each I/O module.

- The two I/O module configurations must match.
- Two connections are used for each I/O module.
- An output module's ideal RPI is 25 ms.
- This speed is for the fastest response to an event. Any output module RPI can be used, but may have increased response time to a fault.
- An input module's ideal RPI is 25 ms, though any input module RPI can be used.
- Direct I/O connections must be used.
- Rack-optimized connections are not supported.

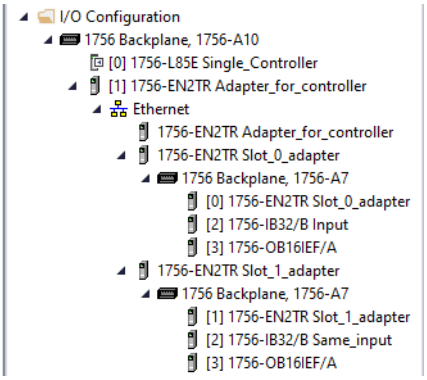
Also see Redundant Owner Configuration Tags on page 143.

Redundant Owner can work in single-controller and multiple-controller applications, with or without redundancy.

Your application determines which controller is the Claiming Owner and which is the Ready Owner. The relationship is similar to a primary and secondary relationship.

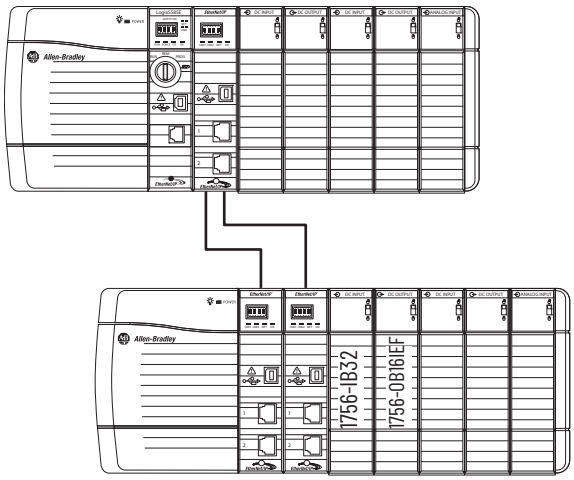
Single Controller Behavior

A single controller case is the simpler one as both connections are owned by the same controller. Thus there is never a case where one connection is in Run mode and the other connection is in Program mode, so no need to worry about synchronizing.



This can also be achieved by using two communication modules in the Controller chassis.

Figure 18 - Single Controller



32763-M

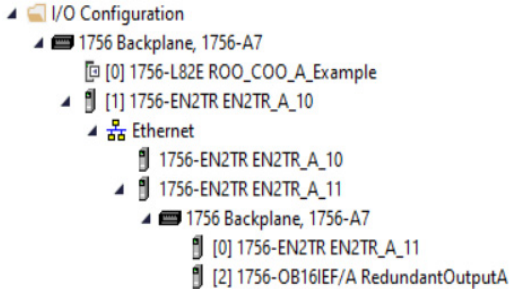
1. Initialize I/O tags.
2. Set Claim in one connection.
3. Set Ready in the other connection.
4. Monitor which connection is the owner and update tags accordingly (Non Owner before Owner to make sure that they're always in sync).

That single controller behavior should result in the following:

1. Output is not owned until the Claim connection is made.
2. Any disruption in the Claim connection causes the I/O module to switch to the Ready path.
3. When the Claim connection recovers from the disruption, the I/O module switches back to Claim.

Multiple Controller Behavior

For multiple controllers, the applications synchronize the behavior between the controllers. Note Ethernet modules A and B, and RedundantOutputA and RedundantOutputB.



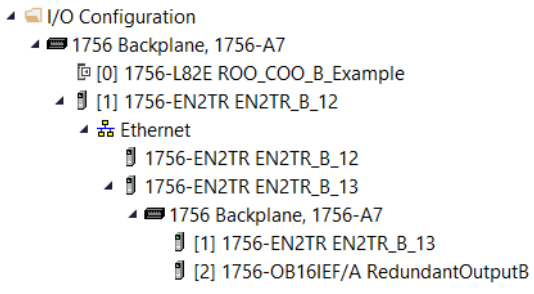
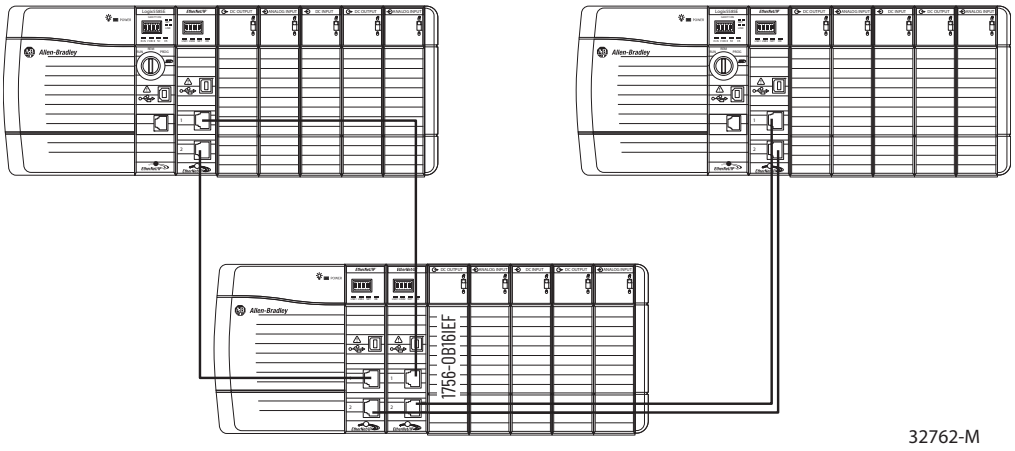


Figure 19 - Multiple Controller



IMPORTANT	If you use ControlLogix Redundancy as the multiple controller system, then you do not have to manage the dual controllers. If you use any other method, then you must manage the primary and secondary controllers yourself. This application does not manage the controllers, just the I/O.

You can use Produced/Consumed tags for synchronization; however, the Redundant Owner Input tags provide the majority of information needed for synchronization.

- After both controllers decide it is safe, the primary controller sets Claim.
- After the secondary controller sees that the primary controller has taken ownership, the secondary controller sets Ready.
- The secondary controller monitors the I/O and the other controller to determine the current owner.
- If the secondary controller becomes the owner, it can set its Claim bit to take or hold ownership, or can just maintain Ready.
- Once the primary controller comes back and is in Run mode, that controller toggles its Claim bit, and the I/O switches back to that controller.
  - A "S:FS" XIC should be used to disable Claim/Ready bits until the controller has entered Run mode and can evaluate if it should make a Claim or Ready transition.
  - Failure to do this could lead to a 'claim' happening before the controller is back in Run mode. Thus, the output would transition briefly to its Program Mode Safe State before entering Run mode rather than making a smooth transition from secondary controller back to primary controller.
- When the secondary controller sees that the primary controller has retaken ownership, it clears its Claim bit and returns to Ready.
- Monitor for Connection Loss on controller. Add GSV to monitor connection status and clear Claim and Ready flags on Connection Loss to help prevent undesired behavior when connection is restored.
- Monitor for Major Fault on controller. Optionally, add Fault Routine to clear Claim and Ready owner flags if Major Fault is not to be cleared in faulted controller to allow secondary controller to take immediate control.

Response Times for Output Modules

Response time to a change in ownership is from the time the event takes place until the time that the output modules use the connection data from the redundant connection.

Digital output response to a change in ownership in less than 250 ms. The average time is 220 ms. A faster RPI does not increase the response time. We recommend a digital output RPI of 25 ms.

These recommendations are for response performance:

- Faster RPIs have a longer response time.
- Slower RPIs can have a much longer response time.
- RPIs should be 4 x RPI = 200 ms, 8 x RPI = 200 ms, or 16 x RPI = 200 ms, so 25 is the recommended RPI.
- If the prior RPI criterion is not met, the CIP™ connection timeout delay minimum will be 200 ms + 1 RPI. If the 4/8/16 x RPI does not equal 200 ms (or 100 ms), then the response will be longer.
- For non-redundant ControlLogix applications, the CIP connection timeout delay minimum is 100 ms.
- Slower RPIs greatly limit the effect of the response time on the application.

IMPORTANT This information pertains only to output modules. Use existing guidelines for setting input module RPIs.

Input Modules

Many ControlLogix 1756 input modules support multiple owners.

The table below lists Bulletin number 1756 digital input modules that **do not** support multiple module owners.

IMPORTANT You must use input modules that support multiple owners.

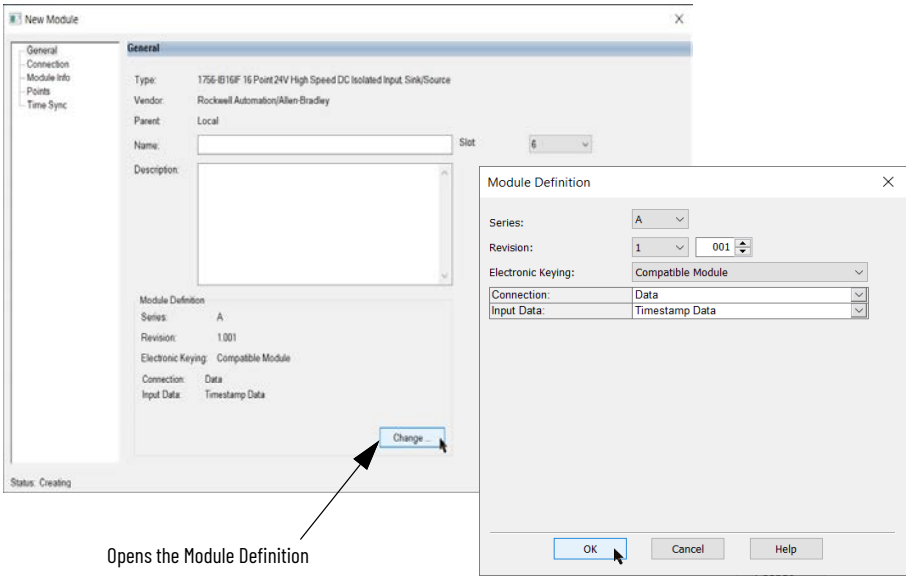
Table 34 - Input Modules that Do not Support Multiple Owners

Cat. No.	Module Type	Replacement Module
1756-IB16ISOE	Sequence of Events Digital Input	–

Configure Fast Input Modules

Follow these steps to configure per-point timestamping and enable COS.

1. On the New Module dialog box, click Change to display the Module Definition dialog box.



2. Use this table to choose a connection format and input data type from the Connection and Input Data dropdown menus.

IMPORTANT To enable timestamping, choose Timestamp Data as the input data type.

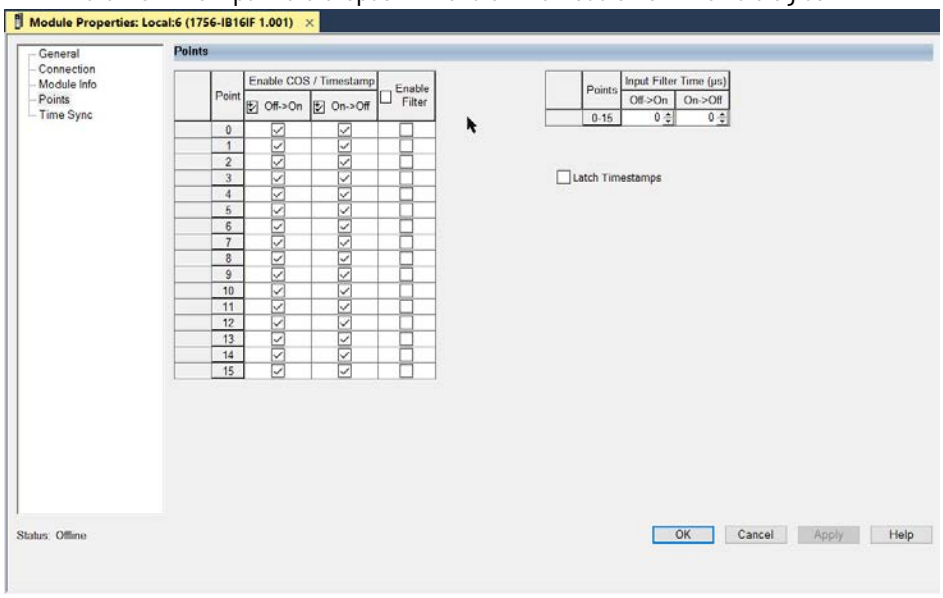
Table 35 - Timestamp Data

Connection Format	Input Data	Data Return
Data	Timestamp Data	Module returns input data with COS timestamps in CIP Sync system time.
	Data	Module returns input data **without** COS timestamps. This format is useful when the highest possible throughput is required, and timestamps are not required.
Data with Event	Timestamp Data	Results in two input connections: • Connection to return input data with COS timestamps in CIP Sync system time. • Connection to initiate event tasks. See page 48.
Listen Only	Timestamp Data	These formats have the same definition as those above except that they are Listen-only connections.
	Data	
Listen Only with Event	Timestamp Data	

You can change the connection format at any time after creating a module except when you are online. The AOP applies all the configuration data and creates the tags that are required for the new connection format.

3. On the New Module or Module Properties dialog box, click the Points tab.

   Timestamp fields only appear on the Configuration tab when you choose Timestamp Data from the Input Data dropdown menu on the Module Definition dialog box.



4. Complete the fields as described in the table and click OK.

Table 36 -

Field	Description	Configuration Tag
Enable COS/ Timestamps Off ? On	To enable COS and timestamping for an Off to On transition for a point, check the corresponding checkbox. To disable COS and timestamping for an Off to On transition for a point, clear the corresponding checkbox.	Pt[x].COSOffOnEn
Enable COS/ Timestamps On ? Off	To enable COS and timestamping for an On to Off transition for a point, check the corresponding checkbox. To disable COS and timestamping for an On to Off transition for a point, clear the corresponding checkbox.	Pt[x].COSOnOffEn
Latch Timestamps	Check the checkbox to latch a CIP Sync timestamp for a COS transition: • When an initial timestamp is latched, timestamps for subsequent COS transitions are dropped. • Once a latched timestamp is acknowledged via the corresponding bit in the Pt[x].NewDataOffOnAck or Pt[x].NewDataOnOffAck tag, the timestamp is overridden upon the next COS transition. **IMPORTANT:** Timestamps are latched only for points that are enabled for COS and timestamping.	LatchTimestamps

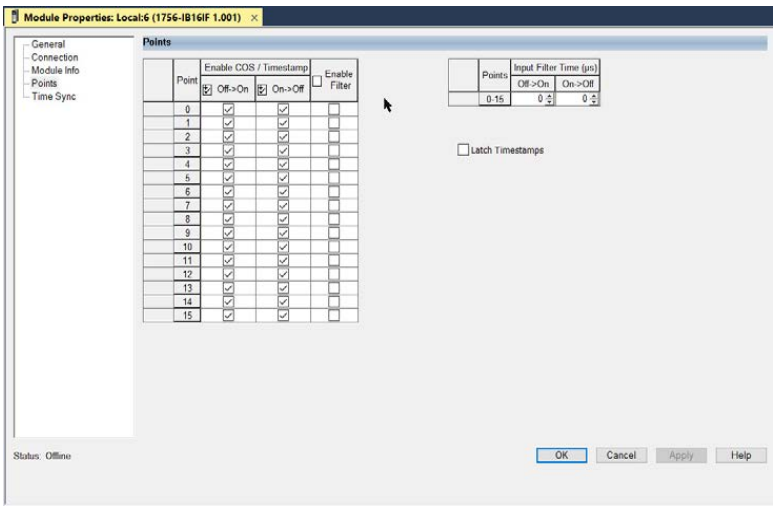
5. If you checked the Latch Timestamps checkbox, use program logic or the Logix Designer application tag editor to acknowledge transitions and clear latched timestamps via the Pt[*x*].NewDataOffOnAck and Pt[*x*].NewDataOnOffAck output tags.

For more information about module tags, refer to Appendix A.

Configure Input Filter Times

Follow these steps to configure input filter times.

1. On the Module Properties dialog box, click the Points tab.
2. In the Input Filter Time column, enter Off to On and On to Off input filter times from 0...30,000 µs and click OK.



3. Complete the fields as described in this table and click OK.

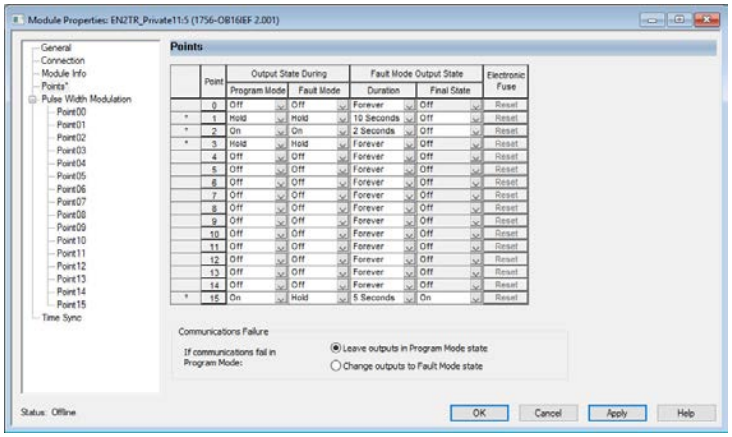
Table 37 -

Field	Description	Configuration Tag
Enable Filter	To enable filtering for a point, check the corresponding checkbox. To disable filtering for a point, clear the corresponding checkbox.	Pt[*x*].FilterEn
Input Filter Time Off ? On	Enter an Off to On input filter time from 0...30,000 µs.	FilterOffOn
Input Filter Time On ? Off	Enter an On to Off input filter time from 0...30,000 µs.	FilterOnOff

Configure Fast Output Modules

Follow these steps to configure a fault state delay.

1. On the Module Properties dialog box, click the Points category.



Complete the fields as described in this table and click OK.

Table 38 -

Field	Description	1756-OB16IEF Configuration Tag	1756-OB16IEFS Configuration Tag
Fault Mode Output State Duration	Choose the length of time that you want the output to remain in Fault mode state before transitioning to the final state: • 1 second • 2 seconds • 5 seconds • 10 seconds • Forever (default) **IMPORTANT:** If you choose Forever, the output remains in the Fault mode state until a connection is re-established. For example, if the Fault mode is Hold, and you specify a duration of Forever, then the output retains its Hold state and does not transition to a Final state if a fault occurs.	Pt[*x*].FaultValueStateDuration	FaultValueStateDuration
Fault Mode Output State Final State	Choose whether you want the module to transition to an On or Off state after the Fault mode duration time elapses. The default final state is Off. If you chose Forever, you cannot choose a final state. The module retains its current Fault mode state.	Pt[*x*].FaultFinalState	FaultFinalState

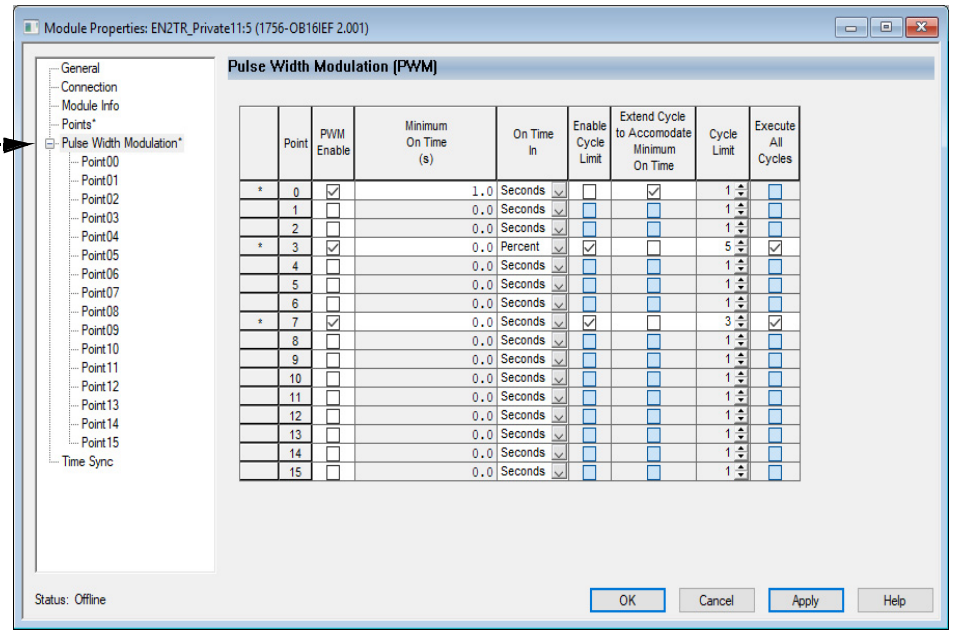
Configure Pulse-width Modulation

Follow these steps to configure PWM.

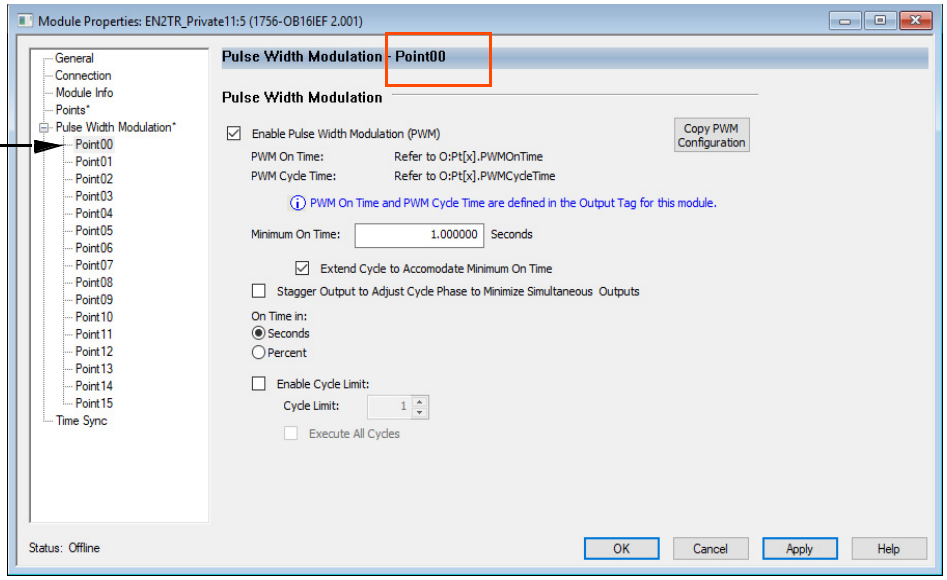
1. Use program logic or the Logix Designer application tag editor to define the Cycle time and On time for an output point via the PWMCycleTime and PWMOnTime output tags.

   For more information about module tags, refer to Appendix A.

2. On the Module Properties dialog box, click the pulse-width modulation roll-up category for a high-level view.



3. Click the PointXX category to view a specific point's configuration.

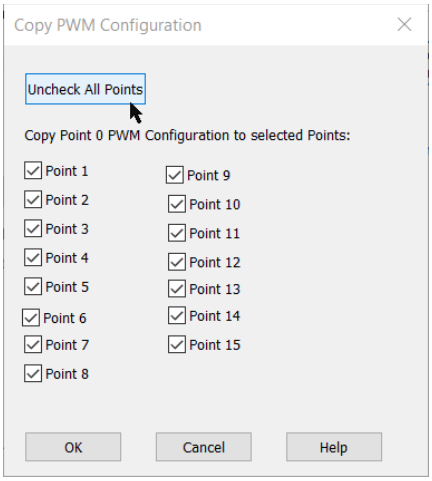


4. To modify that point's configuration, or to set its initial configuration, complete the fields in the PWM area as described in this table.

Field	Description	1756-OB16IEF Tag Name	1756-OB16IEFS Tag Name
Enable pulse-width modulation (PWM)	Check the checkbox to enable PWM. If this checkbox is cleared, all other PWM fields are unavailable, and the PWM On time and cycle time for the point are ignored. By default, PWM is disabled.	C:Pt[*x*].PWMEnable	C:PWM.Enable
PWM On Time (view only)	Displays the length of time that a pulse is active, as defined in the PWMOnTime output tag. By default, this value is defined in seconds with a range of 0.0002…3600.0. However, you can define the value as 0…100% of the cycle time by clicking On Time in Percent. **IMPORTANT:** Before PWM functions, you must enable PWM during configuration and define the PWM cycle time and On time in the PWMCycleTime and PWMOnTime output tags. If PWM is enabled (C:PWMEnable = 1) and the output is instructed to turn On (O:Data = 1), the output generates a PWM signal.	O:Pt[*x*].PWMOnTime	O:PWM.OnTime
PWM Cycle Time (view only)	Displays the duration of each pulse cycle, as defined in the PWMCycleTime output tag. This value is always displayed in seconds with a range of 0.001…3600.0 seconds. **IMPORTANT:** Before PWM functions, you must enable PWM during configuration and define the PWM cycle time and On time in the PWMCycleTime and PWMOnTime output tags. If PWM is enabled (C:PWMEnable = 1) and the output is instructed to turn On (O:Data = 1), the output generates a PWM signal.	O:Pt[*x*].PWM CycleTime	O:PWM.CycleTime
Minimum On Time	Type the minimum length of time required for the output to turn On. This value must be defined in seconds. For example, if a heating coil requires a minimum of 2 seconds to heat up, and you enter a value of 2.000 in this field, the shortest pulse that is allowed is never less than 2.000 seconds. The default value of zero disables the feature.	C:Pt[*x*].PWMMinimumOnTime	C:PWM.MinimumOnTime
Extend Cycle to Accommodate Minimum On Time	Check or clear this checkbox to determine the output behavior when the On time is **less than** the minimum On time: • Check the checkbox to increase the duration of the pulse cycle to maintain the On time to Cycle time ratio while considering the minimum On time. • **Note:** Extending the cycle time is typically useful only when the On time is a result of a calculation. • Clear the checkbox if you do **not** want to increase the duration of the pulse cycle. In this case, the output does not turn On if the On time is less than the minimum On time. By default, the checkbox is cleared, and cycles do not extend.	C:Pt[*x*].PWMExtendCycle	C:PWM.ExtendCycle
Stagger Output to Adjust Cycle Phase to Minimize Simultaneous Outputs	Check the checkbox to minimize the load on the power system by staggering output transitions. See Figure 15 on page 60. By default, this checkbox is cleared and staggering is disabled. When staggering is disabled for an output point, the output always turns On at the beginning of a pulse cycle.	C:Pt[*x*].PWMStaggerOutput	C:PWM.StaggerOutput
On Time in Seconds or On Time in Percent	To define PWM On time in seconds, click On Time in Seconds. To define PWM On time as a percentage of the cycle time, click On Time in Percent. By default, the On time is defined in seconds.	C:Pt[*x*].PWMOnTimeInPercent	C:PWM.OnTimeInPercent
Enable Cycle Limit	Check the checkbox to let only a fixed number of pulse cycles occur. See Figure 12 on page 58. By default, the Enable Cycle Limit checkbox is cleared, and pulse cycles continue to occur until the output turns Off.	C:Pt[*x*].PWMCycleLimitEnable	C:PWM.CycleLimitEnable
Cycle Limit	Enter the maximum number of pulse cycles that you want to occur on each output logic transition when Enable Cycle Limit is checked: • If you check the Execute All Cycles checkbox, the specified number of cycles occur even if the Data output tag turns Off before the completion of the specified number of cycles. • If you clear the Execute All Cycles checkbox, the specified number of cycles occur only if the Data output tag remains On for enough time for the specified number of cycles. For example, if you specify a cycle limit of 4, and the output turns Off after 3 cycles, the fourth cycle does **not** occur. This field is only available when the Enable Cycle Limit checkbox is checked. By default, the cycle limit is 10. Valid values are 1…27.	C:Pt[*x*].PWMCycleLimit	C:PWM.CycleLimit
Execute All Cycles	Check the checkbox to always execute the number of cycles that are specified in the Cycle Limit field even if the Data output tag turns Off. For example, if you specify a cycle limit of 2, and the output turns Off after 1 cycle, the second cycle still occurs despite the output turning Off. See Figure 13 on page 58. If the output logic transitions multiple times before the cycle limit is reached, all subsequent transitions are ignored until the cycle limit is reached. Once the cycle limit is reached, a new cycle sequence begins. This field is only available when the Enable Cycle Limit checkbox is checked. By default, the Execute All Cycles checkbox is cleared.	C:Pt[*x*].PWMExecuteAllCycles	C:PWM.ExecuteAllCycles

5. To copy the current configuration to one or more of the remaining output points, so that multiple outputs share the same PWM behavior, do the following:
   a. Select the PointXX category to copy.
   b. Click Copy PWM Configuration.
   c. On the Copy PWM Configuration dialog box, check the points to which to apply the current configuration and click OK.

   By default, all points are checked.

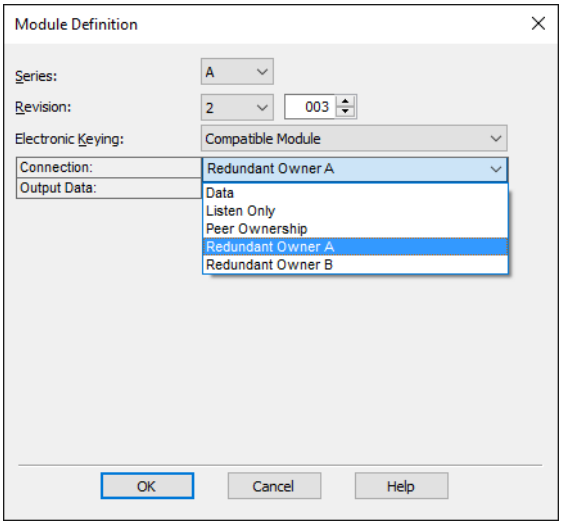


6. To save the configuration for each output point that you specified, click OK.

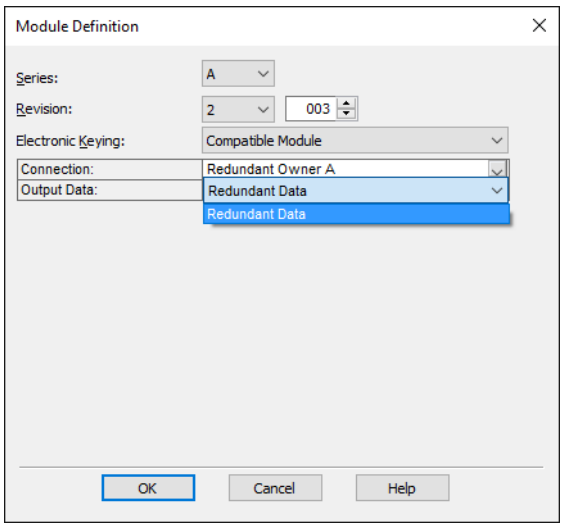
Configure the Output Module as Redundant Owner

In a redundant owner application, configure one output module as Redundant Owner A and the second as Redundant Owner B. In our example project, Redundant Owner A is the module that is connectedmodule that is connectedmodule connected to Ethernet B.

1. In the Module Definition dialog box, in the Connection field, choose Redundant Owner A.



2. In the Output Data field, choose Redundant Data.



3. To configure the second output module as Redundant Owner B, repeat steps 1 and 2, choosing Redundant Owner B and Redundant Data.

   The module definition is shown in the Module Properties dialog box.

Implement Redundant Ethernet Modules

Follow these steps to implement Redundant Ethernet modules in your project.

1. Add the additional I/O configuration to your project for the second Ethernet module.

   In the example project, this is EN2T_B.

   To simplify testing, you may want to create a project just for the redundant Ethernet modules and test that project before adding in your application code.

   We recommend following the module naming examples that are used in the example project.

   - Ethernet module in Slot 0: EN2T_A_<your name for the chassis>
   - Ethernet module in Slot 1: EN2T_B_<your name for the chassis>
   - Reference the example application for more naming examples

2. Add in the task for I/O_Mapping_25ms.
3. Set the periodic rate of this task to 25 ms or a multiple of the fastest output module RPI.
4. Import the example Program into the I/O_Mapping_25ms task.
5. Modify the imported routines for each chassis that you have in your system.

   In the example project the routines are called R001, R002, and so on. One chassis per routine.
6. Add an I/O module to the chassis routines.
7. Insert an Add-On Instruction for each digital input module that you have in the chassis.
8. If the digital input module is only 16 channels, set the I16_Ch tag to 1 (true).

   This limits input processing to the first 16 Booleans and reduce controller scan time.

   If you have a digital module that is not compatible with any of the Add-On Instructions from the example project, you can use the Redundant_Digital_Input Add-On Instruction to map each channel individually. You can also create your own Add-On Instruction for the module.
9. Add the default value for each channel to the Add-On Instruction.

   The default value is the value that the input is set to when communication through both Ethernet modules to the input module is faulted.

10. Insert a rung with two CPS (Synchronous Copy File) instructions for each Digital Output module that you have in the chassis.

    In the example project, the rung number was equal to the slot number of the module being referenced. We used rungs with only an NOP (No Operation) instruction to hold the rung number for slots without an analog module.

11. In each routine add rungs for the analog modules that you have.

    Most analog modules have their own Add-On Instructions (AOI).

    Be aware of the channel count of the AOI and module.

    - If the analog module is in Differential mode, the channel count is cut in half.
    - If you have an analog module that is not compatible with any of the Add-On Instructions from the example project, you can use the Redundant_Analog_Input Add-On Instruction to map each channel individually. You can also create your own Add-On Instruction for the module.
    - In the example project, the rung number was equal to the slot number of the module being referenced. We used rungs with only an NOP (No Operation) instruction to hold the rung number for slots without an analog module.

12. Keep the Add-On Instruction at Hold Last State or set Hold Last State to 0 (zero) to use the default value.
13. Add the default value for each channel to the Add-On Instruction.
14. The default value is the value that the input is set to when communication through both Ethernet modules to the input module is faulted.

Response Times for Output Modules

Response time to a change in ownership is from the time the event takes place until the time that the output modules use the connection data from the redundant connection.

Digital output response to a change in ownership in less than 250 ms. The average time is 220 ms. A faster RPI does not increase the response time. We recommend a digital output RPI of 25 ms.

These recommendations are for response performance:

- Faster RPIs have a longer response time.
- Slower RPIs can have a much longer response time.
- RPIs should be 4 x RPI = 200 ms, 8 x RPI = 200 ms, or 16 x RPI = 200 ms, so 25 is the recommended RPI.
- If the prior RPI criterion is not met, the CIP connection timeout delay minimum will be 200 ms + 1 RPI. If the 4/8/16 x RPI does not equal 200 ms (or 100 ms), then the response is longer.
- For non-redundant ControlLogix applications, the CIP connection timeout delay minimum is 100 ms.
- Slower RPIs greatly limit the effect of the response time on the application.

IMPORTANT	This information pertains only to output modules. Use existing guidelines for setting input module RPIs.

Troubleshoot Your Module

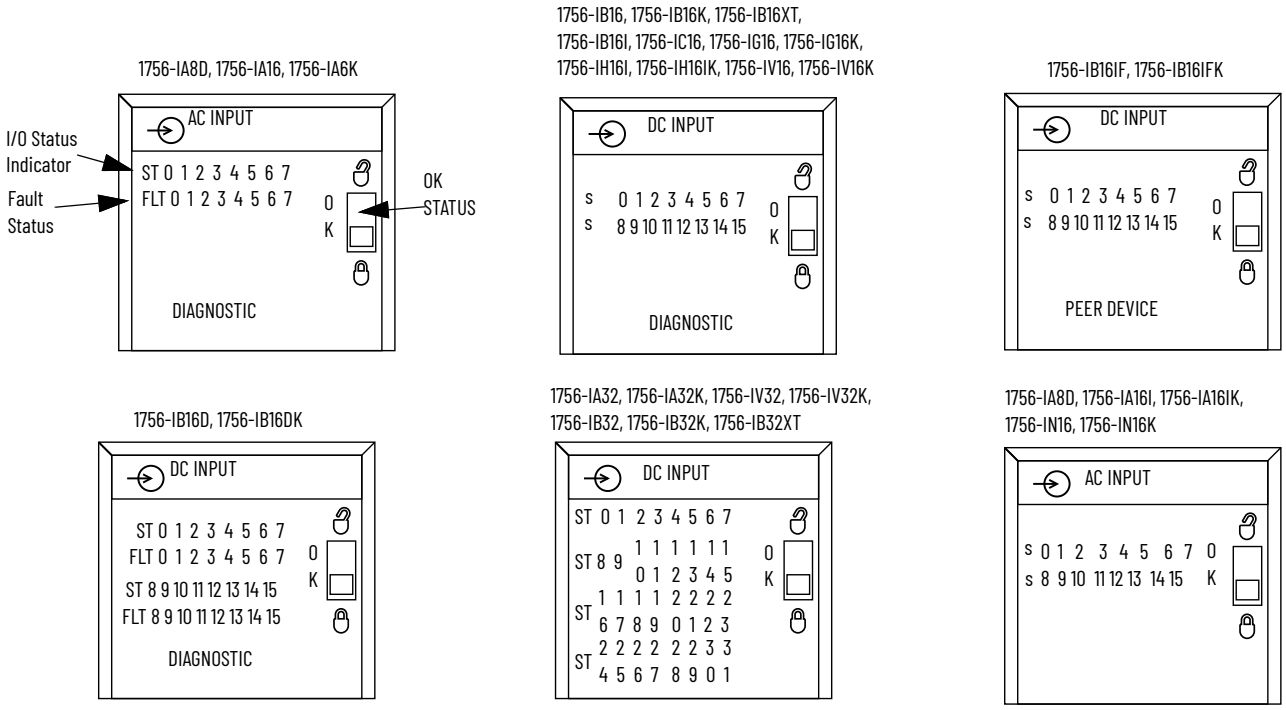
Status Indicators

ControlLogix® input modules support the status indicators that are described in Table 39. The available status indicators vary by module catalog number, as shown in Figure 20 on page 89.

Table 39 - Status Indicators for Input Modules

Indicator	Status	Description
OK Status	Steady green	The inputs are being multicast and in a normal operating state.
	Flashing green	The module has passed internal diagnostics, but is not multicasting inputs or is inhibited. Uninhibit the connection or establish a connection to enable communication to the module.
	Steady red	The module must be replaced.
	Flashing red	Previously established communication has timed out. Check the controller and chassis communication.
I/O Status	Yellow	The input is On.
Fault Status	Red	The input has encountered a fault. Check the input point at the controller.

Figure 20 - Input Module Status Indicators by Catalog Number



Status Indicators for Output Modules

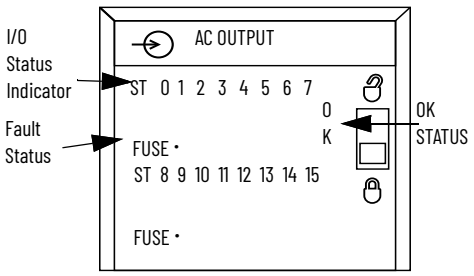
ControlLogix output modules support the status indicators that are described in this table. The available status indicators vary by module catalog number, as shown in Figure 21 on page 91.

Table 40 - Status Indicators for Output Modules

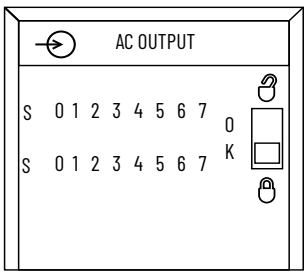
Indicator	Status	Description
OK Status	Steady green	The outputs are actively being controlled by a system processor.
	Flashing green	The module has passed internal diagnostics but is not actively controlled or it is inhibited or controller is in Program mode. Uninhibit connection, establish connection or transition controller to Run mode to enable communication to module.
	Steady red	The module must be replaced.
	Flashing red	Previously established communication has timed out. Check the controller and chassis communication.
I/O Status	Yellow	The output is On.
Fuse Status	Red	A short overload fault has occurred for a point in this group. Check the wiring for a short-overload. Also check the Module Properties dialog box in the Logix Designer application and reset the fuse.
Fault Status	Red	The output has encountered a fault. Check the output point at the controller.
Diagnostic Status	Steady red	The output has encountered a fault. Check the output point at the controller.
	Flashing red	The output is listening for peer inputs and using the inputs to determine the state of the output point.

Figure 21 - Output Module Status Indicators by Catalog Number

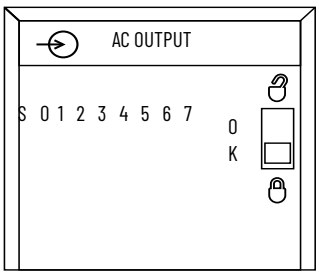
1756-0A16, 1756-0A16K



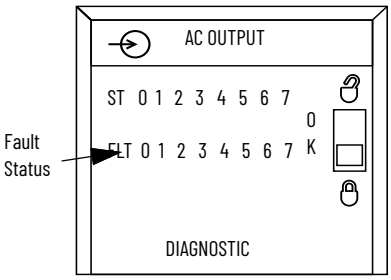
1756-0A16I, 1756-0A16IK



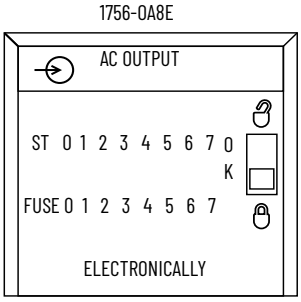
1756-0A8, 1756-0N8, 1756-0N8K



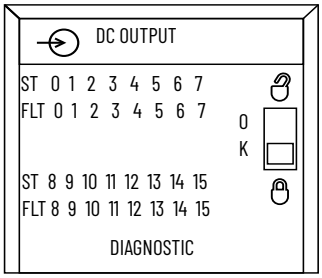
1756-0A8D



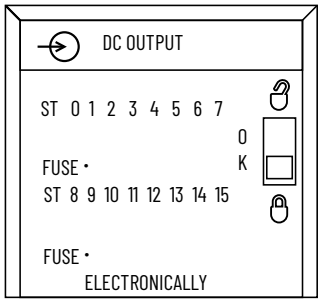
1756-0A8E



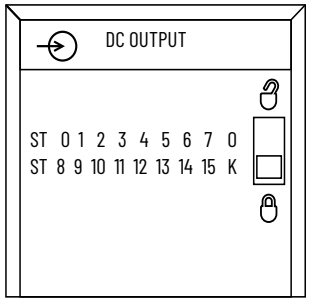
1756-0B16D, 1756-0B16DK



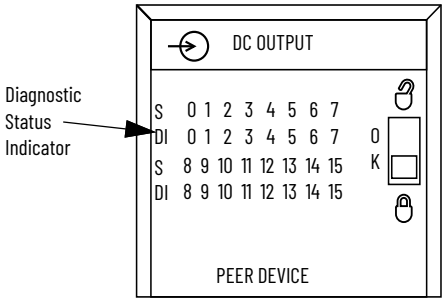
1756-0B16E, 1756-0B16EK **1756-0W16E**, 1756-0W16EK



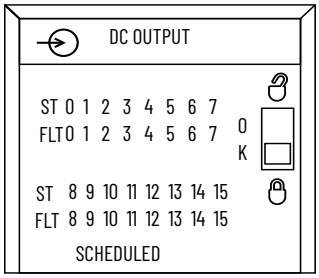
1756-0B16I, 1756-0B16IS, 1756-0G16, 1756-0G16K



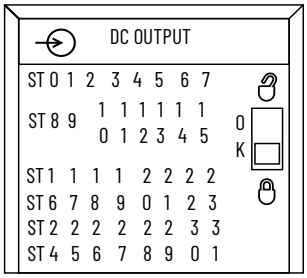
1756-0B16IEF, 1756-0B16IEFK



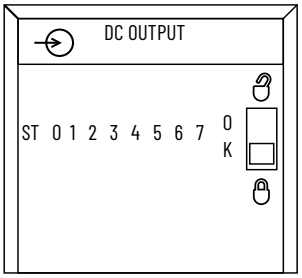
1756-0B16IEFS, 1756-0B16IEFSK



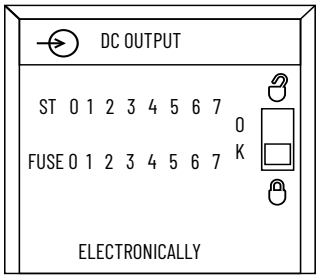
1756-0B32, 1756-0B32K, 1756-0B32XT, **1756-0V32E**, 1756-0V32EK



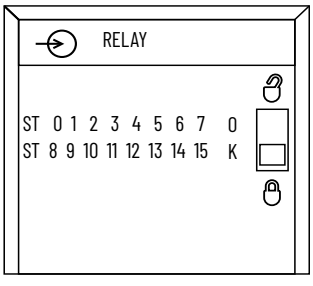
1756-0C8, 1756-0C8K **1756-0H8I**



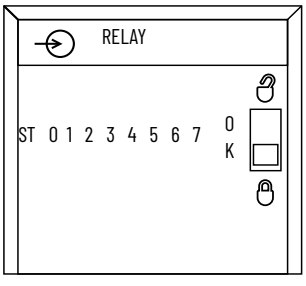
1756-0B8EI, 1756-0B8EIK



1756-0W16I, 1756-0W16IK



1756-0X8I, 1756-0X8IK



Use the Logix Designer Application for Troubleshooting

In addition to the status indicator display on the module, the Logix Designer application alerts you to fault conditions.

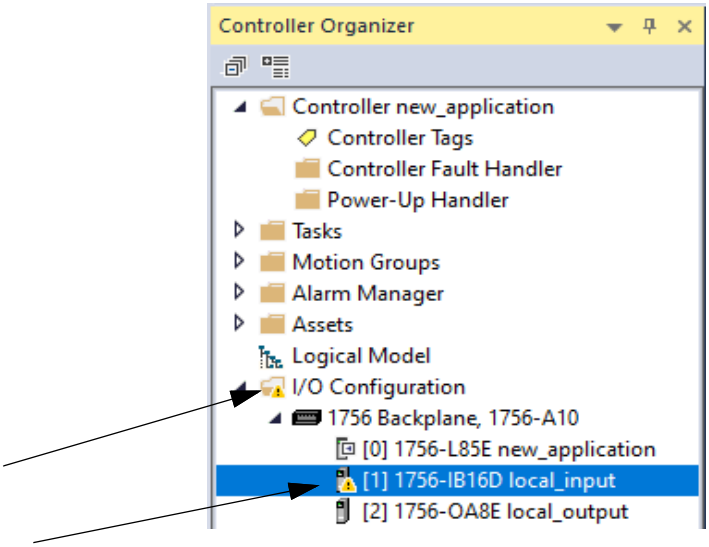
Fault conditions are reported in these ways:

- Warning signal on the main screen next to the module—This occurs when the connection to the module is broken.
- Message in a screen's status line.
- Notification in the Tag Editor—General module faults are also reported in the Tag Editor. Diagnostic faults are reported only in the Tag Editor.
- Status on the Module Info tab.

These figures display fault notification in the Logix Designer application.

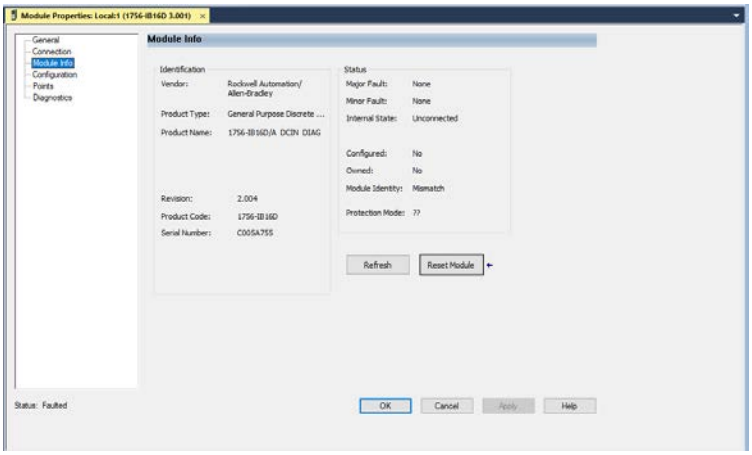
A warning icon ⚠ appears in the I/O Configuration tree when a communication fault occurs.

Figure 22 - Warning Signal on Main Screen



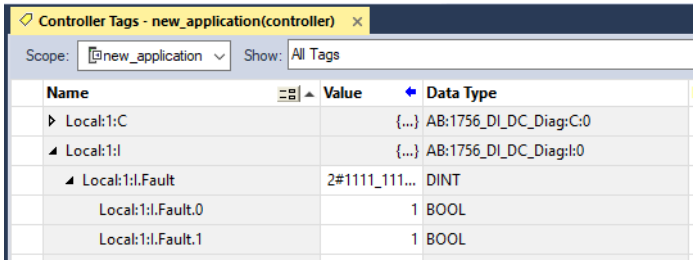
The major and minor faults are listed on the Module Info tab in the Status section.

Figure 23 - Fault Message in Status Line



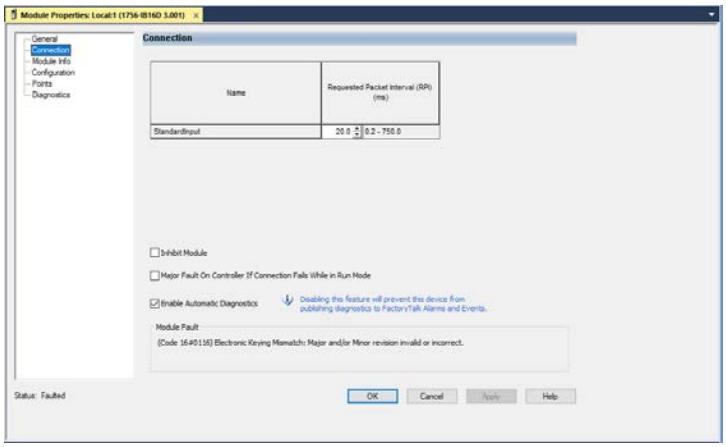
The Value field displays 65535 to indicate that the module connection has been broken.

Figure 24 - Notification in Tag Editor



Fault Type Determination

When you are monitoring a module's configuration properties in the Logix Designer application and receive a Communication fault message, the Connection tab lists the type of fault under Module Fault.



Troubleshooting Fast Modules

Issue: I/O Module Connection Error or I/O Module Configuration Error (yellow triangle in the Logix Designer application I/O configuration)

1. Verify that both entries in the Logix Designer application I/O Configuration have the same RPI.
2. Verify that both entries in the Logix Designer application I/O Configuration have the same configuration.

   You can toggle the Sync_Module_Config BOOL tag in the IO_Mapping Program MainRoutine Rung 1. This triggers a copy of the module A configuration to the module B configuration, making them the same.

IMPORTANT	This copy will not change the module RPI. The two I/O module entries must have the same configuration.

3. Remove the module from the chassis.
4. Reinsert the module.
5. If you still have the error, delete one of the module entries in the Logix Designer application I/O Configuration and add it into your project again.

These troubleshooting steps below assume that the system was commissioned and running without any errors before the issue occurred.

Issue: Output is ON in the user application code, but is not ON at the Output module.

1. Verify that at least one of the connections to the output module is active.
2. Verify that the output is ON in the output module tags.
3. Confirm whether all of the connections in the chassis are faulted, including the Ethernet modules.
4. Troubleshoot the Ethernet communication issue to the Ethernet modules.
5. Troubleshoot the error code displayed in Module Properties > Connection tab.

In the example project, this is EN2T_B.

Issue: Incorrect output behavior on response

1. Verify that only one of the connections to the Output module has the .OwnerClaim output set to true (1).
2. Verify that only one of the connections to the Output module has the .OwnerReady output set to true (1).

Name	Value	Style	Data Type
ENET_A_R002:2:O.OwnerClaim	1	Decimal	BOOL
ENET_A_R002:2:O.OwnerReady	0	Decimal	BOOL

Name	Value	Style	Data Type
ENET_B_R002:2:O.OwnerClaim	0	Decimal	BOOL
ENET_B_R002:2:O.OwnerReady	1	Decimal	BOOL

For all of the issues described in this section, you can consult product manuals, Rockwell Automation® Knowledgebase, and Rockwell Automation Technical Support.

Wiring Diagrams

This chapter provides wiring diagrams for all ControlLogix® digital modules.

Table 41 - Types of Digital I/O Modules

Digital I/O Type	Description
Diagnostic	These modules provide diagnostic features to the point level. These modules have a **D** at the end of the catalog number.
Electronic fusing	These modules have internal electronic fusing to prevent too much current from flowing through the module. These modules have an **E** at the end of the catalog number.
Individually isolated	These modules have individually isolated inputs or outputs. These modules have an **I** at the end of the catalog number.
Fast	These modules provide fast response times. These modules have an **F** at the end of the catalog number.
Conformal coated	These modules provide extended protection in harsh, corrosive environments. These modules have a **K** or an **XT** at the end of the catalog number.

Table 42 - 1756 I/O Module Features

Module Type	Features
1756 digital AC input modules	• Change of state: Software configurable • Timestamp of inputs: ±200 µs • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical
1756 digital AC output modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Fault states per point: Hold last state, on or off (off is default) • States in Program mode per point: Hold last state, on or off (off is default) • Fusing: – 1756-OA8D, 1756-OA8E: Electronically fused per point – 1756-OA16: Mechanically fused/group, 3.15 A @ 250V AC slow blow, 1500 A interruption current, Littelfuse p/n H2153.15 – All other modules: Not protected. A fused IFM is recommended to protect outputs (see publication 1492-TD008) • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical

Table 42 - 1756 I/O Module Features

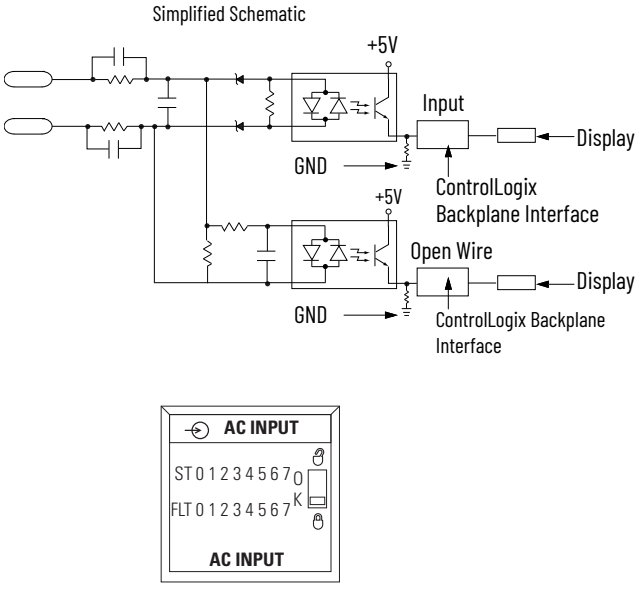
Module Type	Features
1756 digital DC input modules	• Reverse polarity protection: All modules except 1756-IG16 module • Change of state: Software configurable • Timestamp of inputs: – ±100 µs for sequence of events modules(1) – ±200 µs for all other modules • Module keying: Electronic, software configurable • RTB Keying: User-defined mechanical
1756 digital DC output modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Fault states per point: Hold last state, on or off (off is default) • States in Program mode per point: Hold last state, on or off (off is default) • Fusing: – 1756-OB8EI, 1756-OB16D, 1756-OB16E, 1756-OB16IEF, 1756-OB16IEFS, 1756-OV16E, 1756-OV32E: Electronically fused per point – All other modules not protected. A fused IFM is recommended to protect outputs. See publication 1492-TD008. • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical
1756 digital contact modules	• Scheduled outputs: Synchronization within 16.7 seconds maximum, reference to the Coordinated System Time • Configurable fault states per point: Hold last state, on or off (off is default) • Configurable states in Program mode per point: Hold last state, on or off (off is default) • Fusing: Not protected. A fused IFM is recommended to protect outputs (See publication 1492-TD008) • Module keying: Electronic, software configurable • RTB keying: User-defined mechanical

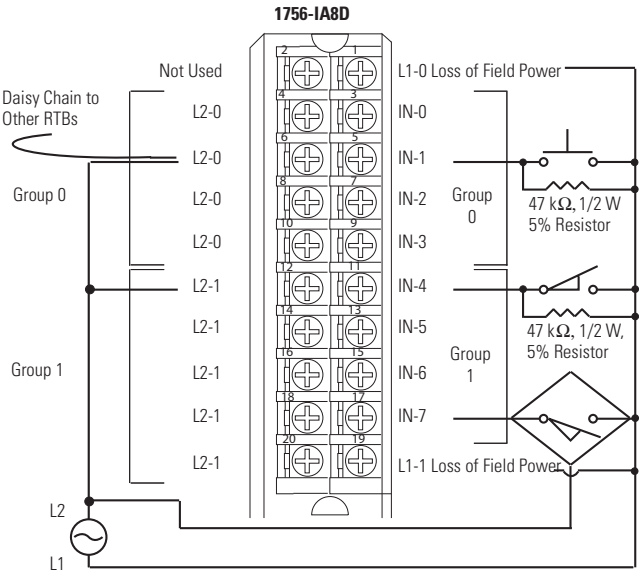
(1) For details, see the ControlLogix Sequence of Events Module Installation Instructions, publication 1756-IN592, and the ControlLogix Sequence of Events Module User Manual, publication 1756-UM528.

IMPORTANT For the latest I/O module specifications, see the 1756 ControlLogix I/O Modules Technical Specifications, publication 1756-TD002.

1756-IA8D

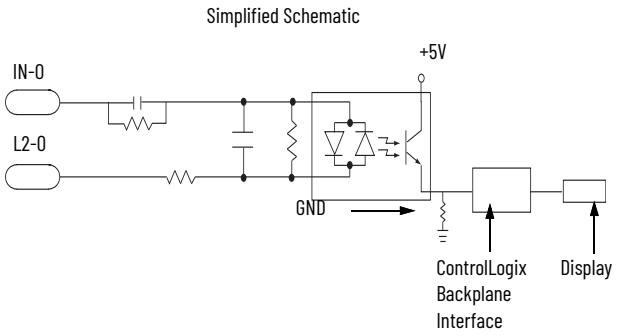
ControlLogix AC (79...132V) diagnostic input module

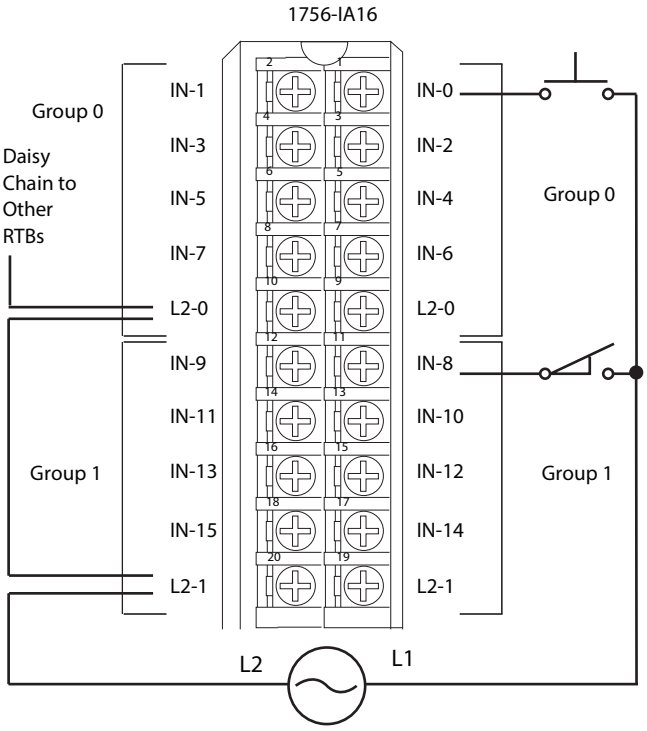




1756-IA16, 1756-IA16K

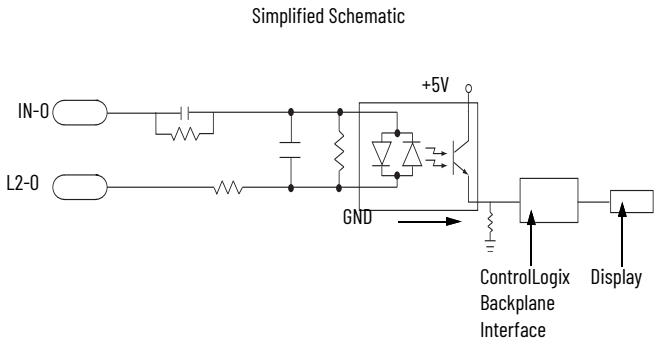
ControlLogix AC (74...132V) input module



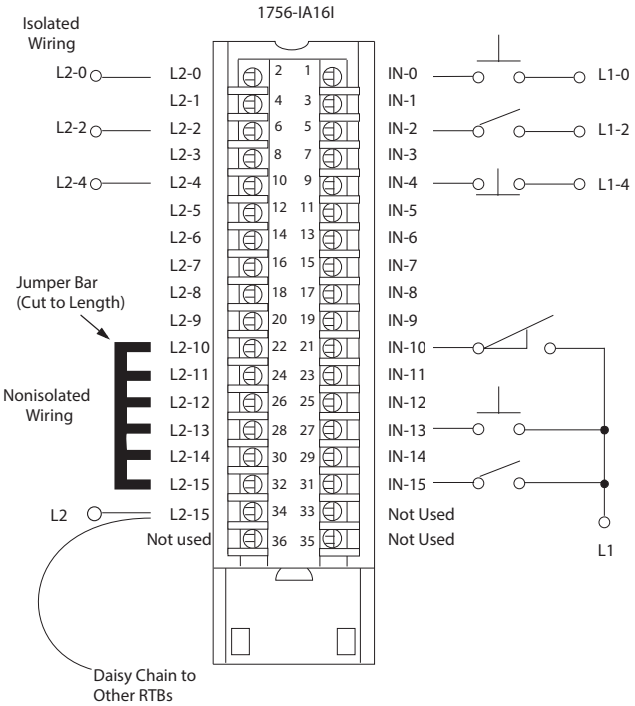


1756-IA16I, 1756-IA16IK

ControlLogix AC (79...132V) isolated input module

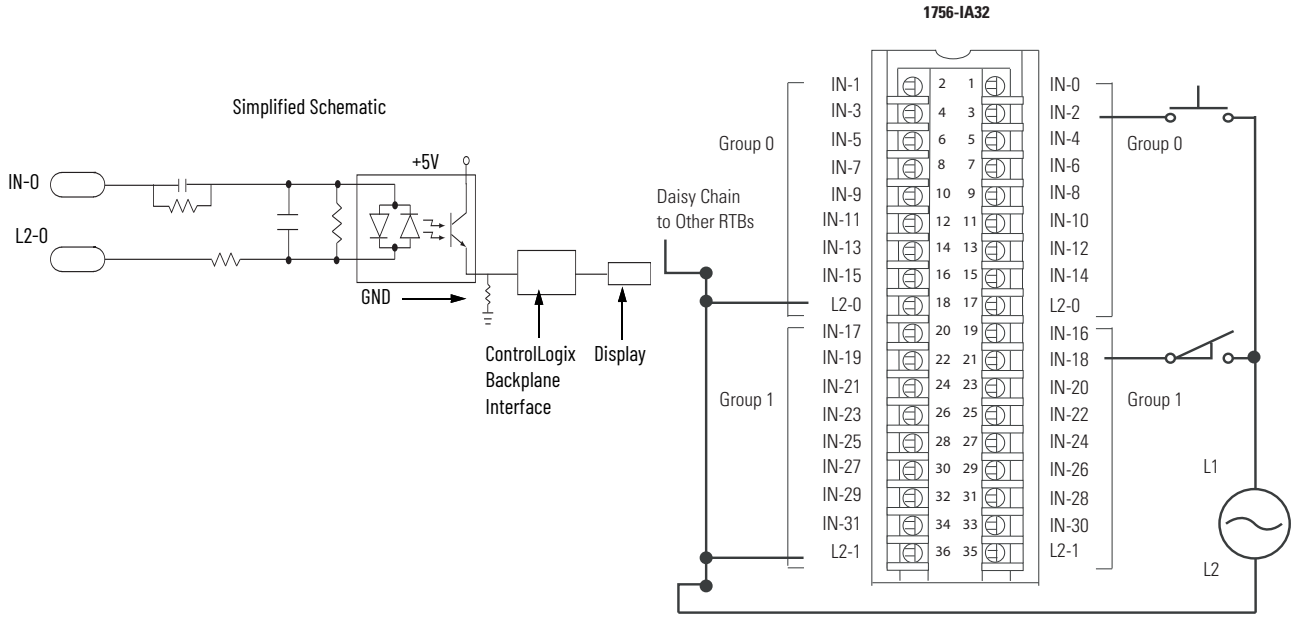


Additional jumper bars can be purchased by using catalog number 1756-JMPR.



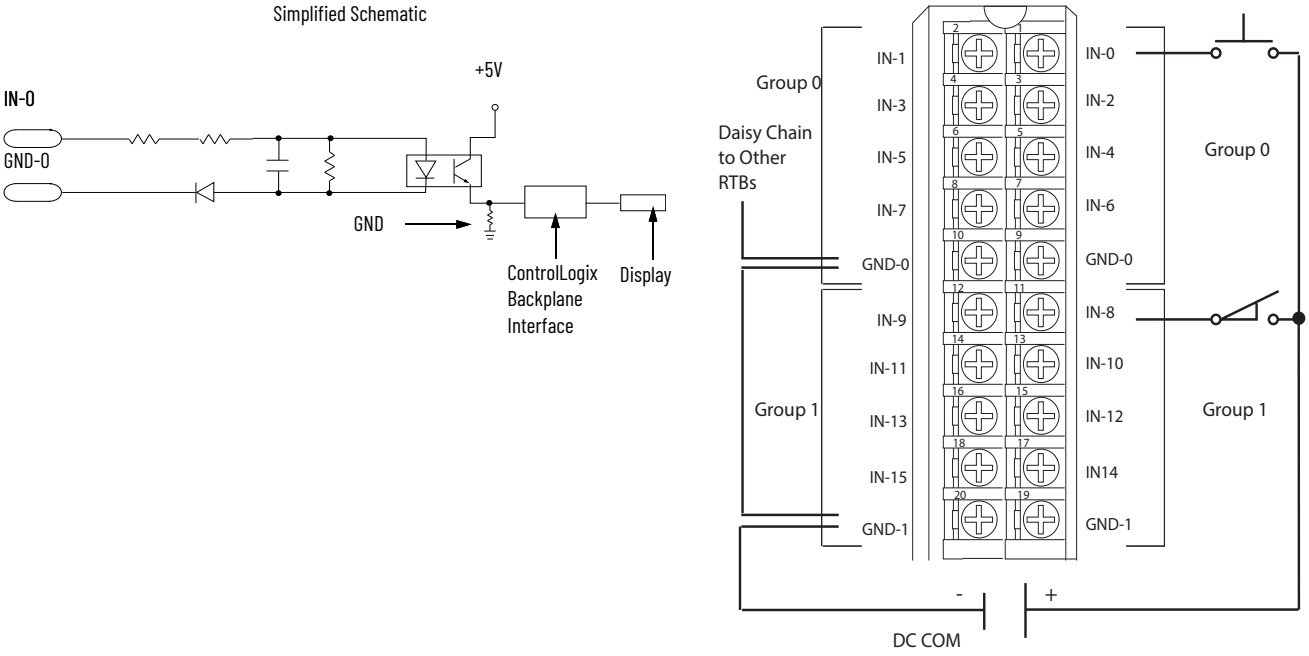
1756-IA32, 1756-IA32K

ControlLogix AC (74...132V) input module



1756-IB16, 1756-IB16K, 1756-IB16XT

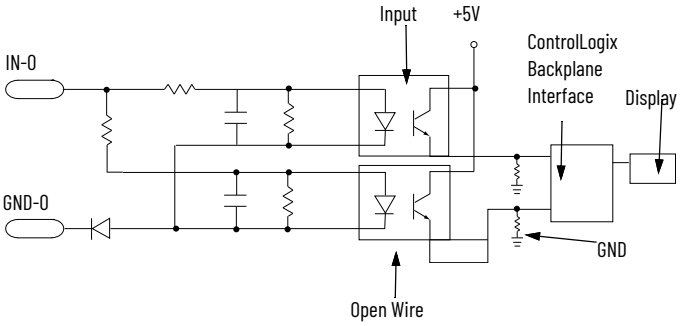
ControlLogix DC (10...31.2V) input module

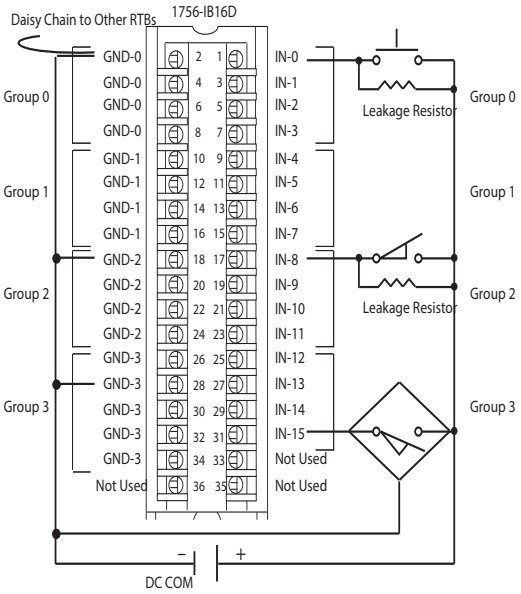


1756-IB16D, 1756-IB16DK

ControlLogix DC (10...30V) diagnostic input module

Simplified Schematic

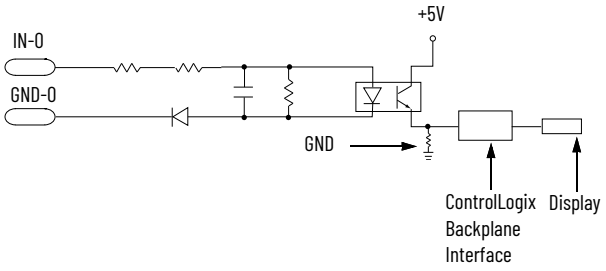


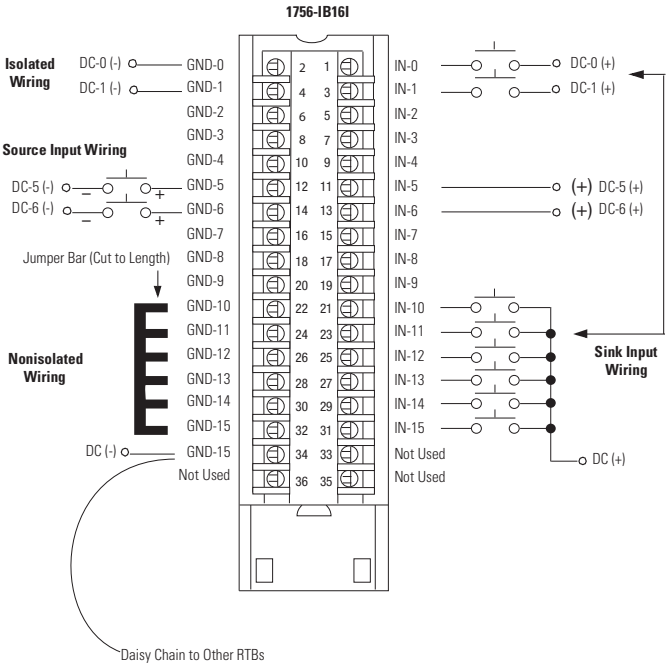


Recommended Leakage Resistor Size 1/4 W, 5%	Supply Voltage
3.9K	10V DC
5.6K	12V DC
15K	24V DC
20K	30V DC

1756-IB16I, 1756-IB16IK

ControlLogix DC (10...30V) isolated input module

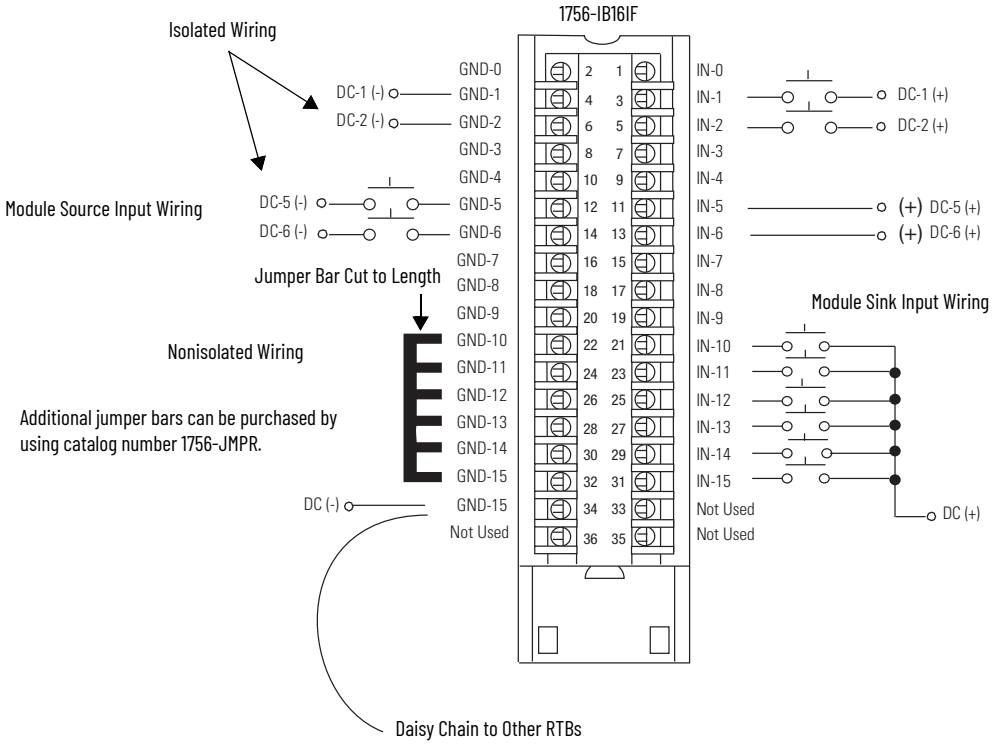


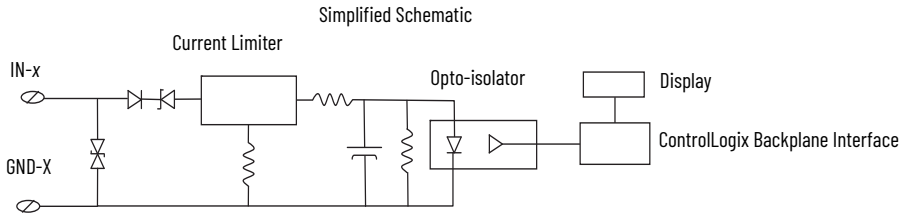


Additional jumper bars can be purchased by using catalog number 1756-JMPR.

1756-IB16IF, 1756-IB16IFK

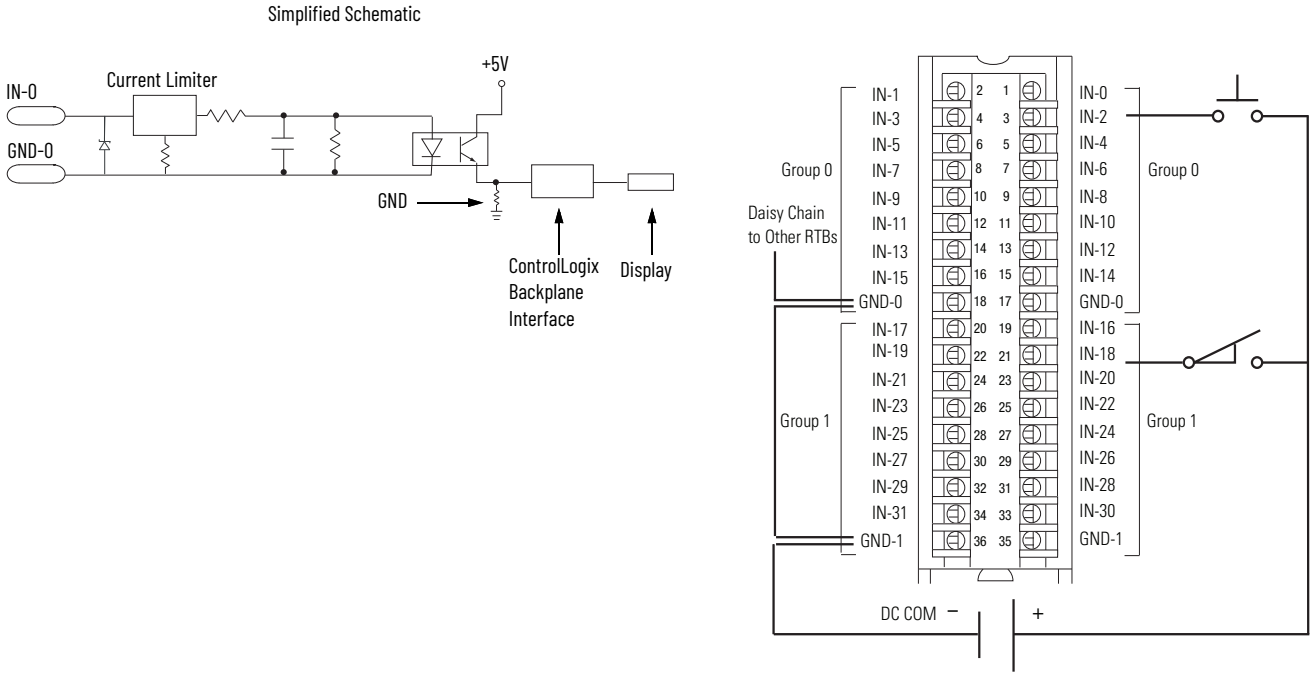
ControlLogix DC (10...30V) sinking or sourcing, isolated, fast input module





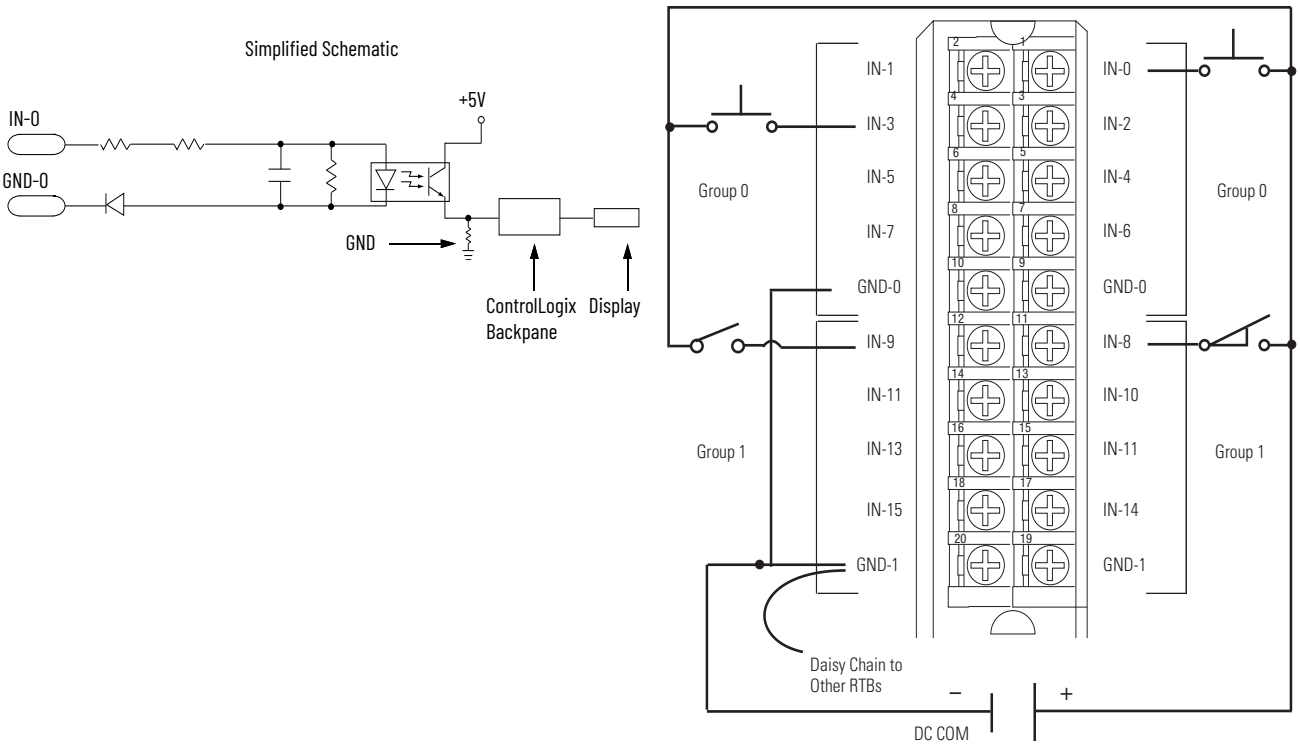
1756-IB32, 1756-IB32K, 1756-IB32XT

ControlLogix DC (10...31.2V) input module



1756-IC16

ControlLogix DC (30...60V) input module

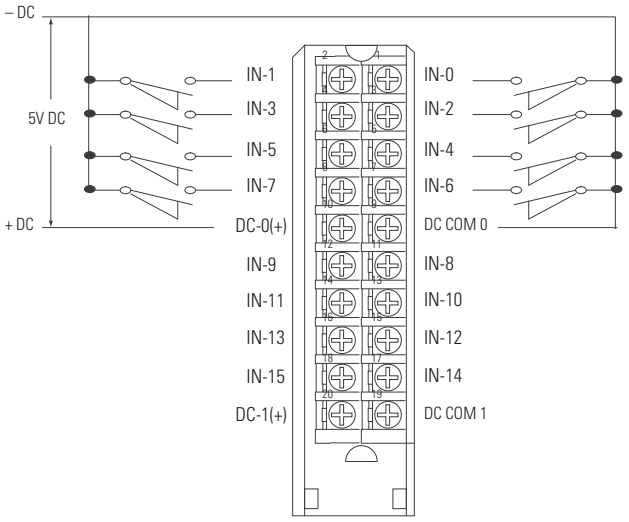


1756-IG16, 1756-IG16K

ControlLogix TTL input module

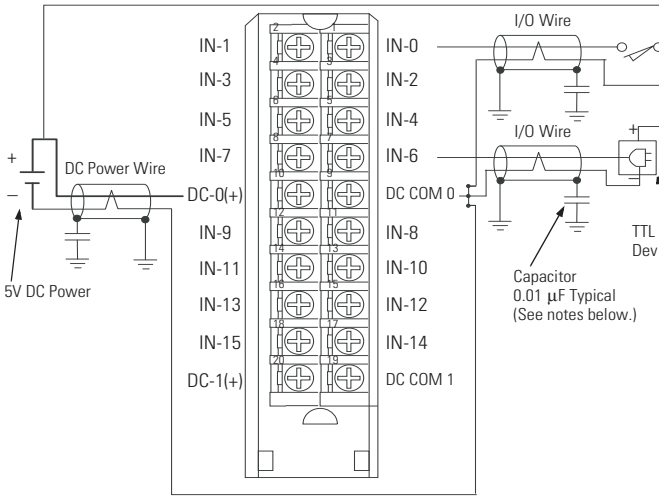
Standard Wiring

1756-IG16

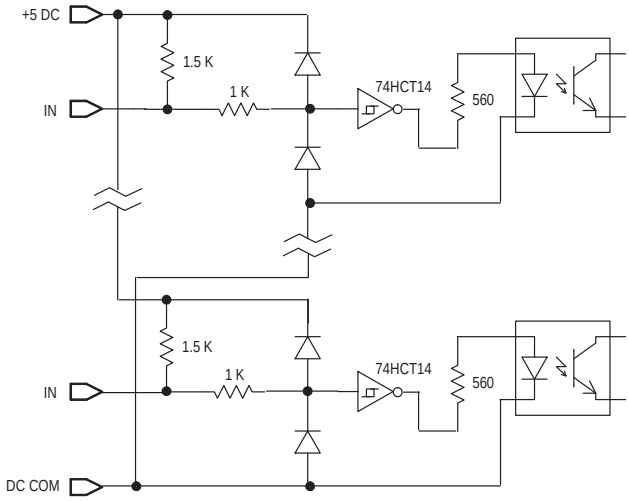


CE-Compliant Wiring

1756-IG16

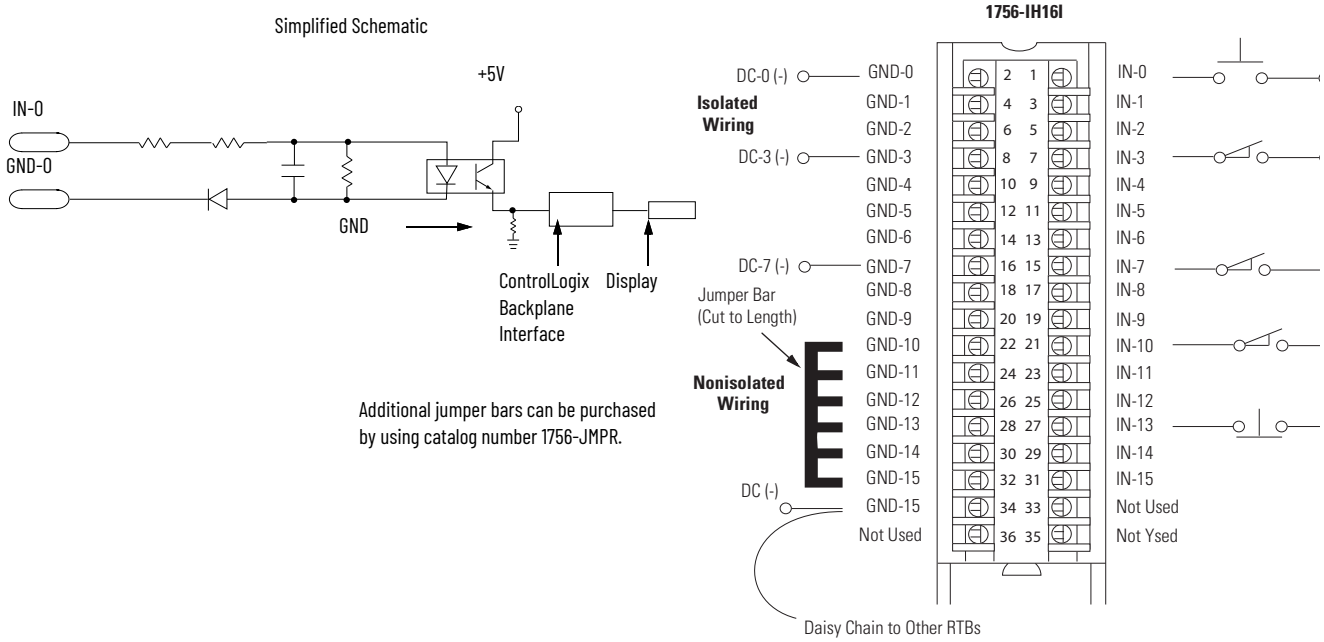


Simplified Schematic



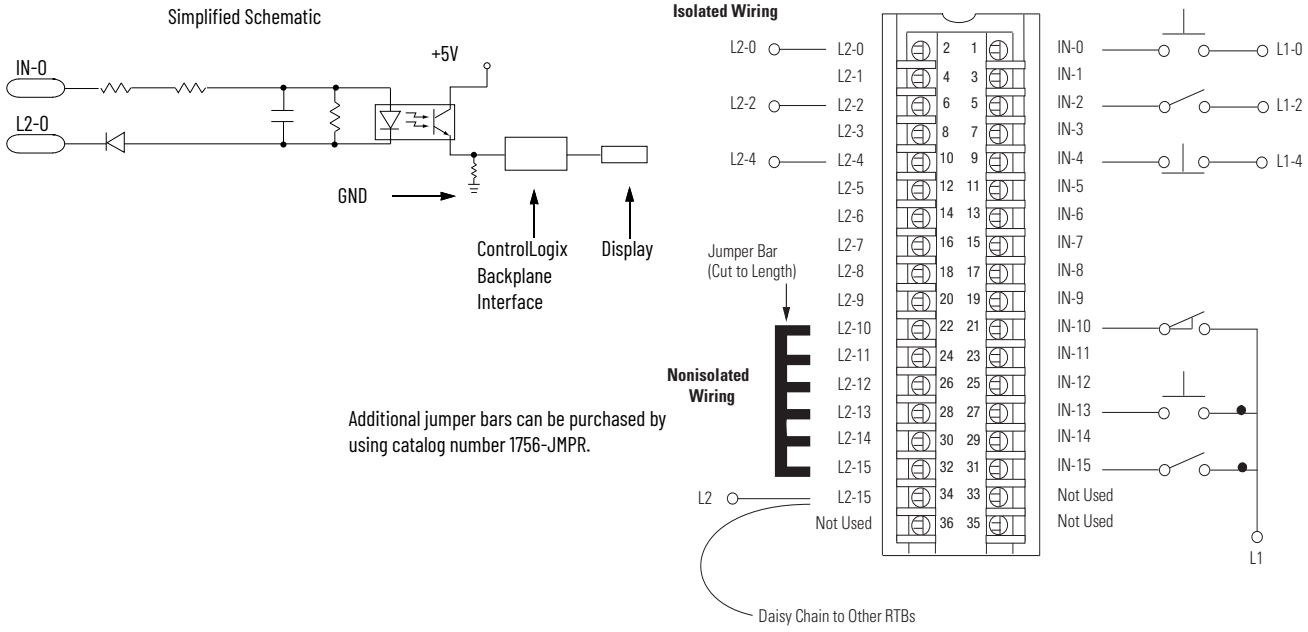
1756-IH16I, 1756-IH16IK

ControlLogix DC (90...146V) isolated input module



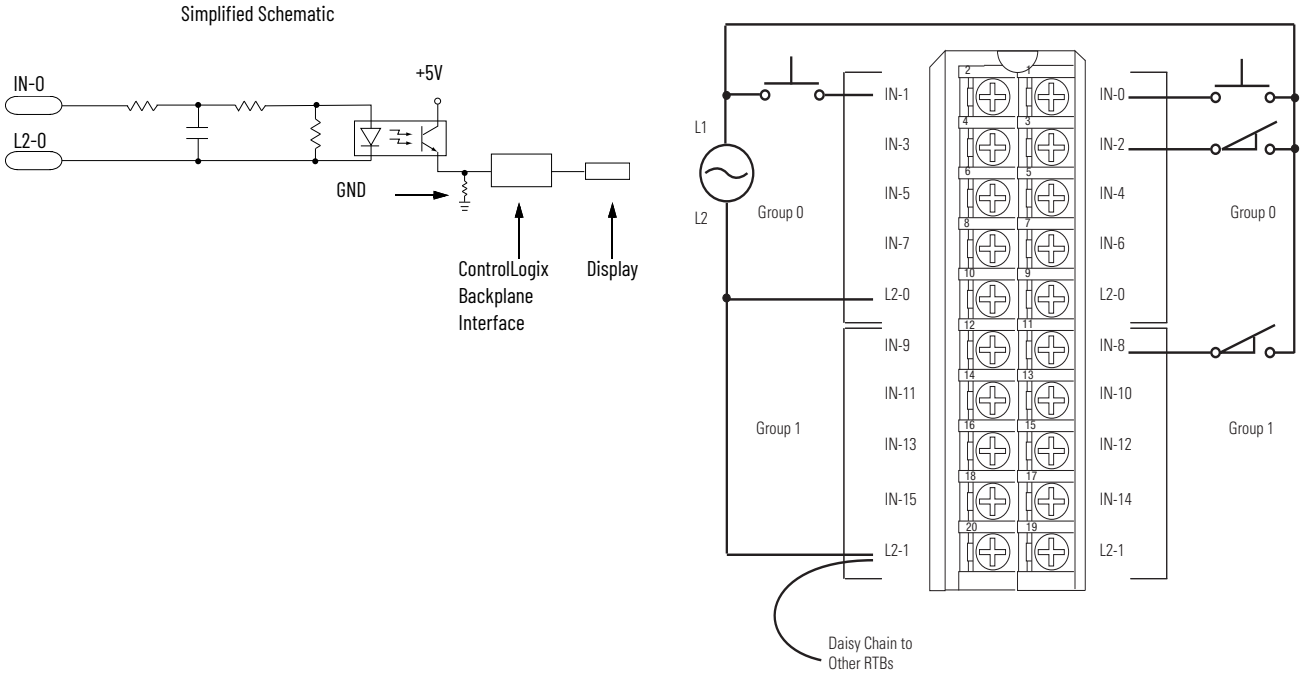
1756-IM16I, 1756-IM16IK

ControlLogix AC (159...265V) input module



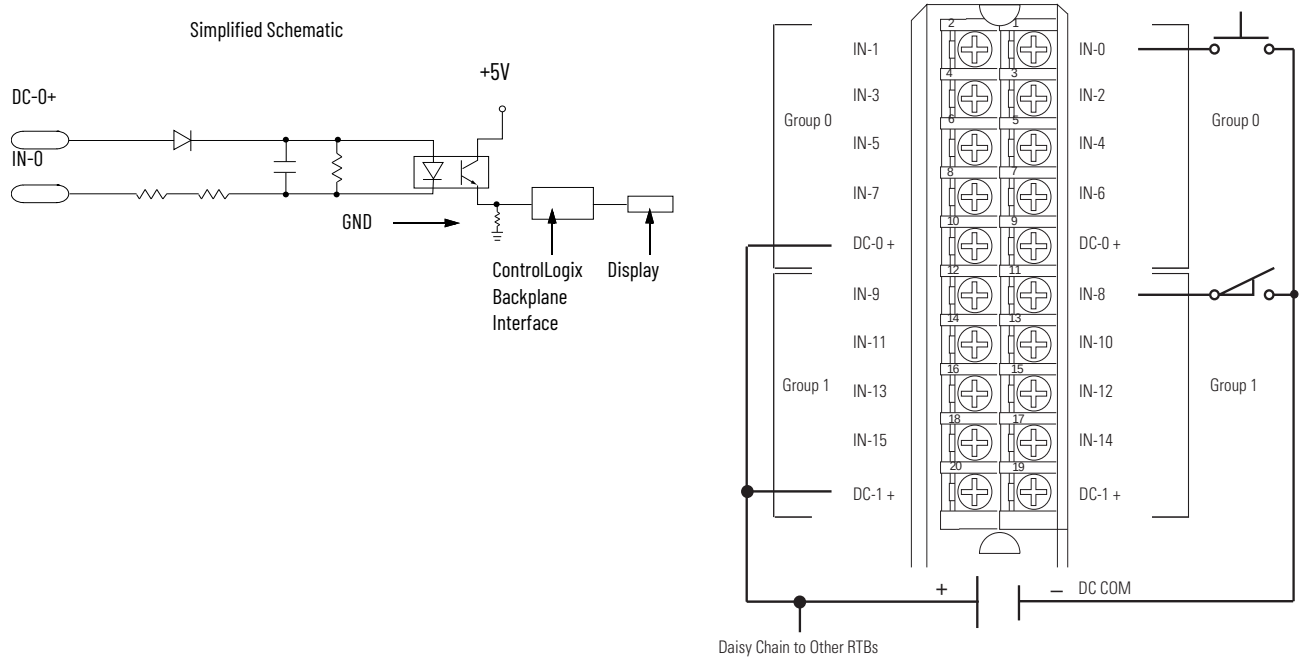
1756-IN16, 1756-IN16K

ControlLogix AC (10...30V) input module



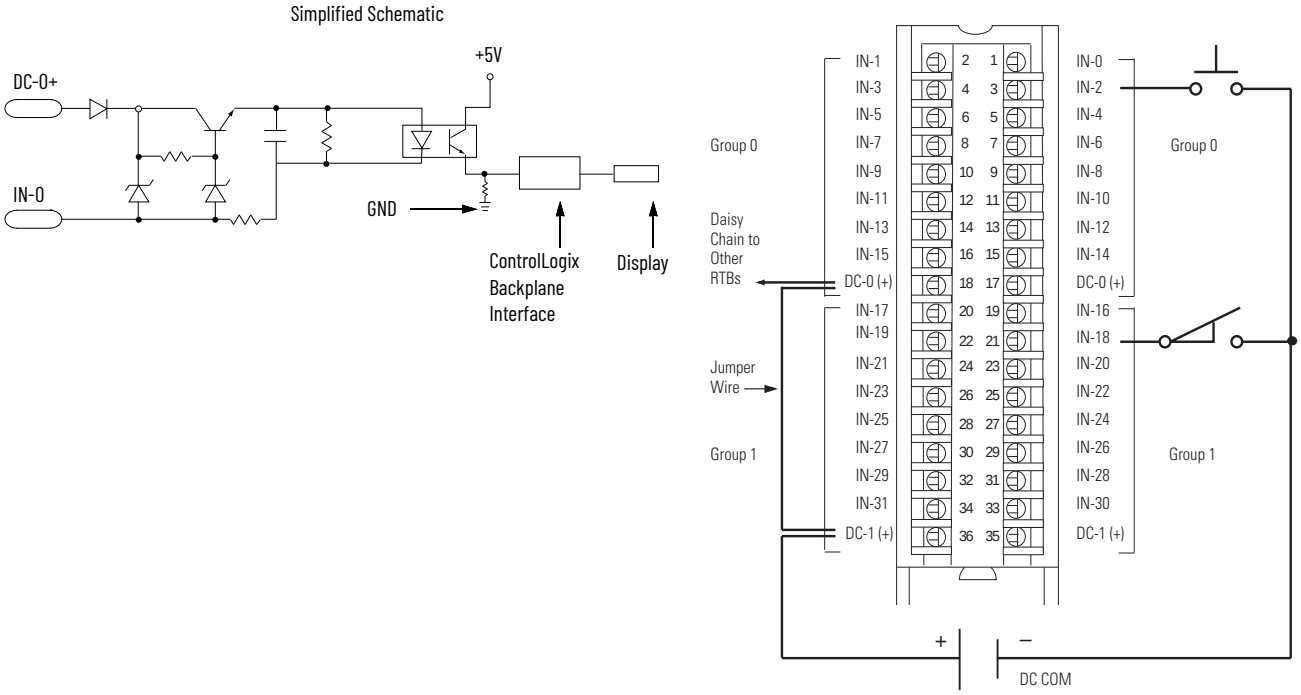
1756-IV16, 1756-IV16K

ControlLogix DC (10...30V) sourcing input module



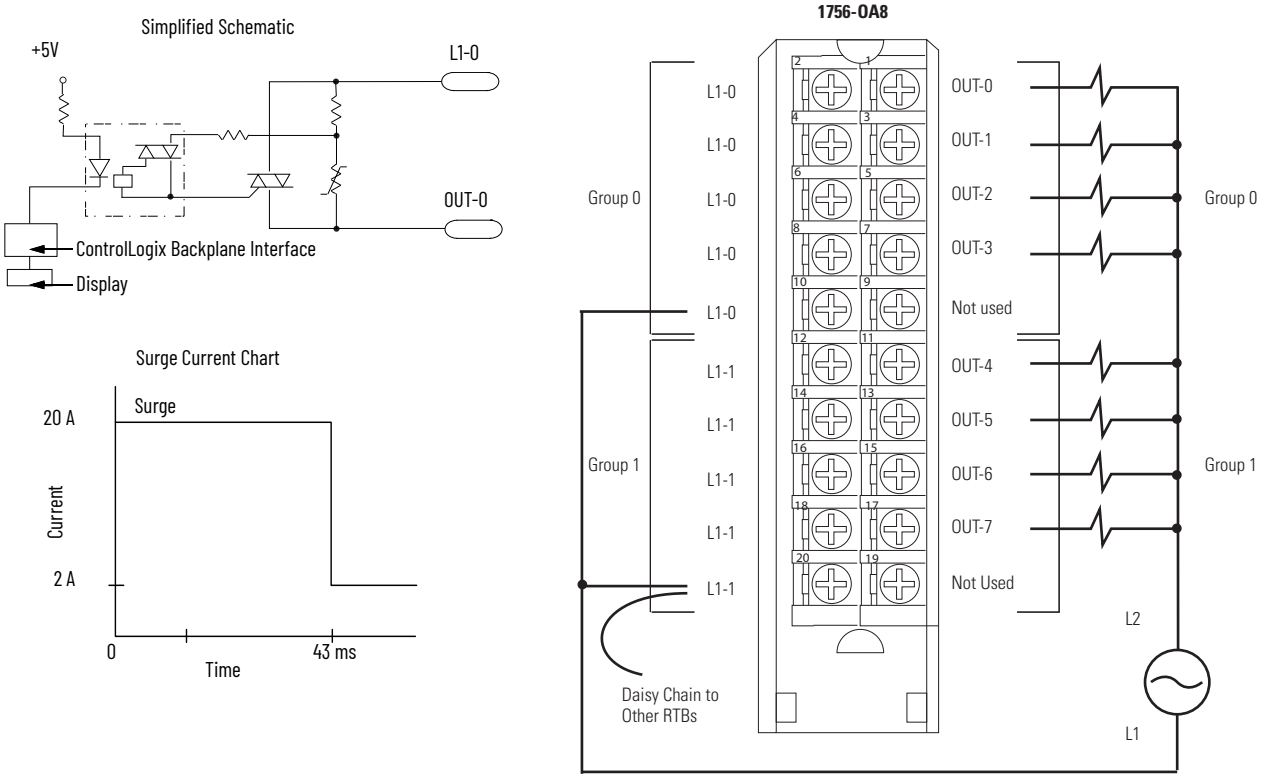
1756-IV32, 1756-IV32K

ControlLogix DC (10...30V) sourcing input module



1756-OA8

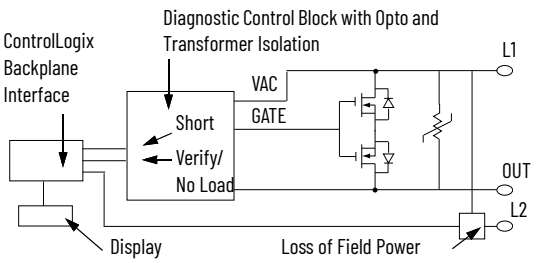
ControlLogix AC (74...265V) output module



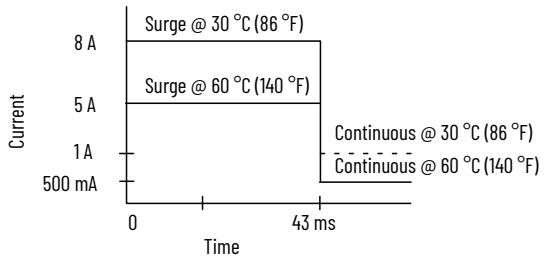
1756-OA8D

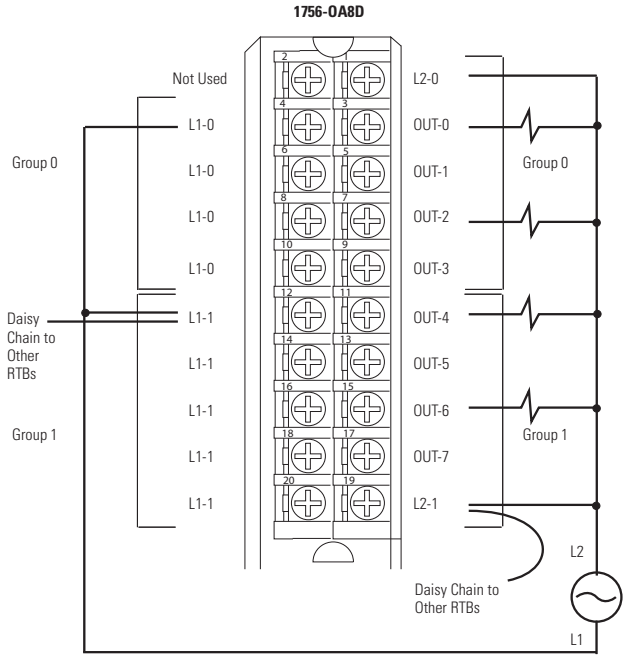
ControlLogix AC (74...132V) diagnostic output module

Simplified Schematic



Surge Current Chart

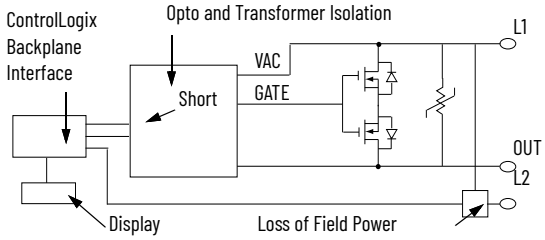




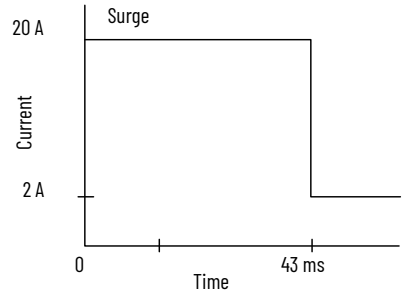
1756-OA8E

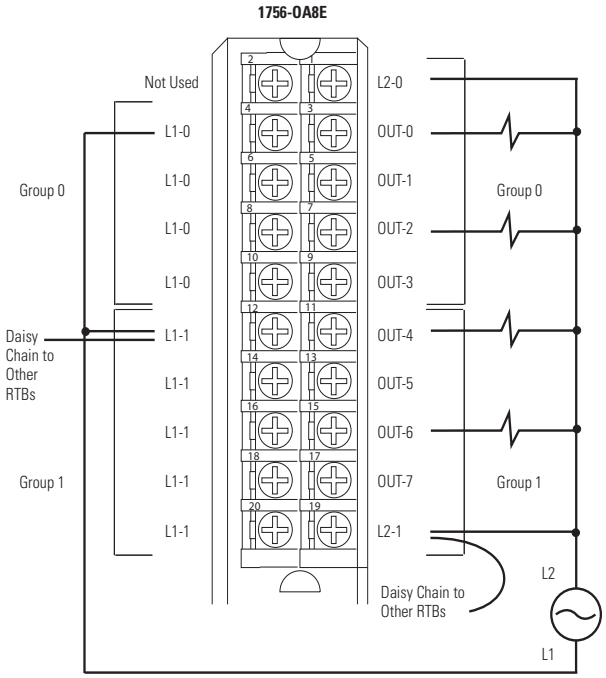
ControlLogix AC (74...132V) electronically fused output module

Simplified Schematic



Surge Current Chart

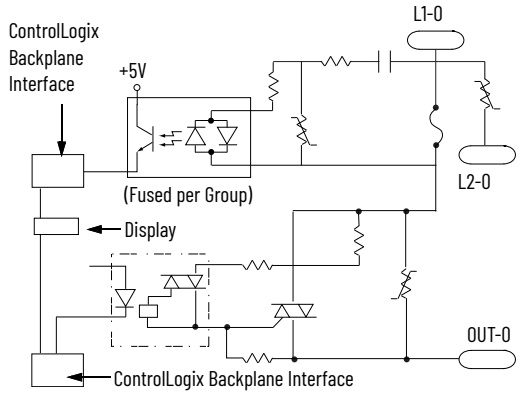




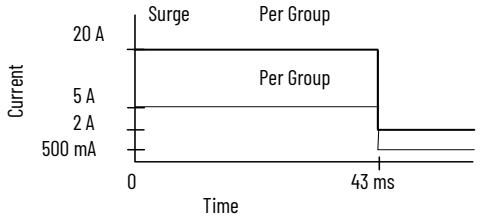
1756-OA16, 1756-OA16K

ControlLogix AC (74...265V) output module

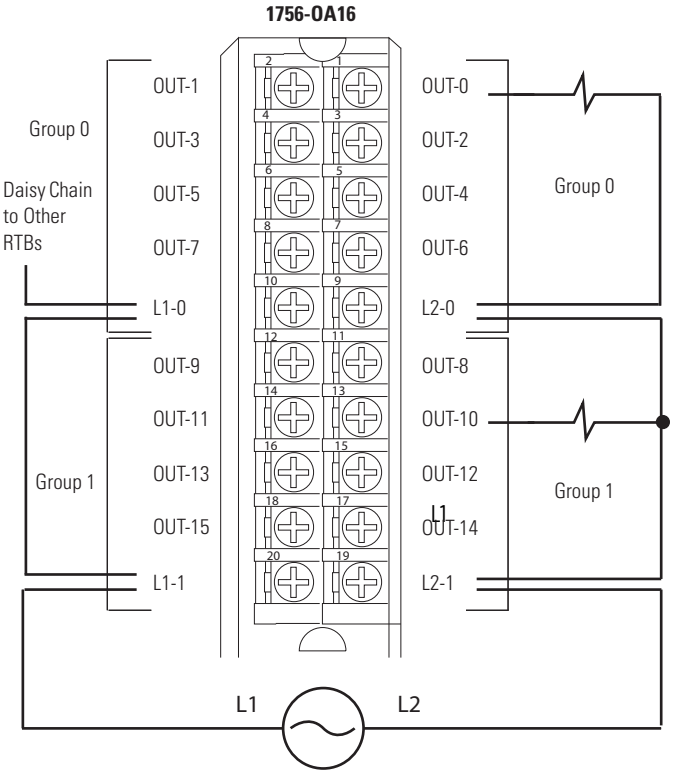
Simplified Schematic



Surge Current Chart



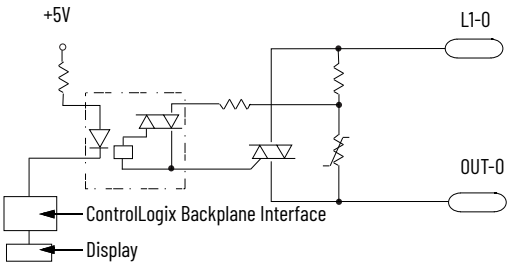
1756-OA16



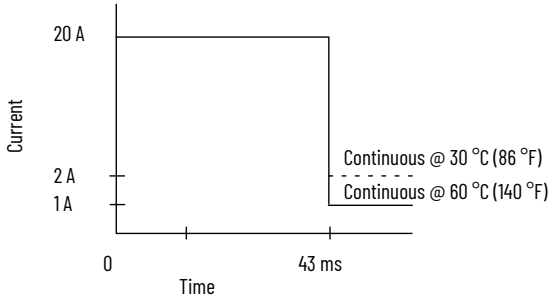
1756-OA16I, 1756-OA16IK

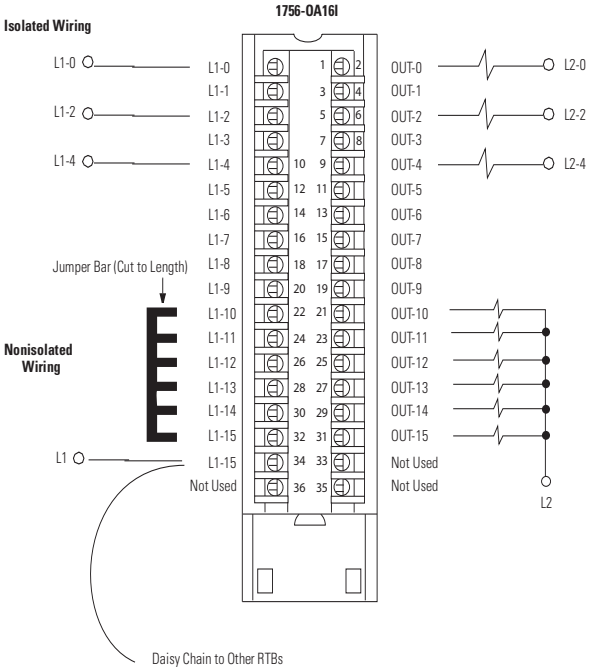
ControlLogix AC (74...265V) isolated output module

Simplified Schematic



Surge Current Chart

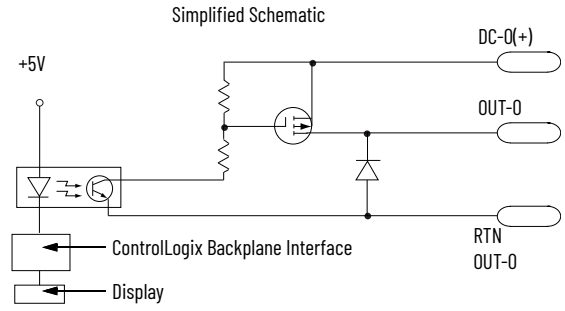


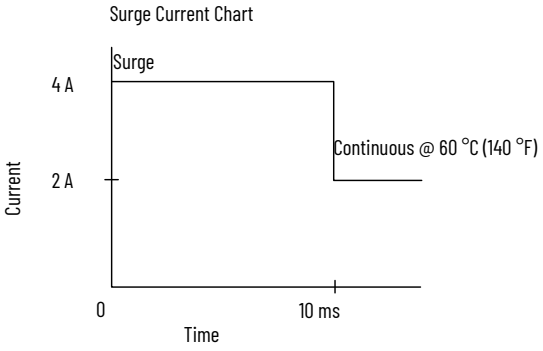


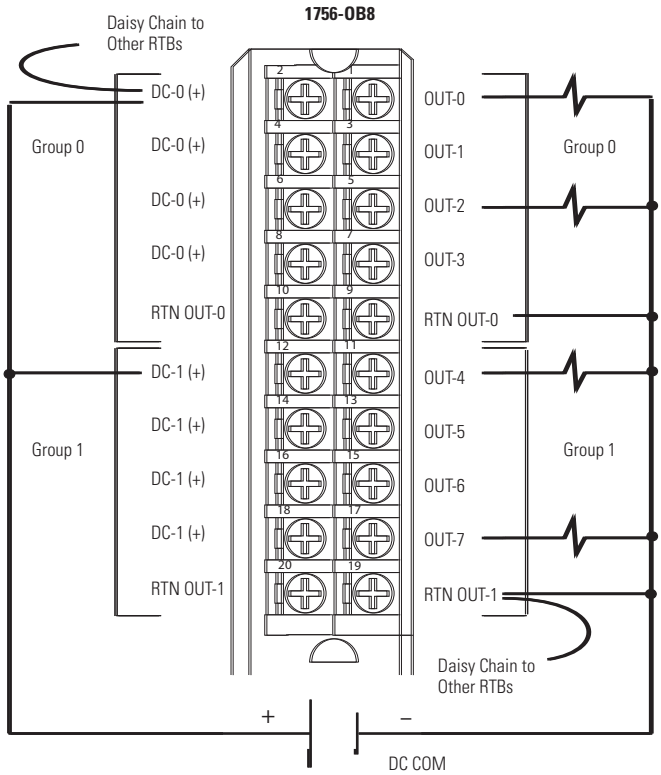
Additional jumper bars can be purchased by using catalog number 1756-JMPR.

1756-OB8, 1756-OB8K

ControlLogix DC (10...30V) output module

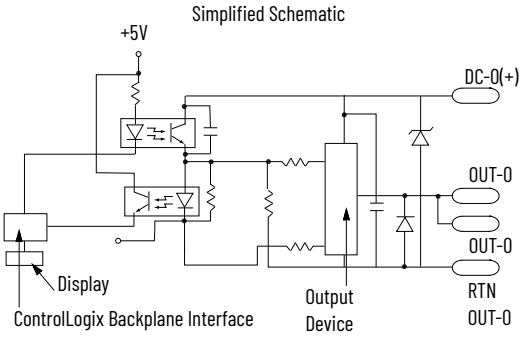


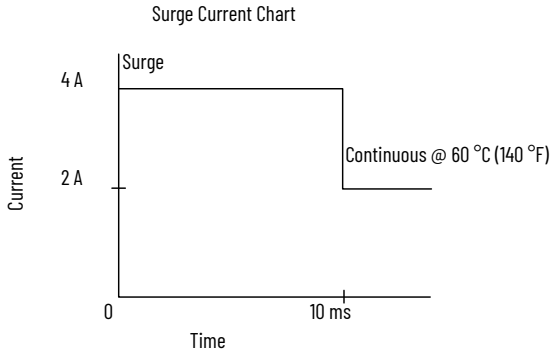


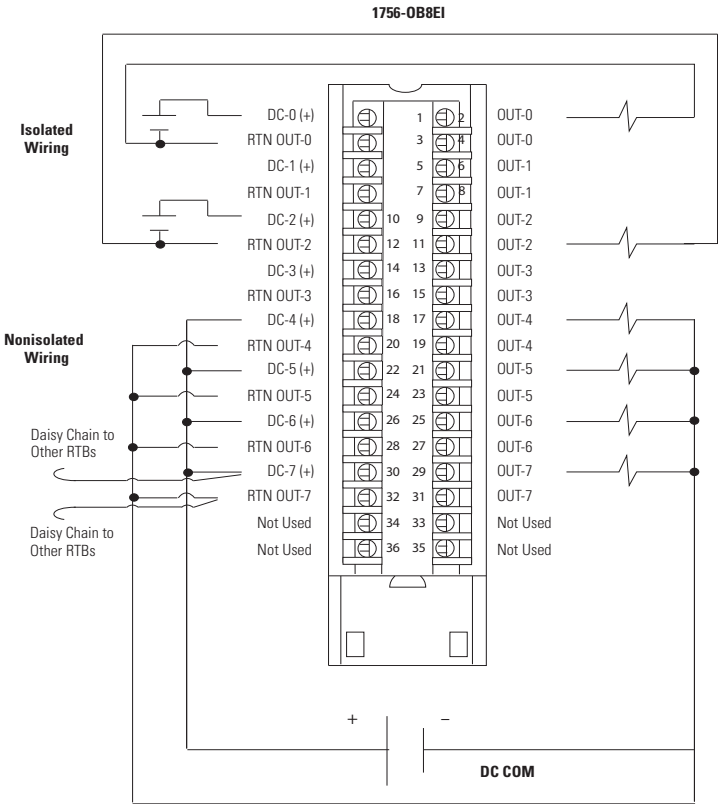


1756-OB8EI, 1756-OB8EIK

ControlLogix DC (10...30V) electronically fused, isolated output module

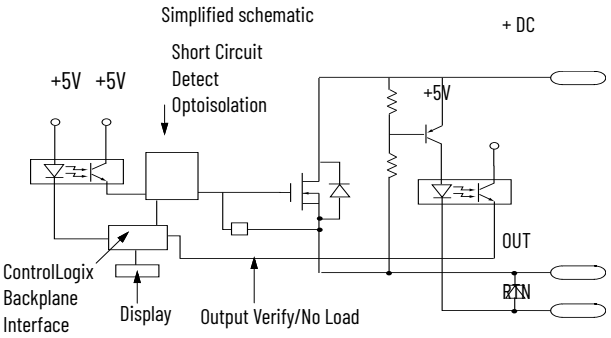


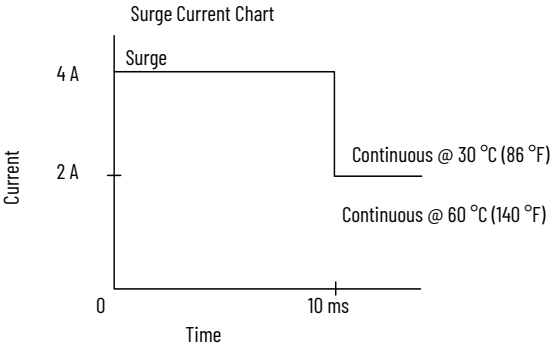


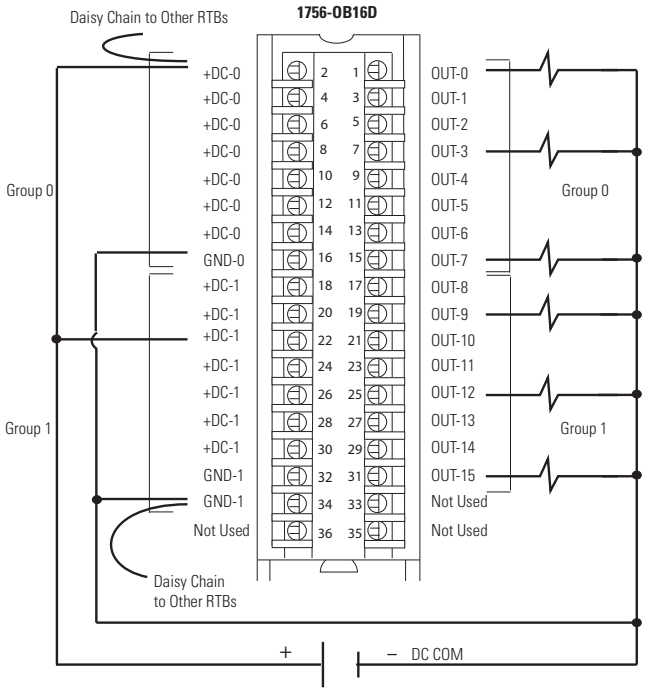


1756-OB16D, 1756-OB16DK

ControlLogix DC (19.2...30V) diagnostic output module

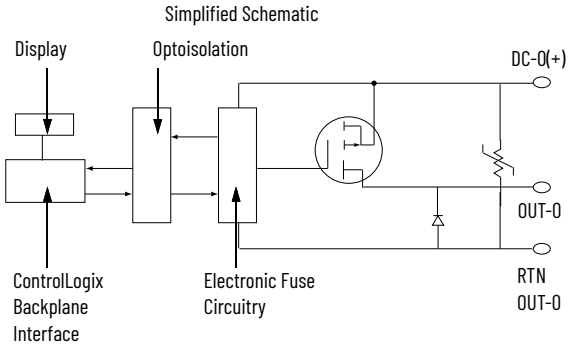


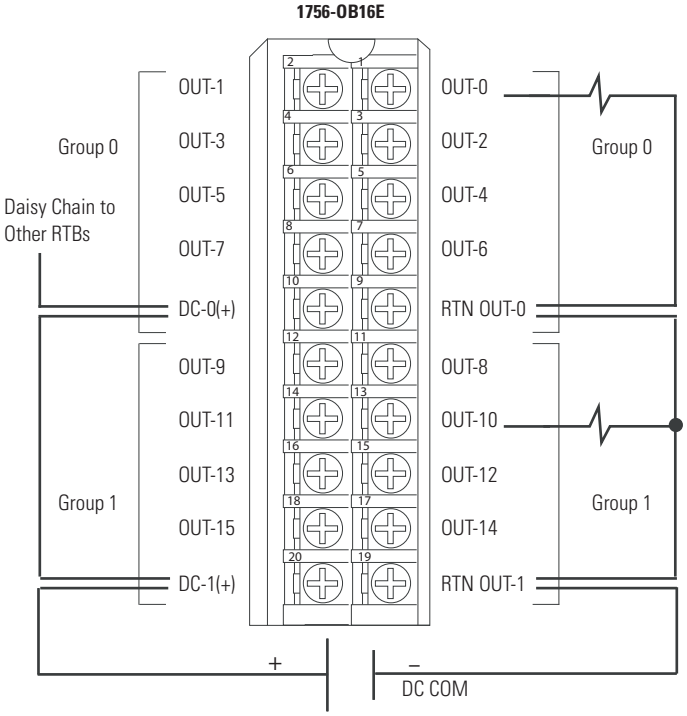




1756-OB16E, 1756-OB16EK

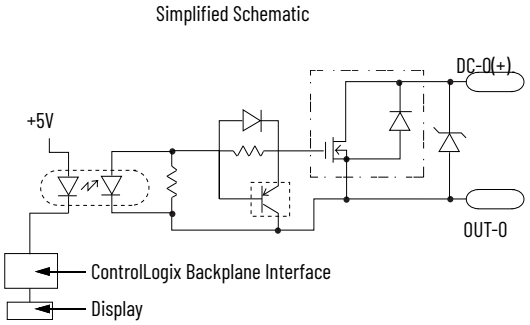
ControlLogix DC (10...31.2V) electronically fused output module

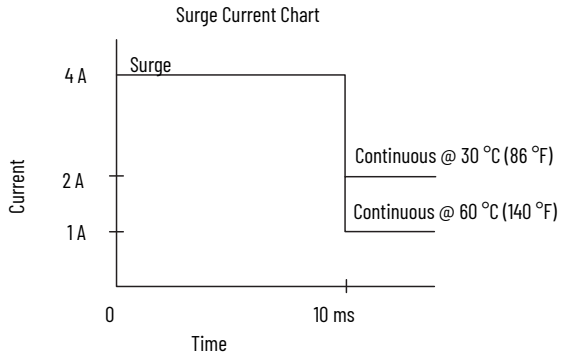


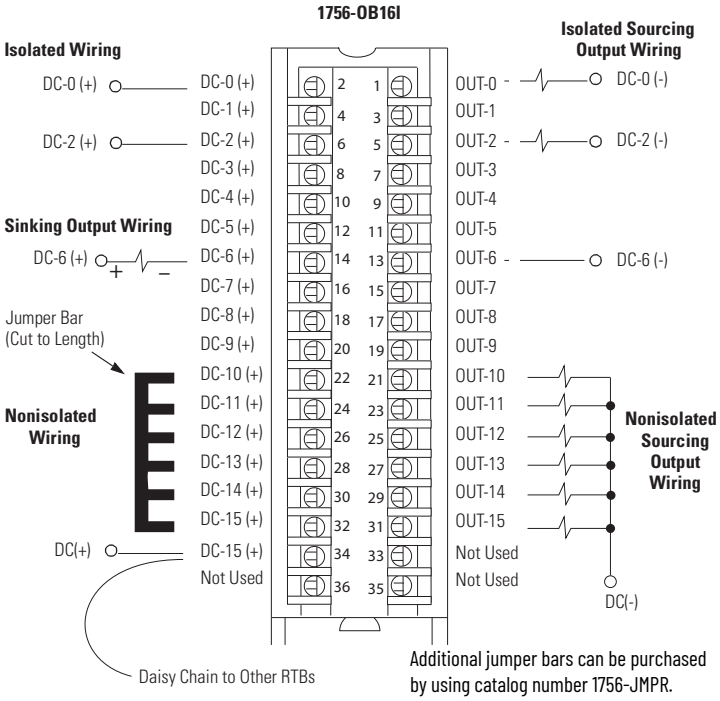


1756-OB16I

ControlLogix DC (10...30V) isolated output module



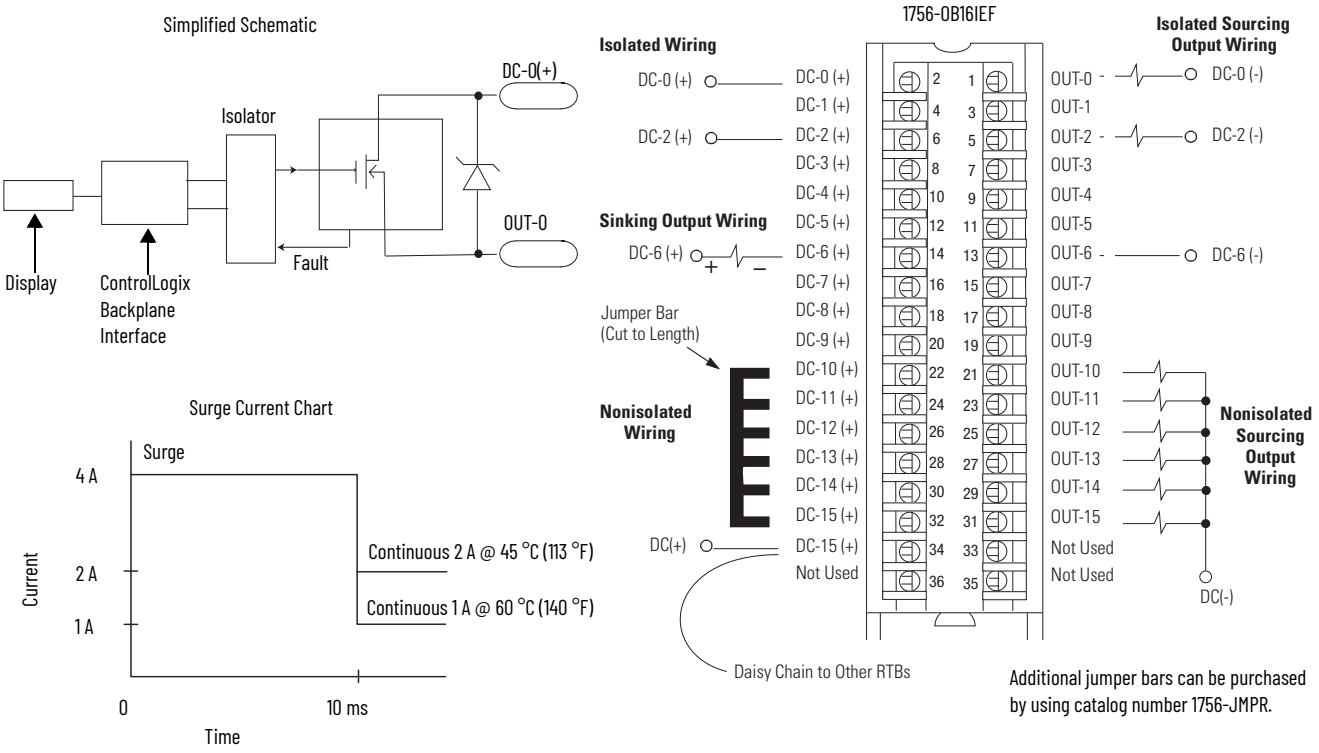




Additional jumper bars can be purchased by using catalog number 1756-JMPR.

1756-OB16IEF, 1756-OB16IEFK

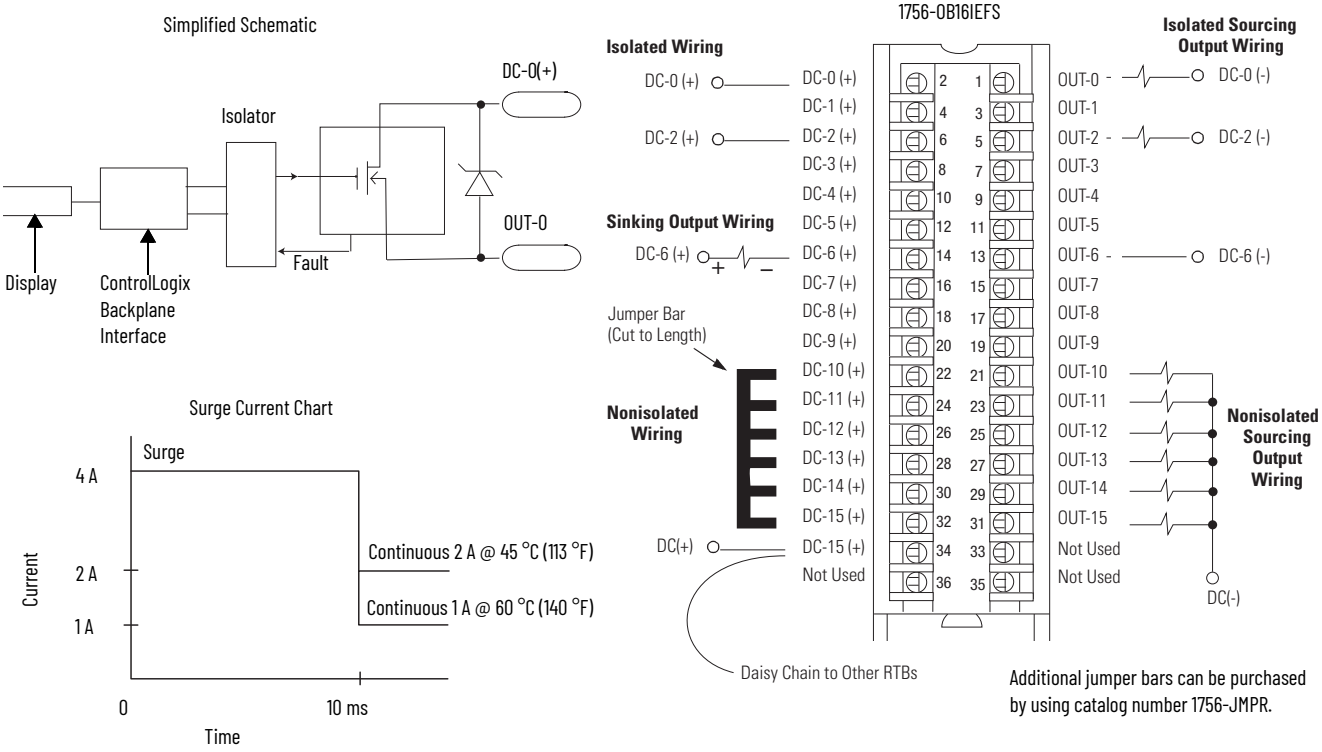
ControlLogix DC (10...30V) electronically protected, sinking or sourcing, isolated, fast output module



Additional jumper bars can be purchased by using catalog number 1756-JMPR.

1756-OB16IEFS, 1756-OB16IEFSK

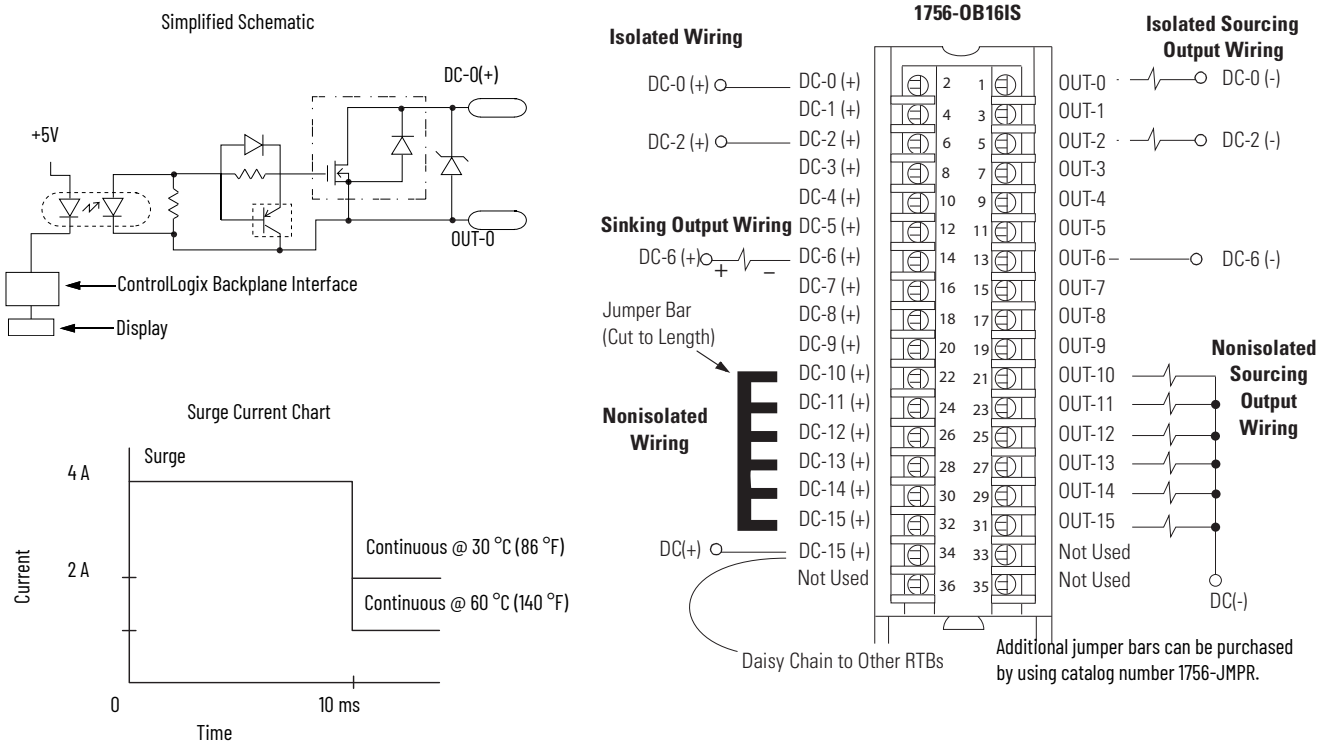
ControlLogix DC (10...30V) scheduled, electronically protected, sinking or sourcing, isolated, fast output module



Additional jumper bars can be purchased by using catalog number 1756-JMPR.

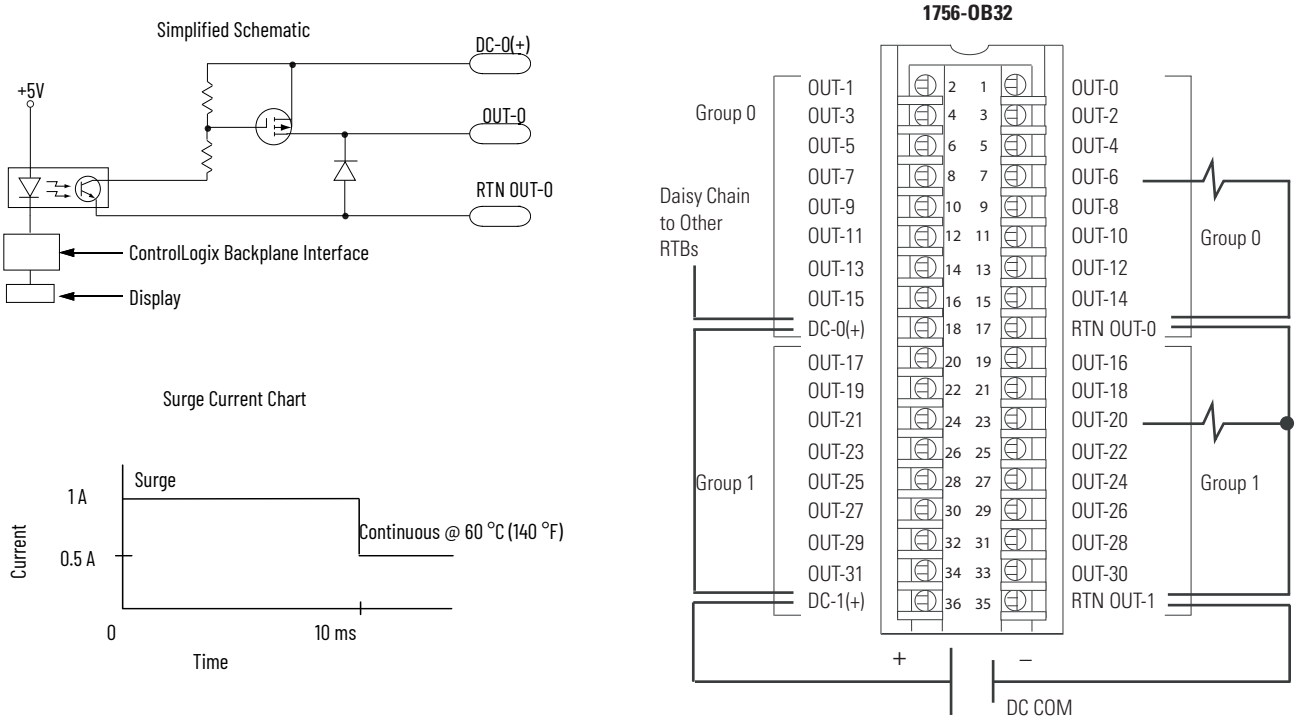
1756-OB16IS

ControlLogix DC (10...30V) scheduled, isolated output module



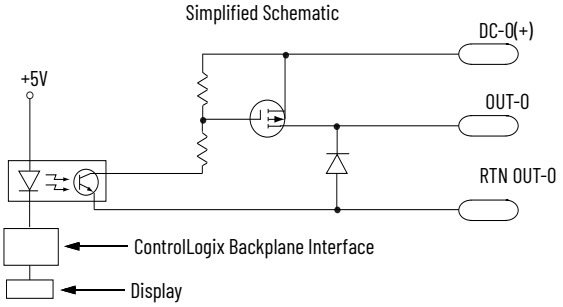
1756-OB32, 1756-OB32K, 1756-OB32XT

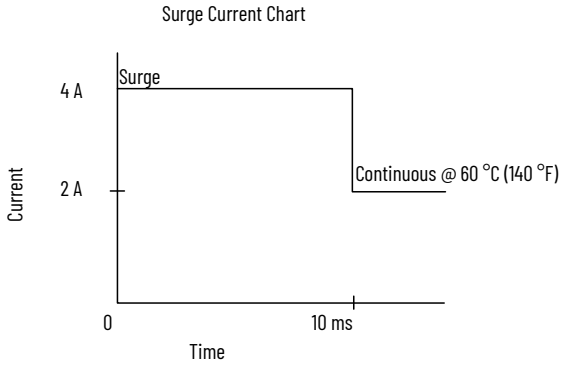
ControlLogix DC (10...31.2V) output module

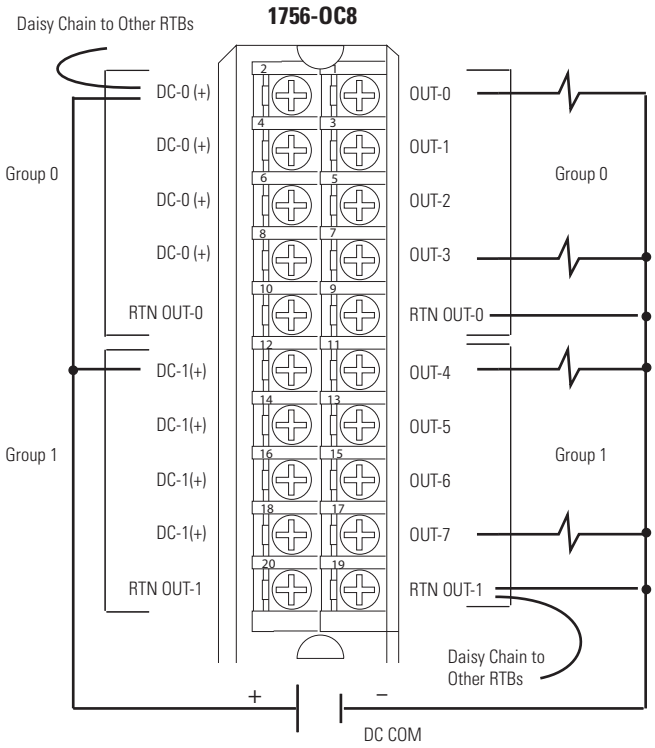


1756-OC8, 1756-OC8K

ControlLogix DC (30...60V) output module





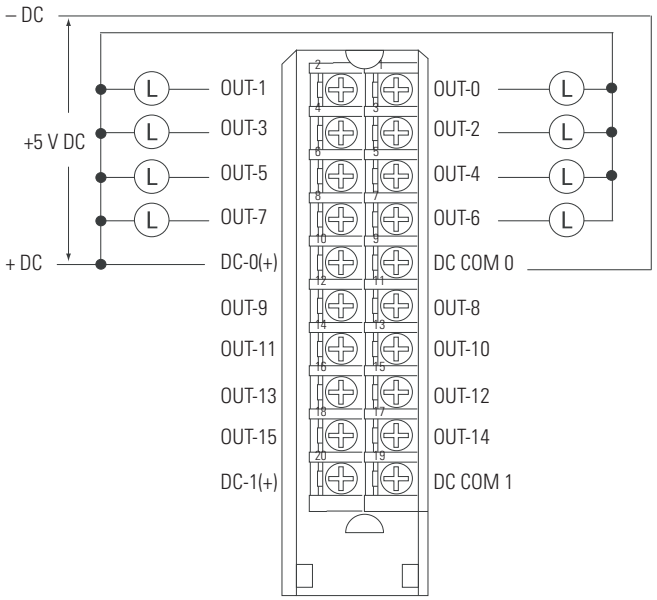


1756-OG16, 1756-OG16K

ControlLogix TTL output module

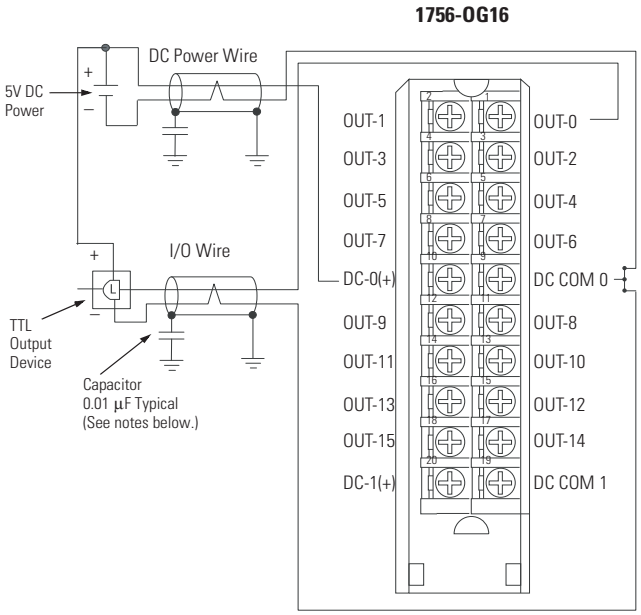
Standard Wiring

1756-OG16

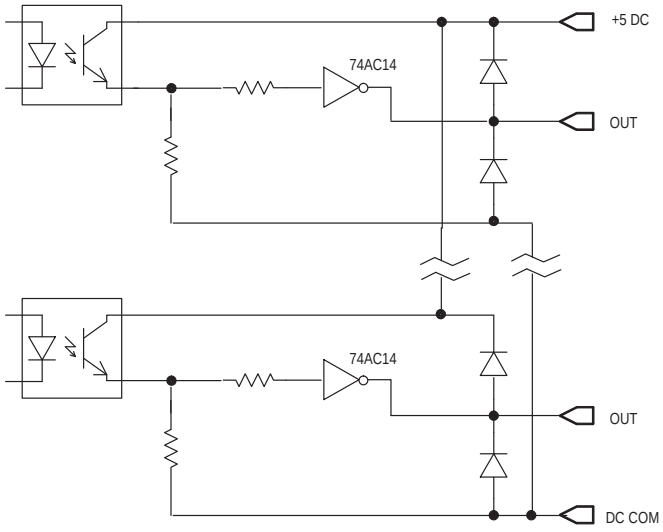


CE-Compliant Wiring

1756-OG16

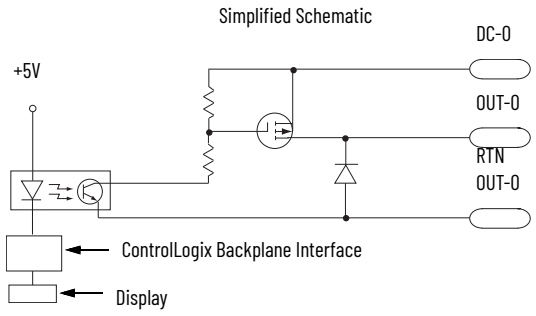


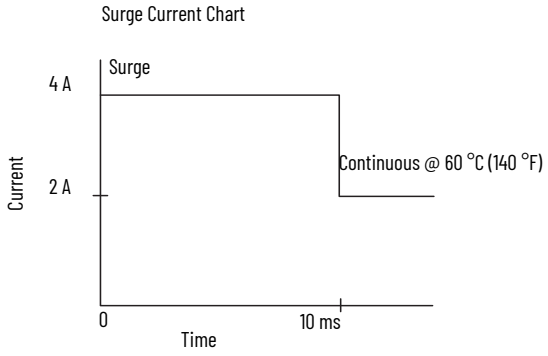
Simplified Schematic

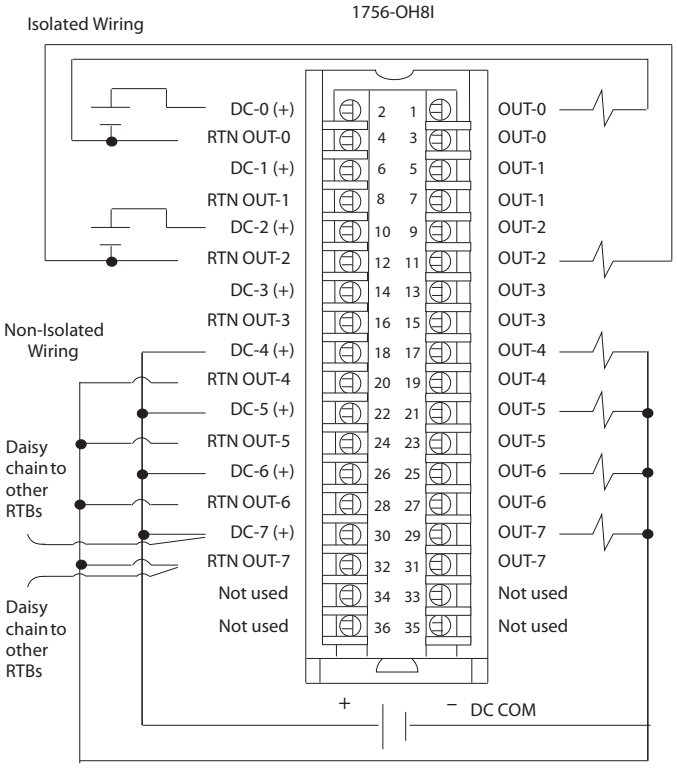


1756-OH8I

ControlLogix DC (90...146V) isolated output module

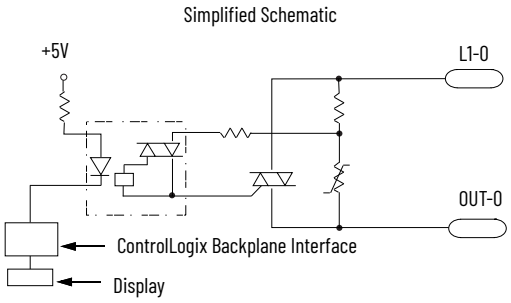


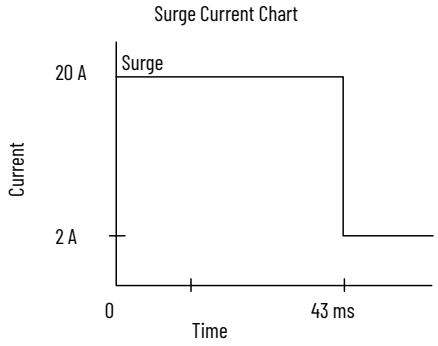


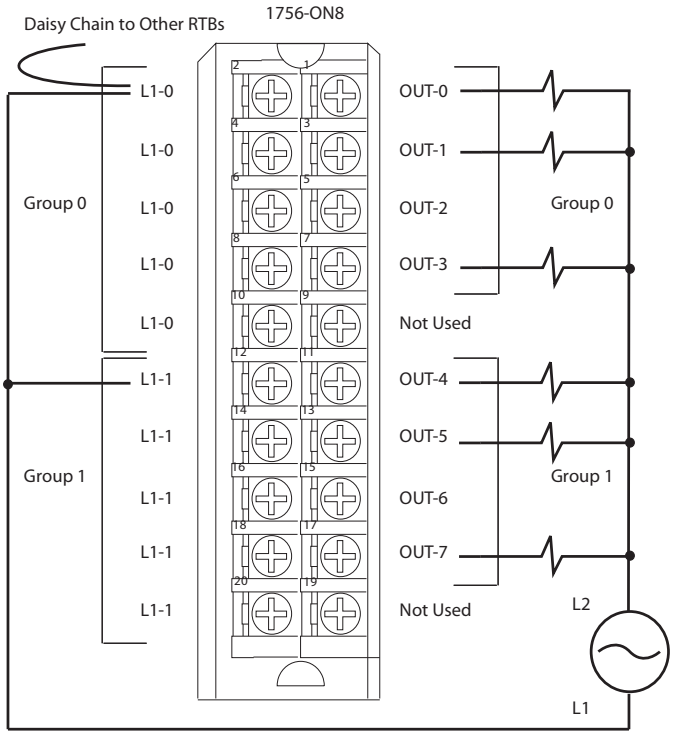


1756-ON8, 1756-ON8K

ControlLogix AC (10...30V) output module

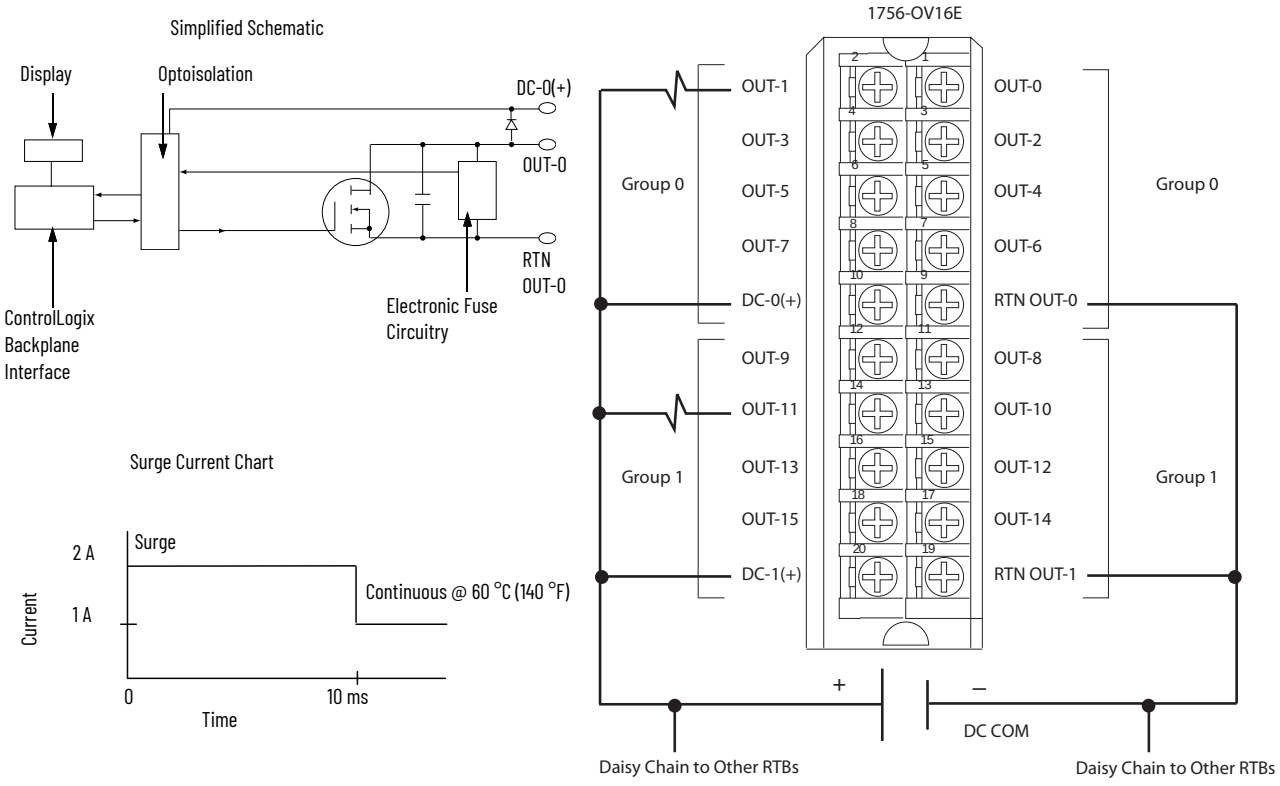






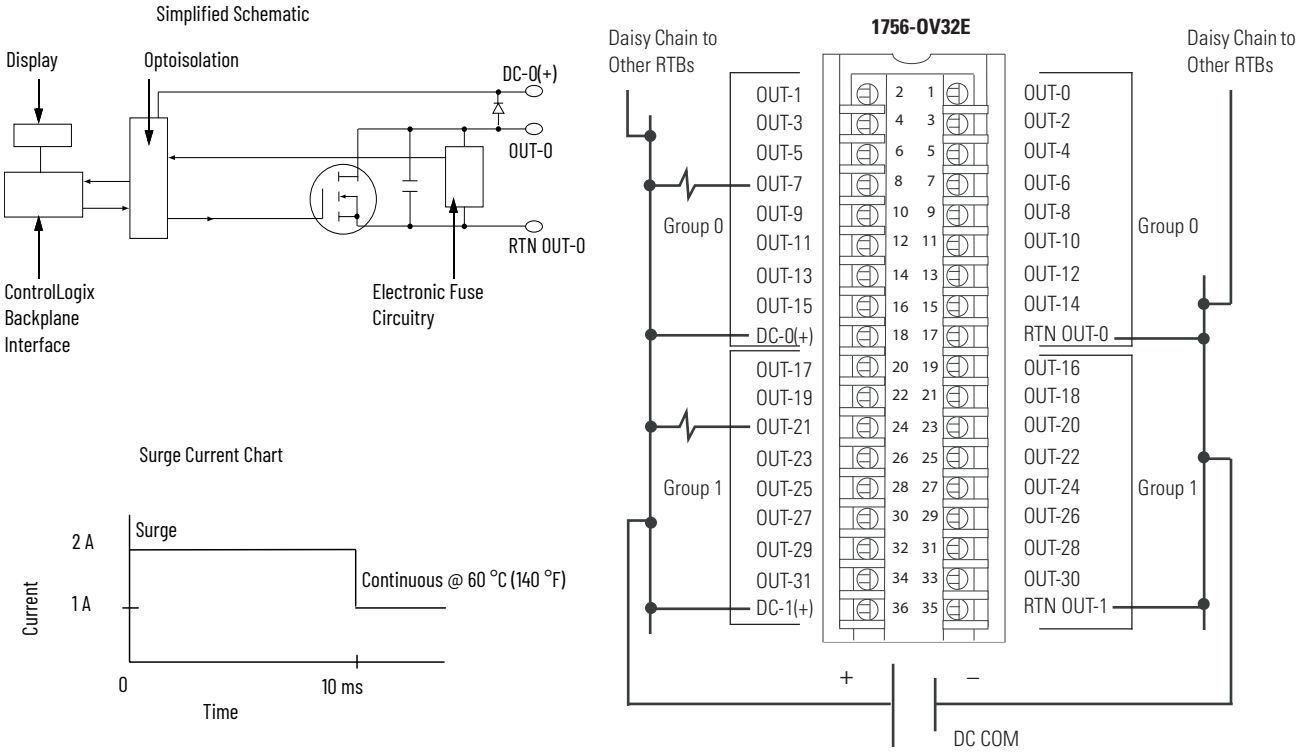
1756-OV16E

ControlLogix DC (10...30V) electronically fused, sinking output module



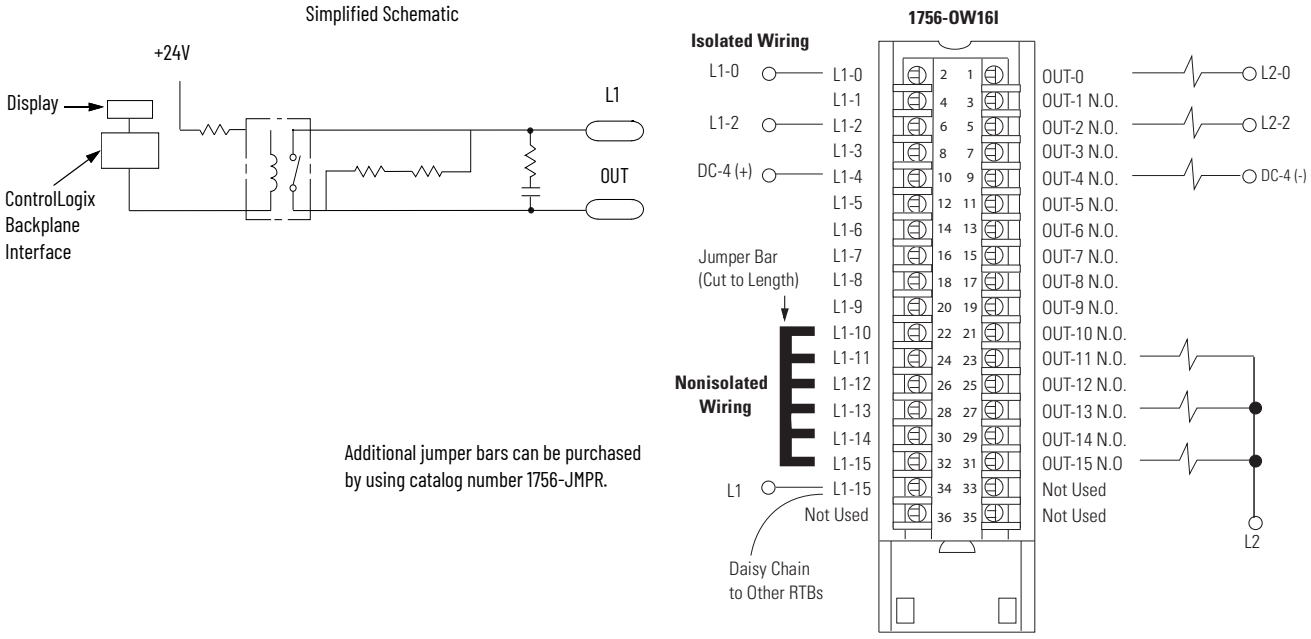
1756-OV32E, 1756-OV32EK

ControlLogix DC (10...30V) electronically fused, sinking output module



1756-OW16I, 1756-OW16IK

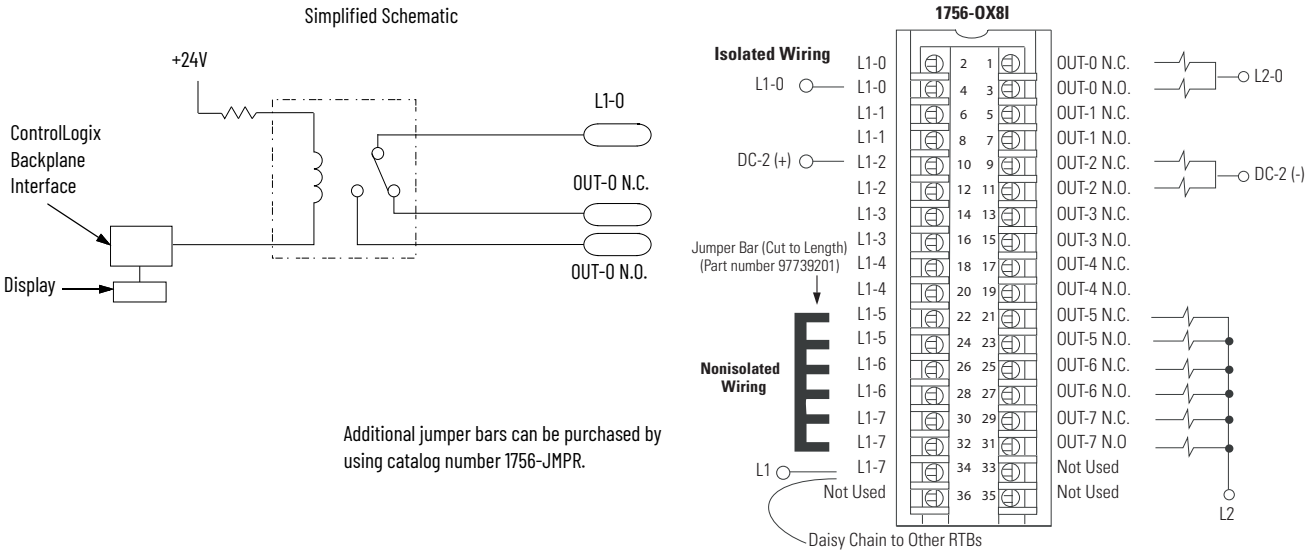
ControlLogix AC (10...240V) DC (5...125V) isolated contact module



Additional jumper bars can be purchased by using catalog number 1756-JMPR.

1756-OX8I, 1756-OX8IK

ControlLogix AC (10...240V) DC (5...125V) isolated contact module



Additional jumper bars can be purchased by using catalog number 1756-JMPR.

Notes:

Tag Definitions

This appendix describes the tags that are used for standard, diagnostic, and fast input and output modules.

Module-defined data types and tags are created when a module is initiated. The set of tags that are associated with any module depends on the type of module and the communication or connection format that is chosen during configuration.

Standard and Diagnostic Input Module Tags

ControlLogix® standard and diagnostic input modules have two types of tags:

- **Configuration**—Structure of data that is sent from the controller to the I/O module upon powerup.
- **Input**—Structure of data continually sent from the I/O module to the controller containing the current operational status of the module.

IMPORTANT The tables below list all possible standard and diagnostic input module tags. In each application, the series of tags varies, depending on how the module is configured.

Table 43 - Standard Input Module Configuration Tags

Name	Data Type	Definition
COSOnOffEn (1 bit per point)	DINT	**Change of State On to Off—**Causes updated data to be sent to the controller immediately after an input for an On to Off transition of the masked input points. The CST timestamp is also updated. May be used to trigger an event task in the controller. 0 = Disable 1 = Enable
COSOffOnEn (1 bit per point)	DINT	**Change of State Off to On—**Causes updated data to be sent to the controller immediately after an input for an Off to On transition of the masked input points. The CST timestamp is also updated. May be used to trigger an event task in the controller. 0 = Disable 1 = Enable
FilterOnOff_0_7... (1 byte per group)	SINT	**Filter Times On to Off—**Filter time for digital filter in digital input modules for On to Off transition. Operates on groups of eight points. Valid DC filter times = 0, 1, 2, 9, 18 ms Valid AC filter times = 1, 2 ms
FilterOffOn_0_7... (1 byte per group)	SINT	**Filter Times Off to On—**Filter time for digital filter in digital input modules for Off to On transition. Operates on groups of eight points. Valid DC filter times = 0, 1, 2 ms Valid AC filter times = 1, 2 ms

Table 44 - Standard Input Module Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp can be configured to indicate the time that data changed (see COSOffOnEn, COSOnOffEn, COSStatus, DiagCOSDisable) and/or the time that a diagnostic fault occurred (see OpenWireEn, Field PwrLossEn).
Data (1 bit per point)	DINT	**Off/On—**Status for each input point. 0 = Off 1 = On
Fault (1 bit per point)	DINT	**Fault Status—**An an ordered status of faults that indicates a point is faulted and input data for that point may be incorrect. Check other diagnostic faults, if they are available, for further diagnosis of the root cause. If communication to the input module is lost, then all points for the module are faulted. 0 = No fault 1 = Fault (OpenWire or FieldPwrLoss or Comm Fault)

Table 45 - Diagnostic Input Module Configuration Tags

Name	Data Type	Definition
COSOnOffEn (1 bit per point)	DINT	**Change of State On to Off—**Triggers an event in the controller for On to Off transition of input point and causes the input module to update the data table as soon as possible. The CST timestamp is also updated. 0 = Disable 1 = Enable
COS OffOnEn (1 bit per point)	DINT	**Change of State Off to On—**Triggers an event in the controller for Off to On transition of input point and causes the input module to update the data table as soon as possible. The CST timestamp is also updated. 0 = Disable 1 = Enable
DiagCOSDisable (1 bit per point)	BOOL	**Diagnostic Change of State—**Triggers the module to transmit diagnostic status data with an updated timestamp as soon as the diagnostic data changes state.
FaultLatchEn (1 bit per point)	DINT	**Latch Fault—**If enabled for a point, any OpenWire or FieldPwrLoss stays latched in the faulted state even if the fault no longer exists until you clear the fault. 0 = Disable 1 = Enable latching
FieldPwrLossEn (1 bit per point)	DINT	**Field Power Loss—**Enables Field Power Loss diagnostic. 0 = Disable 1 = Enable
FilterOnOff_0_7... (1 byte per group)	SINT	**Filter Time On to Off—**Filter time for digital filter in digital input modules for On to Off transition. Operates on groups of eight points. Valid DC filter times = 0, 1, 2, 9, 18 ms. Valid AC filter times = 1, 2 ms.
FilterOffOn_0_7... (1 byte per group)	SINT	**Filter Time Off to On—**Filter time for digital filter in digital input modules for Off to On transition. Operates on groups of eight points. Valid DC filter times = 0, 1, 2 ms. Valid AC filter times = 1, 2 ms.
OpenWireEn (1 bit per point)	DINT	**Open Wire—**Enables Open Wire diagnostic. 0 = Disable. 1 = Enable.

Table 46 - Diagnostic Input Module Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp can be configured to indicate the time that data changed (see COSOffOnEn, COSOnOffEn, COSStatus, DiagCOSDisable) and/or the time that a diagnostic fault occurred (see OpenWireEn, Field PwrLossEn).
Data (1 bit per point)	DINT	**Input Status—**On/Off status for each input point. 0 = Off 1 = On
Fault (1 bit per point)	DINT	**Fault Status—**An ordered status of faults that indicates a point is faulted and input data for that point may be incorrect. Check other diagnostic faults, if they are available, for further diagnosis of the root cause. If communication to the input module is lost or inhibited, then all points for the module are faulted by the processor. 0 = No fault 1 = Fault (OpenWire or FieldPwrLoss or Comm Fault)
FieldPwrLoss (1 bit per point)	DINT	**Field Power Loss—**AC input diagnostic detects that field power has failed or is disconnected from the module. Open Wire also is detected. 0 = No fault 1 = Fault
OpenWire (1 bit per point)	DINT	**Open Wire—**Diagnostic that detects that a wire has been disconnected from the input point. If a group of points shows this fault, then possibly the return (L1 or GND) is missing from the module. Also see FieldPwrLoss. 0 = No fault 1 = Fault

Standard and Diagnostic Output Module Tags

ControlLogix standard and diagnostic digital output modules have three types of tags:

- **Configuration**–Structure of data that is sent from the controller to the I/O module upon powerup.
- **Input**–Structure of data continually sent from the I/O module to the controller containing the current operational status of the module.
- **Output**–Structure of data that is continually sent from the controller to the I/O module that can modify the module behavior.

IMPORTANT The tables below list all possible standard or diagnostic output module tags. In each application, the series of tags varies, depending on how the module is configured.

Table 47 - Standard Output Module Configuration Tags

Name	Data Type	Definition
FaultMode (1bit per point)	DINT	**Fault Mode—**Used in conjunction with FaultValue to configure the state of outputs when a communication fault occurs. See FaultValue. 0 = Use FaultValue (Off or On) 1 = Hold Last State
FaultValue (1 bit per point)	DINT	**Fault Value—**Used in conjunction with FaultMode to configure the state of outputs when a communication fault occurs. See FaultMode. 0 = Off 1 = On
ProgMode (1 bit per point)	DINT	**Program Mode—**Used in conjunction with ProgValue to configure the state of outputs when the controller is in Program mode. See ProgValue. 0 = Use ProgValue (Off or On) 1 = Hold Last State
ProgValue (1 bit per point)	DINT	**Program Value—**Used in conjunction with ProgMode to configure output state when the controller is in Program mode. See ProgMode. 0 = Off 1 = On
ProgToFaultEn (1 byte per module)	BOOL	**Program to Fault Transition—**Diagnostic enables the transition of outputs to FaultMode if a communication failure occurs in Program mode. Otherwise outputs remain in Program mode. See ProgMode, ProgValue, FaultMode, FaultValue. 0 = Outputs stay in Program mode if a communication failure occurs. 1 = Outputs go to FaultMode if a communication failure occurs.

Table 48 - Standard Output Module Input Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp of diagnostic input data including fusing (see BlownFuse, NoLoad, OutputVerifyFault, FieldPwrLoss), which is updated whenever a diagnostic fault occurs or goes away.
Data (1 bit per point)	DINT	**Data—**Off/On status for the output point echoed back from the output module. This is used to verify proper communication only. No field side verification is done. For field side verification, see OutputVerifyFault. 0 = Off 1 = On
Fault (1 bit per point)	DINT	**Fault—**This is an ordered status of faults that indicates a point is faulted and I/O data for that point may be incorrect. Check other diagnostic faults, if they are available, for further diagnosis of the root cause. If communication to the input module is lost, then all points for the module are faulted. 0 = No fault 1 = Fault (FuseBlown, NoLoad, OutputVerifyFault, FieldPwrLoss, or CommFault)
FuseBlown (1 bit per point)	DINT	**Fuse Is Blown—**An electronic or mechanical fuse has detected a short or overload condition for an output point. All FuseBlown conditions are latched and must be reset by the user. 0 = No fault 1 = Fault

Table 49 - Standard Output Module Output Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp to be used with scheduled outputs and coordinated system time (CST). Used to synchronize outputs across the system by indicating the time (CST timestamp) at which the output module is to apply its outputs.
Data (1 bit per point)	DINT	**Output Status—On/Off** status of the output point originating from the controller. 0 = Off 1 = On

Table 50 - Diagnostic Output Module Configuration Tags

Name	Data Type	Definition
FaultLatchEn (1 bit per point)	DINT	**Latch Fault—**If enabled for a point, any NoLoad, OutputVerifyFault or FieldPwrLoss stays latched in the faulted state even if the fault no longer exists until the user clears the fault. This does not affect FuseBlown; it is always latched. 0 = Disable 1 = Enable latching
FaultMode (1 bit per point)	DINT	**Fault Mode—**Used in conjunction with FaultValue to configure the state of outputs when a communication fault occurs. See FaultValue. 0 = Use FaultValue (Off or On) 1 = Hold Last State
FaultValue (1 bit per point)	DINT	**Fault Value—**Used in conjunction with FaultMode to configure the state of outputs when a communication fault occurs. See FaultMode. 0 = Off 1 = On
FieldPwrLoss (1 bit per point)	DINT	**Field Power Loss—**Enables Field Power Loss diagnostic. 0 = Disable 1 = Enable
NoLoadEn (1 bit per point)	DINT	**No Load—**Enables No Load diagnostic. 0 = Disable 1 = Enable
OutputVerifyEn (1 bit per point)	DINT	**Output Verify—**Enables Output Verify diagnostic. 0 = Disable 1 = Enable
ProgMode (1 bit per point)	DINT	**Program Mode—**Used in conjunction with ProgValue to configure output state when the controller is in Program mode. See ProgValue. 0 = Use ProgValue (Off or On) 1 = Hold Last State
ProgValue (1 bit per point)	DINT	**Program Value—**Used in conjunction with ProgMode to configure output state when the controller is in Program mode. See ProgMode. 0 = Off 1 = On
ProgToFaultEn (1 byte per module)	BOOL	**Program to Fault Transition—**Diagnostic enables the transition of outputs to FaultMode if a communication failure occurs in Program mode. Otherwise outputs remain in Program mode. See ProgMode, ProgValue, FaultMode, FaultValue. 0 = Outputs stay in Program mode if a communication failure occurs. 1 = Outputs go to FaultMode if a communication failure occurs.

Table 51 - Diagnostic Output Module Input Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp of diagnostic input data including fusing (see BlownFuse, NoLoad, OutputVerifyFault, FieldPwrLoss), which is updated whenever a diagnostic fault occurs or goes away.
Data (1 bit per point)	DINT	**Output Echo Status—**Off/On status for the output point echoed back from the output module. This is used to verify proper communication only. No field side verification is done. For field side verification, see OutputVerifyFault. 0 = Off 1 = On
Fault (1 bit per point)	DINT	**Fault Status—**Indicates whether a point is faulted. Faulted I/O data for that point may be incorrect. Check other diagnostic faults, if they are available, for further diagnosis of the root cause. If communication to the input module is lost or inhibited, then all points for the module are faulted by the processor. 0 = No fault 1 = Fault (FuseBlown, NoLoad, OutputVerifyFault, FieldPwrLoss, or CommFault)
FieldPwrLoss (1 bit per point)	DINT	**Field Power Loss—**AC output diagnostic detects that field power has failed or is disconnected from the module. No Load also is detected. 0 = No fault 1 = Fault
FuseBlown (1 bit per point)	DINT	**Fuse Is Blown—**An electronic or mechanical fuse has detected a short-circuit condition for an output point. All FuseBlown conditions are latched and must be reset by the user. 0 = No fault 1 = Fault
NoLoad (1 bit per group)	DINT	**No Load—**Indicates the absence of a load (such as, the wire is disconnected from the module). Operates only in the Off state 0 = No fault 1 = Fault
OutputVerifyFault (1 bit per point)	DINT	**Output Verify—**Diagnostic that indicates that the input has been commanded to the On state but the output has not been verified as On. 0 = No fault 1 = Fault (output is not On)

Table 52 - Diagnostic Output Module Output Data Tags

Name	Data Type	Definition
CSTTimestamp (8 bytes)	DINT[2]	**Coordinated System Time Timestamp—**Timestamp to be used with scheduled outputs and coordinated system time (CST). Used to synchronize outputs across the system by indicating the time (CST timestamp) at which the output module is to apply its outputs.
Data (1 bit per point)	DINT	**Output Status—**Status for the output point originating from the controller. 0 = Off 1 = On

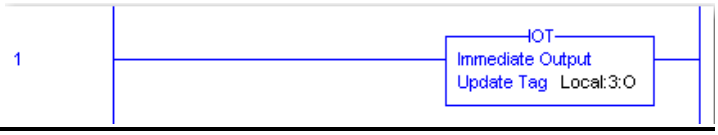
Fast Input Module Tags

The ControlLogix 1756-IB16IF fast input module has four types of tags:

- **Configuration—**Structure of data sent from the controller to the module upon powerup.
- **Input—**Structure of data continually sent from the I/O module to the controller or a listening peer module containing the current operational status of the module.
- **Output—**Structure of output data processed by the input module.

IMPORTANT Output tag information is sent to the 1756-IB16IF module only at the RPI rate defined during configuration. For optimal performance, use an Immediate Output (IOT) instruction.

For example, the rung shown contains an IOT instruction for a fast input module in slot 3. Add a similar rung to your last routine within the Main Task to mimic normal output tag processing.



- **Event—**Structure of event data that is continually sent from the I/O module to the controller or a listening module containing the current operational status of the module.

Fast input modules use array data structures. Array data structures differ from the flat data structures of other digital I/O modules. For more information, see Redundant Owner Configuration Tags on page 143.

IMPORTANT The Module Definition column in each table lists the connection type and input data type combinations that are required to create the corresponding tag. For more information, see Create a New Module on page 62.

Table 53 - 1756-IB16IF Module Configuration Tags

Name	Data Type	Tag Definition	Module Definition
LatchTimestamps	BOOL	**Latch Timestamps—**Latches a CIP Sync™ timestamp for a COS transition: • When an initial timestamp is latched, timestamps for subsequent COS transitions are dropped. • Once a latched timestamp is acknowledged via the corresponding bit in the Pt[x].NewDataOffOnAck or Pt[x].NewDataOnOffAck tag, the timestamp is overridden upon the next COS transition. Requires COS to be enabled via the Pt[x].COSOffOnEn or Pt[x].COSOnOff tags 0 = Timestamps are overridden with each successive COS transition. 1 = Timestamps are latched until acknowledged.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
FilterOffOn	INT	**Filter Time Off to On—**Defines how long an Off to On input transition must remain in the On state before the module considers the transition valid. Valid filter time = 0...30,000 µs	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
FilterOnOff	INT	**Filter Time On to Off—**Defines how long an On to Off input transition must remain in the Off state before the module considers the transition valid. Valid filter time = 0...30,000 µs	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
Pt[x].FilterEn	BOOL	**Filter—**If enabled for a point, input transitions must remain in the new state for a configured length of time before the module considers the transition valid. 0 = Filtering is disabled. 1 = Filtering is enabled.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
Pt[x].COSOffOnEn	BOOL	**Change of State Off to On—**If enabled for a point, an Off to On transition triggers a timestamp recording and sends a COS message on the backplane. 0 = COS data is not produced upon an Off to On transition. 1 = COS data is produced upon an Off to On transition.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
Pt[x].COSOnOffEn	BOOL	**Change of State On to Off—**If enabled for a point, an On to Off transition triggers a timestamp recording and sends a COS message on the backplane. 0 = COS data is not produced upon an On to Off transition. 1 = COS data is produced upon an On to Off transition.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data

Table 54 - 1756-IB16IF Module Input Tags

Name	Data Type	Tag Definition	Module Definition
Fault	DINT	**Fault Status—**Indicates whether a point is faulted. If communication to the input module is lost, then all 32 bits are set. 0 = No fault 1 = Fault	Connection = Data or Listen Only Input Data = Data or Timestamp Data or Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
LocalClockOffset	DINT	**Local Clock Offset—**Indicates the offset in microseconds between the current CST and the CIP Sync value when a valid CIP Sync time is available.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
OffsetTimestamp	DINT	**Timestamp Offset—**Indicates when the CIP Sync time was last updated. The timestamp is in CIP Sync time.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
GrandMasterClockID	DINT	**Grandmaster Clock ID—**Indicates the ID of the CIP Sync Grandmaster to which the module is synced.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].Data	BOOL	**Input Status—**Indicates whether an input point is On or Off. 0 = The input point is Off. 1 = The input point is On.	Connection = Data or Listen Only Input Data = Data or Timestamp Data or Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].Fault	BOOL	**Quality of Data after Fault—**Indicates whether input data for a faulted point is correct or incorrect. 0 = No fault 1 = Fault	Connection = Data or Listen Only Input Data = Data or Timestamp Data or Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].NewDataOffOn	BOOL	**New Data Off to On—**Captures short duration pulses for Off to On transitions. A captured pulse remains latched until acknowledged via the Pt[*x*].NewDataOffOnAck output tag. 0 = No new Off to On transitions have occurred since the last acknowledgment. 1 = A new Off to On transition has occurred, but has not yet been acknowledged.	Connection = Data or Listen Only Input Data = Data or Timestamp Data or Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].NewDataOnOff	BOOL	**New Data On to Off—**Captures short duration pulses for On to Off transitions. Pulse remains latched until acknowledged via the Pt[*x*].NewDataOnOffAck output tag. 0 = No new On to Off transitions have occurred since the last acknowledgment. 1 = A new On to Off transition has occurred, but has not yet been acknowledged.	Connection = Data or Listen Only Input Data = Data or Timestamp Data or Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].TimestampDropped	BOOL	**Dropped Timestamp—**Indicates whether a timestamp was lost as a result of one of the following: • The corresponding bit was set in the LatchTimestamps configuration tag, so a new timestamp was not recorded because the previous timestamp was latched. • The corresponding bit in the LatchTimestamps configuration tag was **not** set, but a timestamp was replaced by a new timestamp because the previous timestamp was not acknowledged via the Pt[x].NewDataOffOnAck or Pt[x].NewDataOnOffAck output tags. 0 = A timestamp was not dropped. 1 = A timestamp was dropped.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].CIPSyncValid	BOOL	**CIP Sync Is Valid—**Indicates whether CIP Sync is available on the backplane. 0 = CIP Sync is not available. 1 = CIP Sync is available.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].CIPSyncTimeout	BOOL	**CIP Sync Timeout—**Indicates whether a valid time master on the backplane has timed out. 0 = A time master is either not detected on the backplane or is valid. See Pt[*x*].CIPSyncValid. 1 = A valid time master was detected on the backplane, but the time master has timed out.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].InputOverrideStatus	BOOL	**Input Override Status—**Indicates whether local inputs are being overridden by the value in the Pt.[x].DataOverrideValue output tag because the corresponding bit in the Pt[x].DataOverrideEn output tag is set. 0 = Inputs are not being overridden. 1 = Inputs are being overridden.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].Timestamp.OffOn	DINT	**Off to On Timestamp—**Records a 64-bit timestamp for the input point's last transition to On. The timestamp is in CIP Sync time.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data
Pt[*x*].Timestamp.OnOff	DINT	**On to Off Timestamp—**Records a 64-bit timestamp for the input point's last transition to Off**.** The timestamp is in CIP Sync time.	Connection = Data, Data with Event, Listen Only, or Listen Only with Event Input Data = Timestamp Data

Table 55 - 1756-IB16IF Module Output Tags

Name	Data Type	Tag Definition	Module Definition
ResetTimestamps	BOOL	**Reset Timestamp—**When set, clears all timestamps when a rising edge occurs. 0 = Timestamps are not reset. 1 = Timestamps are reset when a rising edge occurs.	Connection = Data or Data with Event Input Data = Timestamp Data
ResetEvents	BOOL	**Reset Event—**When set, clears all events in the Event[*x*].NewEvent and Event[*x*].Timestamp tags when a rising edge occurs. 0 = Events are not cleared. 1 = Events are cleared when a rising edge occurs.	Connection = Data with Event Input Data = Timestamp Data
LatchEvents	BOOL	**Latch Event—**When set, latches an event until the event is acknowledged. Once acknowledged, the event is overridden by a new event. 0 = Events are overridden by new events. 1 = Events are latched until acknowledged, and new events are ignored.	Connection = Data with Event Input Data = Timestamp Data
Pt[*x*].NewDataOffOnAck	BOOL	**Acknowledge Off to On Transition—**A rising edge acknowledges Off to On transitions by clearing the corresponding bits in the Pt[x].Timestamp.OffOn[x] and Pt[x].NewDataOffOn input tags. 0 = Off to On transitions are not acknowledged. 1 = Off to On transitions are acknowledged on the initial transition to 1 of this bit.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
Pt[*x*].NewDataOnOffAck	BOOL	**Acknowledge On to Off Transition—**A rising edge acknowledges On to Off transitions by clearing the corresponding bits in the Pt[x].Timestamp.OnOff[x] and Pt[x].NewDataOnOff input tags. 0 = On to Off transitions are not acknowledged. 1 = On to Off transitions are acknowledged on the initial transition to 1 of this bit.	Connection = Data Input Data = Data or Timestamp Data or Connection = Data with Event Input Data = Timestamp Data
Pt[*x*].DataOverrideEn	BOOL	**Override Data—**When set, simulates an input transition when in Run mode by overriding the actual input state with the value defined in the Pt[*x*].DataOverrideValue output tag. This function is useful for validating timestamping. 0 = The state of an input device is not being overridden. 1 = The state of an input device is being overridden by the value defined in the Pt[*x*].DataOverride output tag.	Connection = Data or Data with Event Input Data = Timestamp Data
Pt[*x*].DataOverrideValue	BOOL	**Override Data Value—**Defines the value to be applied to the input point when the corresponding bit in the Pt[*x*].DataOverrideEn tag is enabled. 0 = The input state is Off. A timestamp is recorded in the Pt[*x*].Timestamp.OnOff[*x*] input tag on a falling edge. 1 = The input state is On. A timestamp is recorded in the Pt[*x*].Timestamp.OffOn[*x*] input tag on a rising edge.	Connection = Data or Data with Event Input Data = Timestamp Data
Event[*x*].Mask	INT	**Event Mask—**When enabled for a point, an event is triggered when the state of the input matches the value of the corresponding bits in the Event[*x*].Value tag.	Connection = Data with Event Input Data = Timestamp Data
Event[*x*].Value	INT	**Event Value—**Defines whether an input point must be in the On or Off state before an event is triggered. An event is only triggered if the corresponding bits in the Event[x].Mask tag is enabled. 0 = The input must be in the Off state to trigger an event. 1 = The input must be in the On state to trigger an event.	Connection = Data with Event Input Data = Timestamp Data
Event[*x*].Disarm	BOOL	**Disarm Event—**Prevents events from being triggered for a point via the pattern defined in the Event[*x*].Mask and Event[*x*].Value tags. 0 = Events are triggered. 1 = Events are not triggered.	Connection = Data with Event Input Data = Timestamp Data
Event[*x*].NewEventAck	BOOL	**Acknowledge New Event—**When set, acknowledges a new event has occurred as indicated by the Event[*x*].NewEvent event tag. 0 = A new event has not been acknowledged. 1 = A new event has been acknowledged.	Connection = Data with Event Input Data = Timestamp Data

Table 56 - 1756-IB16IF Module Event Tags

Name	Data Type	Tag Definition	Module Definition
Fault	DINT	**Fault Status—**Indicates whether a point is faulted. If communication to the input module is lost, then all 32 bits are set. 0 = No fault has occurred. 1 = A fault has occurred.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].NewEvent	BOOL	**New Event—**Indicates whether a new event has occurred. This bit is cleared only when acknowledged by the Event[*x*].NewEventAck output tag or reset by the ResetEvents output tag. 0 = No new event has occurred since the last acknowledged event. 1 = A new event has occurred since the last acknowledged event.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].EventDropped	BOOL	**Event Dropped—**Indicates whether an event has been dropped: • If the LatchEvents output tag is set, the last recorded event is retained until acknowledged, and a subsequent event is dropped. • If the LatchEvents output tag is cleared, the last unacknowledged event is overwritten. 0 = An event has not been dropped. 1 = An event has been dropped.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].CIPSyncValid	BOOL	**CIP Sync Valid—**Indicates whether a valid CIP Sync time master existed on the backplane at the time of an event. 0 = CIP Sync was not available on the backplane at the time of an event. 1 = CIP Sync was available on the backplane at the time of an event.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].CIPSyncTimeout	BOOL	**CIP Sync Timout—**Indicates that a valid CIP Sync time master existed on the backplane at the time of an event, but has since timed out. 0 = CIP Sync has not timed out. 1 = CIP Sync was available on the backplane, but has since timed out prior to the event occurring.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].Data	INT	**Module Data—**Shows the input data for all 16 points on the module at the time an event occurs. Data for bits 0…15 is shown as a bit mask where bit 0 is Pt[0].Data and bit 15 is Pt[15].Data. 0 = On a per bit basis, indicates the corresponding bit in the Pt[*x*].Data input tag was Off when the event occurred. 1 = On a per bit basis, indicates the corresponding bit in the Pt[*x*].Data input tag was On when the event occurred.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data
Event[*x*].Timestamp	DINT	**Event Timestamp—**Records a 64-bit timestamp in CIP Sync format at the time an event occurs.	Connection = Data with Event or Listen Only with Event Input Data = Timestamp Data

Fast Output Module Tags

ControlLogix fast output modules have three types of tags:

- **Configuration—**Structure of data sent from the controller to the I/O module upon powerup
- **Input—**Structure of data continually sent from the I/O module to the controller containing the current operational status of the module
- **Output—**Structure of data continually sent from the controller to the I/O module that can modify the module behavior

IMPORTANT The Module Definition column in each table lists the connection type and input data type combinations that are required to create the corresponding tag. For more information about defining connection and input data types, see Create a New Module on page 62.

For description of module tags, see:

- 1756-OB16IEF Module
- 1756-OB16IEFS Module

1756-OB16IEF Module

IMPORTANT Output tag information is sent to the 1756-OB16IEF module only at the RPI rate defined during configuration. For optimal performance, use an Immediate Output (IOT) instruction.

For example, the rung shown contains an IOT instruction for a fast output module in slot 3. Add a similar rung to your last routine within the Main Task to mimic normal output tag processing.

The 1756-OB16IEF module uses array data structures. Array data structures differ from the flat data structures of other digital I/O modules. For more information, see Redundant Owner Configuration Tags on page 143.

Table 57 - 1756-OB16IEF Module Configuration Tags

Name	Data Type	Tag Definition	Module Definition
ProgToFaultEn	BOOL	**Program to Fault Mode—**Enables the transition of outputs to Fault mode if a communication failure occurs in Program mode. Otherwise, outputs remain in Program mode. See Pt[*x*].FaultMode, Pt[*x*]FaultValue Pt[*x*]ProgMode, and Pt[*x*]ProgValue. 0 = Outputs stay in Program mode if communication fails. 1 = Outputs go to Fault mode if communication fails.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
InputPartnerSlot	SINT	**Peer Partner Slot—**Identifies the slot number of the local chassis where the peer input module resides. Valid values: • 0...16 • -1 = No input module has been identified as a peer.	Connection = Peer Ownership Output Data = Data with Peer
InputPartnerID	SINT	**Peer Partner ID—**Identifies the peer input module that controls outputs on the 1756-OB16IEF module. The type of module determines the connection type of format of input data. Valid values: 0 = None (default) 1 = 1756-IB16IF 2 = 1756-LSC8XIB8I	Connection = Peer Ownership Output Data = Data with Peer

Table 57 - 1756-OB16IEF Module Configuration Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
Pt[*x*].FaultMode	BOOL	**Fault Mode—**Used in conjunction with the Pt[*x*].FaultValue tag to determine the state of outputs when a communication failure occurs. 0 = Uses the output value defined in the Pt[*x*].FaultValue configuration tag (default). 1 = Holds the last state of the output for the length of time defined in the Pt[*x*].FaultValueStateDuration tag. If PWM is enabled for the output point and the output is currently On, the output continues PWM until the cycle limit is reached or a final fault state goes into effect via the Pt[*x*].FaultFinalState tag.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].FaultValue	BOOL	**Fault Value—**Defines the output value when a fault occurs. Holds the configured state of the output for the length of time defined in the Pt[*x*].FaultValueStateDuration tag. Requires the corresponding bit in the FaultMode tag to be cleared. 0 = Off 1 = On	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].FaultFinalState	BOOL	**Fault Final State—**Determines the final output state once the time in the Pt[*x*].FaultValueStateDuration tag elapses. 0 = Output turns Off once the time in the Pt[*x*].FaultValueStateDuration tag elapses, and module is still faulted. 1 = Output turns On once the time in the Pt[*x*].FaultValueStateDuration tag elapses, and module is still faulted.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].ProgMode	BOOL	**Program Mode—**Used in conjunction with the Pt[*x*].ProgValue tag to determine the state of outputs when the controller is in Program mode. 0 = Uses the output value defined in the Pt[*x*].ProgValue tag (default). 1 = Holds the last state of the output. If PWM is enabled for the output point and the output is currently On, the output continues to use PWM until the cycle limit is reached.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].ProgValue	BOOL	**Program Value—**Defines the output state during Program mode. Requires the corresponding bit for the Pt[*x*].ProgMode tag to be cleared. 0 = The output state is Off during Program mode. 1 = The output state is On during Program mode.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMEnable	BOOL	**Enable PWM—**When set, the pulse train for the output point is controlled by the current PWM configuration. 0 = PWM is disabled (default). 1 = PWM is enabled, and the output uses PWM when the output is On.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMExtendCycle	BOOL	**Extend PWM Cycle—**Determines the output behavior when the value in the Pt[*x*]PWMOnTime output tag is less than the value in the Pt[x].PWMMinimunOnTime configuration tag. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag. 0 = The duration of the pulse cycle is not extended (default). If the bit is cleared when the On time is less than the minimum On time, the output is never enabled. 1 = The duration of the pulse cycle is extended to maintain the On time to cycle time ratio while taking into account the minimum On time. **IMPORTANT:** An extension of the pulse cycle is limited to 10 times the cycle time. If the requested On time is less than 1/10 of the minimum On time, the output remains Off and the cycle does not extend.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMOnTimeInPercent	BOOL	**PWM On Time in Percent—**Determines whether PWM On time is defined as a percentage of the cycle time or is defined in seconds. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag. 0 = Defines PWM On time in seconds (default). 1 = Defines PWM On time as a percentage.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMStaggerOutput	BOOL	**Stagger PWM Outputs—**When set, minimizes the load on the power system by staggering On transitions for outputs. Otherwise, outputs turn On immediately at the start of a cycle. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag. 0 = Does not stagger output On transitions (default). Outputs turn On immediately when the Pt[x].Data tag is set to 1 beginning the PWM cycle with a rising edge. 1 = Staggers output On transitions. All outputs configured for PWM staggering turn On at different intervals to minimize a possible power surge if many outputs became energized simultaneously.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer

Table 57 - 1756-OB16IEF Module Configuration Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
Pt[*x*].PWMCycleLimitEnable	BOOL	**Enable PWM Cycle Limit—**Determines whether to let only a fixed number of pulse cycles occur. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag. 0 = Pulse cycles continue to occur until the output turns Off (default). 1 = Lets only the number of pulse cycles defined via the Pt[x].PWMCycleLimit tag to occur.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMExecuteAllCycles	BOOL	**Execute All PWM Cycles—**Determines whether to execute the number of cycles defined via the Pt[*x*].PWMCycleLimit tag regardless of the output logic. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag, and a cycle limit to be enabled via the Pt[*x*].PWMCycleLimitEnable tag. 0 = The output logic determines the number of cycles to produce (default). 1 = The Pt[*x*].PWMCycleLimit tag determines the number of cycles to produce regardless of output logic. For example, if you specify a cycle limit of 4, and the output turns Off after 3 cycles, all 4 cycles still occur despite the output being instructed to turn Off.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].FaultValueStateDuration	SINT	**Fault State Duration—**Defines the length of time that the output state remains in the Fault mode state before transitioning to a final state of On or Off. The Fault mode state is defined in the Pt[x].FaultValue tag. Valid values: • 0 = Hold forever (default). Output remains in Fault mode for as long as the fault condition persists. • 1, 2, 5, or 10 seconds	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMCycleLimit	SINT	**PWM Cycle Limit—**Defines the number of pulse cycles to occur when the output turns On: • If the corresponding bit in the Pt[*x*].PWMExecuteAllCycles tag is set, the configured number of cycles occur even if the output turns Off. • If the corresponding bit in the Pt[*x*].PWMExecuteAllCycles tag is cleared, the configured number of cycles occur only if the output remains On. For example, if the cycle limit is 4, and the output turns Off after 3 cycles, the 4th cycle does **not** occur. The default cycle limit is 10. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag, and cycle limits to be enabled via the Pt[x].PWMCycleLimitEnable tag.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMMinimumOnTime	REAL	**PWM Minimum On Time—**Defines the minimum length of time required for the output to turn On. Requires PWM to be enabled via the Pt[*x*].PWMEnable tag. Valid values: 0.0002…3600.0 seconds or 0…100 percent	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].AndToControllerData	INT	**Controller Data with AND Logic—**Determines the output state by applying AND logic to these sources: • Corresponding bits from the controller's output data (O:Data) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].OrToControllerData	INT	**Controller Data with OR Logic—**Determines the output state by applying OR logic to these sources: • Corresponding bits from the controller's output data (O:Data) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].AndToPeerInput	INT	**Peer Data with AND Logic—**Determines the output state by applying AND logic to these sources: • Corresponding bits from peer input data (I:Data) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].OrToPeerInput	INT	**Peer Data with OR Logic—**Determines the output state by applying OR logic to these sources: • Corresponding bits from peer input data (I:Data) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].AndToPeerWindow0	SINT	**Peer Data with AND Logic—**Determines the output state by applying AND logic to these sources: • Corresponding bits from window 0 of the peer counter module (I:Counter[*x*].InputWindow0) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer

Table 57 - 1756-OB16IEF Module Configuration Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
OutputMap[*x*].OrToPeerWindow0	SINT	**Peer Data with OR Logic—**Determines the output state by applying OR logic to these sources: • Corresponding bits from window 0 of the peer counter module (I:Counter[*x*].InputWindow0) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].AndToPeerWindow1	SINT	**Peer Data with AND Logic—**Determines the output state by applying AND logic to these sources: • Corresponding bits from window 1 of the peer counter module (I:Counter[*x*].InputWindow1) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer
OutputMap[*x*].OrToPeerWindow1	SINT	**Peer Data with OR Logic—**Determines the output state by applying OR logic to these sources: • Corresponding bits from window 1 of the peer counter module (I:Counter[*x*].InputWindow1) • Other mapped bits specified in the output configuration	Connection = Peer Ownership Output Data = Data with Peer

Table 58 - 1756-OB16IEF Module Input Data Tags

Name	Data Type	Tag Definition	Module Definition
Fault	DINT	**Fault Status—**Indicates whether a point is faulted. If communication to the output module is lost, then all 32 bits of the Module Fault word are set. 0 = No fault 1 = Fault	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
GrandMasterClockID	DINT	**Grandmaster Clock ID—**Indicates the ID of the CIP Sync Grandmaster to which the module is synced.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
InputPartnerActive	BOOL	**Input Partner is Active—**Indicates whether the peer input module is actively producing input data to be consumed by a 1756-OB16IEF module. 0 = No input peer module is currently producing input data to be consumed by a 1756-OB16IEF module. 1 = The input peer module is actively producing input data to be consumed by a 1756-OB16IEF module for use in its peer logic.	Connection = Peer Ownership Output Data = Data with Peer
InputPartnerFault	BOOL	**Input Partner Fault—**Indicates whether the peer input module has faulted due to a connection loss. If the peer input module is faulted, the output module uses only controller data to determine the output state. 0 = The input peer module has not faulted. 1 = The input peer module has faulted and outputs transition to the configured Fault mode state.	Connection = Peer Ownership Output Data = Data with Peer
InputPartnerSlot	SINT	**Input Partner Slot—**Indicates the slot number of the peer input module. Valid values: • 0...16 • -1 = No peer input module is defined.	Connection = Peer Ownership Output Data = Data with Peer
InputPartnerStatus	SINT	**Input Partner Status—**Indicates the status of the peer input module. Valid values: 2 = Communication Fault (Peer connection is lost) 6 = Run (Peer connection open and in Run mode)	Connection = Peer Ownership Output Data = Data with Peer
LocalClockOffset	DINT	**Local Clock Timestamp—**Indicates the offset between the current CST and the CIP Sync value when a valid CIP Sync time is available.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer

Table 58 - 1756-OB16IEF Module Input Data Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
OffsetTimestamp	DINT	**Timestamp Offset—**Indicates when the CIP Sync LocalClockOffset and GrandMasterID were last updated in CIP Sync format.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
OwnerActive	BOOL	**Owner Active—**Indicates that the output has a controlling owner.	B4
OwnerID	BOOL	**Owner ID—**Indicates which owner is active (controlling): 0 = Owner A 1 = Owner B	B5
OwnerAConnected	BOOL	**Owner A Connected—**Indicates that Owner A is connected.	B6
OwnerAClaim	BOOL	**Owner A Claim—**Indicates that Owner A is claiming outputs (C00).	B7
OwnerAReady	BOOL	**Owner A Ready—**Indicates that Owner A is Ready to claim outputs (R00).	B8
OwnerBConnected	BOOL	**Owner B Connected—**Indicates that Owner B is connected.	B9
OwnerBClaim	BOOL	**Owner B Claim—**Indicates that Owner B is claiming outputs (C00).	B10
OwnerBReady	BOOL	**Owner B Ready—**Indicates that Owner B is Ready to claim outputs (R00).	B11
Pt[*x*].Data	BOOL	**Data**—Indicates the current value to be sent to the corresponding output point. If PWM is enabled, this value transitions from 0 to 1 based on the PWM pulse train. 0 = Off 1 = On	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].Fault	BOOL	**Fault—**Indicates whether I/O data for the corresponding point may be incorrect due to a fault. 0 = No fault. 1 = A fault exists and I/O data may be incorrect. Any of these conditions set the bit for this tag: • Pt[*x*].FuseBlown = 1 • Pt[*x*].PWMCycleTime outside the valid range of 0.001...3600.0 seconds • Pt[*x*].PWMOnTime outside the valid range of 0.0002...3600.0 seconds or 0...100 percent • Pt[*x*].PWMCycleTime ≤ Pt[*x*].PWMOnTime	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].FuseBlown	BOOL	**Fuse Is Blown—**Indicates whether a fuse has blown due to a short or overload condition for the corresponding point. All blown fuse conditions are latched and must be reset. 0 = Fuse is not blown. 1 = Fuse is blown and has not been reset.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PWMCycleLimitDone	BOOL	**PWM Cycle Limit Done—**Indicates whether the PWM pulse cycle limit defined in the Pt[*x*].PWMCycleLimit configuration tag has been reached. 0 = The PWM cycle limit has not yet been reached. The bit resets to 0 each time the output transitions to On to begin a new PWM cycle. 1 = The PWM cycle limit has been reached.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].CIPSyncValid	BOOL	**CIP Sync Is Valid—**Indicates whether the module has synchronized to a valid CIP Sync time master on the backplane. 0 = CIP Sync is not available. 1 = CIP Sync is available.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer

Table 58 - 1756-OB16IEF Module Input Data Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
Pt[*x*].CIPSyncTimeout	BOOL	**CIP Sync Timeout—**Indicates whether a valid time master on the backplane has timed out. 0 = A valid time master has not timed out. 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OutputOverrideStatus	BOOL	**Output Override Status—**Indicates whether local output data or logic point is set up to be overridden by the value in the Pt[*x*].OverrideOutputValue output tag. Requires the Pt[*x*].OverrideOutputEn output tag to be enabled. 0 = The override feature for the corresponding output is not enabled. 1 = The override feature for the corresponding output is enabled.	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PeerInputOverrideStatus	BOOL	**Peer Input Override Status—**Indicates whether peer input data mapped to the corresponding output point is set up to be overridden by the value in the Pt[*x*].OverridePeerInputValue output tag. Requires the O:Pt[*x*].OverridePeerInputEn output tag to be enabled. 0 = The override feature for peer inputs is not enabled. 1 = The override feature for peer inputs is enabled.	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PeerWindows0OverrideStatus	BOOL	**Peer Window 0 Override Status—**Indicates whether peer window 0 data mapped to the corresponding output point is set up to be overridden by the value in the Pt[*x*].OverridePeerWindow0Value output tag. Requires the O:Pt[*x*].OverridePeerWindow0En output tag to be enabled. 0 = The override feature for peer window 0 is not enabled. 1 = The override feature for peer window 0 is enabled.	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].PeerWindow1OverrideStatus	BOOL	**Peer Window 1 Override Status—**Indicates whether peer window 1 data mapped to the corresponding output point is set up to be overridden by the value in the Pt[*x*].OverridePeerWindow1Value output tag. Requires the O:Pt[*x*].OverridePeerWindow1En output tag to be enabled. 0 = The override feature for peer window 1 is not enabled. 1 = The override feature for peer window 1 is enabled.	Connection = Peer Ownership Output Data = Data with Peer
Timestamp	DINT	**Timestamp—**A 64-bit CIP Sync timestamp of the last new output data or FuseBlown event.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Listen Only Output Data = None or Connection = Peer Ownership Output Data = Data with Peer

Table 59 - 1756-OB16IEF Module Output Data Tags

Name	Data Type	Tag Definition	Module Definition
OwnerClaim	BOOL	B0 0 = Not Requesting Ownership 1 = Claim Ownership	When set, indicates that the controller wants to Claim Ownership of the Redundant connection and have its Outputs actively used. If both Redundant Owners have COO set, the last originator application that transitioned its COO flag from reset to set is the owner. Only an Rx'd 0 to a 1 and not just the receipt of a new connection is considered such a transition. If neither Redundant Owner has COO set, then the highest ROO becomes the owner.
OwnerReady	BOOL	B1 0 = Not Ready to Own 1 = Ready to Own	Indicates that the controller is Ready for Output Ownership. A value of 1 indicates ready while 0 indicates that the controller is not Ready to Own the Outputs. If neither controller has the COO bit set, the ROO determines the current Owner. If both controllers have COO=0 and ROO=0, then the Outputs go to IDLE (Program mode). If both controllers have COO=0 and ROO=1, OwnerA is Active.
Pt[*x*].Data	BOOL	**Data—**Indicates the On/Off state to apply to the output point. 0 = Off 1 = On	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].ResetFuseBlown	BOOL	**Reset Blown Fuse—**Attempts to clear a blown fuse status and apply output data when the bit transitions from Off to On.	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverrideOutputEn	BOOL	**Override Output—**Overrides local output data for peer logic with the value defined in the Pt[*x*].OverrideOutputValue tag. 0 = Disable 1 = Enable	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverrideOutputValue	BOOL	**Override Output Value—**Indicates the On/Off status to apply to all outputs mapped to the output point when the corresponding bit in the Pt[*x*].OverrideOutputEn tag is set. 0 = Off 1 = On	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverridePeerInputEn	BOOL	**Override Peer Input—**Overrides peer input data mapped to the output point with the value defined in the Pt[*x*].OverridePeerInputValue output tag. 0 = Disable 1 = Enable	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverridePeerInputValue	BOOL	**Override Peer Input Value—**Indicates the On/Off status to apply to all peer inputs mapped to the output point when the corresponding bit in the Pt[x].OverridePeerInputEn output tag is enabled. 0 = Off 1 = On	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverridePeerWindow0En	BOOL	**Override Peer Window 0—**Overrides peer window 0 inputs mapped to the output point with the value defined in the Pt[x].OverridePeerWindow0Value output tag. 0 = Disable 1 = Enable	Connection = Peer Ownership Output Data = Data with Peer
Pt[*x*].OverridePeerWindow0Value	BOOL	**Override Peer Window 0 Value**—Indicates the On/Off status to apply to peer window 0 inputs mapped to the output point when the corresponding bit in the Pt[x].OverridePeerWindow0En output tag is enabled. 0 = Off 1 = On	Connection = Peer Ownership Output Data = Data with Peer

Table 59 - 1756-OB16IEF Module Output Data Tags (Continued)

Name	Data Type	Tag Definition	Module Definition
Pt[x].OverridePeerWindow1En	BOOL	**Override Peer Window 1—**Overrides peer window 1 inputs mapped to the output point with the value defined in the Pt[x].OverridePeerWindow1Value output tag. 0 = Disable 1 = Enable	Connection = Peer Ownership Output Data = Data with Peer
Pt[x].OverridePeerWindow1Value	BOOL	**Override Peer Window 1 Value**—Indicates the On/Off status to apply to peer window 1 inputs mapped to the output point when the corresponding bit in the Pt[x].OverridePeerWindow1En output tag is enabled. 0 = Off 1 = On	Connection = Peer Ownership Output Data = Data with Peer
Pt[x].PWMCycleTime	REAL	**PWM Cycle Time—**Defines the duration of each pulse cycle. Requires PWM to be enabled via the Pt[x].PWMEnable configuration tag. Valid values: 0.001...3600.0 seconds	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Pt[x].PWMOnTime	REAL	**PWM On Time—**Defines the length of time that a pulse is active. Requires PWM to be enabled via the Pt[x].PWMEnable configuration tag. Valid values: 0.0002...3600.0 seconds or 0...100.0 percent	Connection = Data Output Data = Data or Scheduled per Module or Connection = Peer Ownership Output Data = Data with Peer
Timestamp	DINT	**Timestamp—**CIP Sync time at which to apply scheduled output data.	Connection = Data Output Data = Scheduled per Module
TimestampOffset	DINT	**Timestamp Offset**—Indicates the difference between the system time and the module's local time. The timestamp is in CIP Sync time. This value is typically set to zero but can be updated with the value of the SystemOffset in the controller's TIMESYNCHRONIZE object to enable Time Step Compensation in the module.	Connection = Data Output Data = Scheduled per Module

1756-OB16IEFS Module

The tag names and data structures for the 1756-OB16IEFS module vary based on the module definition:

- For Scheduled Per Point output, the module uses a flat data structure. See Table 60, Table 62, and Table 64.
- For Data output or Listen Only connections, the module uses an array data structure. See Table 61, Table 63, and Table 65. For more information about array data structures, see Redundant Owner Configuration Tags on page 143.

Table 60 - 1756-OB16IEFS Module Configuration Tags—Scheduled per Point Output

Name	Data Type	Tag Definition	Module Definition
ProgToFaultEn	BOOL	**Program to Fault Mode—**Enables the transition of outputs to Fault mode if a communication failure occurs in Program mode. Otherwise, outputs remain in Program mode. See FaultMode, FaultValue, ProgMode, and ProgValue. 0 = Outputs stay in Program mode if communication fails. 1 = Outputs go to Fault mode if communication fails.	Connection = Data Output Data = Scheduled per Point
FaultMode	BOOL	**Fault Mode—**Used in conjunction with the FaultValue tag to determine the state of outputs when a communication failure occurs. 0 = Uses the output value defined in the Pt[x].FaultValue configuration tag (default). 1 = Holds the last state of the output for the length of time defined in the FaultValueStateDuration tag. If PWM is enabled for the output point and the output is currently On, the output continues PWM until the cycle limit is reached or a final fault state goes into effect via the FaultFinalState tag.	Connection = Data Output Data = Scheduled per Point
FaultValue	BOOL	**Fault Value—**Defines the output value when a fault occurs. Holds the configured state of the output for the length of time defined in the FaultValueStateDuration tag. Requires the corresponding bit in the FaultMode tag to be cleared. 0 = Off 1 = On	Connection = Data Output Data = Scheduled per Point

Table 60 - 1756-OB16IEFS Module Configuration Tags—Scheduled per Point Output (Continued)

Name	Data Type	Tag Definition	Module Definition
FaultFinalState	BOOL	**Fault Final State—**Determines the final output state once the time in the FaultValueStateDuration tag elapses. 0 = Output turns Off once the time in the FaultValueStateDuration tag elapses, and module is still faulted. 1 = Output turns On once the time in the FaultValueStateDuration tag elapses, and module is still faulted.	Connection = Data Output Data = Scheduled per Point
ProgMode	BOOL	**Program Mode—**Used in conjunction with the ProgValue tag to determine the state of outputs when the controller is in Program mode. 0 = Uses the output value defined in the ProgValue tag (default). 1 = Holds the last state of the output. If PWM is enabled for the output point and the output is currently On, the output continues to use PWM until the cycle limit is reached.	Connection = Data Output Data = Scheduled per Point
ProgValue	BOOL	**Program Value—**Defines the output state during Program mode. Requires the corresponding bit for the ProgMode tag to be cleared. 0 = The output state is Off during Program mode. 1 = The output state is On during Program mode.	Connection = Data Output Data = Scheduled per Point
FaultValueStateDuration	SINT	**Fault State Duration—**Defines the length of time that the output state remains in the Fault mode state before transitioning to a final state of On or Off. The Fault mode state is defined in the FaultValue tag. Valid values: • 0 = Hold forever (default). Output remains in Fault mode for as long as the fault condition persists. • 1, 2, 5, or 10 seconds	Connection = Data Output Data = Scheduled per Point
PWM[*x*].Enable	BOOL	**Enable PWM—**When set, the pulse train for the output point is controlled by the current PWM configuration. 0 = PWM is disabled (default). 1 = PWM is enabled, and the output uses PWM when the output is On.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].ExtendCycle	BOOL	**Extend PWM Cycle—**Determines the output behavior when the value in the PWM.OnTime output tag is less than the value in the PWM.MinimunOnTime configuration tag. Requires PWM to be enabled via the PWM.Enable tag. 0 = The duration of the pulse cycle is not extended (default). If the bit is cleared when the On time is less than the minimum On time, the output is never enabled. 1 = The duration of the pulse cycle is extended to maintain the On time to cycle time ratio while taking into account the minimum On time. **IMPORTANT:** An extension of the pulse cycle is limited to 10 times the cycle time. If the requested On time is less than 1/10 of the minimum On time, the output remains Off and the cycle does not extend.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].OnTimeInPercent	BOOL	**PWM On Time in Percent—**Determines whether PWM On time is defined as a percentage of the cycle time or is defined in seconds. Requires PWM to be enabled via the PWM.Enable tag. 0 = Defines PWM On time in seconds (default). 1 = Defines PWM On time as a percentage.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].StaggerOutput	BOOL	**Stagger PWM Outputs—**When set, minimizes the load on the power system by staggering On transitions for outputs. Otherwise, outputs turn On immediately at the start of a cycle. Requires PWM to be enabled via the PWM.Enable tag. 0 = Does not stagger output On transitions (default). Outputs turn On immediately when the Data tag is set to 1 beginning the PWM cycle with a rising edge. 1 = Staggers output On transitions. All outputs configured for PWM staggering turns On at different intervals to minimize a possible power surge if many outputs became energized simultaneously.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].CycleLimitEnable	BOOL	**Enable PWM Cycle Limit—**Determines whether to let only a fixed number of pulse cycles occur. Requires PWM to be enabled via the PWM.Enable tag. 0 = Pulse cycles continue to occur until the output turns Off (default). 1 = Lets only the number of pulse cycles defined via the PWM.CycleLimit tag to occur.	Connection = Data Output Data = Scheduled per Point

Table 60 - 1756-OB16IEFS Module Configuration Tags—Scheduled per Point Output (Continued)

Name	Data Type	Tag Definition	Module Definition
PWM[*x*].ExecuteAllCycles	BOOL	**Execute All PWM Cycles—**Determines whether to execute the number of cycles defined via the PWM.CycleLimit tag regardless of the output logic. Requires PWM to be enabled via the PWM.Enable tag, and a cycle limit to be enabled via the PWM.CycleLimitEnable tag. 0 = The output logic determines the number of cycles to produce (default). 1 = The PWM.CycleLimit tag determines the number of cycles to produce regardless of output logic. For example, if you specify a cycle limit of 4, and the output turns Off after 3 cycles, all 4 cycles still occur despite the output being instructed to turn Off.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].CycleLimit	SINT	**PWM Cycle Limit—**Defines the number of pulse cycles to occur when the output turns On: • If the corresponding bit in the PWM.ExecuteAllCycles tag is set, the configured number of cycles occur even if the output turns Off. • If the corresponding bit in the PWM.ExecuteAllCycles tag is cleared, the configured number of cycles occur only if the output remains On. For example, if the cycle limit is 4, and the output turns Off after 3 cycles, the 4th cycle does **not** occur. The default cycle limit is 10. Requires PWM to be enabled via the PWM.Enable tag, and cycle limits to be enabled via the PWM.CycleLimitEnable tag.	Connection = Data Output Data = Scheduled per Point
PWM[*x*].MinimumOnTime	REAL	**PWM Minimum On Time—**Defines the minimum length of time required for the output to turn On. Requires PWM to be enabled via the PWM.Enable tag. Valid values: 0.0002…3600.0 seconds or 0…100 percent	Connection = Data Output Data = Scheduled per Point

Table 61 - 1756-OB16IEFS Module Configuration Tags—Data Output

Name	Data Type	Tag Definition	Module Definition
ProgToFaultEn	BOOL	**Program to Fault Mode—**Enables the transition of outputs to Fault mode if a communication failure occurs in Program mode. Otherwise, outputs remain in Program mode. See FaultMode, FaultValue, ProgMode, and ProgValue. 0 = Outputs stay in Program mode if communication fails. 1 = Outputs go to Fault mode if communication fails.	Connection = Data Output Data = Data
Pt[*x*].FaultMode	BOOL	**Fault Mode—**Used in conjunction with the FaultValue tag to determine the state of outputs when a communication failure occurs. 0 = Uses the output value defined in the Pt[*x*].FaultValue configuration tag (default). 1 = Holds the last state of the output for the length of time defined in the FaultValueStateDuration tag. If PWM is enabled for the output point and the output is currently On, the output continues PWM until the cycle limit is reached or a final fault state goes into effect via the FaultFinalState tag.	Connection = Data Output Data = Data
Pt[*x*].FaultValue	BOOL	**Fault Value—**Defines the output value when a fault occurs. Holds the configured state of the output for the length of time defined in the FaultValueStateDuration tag. Requires the corresponding bit in the FaultMode tag to be cleared. 0 = Off 1 = On	Connection = Data Output Data = Data
Pt[*x*].FaultFinalState	BOOL	**Fault Final State—**Determines the final output state once the time in the FaultValueStateDuration tag elapses. 0 = Output turns Off once the time in the FaultValueStateDuration tag elapses, and module is still faulted. 1 = Output turns On once the time in the FaultValueStateDuration tag elapses, and module is still faulted.	Connection = Data Output Data = Data
Pt[*x*].ProgMode	BOOL	**Program Mode—**Used in conjunction with the ProgValue tag to determine the state of outputs when the controller is in Program mode. 0 = Uses the output value defined in the ProgValue tag (default). 1 = Holds the last state of the output. If PWM is enabled for the output point and the output is currently On, the output continues to use PWM until the cycle limit is reached.	Connection = Data Output Data = Data
Pt[*x*].ProgValue	BOOL	**Program Value—**Defines the output state during Program mode. Requires the corresponding bit for the ProgMode tag to be cleared. 0 = The output state is Off during Program mode. 1 = The output state is On during Program mode.	Connection = Data Output Data = Data
Pt[*x*].PWMEnable	BOOL	**Enable PWM—**When set, the pulse train for the output point is controlled by the current PWM configuration. 0 = PWM is disabled (default). 1 = PWM is enabled, and the output uses PWM when the output is On.	Connection = Data Output Data = Data

Table 61 - 1756-OB16IEFS Module Configuration Tags—Data Output (Continued)

Name	Data Type	Tag Definition	Module Definition
Pt[*x*].PWMExtendCycle	BOOL	**Extend PWM Cycle—**Determines the output behavior when the value in the PWM.OnTime output tag is less than the value in the PWM.MinimunOnTime configuration tag. Requires PWM to be enabled via the PWM.Enable tag. 0 = The duration of the pulse cycle is not extended (default). If the bit is cleared when the On time is less than the minimum On time, the output is never enabled. 1 = The duration of the pulse cycle is extended to maintain the On time to cycle time ratio while taking into account the minimum On time. **IMPORTANT:** An extension of the pulse cycle is limited to 10 times the cycle time. If the requested On time is less than 1/10 of the minimum On time, the output remains Off and the cycle does not extend.	Connection = Data Output Data = Data
Pt[*x*].PWMOnTimeInPercent	BOOL	**PWM On Time in Percent—**Determines whether PWM On time is defined as a percentage of the cycle time or is defined in seconds. Requires PWM to be enabled via the PWM.Enable tag. 0 = Defines PWM On time in seconds (default). 1 = Defines PWM On time as a percentage.	Connection = Data Output Data = Data
Pt[*x*].PWMStaggerOutput	BOOL	**Stagger PWM Outputs—**When set, minimizes the load on the power system by staggering On transitions for outputs. Otherwise, outputs turn On immediately at the start of a cycle. Requires PWM to be enabled via the PWM.Enable tag. 0 = Does not stagger output On transitions (default). Outputs turn On immediately when the Data tag is set to 1 beginning the PWM cycle with a rising edge. 1 = Staggers output On transitions. All outputs configured for PWM staggering turn On at different intervals to minimize a possible power surge if many outputs became energized simultaneously.	Connection = Data Output Data = Data
Pt[*x*].PWMCycleLimitEnable	BOOL	**Enable PWM Cycle Limit—**Determines whether to let only a fixed number of pulse cycles occur. Requires PWM to be enabled via the PWM.Enable tag. 0 = Pulse cycles continue to occur until the output turns Off (default). 1 = Lets only the number of pulse cycles defined via the PWM.CycleLimit tag to occur.	Connection = Data Output Data = Data
Pt[*x*].PWMExecuteAllCycles	BOOL	**Execute All PWM Cycles—**Determines whether to execute the number of cycles defined via the PWM.CycleLimit tag regardless of the output logic. Requires PWM to be enabled via the PWM.Enable tag, and a cycle limit to be enabled via the PWM.CycleLimitEnable tag. 0 = The output logic determines the number of cycles to produce (default). 1 = The PWM.CycleLimit tag determines the number of cycles to produce regardless of output logic. For example, if you specify a cycle limit of 4, and the output turns Off after 3 cycles, all 4 cycles still occur despite the output being instructed to turn Off.	Connection = Data Output Data = Data
Pt[*x*].PWMFaultValueStateDuration	SINT	**Fault State Duration—**Defines the length of time that the output state remains in the Fault mode state before transitioning to a final state of On or Off. The Fault mode state is defined in the FaultValue tag. Valid values: • 0 = Hold forever (default). Output remains in Fault mode for as long as the fault condition persists. • 1, 2, 5, or 10 seconds	Connection = Data Output Data = Data
Pt[*x*].PWMCycleLimit	SINT	**PWM Cycle Limit—**Defines the number of pulse cycles to occur when the output turns On: • If the corresponding bit in the PWM.ExecuteAllCycles tag is set, the configured number of cycles occur even if the output turns Off. • If the corresponding bit in the PWM.ExecuteAllCycles tag is cleared, the configured number of cycles occur only if the output remains On. For example, if the cycle limit is 4, and the output turns Off after 3 cycles, the 4th cycle does **not** occur. The default cycle limit is 10. Requires PWM to be enabled via the PWM.Enable tag, and cycle limits to be enabled via the PWM.CycleLimitEnable tag.	Connection = Data Output Data = Data
Pt[*x*].PWMMinimumOnTime	REAL	**PWM Minimum On Time—**Defines the minimum length of time required for the output to turn On. Requires PWM to be enabled via the PWM.Enable tag. Valid values: 0.0002…3600.0 seconds or 0…100 percent	Connection = Data Output Data = Data

Table 62 - 1756-OB16IEFS Module Input Data Tags—Scheduled per Point Output

Name	Data Type	Tag Definition	Module Definition
Fault	DINT	**Fault Status—**Indicates whether a point is faulted. If communication to the output module is lost, then all 32 bits of the Module Fault word are set. 0 = No fault 1 = Fault	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
Data	BOOL	**Data**—Indicates the current value to be sent to the corresponding output point. If PWM is enabled, this value does transition from 0 to 1 based on the PWM pulse train. 0 = Off 1 = On	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
FuseBlown	BOOL	**Fuse Is Blown—**Indicates whether a fuse has blown due to a short or overload condition for the corresponding point. All blown fuse conditions are latched and must be reset. 0 = Fuse is not blown. 1 = Fuse is blown and has not been reset.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
CIPSyncValid	BOOL	**CIP Sync Is Valid—**Indicates whether the module has synchronized to a valid CIP Sync time master on the backplane. 0 = CIP Sync is not available. 1 = CIP Sync is available.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
CIPSyncTimeout	BOOL	**CIP Sync Timeout—**Indicates whether a valid time master on the backplane has timed out. 0 = A valid time master has not timed out. 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
LateScheduleCount	INT	**Late Schedule Count**—Increments each time a schedule is received late after its scheduled time. The counter rolls over every 65,535 late schedules. If a late schedule is the most recent schedule for a point, the output is still driven to new state. Monitoring the late schedule count may be useful to determine whether network delays or connection losses are impacting schedules.	Connection = Data Output Data = Scheduled per Point
LostScheduleCount	INT	**Lost Schedule Count**—Increments each time the Schedule.SequenceNumber output tag skips a value. A skipped sequence number may indicate a lost schedule. The counter rolls over every 65,535 lost schedules.	Connection = Data Output Data = Scheduled per Point
LocalClockOffset	DINT	**Local Clock Timestamp—**Indicates the offset between the current CST and the CIP Sync value when a valid CIP Sync time is available.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
OffsetTimestamp	DINT	**Timestamp Offset—**Indicates when the CIP Sync LocalClockOffset and GrandMasterID were last updated in CIP Sync format.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
GrandMasterClockID	DINT	**Grandmaster Clock ID—**Indicates the ID of the CIP Sync Grandmaster to which the module is synced.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
Timestamp	DINT	**Timestamp—**A 64-bit CIP Sync timestamp of the last new output data or FuseBlown event.	Connection = Data Output Data = Scheduled per Point or Connection = Listen Only Output Data = None
Schedule.State	SINT	**Schedule State—**State of the Current Schedule: • 0 = Inactive • 1 = Active – schedule is active but not yet applied • 2 = Current – schedule is active and next to be applied • 3 = Expired – schedule has been applied • 4 = Schedule discarded – request in error • 5 = Late, but applied – schedule arrived after scheduled time but was applied since no more current schedule received	Connection = Data Output Data = Scheduled per Point
Schedule.SequenceNumber	SINT	**Schedule Sequence Number—**The data echo indicating the sequence number of the schedule.	Connection = Data Output Data = Scheduled per Point

Table 63 - 1756-OB16IEFS Module Input Data Tags—Data Output or Listen Only Connections

Name	Data Type	Tag Definition	Module Definition
Fault	DINT	**Fault Status—**Indicates whether a point is faulted. If communication to the output module is lost, then all 32 bits of the Fault word are set. 0 = No fault 1 = Fault	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].Data	BOOL	**Data**—Indicates the current value to be sent to the corresponding output point. If PWM is enabled, this value transitions from 0 to 1 based on the PWM pulse train. 0 = Off 1 = On	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].Fault	BOOL	**Fault Status—**Indicates whether a point is faulted. If communication to the output module is lost, then all 32 bits of the Fault word are set. 0 = No fault 1 = Fault	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].FuseBlown	BOOL	**Fuse Is Blown—**Indicates whether a fuse has blown due to a short or overload condition for the corresponding point. All blown fuse conditions are latched and must be reset. 0 = Fuse is not blown. 1 = Fuse is blown and has not been reset.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].PWMCycleLimitDone	BOOL	**PWM Cycle Limit Done—**Indicates whether the PWM pulse cycle limit defined in the Pt[*x*].PWMCycleLimit configuration tag has been reached. 0 = The PWM cycle limit has not yet been reached. The bit resets to 0 each time the output transitions to On to begin a new PWM cycle. 1 = The PWM cycle limit has been reached.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].CIPSyncValid	BOOL	**CIP Sync Is Valid—**Indicates whether the module has synchronized to a valid CIP Sync time master on the backplane. 0 = CIP Sync is not available. 1 = CIP Sync is available.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Pt[*x*].CIPSyncTimeout	BOOL	**CIP Sync Timeout—**Indicates whether a valid time master on the backplane has timed out. 0 = A valid time master has not timed out. 1 = A valid time master was detected on the backplane, but the time master has timed out. The module is currently using its local clock.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
LocalClockOffset	DINT	**Local Clock Timestamp—**Indicates the offset between the current CST and the CIP Sync value when a valid CIP Sync time is available.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
OffsetTimestamp	DINT	**Timestamp Offset—**Indicates when the CIP Sync LocalClockOffset and GrandMasterID were last updated in CIP Sync format.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
GrandMasterClockID	DINT	**Grandmaster Clock ID—**Indicates the ID of the CIP Sync Grandmaster to which the module is synced.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None
Timestamp	DINT	**Timestamp—**A 64-bit CIP Sync timestamp of the last new output data or FuseBlown event.	Connection = Data Output Data = Data or Connection = Listen Only Output Data = None

Table 64 - 1756-OB16IEFS Module Output Data Tags—Scheduled per Point Output

Name	Data Type	Tag Definition	Module Definition
Data	BOOL	**Data—**Indicates the On/Off state to apply to a nonscheduled output point. 0 = Off 1 = On	Connection = Data Output Data = Scheduled per Point
ScheduleMask	BOOL	**Schedule Mask—**A mask indicating which output points are scheduled. 0 = The output point is unscheduled. The On/Off state is determined by the value in the Data output tag. 1 = The output point is scheduled. The On/Off state is determined by the Schedule[*x*].Data output tag.	Connection = Data Output Data = Scheduled per Point
ResetFuseBlown	BOOL	**Reset Blown Fuse—**Attempts to clear a blown fuse status and apply output data when the bit transitions from Off to On.	Connection = Data Output Data = Scheduled per Point
TimestampOffset	DINT	**Timestamp Offset**—Indicates the difference between the system time and the module's local time. The timestamp is in CIP Sync time. This value is typically set to zero but can be updated with the value of the SystemOffset in the controller's TIMESYNCHRONIZE object to enable Time Step Compensation in the module.	Connection = Data Output Data = Scheduled per Point
ScheduleTimestamp	DINT	**Schedule Timestamp—**The baseline CIP Sync time for all schedules. The module uses the baseline CIP Sync time combined with the offset value in the Schedule.Offset tag to calculate the absolute time a physical output turns On or Off.	Connection = Data Output Data = Scheduled per Point
Schedule[*x*].ID	SINT	**Schedule ID—**Identifies which schedule to apply to an output point. Valid schedules: 1…32 0= No schedule	Connection = Data Output Data = Scheduled per Point
Schedule[*x*].SequenceNumber	SINT	**Schedule Sequence Number—**Indicates the sequence count received with a schedule. The module recognizes a new schedule only when there is a change in sequence number. The first message received initializes the schedule.	Connection = Data Output Data = Scheduled per Point
Schedule[*x*].OutputPointSelect	SINT	**Schedule Output Point—**Indicates which physical output point is associated with a schedule. The module recognizes a new schedule only when there is a change in output point. The first message received initializes the schedule. Valid values: 0…15	Connection = Data Output Data = Scheduled per Point
Schedule[*x*].Data	SINT	**Schedule Data—**Indicates the On/Off state to apply to an output point at the scheduled time. 0 = Off 1 = On	Connection = Data Output Data = Scheduled per Point
Schedule[*x*].Offset	DINT	**Schedule Offset—**Indicates a schedule's offset value to be added to the baseline ScheduleTimestamp value to determine the absolute time at which a physical output turns On or Off. The offset value must be +/-35 minutes from the baseline ScheduleTimestamp value.	Connection = Data Output Data = Scheduled per Point
PWM.CycleTime	REAL	**PWM Cycle Time—**Defines the duration of each pulse cycle. Requires PWM to be enabled via the PWM.Enable configuration tag. Valid values: 0.001…3600.0 seconds	Connection = Data Output Data = Scheduled per Point
PWM.OnTime	REAL	**PWM On Time—**Defines the length of time that a pulse is active. Requires PWM to be enabled via the PWM.Enable configuration tag. Valid values: 0.0002…3600.0 seconds or 0…100.0 percent	Connection = Data Output Data = Scheduled per Point

Table 65 - 1756-OB16IEFS Module Output Data Tags—Data Output

Name	Data Type	Tag Definition	Module Definition
Pt[*x*].Data	BOOL	**Data—**Indicates the On/Off state to apply to a nonscheduled output point. 0 = Off 1 = On	Connection = Data Output Data = Data
Pt[*x*].ResetFuseBlown	BOOL	**Reset Blown Fuse—**Attempts to clear a blown fuse status and apply output data when the bit transitions from Off to On.	Connection = Data Output Data = Data
Pt[*x*].PWMCycleTime	REAL	**PWM Cycle Time—**Defines the duration of each pulse cycle. Requires PWM to be enabled via the PWM.Enable configuration tag. Valid values: 0.001…3600.0 seconds	Connection = Data Output Data = Data
Pt[*x*].PWMOnTime	REAL	**PWM On Time—**Defines the length of time that a pulse is active. Requires PWM to be enabled via the PWM.Enable configuration tag. Valid values: 0.0002…3600.0 seconds or 0…100.0 percent	Connection = Data Output Data = Data

Redundant Owner Configuration Tags

The redundant owner configuration tags are identical to the existing 1756-OB16IEF configuration.

Redundant Owner Input Tag Layout

We added eight Input tags to the existing Input data layout. The bit tag field, *PartnerBits*, increased from 2 bits to 10 bits to cover OwnerActive, Owner ID, and Active/Claim/Ready status for the A and B controllers.

Table 66 - New Redundant Input Tag Description – 1756-OB16IEF

Field	Data Type	Legal Values	Usage
OwnerActive	BOOL	B4	The Output has a Controlling Owner
OwnerID	BOOL	B5	Which Owner is Active (Controlling): 0 = Owner A 1 = Owner B
OwnerAConnected	BOOL	B6	Owner A is Connected.
OwnerAClaim	BOOL	B7	Owner A is claiming Outputs (COO).
OwnerAReady	BOOL	B8	Owner A is Ready to claim Outputs (ROO).
OwnerBConnected	BOOL	B9	Owner B is Connected.
OwnerBClaim	BOOL	B10	Owner B is claiming Outputs (COO).
OwnerBReady	BOOL	B11	Owner B is Ready to claim Outputs (ROO).

Redundant Owner Output Tag Layout

We added two Input tags in the Output data: a BOOL to reflect the COO bit and another for the ROO bit.

Table 67 - New Redundant Output Tag Description – 1756-OB16IEF

Field	Data Type	Legal Values	Usage
OwnerClaim	BOOL	BO 0 = Not Requesting Ownership 1 = Claim Ownership	When set, indicates that the controller wants to Claim Ownership of the redundant connection and have its outputs actively used. • If both Redundant Owners have COO set, the last originator application that transitioned its COO flag from reset to set shall be the owner. **NOTE:** Only an Rx'd 0 to a 1 and not just the receipt of a new connection is considered such a transition. • If neither Redundant Owner has COO set, then the highest ROO becomes Owner.
OwnerReady	BOOL	B1 0 = Not Ready to Own 1 = Ready to Own	Indicates the controller's readiness for output ownership. A value of 1 indicates ready while 0 indicates the controller is not ready to own the outputs. • If neither controller has the COO bit set, the ROO determines the current owner. • If both controllers have COO=0 and ROO=0, then the outputs go to IDLE (Program mode). • If both controllers have COO=0 and ROO=1, OwnerA will be active.

Array Data Structures

Fast digital I/O modules use an array data structure. In this type of structure, all the tags for a particular point are organized under that point. For example, in Figure , all of the tags that appear under point 0 also appear under points 1...15 for the input module in slot 1. With this structure, you can copy or access all of the data for a particular point by simply referencing or copying the point or alias for the point, such as Pt[3] or PressureValveTank3.

Array Data Structure

Local:1:I.Pt	{...}
Local:1:I.Pt[0]	{...}
Local:1:I.Pt[0].Data	0
Local:1:I.Pt[0].Fault	0
Local:1:I.Pt[0].NewDataOffOn	0
Local:1:I.Pt[0].NewDataOnOff	0
Local:1:I.Pt[0].TimestampDropped	0
Local:1:I.Pt[0].CIPSyncValid	0
Local:1:I.Pt[0].CIPSyncTimeout	0
Local:1:I.Pt[0].InputOverrideStatus	0
Local:1:I.Pt[0].Timestamp	{...}
Local:1:I.Pt[0].Timestamp.OffOn	{...}
Local:1:I.Pt[0].Timestamp.OnOff	{...}
Local:1:I.Pt[1]	{...}
Local:1:I.Pt[2]	{...}

Other digital I/O modules use a flat data structure. In this type of structure, only one instance of a tag exists for a module. For example, in Figure , only one instance of each tag appears under the input module in slot 3. To reference or copy data for an individual point, you specify the tag name followed by a bit number, such as Data.0 or EventOverflow.3. Unlike an array structure where all the data for a point can be accessed via a single tag reference, a flat structure requires multiple tag references to access all the data for a point.

Flat Data Structure

Local:3:I	{...}
Local:3:I.Fault	2#1111_1111_1111_1111_1111_1111_1111_1111
Local:3:I.Data	2#0000_0000_0000_0000_0000_0000_0000_0000
Local:3:I.NewData	2#0000_0000_0000_0000_0000_0000_0000_0000
Local:3:I.EventOverflow	2#0000_0000_0000_0000_0000_0000_0000_0000
Local:3:I.ReturningUCTTime	0
Local:3:I.ReturningCIPSyncTime	0
Local:3:I.CIPSyncValid	0
Local:3:I.CIPSyncTimeout	0
Local:3:I.EventNumber	0
Local:3:I.LocalClockOffset	{...}
Local:3:I.Offsettimestamp	{...}
Local:3:I.Timestamp	{...}

The 1756-OB16IEFS module uses either type of data structure depending on how you configure the module. For more information, see page 136.

Use Ladder Logic To Perform Run Time Services and Reconfiguration

You can use ladder logic to perform run-time services on your module. For example, page 154 shows how to reset an electronic fuse module by using the Studio 5000 Logix Designer® application. This appendix provides an example of how to reset the same fuse without using the Logix Designer application.

In addition to performing run-time services, you can use ladder logic to change configuration. Chapter 4 explained how to use the Logix Designer application to set configuration parameters in your ControlLogix® digital I/O module. Some of those parameters may also be changed through ladder logic.

Using Message Instructions

In ladder logic, you can use message instructions to send occasional services to any ControlLogix I/O module. Message instructions send an explicit service to the module, causing specific behavior to occur. For example, unlatching a high alarm can be performed by a message instruction.

Message instructions maintain these characteristics:

- Messages use unscheduled portions of system communication bandwidth
- One service is performed per instruction
- Performing module services does not impede module functionality, such as sampling inputs or applying new outputs

Processing Real-time Control and Module Services

Services that are sent through message instructions are not as time critical as the module behavior defined during configuration and maintained by a real-time connection. Therefore, the module processes messaging services only after the needs of the I/O connection have been met.

For example, you may want to unlatch all process alarms on the module, but real-time control of your process is still occurring by using the input value from that same channel. Because the input value is critical to your application, the module prioritizes the sampling of inputs ahead of the unlatch service request.

This prioritization lets input channels be sampled at the same frequency and the process alarms to be unlatched in the time between sampling and producing the real-time input data.

One Service Performed Per Instruction

A message instruction causes a module service to be performed only once per execution. For example, if a message instruction sends a service to the module to unlatch the high high alarm on a particular channel, that channel's high high alarm unlatches, but may be set on a subsequent channel sample. The message instruction must then be re-executed to unlatch the alarm a second time.

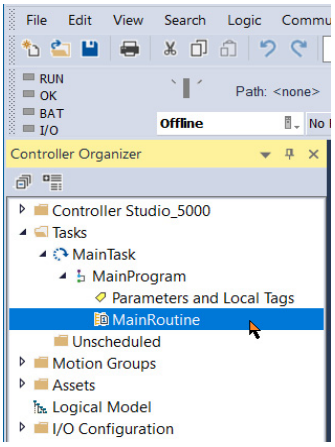
Create a New Tag

This section shows how to create a tag in ladder logic when adding a message instruction. Ladder logic is in the main routine within the Logix Designer application.

Follow these steps to create a tag.

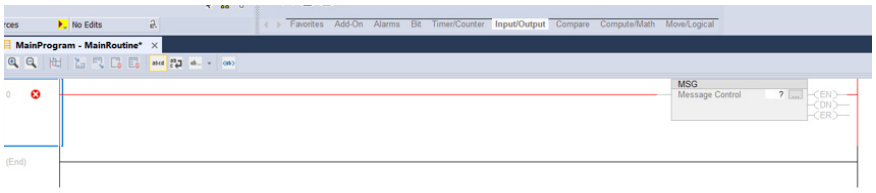
1. Start the Logix Designer application and open an existing I/O project or create a new one.
2. On the Controller Organizer, double-click MainTask.

   Expand MainProgram to see Main Routine as a submenu item.



   A graphic that looks like a ladder, with rungs, appears in the right side of the Logix Designer application. You attach run-time service, such as a message instruction, to the rungs and then download the information to a controller.

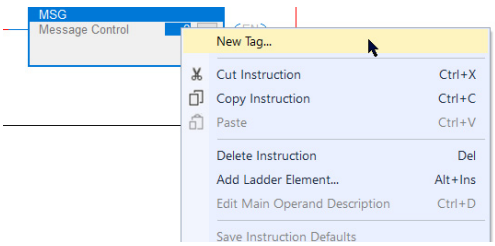
   You can tell that the rung is in Edit mode because of the 'e' at the left side of the rung.



3. Find, then click MSG (message) instruction on the instruction toolbar.

   The MSG icon is among the formats on the Input/Output tab of the instruction toolbar.

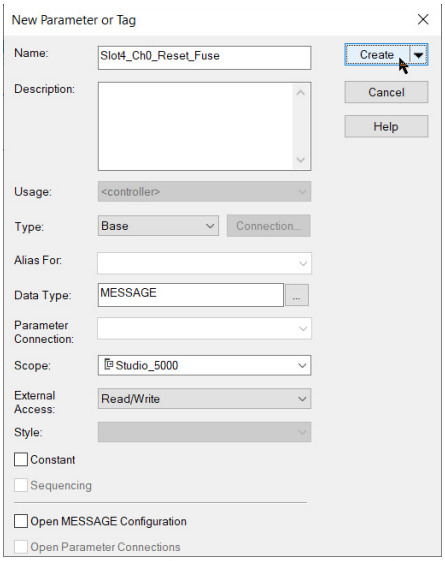
   You can also drag-and-drop an instruction icon onto a rung. A green dot appears when a valid location is detected for the instruction on the rung.
4. Inside the message box in the Message Control field, right-click the question mark to access a dropdown menu.



5. Choose New Tag.

   The New Tag dialog box appears with the cursor in the Name field.

IMPORTANT We suggest you name the tag to indicate what module service the message instruction is sending. For example, if a message instruction is to reset an electronic fuse, then name the tag, 'reset fuse', to reflect this.



6. Complete the fields on the New Tag dialog box.

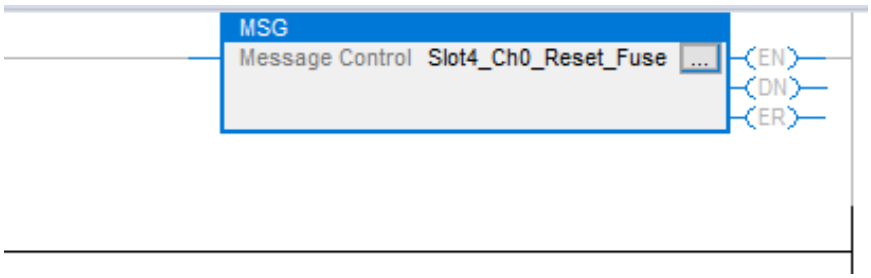
Field	Description
Name	Type the tag name, including the slot number in the module.
Description	Type an option tag description.
Usage	Use the default.
Type	Use the default.
Alias for	Leave blank.
Data Type	Choose MESSAGE.
Scope	Choose the Controller scope. **Note:** Message tags can be created only with the Controller scope.
External Access	Use the default.
Style	Leave blank.
Constant	Leave blank.
Open MESSAGE Configuration	Leave the box blank if you do NOT want to automatically access the Message Configuration screen when OK is clicked. You can still access the Message Configuration screen later by following the procedures on page 148.

7. Click OK.

Enter Message Configuration

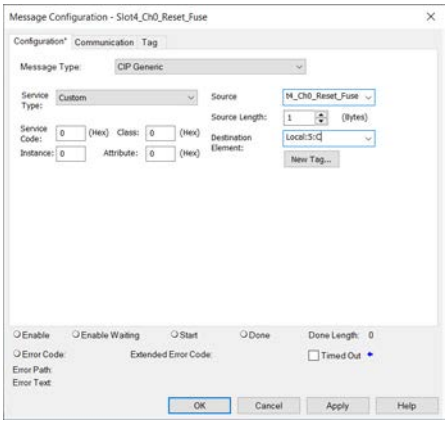
After creating a tag, you must enter certain parameters for the message configuration. This information is entered on the Configuration and Communication tabs of the Message Configuration dialog box.

The Message Configuration dialog box is accessed by clicking the box with the ellipses (in the Message Control field).



Configuration Tab

The Configuration tab provides information on what module service to perform and where to perform it.



This table explains the relationship of the fields in the above dialog boxes. For example, despite different entry fields, both screen examples are configured to send a message to reset an electronic fuse (module service) on Channel 0 of a 1756-OA8D module (where to perform the service).

Table 68 - Relationship of Message Configuration Parameters

Parameter	Description
Service Type	Defines the type of module service to be performed. For example, a reset. **Note:** In version 10.07.00 or later, you can use a dropdown menu to choose the Service Type. The application defaults the Service Code, Instance, Class, and Attribute parameters based on the Service Type that you choose. All values are in Hex.
Class	Object that you are sending a message to, such as the device object or a discrete output point.
Instance	Each object can have multiple instances. For example, a discrete output can have 16 points or instances of where a message can be sent. This specifies the instance.
Attribute	Further identifies the exact address for the message. An analog input can have multiple alarms so this attribute acknowledges a specific alarm and not the other alarms. If an attribute is not specified (default to 0) the Service applies to all attributes of the Class/Instance.

This table lists tags that are used in the Source and Destination fields of the message instructions.

Table 69 - Source and Destination Field Tags

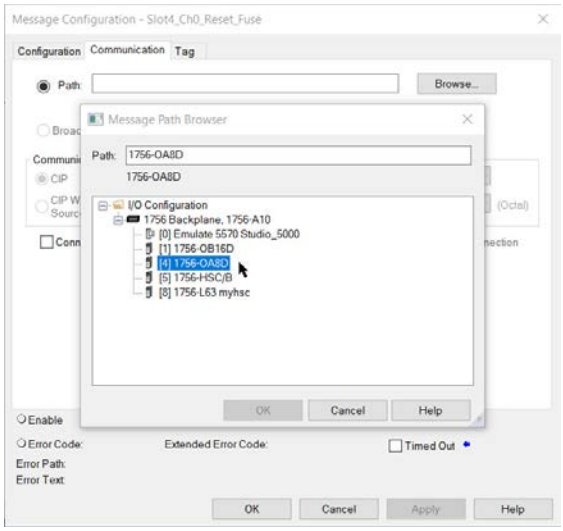
Source Tag	Description
Enable_32_Points DINT	Parameter used to determine which points are enabled for the service. That is, if bit 0 = 1 for Reset Fuse, then point 0 has its electronic fuse reset.
Results_32_Points DINT	Pass (0)/ Fail (1) result for the service. That is, if bit 0 = 1 for the results of the Reset Fuse, then the Reset Fuse failed for point 0.

Choose the physical location, slot number, and data type in the Source Element and Destination fields.

Communication Tab

The Communication tab provides information on the path of the message instruction. For example, the slot number of a 1756-OA8D module distinguishes exactly which module a message is designated for.

IMPORTANT	Use the Browse button to see a list of the I/O modules in the system. You choose a path when you choose a module from the list. You must name an I/O module during initial module configuration to choose a path for your message instruction. Click OK to set the path.



Timestamped Inputs and Scheduled Outputs - Standard or Diagnostic Modules

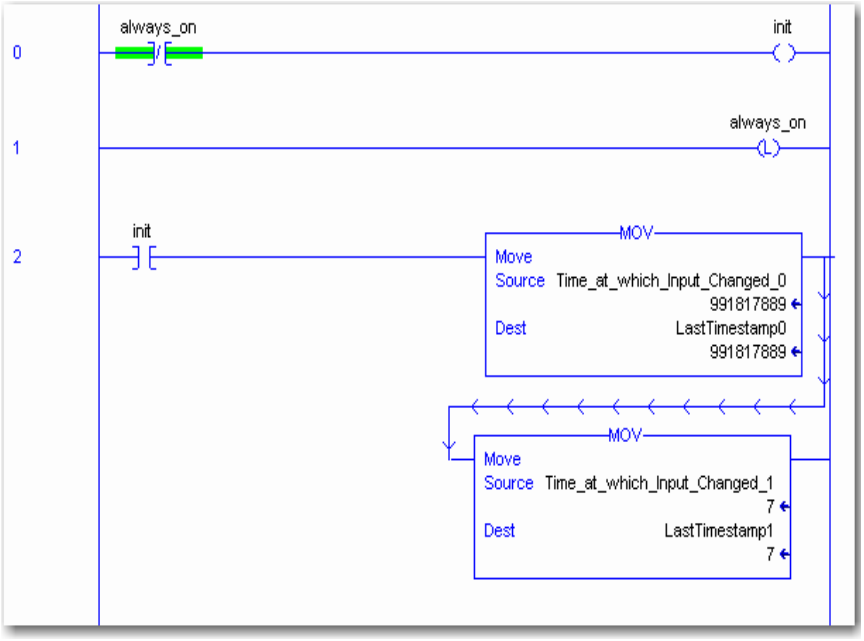
This section demonstrates the use of timestamped inputs and scheduled outputs for standard and diagnostic digital I/O modules. The Change of State timestamp can be used to synchronize the output turning On or Off based on the time that the input transitions. The program can be extended to include synchronizing multiple output modules by sending the same timestamp to all output modules.

In the illustration below, the output follows the state of input 0, but it is delayed by exactly 10 ms. The advantage of using CST over timers is that the synchronization is performed at the I/O module, which eliminates any jitter due to controller or communication delays.

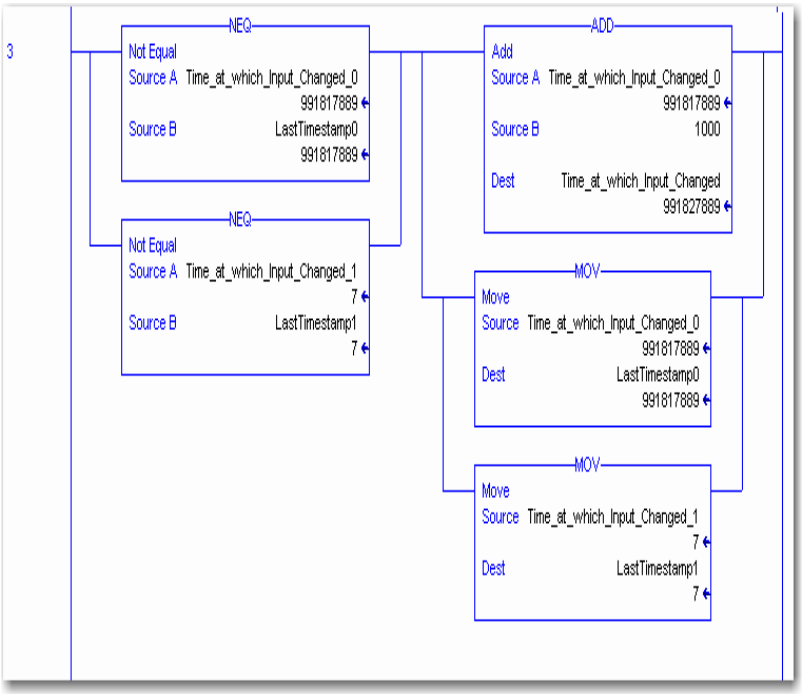
Your control becomes much more deterministic even under changing loads. For this synchronization to work properly, the 10 ms delay must be long enough to account for any controller, backplane, and network delays. The input and output modules must reside in the same rack as a Time Master (controller). Timestamp units are microseconds.

The following illustrations show the ladder instructions the program uses. The rungs perform these tasks:

- Rungs 0 and 1 detect the transition from Program to Run mode. This is used to turn On 'init', which causes the program to initialize its tags.
- Rung 2 only executes once and initializes the LastTimestamp. LastTimestamp is used to detect a Change of State on the input point by checking to see if the timestamp of the input data has changed.



- Rung 3 is the main rung that checks for Change of State on the input point by comparing the current input timestamp (Time_at_which_Input_Changed) with the last timestamp (LastTimestamp).

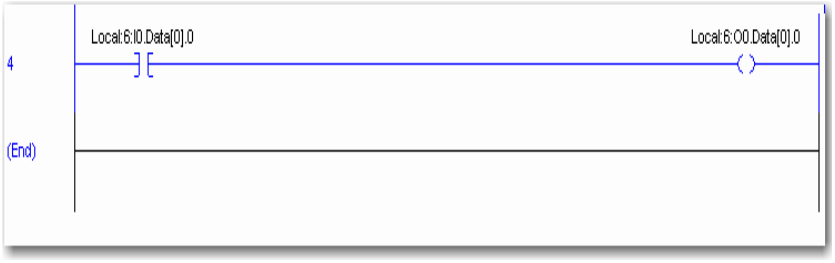


The input point (point 0) must have Change of State enabled or the timestamp does not update when the point transitions. Once Change of State has been detected, 10 ms is added to the input timestamp and sent to the output module's timestamp. This causes the output module to apply its output exactly 10 ms (10,000 µs) after the input changed state.

The MOVe instructions update LastTimestamp in preparation for the next change of state.

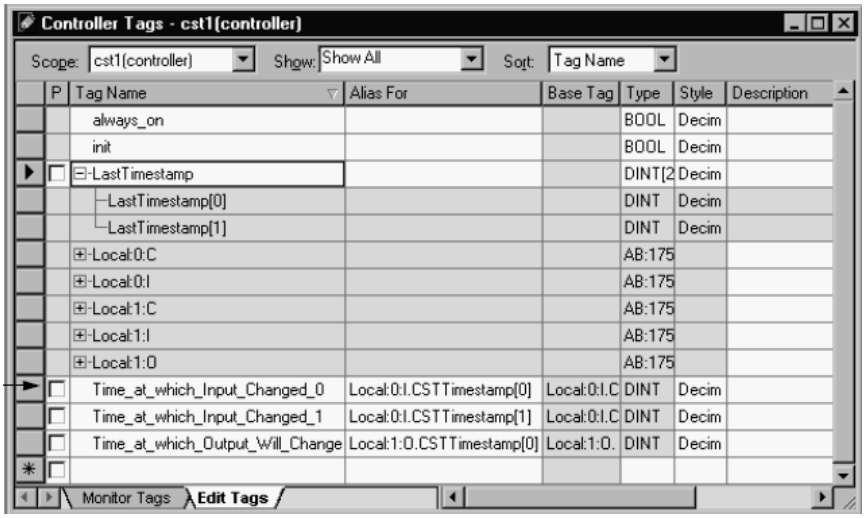
IMPORTANT	Timestamps are 8 bytes in size, two DINTS, but only the lower 4 bytes of the output timestamp (Time_at_which_Ouput_Will_Change) are used to schedule the outputs into the future (to a max of 16.7 s or 16,700,000 µs).

- Rung 4 is the standard XIC-OTE rung that controls the output point based on the input point.



The only difference is the output module is configured for scheduled outputs. The outputs are not applied until the scheduled time has occurred.

The Controller Tags dialog box shows examples of the tags created in ladder logic.



Timestamped Inputs and Scheduled Outputs - Fast Modules

This section demonstrates the use of timestamped inputs and scheduled outputs for fast digital I/O modules. The Change of State timestamp can be used to synchronize the output turning On or Off based on the time that the input transitions. The program can be extended to include synchronizing multiple output modules by sending the same timestamp to all output modules.

In the example on page 152, the output follows the state of input 0, but it is delayed by the amount of time in the Delay tag. The advantage of using CIP Sync™ over timers is that the synchronization is performed at the I/O module, which eliminates any jitter due to controller or communication delays.

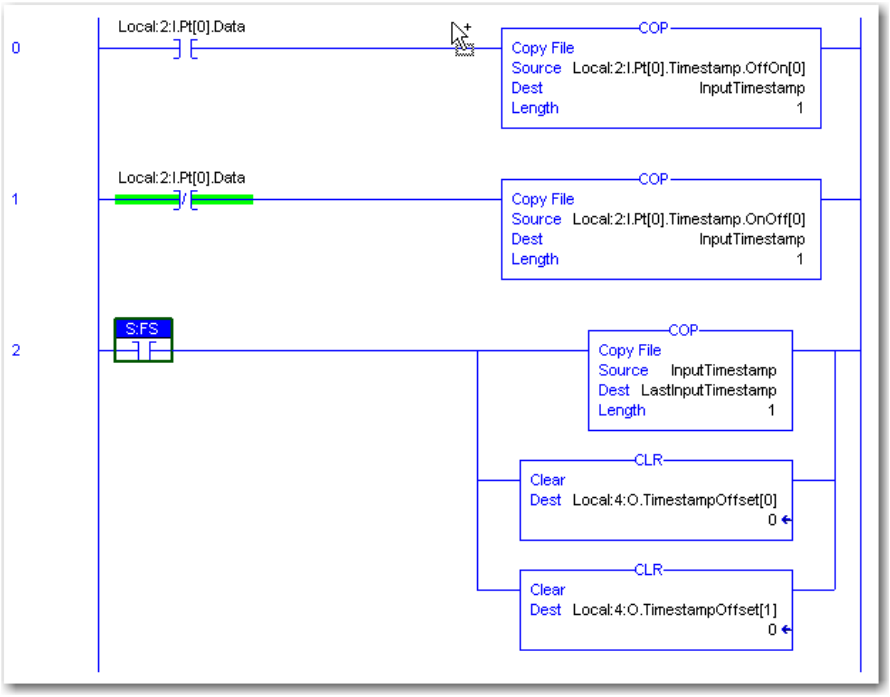
Your control becomes much more deterministic even under changing loads. For this synchronization to work properly, the value in the Delay tag must be long enough to account for any controller, backplane, and network delays.

In this example, the controller, input, and output modules all reside in the same chassis, but they can reside in separate chassis as long as they are all part of the same synchronized CIP Sync system. Time-stamp units are microseconds.

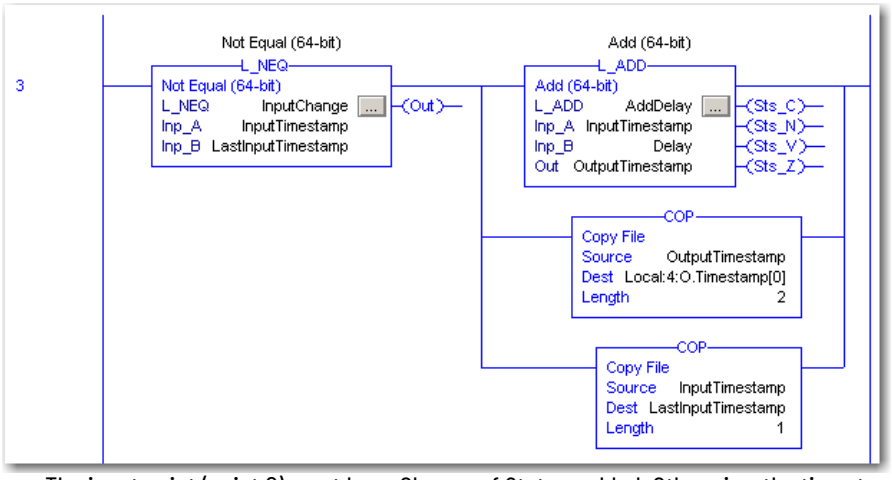
IMPORTANT Unlike standard and diagnostic I/O modules that use CST for timestamps, fast I/O modules use CIP Sync timestamps, which are a full 64 bits in width. Manipulation of CIP Sync time values requires the use of 64-bit math. The following example uses 64-bit Add-On Instructions contained in the LINT (64-bit signed 2's complement integer) Math Library at https://www.rockwellautomation.com/en-us/support/product/product-downloads/application-code-library/sample-code.html.

The following illustrations show the ladder instructions the program uses. The rungs perform these tasks:

- Rungs 0 and 1 capture the rising or falling timestamps for input 0 of a 1756-IB16IF module.
- Rung 2 executes only once at the transition from Program to Run mode. It initializes LastInputTimestamp, which is used to detect a change of state on the input point by checking to see if the timestamp of the input data has changed. This rung also clears the output module's TimestampOffset bit to disable its Time Step Compensation algorithm.



- Rung 3 is the main rung that checks for a change of state on the input point by comparing the current input timestamp with the last timestamp (LastInputTimestamp).

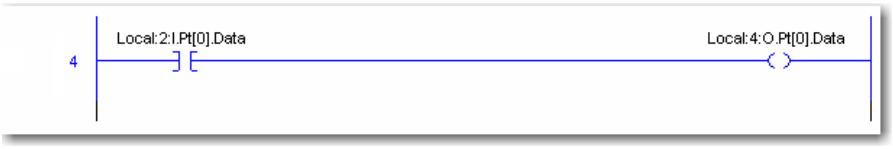


The input point (point 0) must have Change of State enabled. Otherwise, the timestamp does not update when the point transitions.

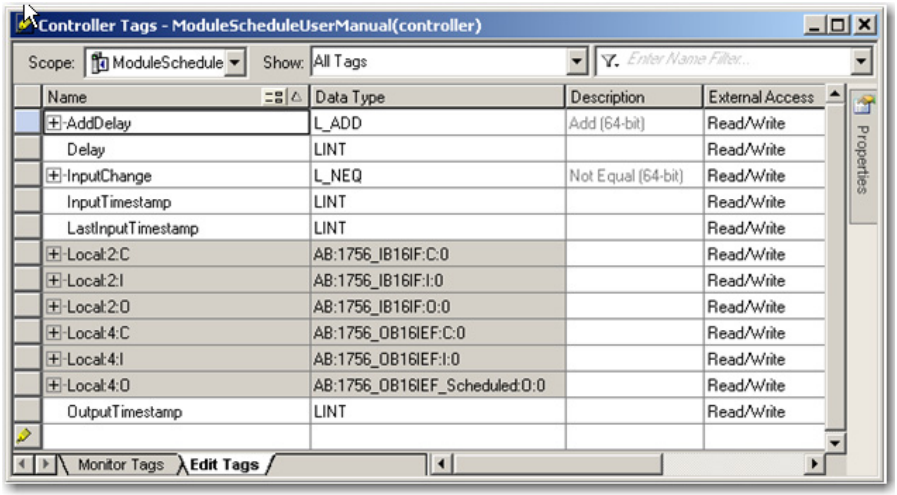
Once Change of State has been detected, the value in the Delay tag is added to the input timestamp and sent to the output module's timestamp using a COP instruction. This causes the output module to apply its output at a time equal to the time that the input changed state plus the Delay time.

The final COP instruction updates LastInputTimestamp in preparation for the next change of state.

- Rung 4 is the standard XIC-OTE rung that controls the output point based on the input point. The only difference is that the output module is configured for scheduled outputs. The outputs are not applied until the scheduled time has occurred.



The Controller Tags dialog box shows examples of the tags created in ladder logic.

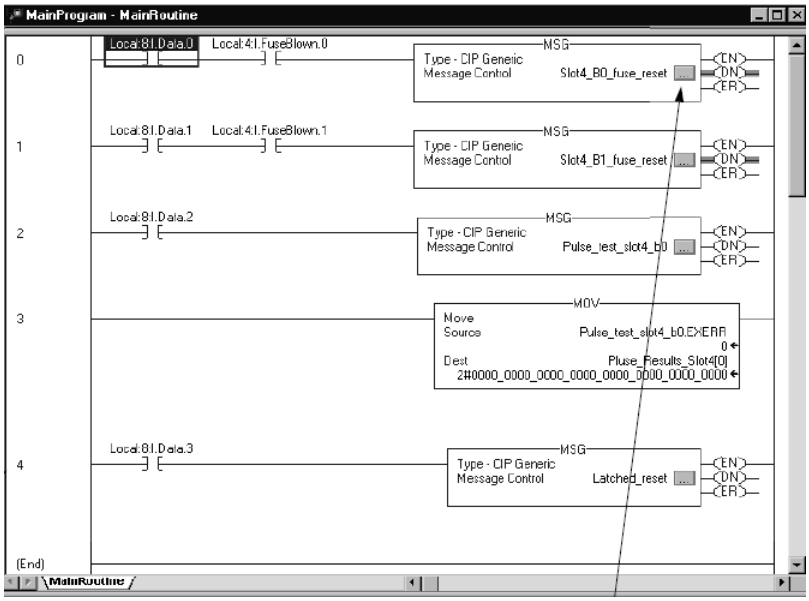


Reset a Fuse, Perform Pulse Test, and Reset Latched Diagnostics

If an electronic fuse in a digital I/O module is shorted, a red LED appears on the front of the module and the FuseBlown bits for the output group, in the local input tag, will become true.

Once the short has been fixed, you can cycle power to the module with an electronic fuse via turning off the chassis power or re-seating the module itself, or you can use ladder logic to reset the electronic fuse.

This ladder logic program shows how to use ladder logic to reset an electronic fuse for a faulted point, perform a pulse test, and to reset latched diagnostics.

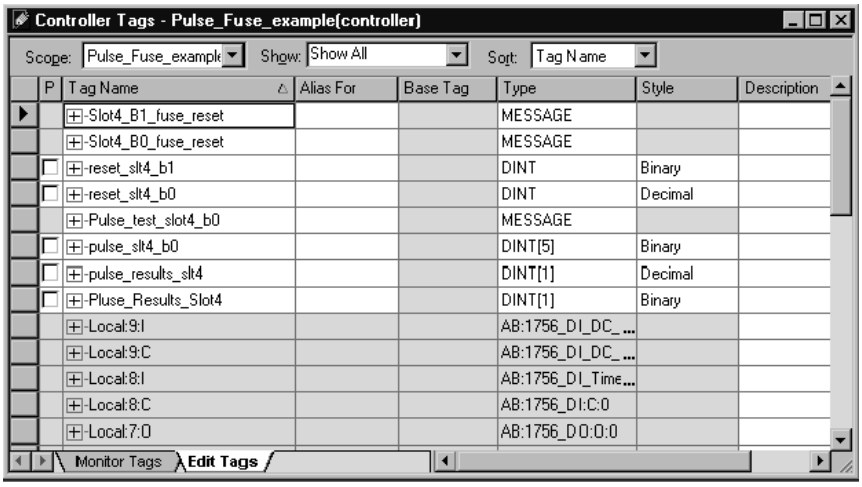


Click the box in each rung to see the associated configuration and communication.

The rungs perform these functions:

- Rungs 0 and 1 are used to perform a reset fuse service on Bits 0 and 1, respectively. The example is of a 1756-OA8D module in slot 4.
- Rung 2 performs a pulse test service to slot 4.
- Rung 3 moves the results of the pulse test to a data storage location. (The actual results appear in the message instruction tags under the tag name EXERR).
- Rung 4 performs a reset latched diagnostics service to slot 4. This example shows an output module.

The Controller Tags dialog box shows examples of the tags created in the ladder logic, as displayed in the tag editor.



Perform a WHO to Retrieve Module Identification and Status

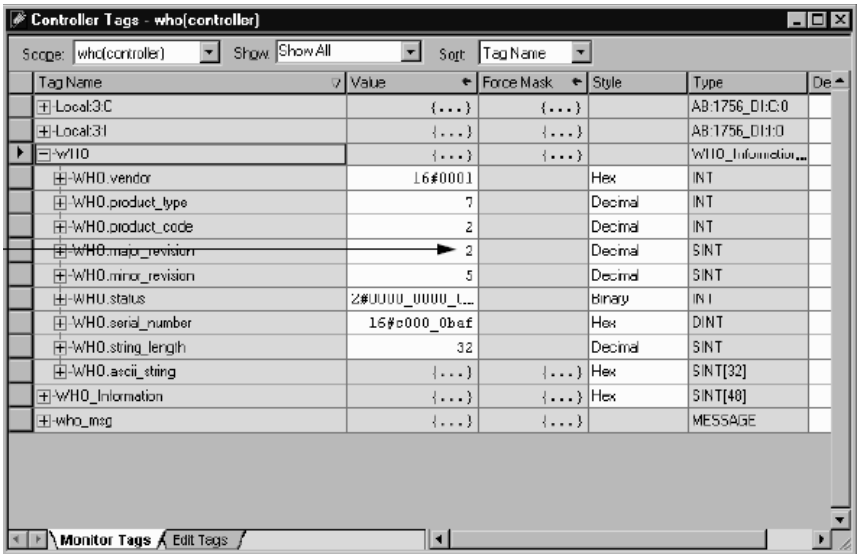
This ladder logic example shows how to retrieve module identification and status through a WHO service. A message instruction retrieves this module identification information:

- Product type
- Product code
- Major revision
- Minor revision
- Status
- Vendor
- Serial number
- String length
- ASCII string

An explanation of each identification category is provided after the ladder logic application.

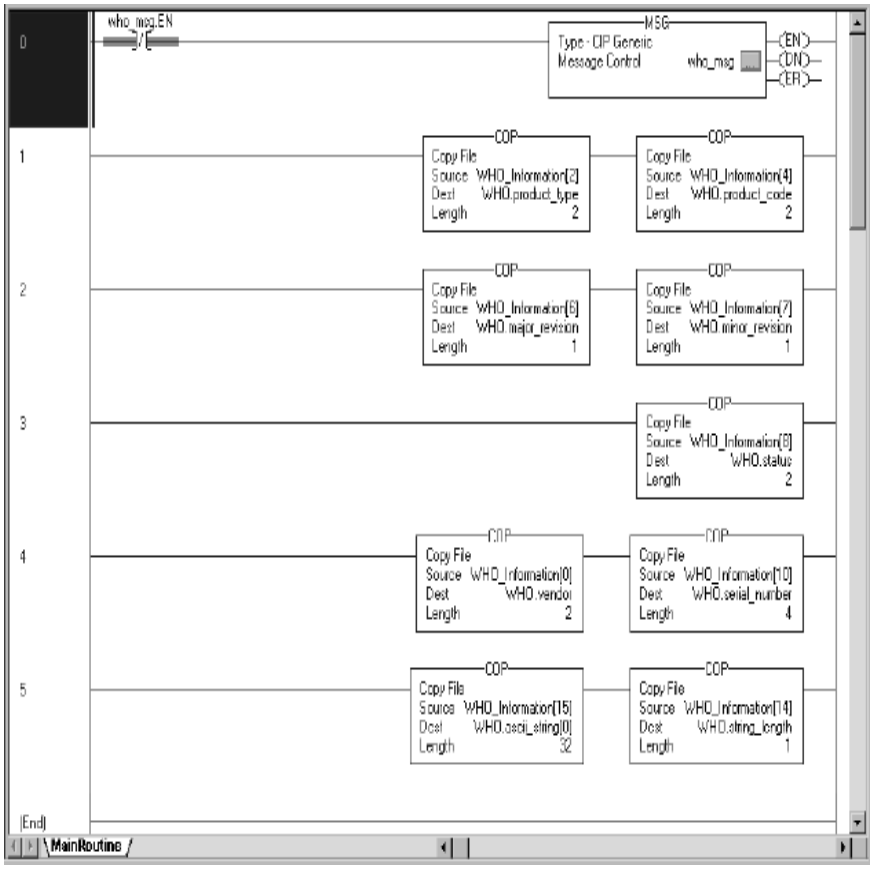
IMPORTANT The ladder logic example in this section uses a user-defined WHO data structure and a series of Copy instructions (following the Message instruction in the screen capture) to make the module identification information more easily understood.

The user-defined WHO data structure displays module identification information. For example, the Controller Tags dialog box shows the module's major revision is 2.



You do not have to create the user-defined data structure. If you choose not to create this structure, you can use the ASCII string and String length to retrieve and understand module identification through some interface excluding the Logix Designer application.

The illustration shows an example WHO ladder logic application.



The rungs perform these functions:

- Rung 0 constantly polls the module for WHO status. To conserve bandwidth, only poll for status when necessary.
- Rung 1 extracts the product type and catalog code.
- Rung 2 extracts the module's major and minor revisions.
- Rung 3 extracts the module's status information.
- Rung 4 extracts the vendor ID and serial number.
- Rung 5 extracts the module's ASCII text string and the length of the text string in bytes.

This table defines the values returned for each rung.

Table 70 - Rung Values

Rung	Module ID Retrieved	Description
1	Product Type Catalog Code	Module's product type, 7=Digital I/O, 10=Analog I/O Module's catalog number
2	Major Revision Minor Revision	Module's major revision Module's minor revision
3	Status	Module's status. Multiple bits listed. Bit 0: 0 = Unowned, 1 =Owned Bit 1: Reserved Bit 2: 0 = Unconfigured, 1 = Configured Bit 3: Reserved Bits 7-4: Forms a 4-bit number indicating Device-Specific Status. 0 = Self-Test 1 = Flash update in progress 2 = Communications fault 3 = Not owned (outputs in Program mode) 4 = Unused 5 = Internal fault (need flash update) 6 = Run mode 7 = Program mode (output mods only) Bit 8: 0 = No fault, 1 = Minor recoverable fault Bit 9: 0 = No fault, 1 = Minor recoverable fault Bit 10: 0 = No fault, 1 = Minor recoverable fault Bit 11: 0 = No fault, 1 = major nonrecoverable fault Bits 15...12: Unused
4	Vendor ID Serial Number	Module manufacturer vendor, 1 = Allen-Bradley Module serial number
5	Length of ASCII Text String ASCII Text String	Number of characters in module's text string Module's ASCII text string description

Review of Tags in Ladder Logic

When you use tags in ladder logic applications, remember these guidelines:

- Ladder logic tags represent the module on a **point per bit basis**. For example, point 0 = bit 0 on the module.
- If you are **performing a service** through the tags, a value of 0 helps prevent the action from occurring, and a value of 1 causes the action to occur. For example, if you want to reset the electronic fuse on a particular bit, enter 1 in the tags.
- If you are checking the **response of a service** through the tags, a value of 0 means the bit passed the service, and a value of 1 means the bit failed the service. For example, if you perform a pulse test and the response displays a 0 for a particular bit, the bit passed the test.

Notes:

Choose a Correct Power Supply

Use the chart to determine the power your ControlLogix® chassis is using to help prevent an inadequate power supply. We recommend that you use this worksheet to check the power supply of each ControlLogix chassis used.

Slot Number	Module Cat. No.	Current @ 5.1V DC (mA)		Power @ 5.1V DC (Watts)	Current @ 24V DC (mA)		Power @ 24V DC (Watts)	Current @ 3.3V DC (mA)		Power @ 3.3V DC (Watts)
0			x 5.1V =			x 24V =			x 3.3V =	
1			x 5.1V =			x 24V =			x 3.3V =	
2			x 5.1V =			x 24V =			x 3.3V =	
3			x 5.1V =			x 24V =			x 3.3V =	
4			x 5.1V =			x 24V =			x 3.3V =	
5			x 5.1V =			x 24V =			x 3.3V =	
6			x 5.1V =			x 24V =			x 3.3V =	
7			x 5.1V =			x 24V =			x 3.3V =	
8			x 5.1V =			x 24V =			x 3.3V =	
9			x 5.1V =			x 24V =			x 3.3V =	
10			x 5.1V =			x 24V =			x 3.3V =	
11			x 5.1V =			x 24V =			x 3.3V =	
12			x 5.1V =			x 24V =			x 3.3V =	
13			x 5.1V =			x 24V =			x 3.3V =	
14			x 5.1V =			x 24V =			x 3.3V =	
15			x 5.1V =			x 24V =			x 3.3V =	
16			x 5.1V =			x 24V =			x 3.3V =	
	Totals	mA		W (1)	mA		W (2)	mA		W (3)
		This number cannot exceed the following: 10,000 mA for 1756-PA72, 1756-PB72 13,000 mA for 1756-PA75, 1756PB75, 1756-PC75, 1756-PH75			This number cannot exceed 2800 mA			This number cannot exceed 4000 mA		
				These three wattage values (1, 2, 3), added together, cannot exceed 75 W @ 60 °C (140 °F) for any power supply.						

Notes:

Motor Starters for Digital I/O Modules

This appendix provides data to help you choose a ControlLogix® digital I/O module to drive Bulletin 500 series motor starters in your application. The tables list the number of motor starters (five sizes are listed for each module) that a particular digital I/O module can drive.

IMPORTANT When using the tables, remember that the supply voltage for each module must not drop below the minimum state motor starter supply voltage.

Table 71 - Maximum Allowed 2-3 Pole Motor Starters (120V AC/60 Hz)

Cat. No.	Motor Starters				
	Size 0...1	Size 2	Size 3	Size 4	Size 5
1756-OA16I	16	15 @ 30 °C (86 °F) 12 @ 60 °C (140 °F)	13 @ 30 °C (86 °F) 10 @ 60 °C (140 °F)	8 @ 30 °C (86 °F) 6 @ 60 °C (140 °F)	5 @ 30 °C (86 °F) 4 @ 60 °C (140 °F)
1756-OA16	16	14 (only 7 per group)	4 (Only 2 per group)	None	None
1756-OA8	8	8	8	8 @ 30 °C (86 °F) 6 @ 60 °C (140 °F)	5 @ 30 °C (86 °F) 4 @ 60 °C (140 °F)
1756-OA8D	8	8	8	None	None
1756-OA8E	8	8	8	6 (only 3 per group)	6 @ 30 °C (86 °F) (only 3 per group) 4 @ 60 °C (140 °F) (only 2 per group)

Table 72 - Maximum Allowed 2-3 Pole Motor Starters (230V AC/60 Hz)

Cat. No.	Motor Starters				
	Size 0-1	Size 2	Size 3	Size 4	Size 5
1756-OA16I	16	16	16	16 @ 30 °C (86 °F) 13 @ 60 °C (140 °F)	11 @ 30 °C (86 °F) 9 @ 60 °C (140 °F)
1756-OA16	16	16	16	4 (only 2 per group)	2 (only 1 per group)
1756-OA8	8	8	8	8	8

Table 73 - Maximum Allowed 2-3 Pole Motor Starters (24V AC/60 Hz)

Cat. No.	Motor Starters				
	Size 0-1	Size 2	Size 3	Size 4	Size 5
1756-ON8	4 @ 30 °C (86 °F) 3 @ 60 °C (140 °F)	4 @ 30 °C (86 °F) 3 @ 60 °C (140 °F)	None	None	None

Determine the Maximum Number of Motor Starters

To determine the maximum number of motor starters that can be used by any 1756 digital I/O module, refer to this example.

Table 74 - Number of Motor Starters to be Used

Step	Value used in this example
1. Choose your motor starter.	Allen-Bradley® Bulletin 500 Size 3 120V AC/60 Hz/2-3 Poles. Inrush 1225VA, Sealed=45VA
2. Determine the number of motor starters required for your application.	11 size 3 motor starters
3. Choose a ControlLogix digital output module.	1756-OA16I • Output voltage = 74…265V AC • Output steady state current per point = 2 A maximum @ 30 °C (86 °F) • & 1 A maximum @ 60 °C (140 °F) Linear derating • Output steady state current per module = 5 A maximum @ 30 °C (86 °F) & 4 A maximum @ 60 °C (linear derating) • Output surge current p= 20 A maximum for 43 ms repeatable every 2 s @ 60 °C (140 °F)
4. Determine the maximum environmental operating temperature.	50 °C (122 °F)
5. Confirm that the voltage range is within the motor starter range.	Motor starter uses 120V AC 1756-OA16I operates in a 74…120V AC voltage range
6. Confirm the inrush current per point.	Inrush of motor starter - Line voltage = Inrush current = 1225VA/120V AC = 10.2 A Inrush
7. Confirm the steady state point current of the module can drive the motor starter.	Sealed/Line voltage = Steady state current = 45VA/120V AC = 0.375 A @ 50 °C (122 °F) Output point current can drive: 2 A- (.033 A x 20 °C) = 2 A - 0.66 A = 1.34 A @ 50 °C (122 °F) Above 30 °C (86 °F), output point derates to 0.033 mA/°C (point derating) The 1756-OA16I output point current (1.34 A) can drive the motor starter (0.375 A @ 50 °C (122 °F)
8. Confirm that the 1756-OA16I/A total module current can drive 11 size 3 motor starters @ 50 °C (122 °F).	Motor starter steady state current x 11 motor starters = 0.375 x 11 = 4.125 A @ 50 °C (122 °F) The output total module current can drive: 5 A…(.033 A x 20 °C) = 5 A -0.66 A =4.34 A @ 50 °C (122 °F) Above 30 °C (86 °F) total output current derates to 0.033 mA/°C (Module derating) The 1756-OA16I total output current (4.34 A) can drive the 11 motor starters (4.125 A) @ 50 °C (122 °F)

Major Revision Upgrades

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If Using a Compatible or Disabled Keying I/O Configuration	163
If Using an Exact Match Keying Configuration	163

Except for fast digital I/O modules (catalog numbers 1756-IB16IF, 1756-OB16IEF, and 1756-OB16IEFS), ControlLogix® 1756 digital I/O modules are transitioning to use a new, internal backplane Application Specific Integrated Circuits (ASIC) chip. As a result, the Major Revision number for these modules has also been upgraded. Digital I/O modules with the new ASIC have Major Revision 3.*x*.

IMPORTANT	Do not downgrade your module's firmware from firmware revision 3.*x* to 2.*x*. Attempting to downgrade or downgrade a module's firmware from 3.*x* to 2.*x* will irreversibly damage the module. You must return modules that are damaged by an attempt to downgrade to firmware 2.*x* to Rockwell Automation.

Modules with the new internal backplane ASIC are form-fit, functional equivalents to the 2.*x* modules.

You can use Major Revision 3.*x* modules as direct replacements for Major Revision 2.*x* modules in these cases:

- The electronic keying of the module is specified as Compatible or Disabled Keying.
- The electronic keying of the module is Exact Keying, then additional steps are required. See page 163 for details.

The use of the upgraded ASIC also impacts the firmware revisions that can be update upgraded to the module. Digital I/O modules at Major Revision 3.*x* cannot be backflashed to any 2.*x* firmware revision. Digital I/O modules at firmware revision 2.*x* cannot be update upgraded to any firmware revision 3.*x*.

If Using a Compatible or Disabled Keying I/O Configuration

If you are replacing a 2.*x* module with a 3.*x* module and have configured the 2.*x* module to use Compatible or Disabled Keying, further steps are not required.

If you use Compatible or Disabled Keying configurations, 3.*x* modules can be used as a direct replacement for 2.*x* modules.

If Using an Exact Match Keying Configuration

If you are currently using a 2.*x* module that is configured at Exact Match keying, consider changing the module's electronic keying in the I/O configuration to Compatible or Disabled Keying.

If you are replacing a 2.*x* module with a 3.*x* module and must use Exact Match keying in the I/O configuration, take additional action depending on your version of the programming software.

If you use Exact Match Keying and	Then Do this
RSLogix 5000® software, version 13.04.00 and later	1. Delete the 2.*x* module from the I/O configuration in the project. 2. Add a new 3.*x* revision module to the I/O configuration.
RSLogix 5000 software, version 12.06.00 and earlier	Do one of the following: • Change the module's configuration to Disable Keying. • Upgrade the software to version 13.04.00 or later and complete the steps that are listed for RSLogix™ software, version 13.04.00 or later.

Notes:

1492 IFMs for Digital I/O Modules

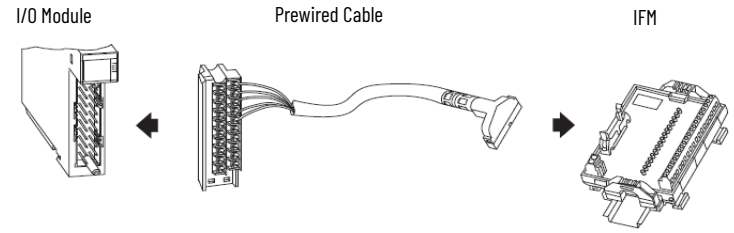
Cable Overview

As an alternative to buying RTBs and connecting the wires yourself, you can buy a wiring system that connects to I/O modules through prewired and pretested cables.

IMPORTANT	The ControlLogix® system has been agency certified using only the ControlLogix RTB catalog numbers 1756-TBCH, 1756-TBCHXT, 1756-TBNH, 1756-TBNHXT, 1756-TBSH, 1756-TBSHXT, 1756-TBS6H, and 1756-TBS6HXT. Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application-specific approval by the certifying agency.

The combinations include the following:

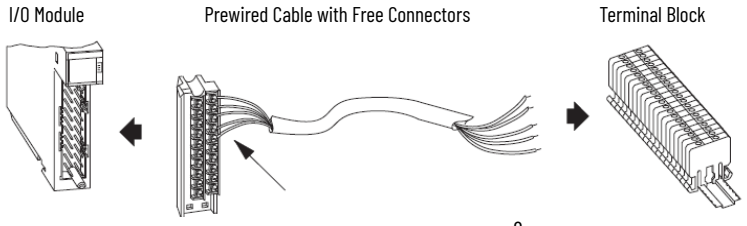
- **Interface modules (IFMs)** mount on DIN rails to provide the output terminal blocks for the I/O module. Use the IFMs with the prewired cables that match the I/O module to the interface module.



- **Prewired cables** are individually color-coded conductors that connect to a standard terminal block. The other end of the cable assembly is an RTB that plugs into the front of the I/O module. All of the prewired cables use 0.326 mm^2 (22 AWG) wire.

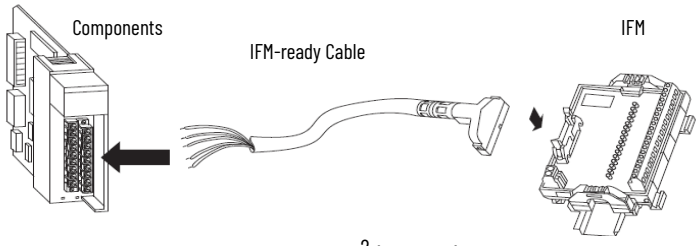
Additional prewired cable combinations include the following:

- **Digital I/O module-ready cables with free connectors** wire into standard terminal blocks or other type of connectors. The other end of the cable assembly is an RTB that plugs into the front of the I/O module.



  Most of the I/O module-ready cables use 0.823 mm^2 (18 AWG) conductors for higher current applications or longer cable runs.

- **IFM-ready cables** have a cable connection to attach to the IFM prewired to one end. The other end has free connectors to wire to I/O modules or other components.



  The IFM-ready cables use 0.326 mm^2 (22 AWG) wire.

This table lists the IFMs and prewired cables to be used with ControlLogix digital I/O modules.

IMPORTANT For the latest list, see the Digital/Analog Programmable Controller Wiring Systems Technical Data, publication 1492-TD008.

IMPORTANT IFMs and prewired cables are not rated for harsh environments (corrosive atmosphere, extended temperature, etc.). When they are used in a system with products that are rated for harsh environments, the system is derated to the specification values of the IFMs and cables.

Table 75 - IFMs and Prewired Cables

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-IA8D, 1756-IA8DK	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20D120	Status-indicating	Standard with 120V AC/DC status indicators(1)	
	1492-IFM20D120N		Narrow standard with 120V AC status indicators	
	1492-IFM20D120A-2		120V AC with extra terminals for inputs	
	1492-IFM20F-FS120A-4	Fusible	Two 4-point isolated groups with four terminals per input and 120V AC/DC blown fuse indicators	
1756-IA16, 1756-IA16K	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20F-3		3-wire sensor type input devices	
	1492-IFM20D120	Status-indicating	Standard with 120V AC/DC status indicators(1)	
	1492-IFM20D120N		Narrow standard with 120V AC status indicators	
	1492-IFM20D120A-2		120V AC with extra terminals for inputs	
	1492-IFM20F-F120A-2	Fusible	Extra terminals with 120V AC/DC blown fuse status indicators.	
1756-IA16I, 1756-IA16IK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS120A-4	Fusible	Isolated with 120V AC status indicators and four terminals per input	
	1492-IFM40F-FSA-4		Isolated 120V AC/DC with four terminals per input	
	1492-IFM40F-FS120A-4		Isolated with 120V AC/DC blown fuse indicators and four terminals per input.	
1756-IA32, 1756-IA32K	1492-IFM40F	Feed-through	Standard	1492-CABLExZ (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40D120A-2	Status-indicating	120V AC status indicators and extra terminals for inputs	
1756-IB16, 1756-IB16K	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20F-3		3-wire sensor type input devices	
	1492-IFM20D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM20D24N		Narrow standard with 24V AC/DC status indicators	
	1492-IFM20D24A-2		24V AC/DC status indicators and extra terminals for inputs	
	1492-IFM20D24-3		3-wire sensor with 24V AC/DC status indicators	
	1492-IFM20F-F24A-2	Fusible	Extra terminals with 24V AC/DC blown fuse indicators for inputs	
1756-IB16D, 1756-IB16DK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40DS24A-4	Status-indicating	Isolated with 24V AC/DC status indicators and four terminals per input	
	1492-IFM40F-F24AD-4	Fusible	Fused with 24V DC blown fuse low leakage indicators, four isolated groups, and four terminals per input	
	1492-IFM40F-FS24A-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per input(2)	
	1492-IFM40F-FSA-4		Isolated with 120V AC/DC with four terminals per input	

Table 75 - IFMs and Prewired Cables (Continued)

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-IB16I, 1756-IB16IK, 1756-IB16IF, 1756-IB16IFK, 1756-IB16ISOE, 1756-IB16ISOEK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24A-4	Status-indicating	Isolated with 24V AC/DC status indicators and four terminals per input	
	1492-IFM40F-FS24A-4	Fusible	Isolated with 24V AC/DC blown fuse indicators and four terminals per input	
	1492-IFM40F-FSA-4		Isolated with 120V AC/DC with four terminals per input	
1756-IB32, 1756-IB32K	1492-IFM40F	Feed-through	Standard	1492-CABLExZ (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40F-3		3-wire sensor type input devices	
	1492-IFM40D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM40D24A-2		24V AC/DC status indicators and extra terminals for inputs	
	1492-IFM40D24-3		3-wire sensor with 24V AC/DC status indicators for inputs	
1756-IC16	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20F-3		3-wire sensor type input devices	
1756-IG16, 1756-IG16K	N/A			
1756-IH16I, 1756-IH16IK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40F-FSA-4	Fusible	Isolated with 120V AC/DC with four terminals per input	
	1492-IFM40F-FS120A-4		Isolated with 120V AC/DC blown fuse indicators with four terminals per input	
1756-IM16I, 1756-IM16IK	1492-IFM40DS240A-4	Status-indicating	Isolated with 240V AC status indicators and four terminals per input	1492-CABLExY (x=cable length)
	1492-IFM40F-FS240A-4	Fusible	Isolated with 240V AC/DC blown fuse indicators and four terminals per input	
1756-IN16, 1756-IN16K	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20F-3		3-wire sensor type input devices	
	1492-IFM20D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM20D24N		Narrow standard with 24V AC/DC status indicators	
	1492-IFM20D24A-2		24V AC/DC status indicators and extra terminals for inputs	
	1492-IFM20D24-3		3-wire sensor with 24V AC/DC status indicators	
	1492-IFM20F-F24A-2	Fusible	Extra terminals with 24V AC/DC blown fuse indicators for inputs	
1756-IV16, 1756-IV16K	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20F-3		3-wire sensor type input devices	
	1492-IFM20D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM20D24N		Narrow standard with 24V AC/DC status indicators	
	1492-IFM20D24A-2		24V AC/DC status indicators and extra terminals for inputs	
	1492-IFM20D24-3		3-wire sensor with 24V AC/DC status indicators	
1756-IV32, 1756-IV32K	1492-IFM40F	Feed-through	Standard	1492-CABLExZ (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40F-3		3-wire sensor type input devices	
	1492-IFM40D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM40D24A-2		24V AC/DC status indicators	
	1492-IFM20D24-2		24V AC/DC status indicators and extra terminals for inputs	
	1492-IFM20D24-3		3-wire sensor with 24V AC/DC status indicators	

Table 75 - IFMs and Prewired Cables (Continued)

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-OA8, 1756-OA8K	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20DS120-4	Status-indicating	Isolated with 120V AC status indicators and four terminals per output	1492-CABLExW (x=cable length)
	1492-IFM20F-FS-2	Fusible	Isolated with 120V AC/DC with extra terminals for outputs	
	1492-IFM20F-FS120-2		Isolated with extra terminals with 120V AC/DC blown fuse indicators for outputs	
	1492-IFM20F-FS120-4		Isolated with four terminals with 120V AC blown fuse indicators for outputs	
	1492-IFM20F-FS240-4		Isolated with four terminals with 240V AC/DC blown fuse indicators for outputs	
1756-OA8D	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20DS120-4	Status-indicating	Isolated with 120V AC status indicators and four terminals per output	1492-CABLExV (x=cable length)
	1492-IFM20F-FS-2	Fusible	Isolated 120V AC/DC with extra terminals for outputs	
	1492-IFM20F-FS120-2		Isolated with extra terminals with 120V AC/DC blown fuse indicators	
	1492-IFM20F-FS120-4		Isolated with four terminals per output and 120V AC/DC blown fuse indicators	
1756-OA8E, 1756-OA8EK	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20DS120-4	Status-indicating	Isolated with 120V AC status indicators and four terminals per output	1492-CABLExV (x=cable length)
	1492-IFM20F-FS-2	Fusible	Isolated 120V AC/DC with extra terminals for outputs	
	1492-IFM20F-FS120-2		Isolated with extra terminals with 120V AC/DC blown fuse indicators	
	1492-IFM20F-FS120-4		Isolated with four terminals per output and 120V AC/DC blown fuse indicators	
1756-OA16, 1756-OA16K	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20D120N	Status-indicating	Narrow standard with 120V AC status indicators	
	1492-IFM20D120-2		120V AC/DC status indicators and extra terminals for outputs	
	1492-IFM20F-F2	Fusible	Extra terminals for outputs	
	1492-IFM20F-F120-2		Extra terminals with 120V AC blown fuse indicators for outputs	
	1492-IFM20F-F240-2		Extra terminals with 240V AC blown fuse indicators for outputs	
	1492-XIM20120-8R	Relay Master	20-pin master with eight, 24V DC relays[3]	
	1492-XIM20120-16R		20-pin master with 16, 120V AC relays	
	1492-XIM20120-16RF		20-pin master with 16, 120V AC relays with fusing	
	1492-XIM120-8R	Relay Expander	Expander with eight, 120V AC relays[4]	
	1492-XIMF-F120-2	Fusible Expander	Expander with eight, 120V channels with blown fuse indicators[4]	
	1492-XIMF-2	Feed-through Expander	Expander with eight feed-through channels[4]	
1756-OA16I, 1756-OA16IK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS120-4	Status-indicating	Isolated with 120V AC status indicators and four terminals per output	
	1492-IFM40-FS-2	Fusible	Isolated with extra terminals for outputs	
	1492-IFM40-FS-4		Isolated 240V AC/DC with four terminals per output	
	1492-IFM40F-FS120-2		Isolated with extra terminals and 120V AC/DC blown fuse indicators	
	1492-IFM40F-FS120-4		Isolated with 120V AC/DC blown fuse indicators and four terminals per output	
	1492-IFM40F-FS240-4		Isolated with 240V AC/DC blown fuse indicators and four terminals per output	
1756-OB8, 1756-OB8K	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IMF20F-2		Extra terminals	
	1492-IFM20DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	1492-CABLExW (x=cable length)
	1492-IFM20F-FS-2	Fusible	Isolated 120V AC/DC with extra terminals for outputs	
	1492-IFM20F-FS24-2		Isolated with extra terminals per output and 24V AC/DC blown fuse indicators	

Table 75 - IFMs and Prewired Cables (Continued)

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-OB8EI, 1756-OB8EIK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs	
	1492-IFM40F-FS24-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per output	
	1492-IFM40F-FS-4		Isolated 240V AC/DC with four terminals per output	
1756-OB16D, 1756-OB16DK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output(5)	
	1492-IFM40F-F24D-2	Fusible	Fused with 24V DC blown fuse low leakage status indicator circuit with four isolated groups and four terminals per output	
	1492-IFM40F-FS-2		Isolated with extra terminals for 120V AC/DC outputs	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs(6)	
	1492-IFM40F-FS24-4		Isolated with extra terminals and 24V AC/DC blown fuse indicators and four terminals per output(6)	
	1492-IFM40F-FS-4		Isolated 240V AC/DC with four terminals per output	
1756-OB16E, 1756-OB16EK	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM20D24N		Narrow standard with 24V AC/DC status indicators	
	1492-IFM20D24-2		24V AC/DC status indicators and extra terminals for outputs	
	1492-IFM20F-F2	Fusible	120V AC/DC with extra terminals for outputs	
	1492-IFM20F-F24-2		Extra terminals with 24V AC/DC blown fuse indicators	
	1492-XIM2024-8R	Relay Master	20-pin master with eight, 24V DC relays(7)	
	1492-XIM2024-16R		20-pin master with 16, 24V DC relays	
	1492-XIM2024-16RF		20-pin master with 16, 24V DC relays with fusing	
	1492-XIM24-8R	Relay Expander	Expander with eight, 24V DC relays(4)	
	1492-XIMF-F24-2	Fusible Expander	Expander with eight, 24V channels with blown fuse indicators(4)	
	1492-XIMF-2	Feed-through Expander	Expander with eight feed-through channels(4)	
1756-OB16I, 1756-OB16IK, 1756-OB16IEF, 1756-OB16IEFK, 1756-OB16IEFS, 1756-OB16IEFSK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs(8)	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs(8)	
	1492-IMF40F-FS24-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per output(8)	
	1492-IFM40F-FS-4		Isolated with 240V AC/DC and four terminals per output(8)	
1756-OB16IS	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs(8)	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs(8)	
	1492-IMF40F-FS24-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per output(8)	
	1492-IFM40F-FS-4		Isolated with 240V AC/DC and four terminals per output(8)	

Table 75 - IFMs and Prewired Cables (Continued)

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-OB32, 1756-OB32K	1492-IFM40F	Feed-through	Standard	1492-CABLExZ (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM40D24-2		24V AC/DC status indicators and extra terminals for outputs	
	1492-IFM40F-F2	Fusible	120V AC/DC with extra terminals for outputs	
	1492-IFM40F-F24-2		Extra terminals with 24V AC/DC blown fuse indicators for outputs	
	1492-XIM4024-8R	Relay Master	40-pin master with eight, 24V DC relays	
	1492-XIM4024-16R		40-pin master with 16, 24V DC relays	
	1492-XIM4024-16RF		40-pin master with 16, 24V DC relays with fusing	
	1492-XIM24-8R	Relay Expander	Expander with eight, 24V DC relays[4]	
	1492-XIMF-F24-2	Fusible Expander	Eight-channel expander with 24V AC blown fuse indicators[4]	
	1492-XIM24-16RF		Expander with 16, 24V DC relays with fusing[9]	
	1492-XIMF-2	Feed-through Expander	Expander with eight feed-through channels[4]	
1756-OC8, 1756-OC8K	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	1492-CABLExW (x=cable length)
	1492-IFM20F-FS2	Fusible	Isolated 120V AC/DC with extra terminals for outputs	
	1492-IFM20F-FS24-2		Isolated with extra terminals per output and 24V AC/DC blown fuse indicators	
1756-OG16, 1756-OG16K	N/A			
1756-OH8I	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs	
	1492-IFM40F-FS120-2		Isolated with extra terminals and 120V AC/DC blown fuse indicators	
1756-ON8, 1756-ON8K	1492-IFM20F	Feed-through	Standard	1492-CABLExU (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	1492-CABLExW (x=cable length)
	1492-IFM20F-FS2	Fusible	Isolated 120V AC/DC with extra terminals for output	
	1492-IFM20F-FS24-2		Isolated with extra terminals per output and 24V AC/DC blown fuse indicators	
1756-OV16E	1492-IFM20F	Feed-through	Standard	1492-CABLExX (x=cable length)
	1492-IFM20FN		Narrow standard	
	1492-IFM20F-2		Extra terminals	
	1492-IFM20D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM20D24-2		24V AC/DC status indicators and extra terminals for outputs	
	1492-IFM20F-F2	Fusible	120V AC/DC with extra terminals for outputs	
	1492-IFM20F-F24-2		Extra terminals with 24V AC/DC blown fuse indicators	
1756-OV32E, 1756-OV32EK	1492-IFM40F	Feed-through	Standard	1492-CABLExZ (x=cable length)
	1492-IFM40F-2		Extra terminals	
	1492-IFM40D24	Status-indicating	Standard with 24V AC/DC status indicators	
	1492-IFM40D24-2		24V AC/DC status indicators and extra terminals for outputs	
	1492-IFM40F-F2	Fusible	120V AC/DC with extra terminals for outputs	
	1492-IFM40F-F24-2		Extra terminals with 24V AC/DC blown fuse indicators for outputs	

Table 75 - IFMs and Prewired Cables (Continued)

I/O Cat. No.	IFM Cat. No.	IFM Type	IFM Description	Prewired Cable
1756-OW16I, 1756-OW16IK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	
	1492-IFM40DS120-4		Isolated with 120V AC status indicators and four terminals per output	
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs	
	1492-IMF40F-FS24-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per output	
	1492-IFM40F-FS-4		Isolated 240V AC/DC with four terminals per output	
	1492-IMF40F-FS120-2		Isolated with extra terminals and 120V AC blown fuse indicators	
	1492-IMF40F-FS120-4		Isolated with 120V AC/DC blown fuse indicators and four terminals per output	
	1492-IMF40F-FS240-4		Isolated with 240V AC/DC blown fuse indicators and four terminals per output	
1756-OX8I, 1756-OX8IK	1492-IFM40F	Feed-through	Standard	1492-CABLExY (x=cable length)
	1492-IFM40DS24-4	Status-indicating	Isolated with 24/48V AC/DC status indicators and four terminals per output	
	1492-IFM40DS120-4		Isolated with 120V AC status indicators and four terminals per output	
	1492-IFM40F-FS-2	Fusible	Isolated with extra terminals for 120V AC/DC outputs	
	1492-IFM40F-FS24-2		Isolated with extra terminals and 24V AC/DC blown fuse indicators for outputs	
	1492-IMF40F-FS24-4		Isolated with 24V AC/DC blown fuse indicators and four terminals per output	
	1492-IFM40F-FS-4		Isolated 240V AC/DC with four terminals per output	
	1492-IMF40F-FS120-2		Isolated with extra terminals and 120V AC blown fuse indicators	
	1492-IMF40F-FS120-4		Isolated with 120V AC/DC blown fuse indicators and four terminals per output	
	1492-IMF40F-FS240-4		Isolated with 240V AC/DC blown fuse indicators and four terminals per output	

(1) This IFM is not recommended for use with I/O modules that have an off-state leakage current exceeding 0.5 mA. Use a 1492-IFM20D120N or 1492-IFM20D120A-2 module for inputs. Use a 1492-IFM20D120-2 module for outputs.
(2) The 1492-IFM40F-FS24A-4 module and the 1492-CABLExY cable can be used with the 1756-IB16D module. However, due to the 1492-IFM40F-FS24A-4 module's blown fuse leakage current rating, the wire off diagnostic function of the 1756-IB16D module does not indicate a blown or removed fuse as a wire off condition. If you require this diagnostic to function for a blown or removed fuse, you must use a 1492-IFM40F-F24AD-4 module.
(3) Expandable to 16 by using a XIM120-BR or XIMF-24-2 module.
(4) Can have up to 1 expandable module depending upon master used (total 16 pts or less). Extender cable is provided.
(5) IFMs status indicator provides output On/Off indication. Due to the magnitude of current through the status indicator, the 1756-OB16D module no load diagnostic function does not work. If this function is required, use the 1492-IFM40F-2 module.
(6) The 1492-IFM40F-FS24-2 and 1492-IFM40F-FS24-4 modules and the 1492-CABLExY cable can be used with the 1756-OB16D module. However, due to the 1492-IFM40F-FS24-2 and 1492-IFM40F-FS24-4 module's blown fuse leakage current rating, the no load diagnostic function of the 1756-OB16D module does not indicate a blown or removed fuse as a no load condition. If you require this diagnostic to function for a blown or removed fuse, you must use a 1492-IFM40F-F24D-2 module.
(7) Expandable to 16 by using a XIM24-8R or XIMF-24-2 module.
(8) Do not use this module in Output Sinking mode with fused IFM modules. The IFM module fuses do not properly protect the circuit.
(9) One 1492-XIM24-16RF module is to be used with one 1492-XIM4024-16R or 1492-XIM4024-16RF master (32 pt. only).

Tables 76 and 77 describe the prewired, module-ready cables and connectors available for your ControlLogix digital I/O modules.

Table 76 - Module-Ready Cables

Cat. No.(1)	No. of Conductors	Conductor Size	Nominal Outer Diameter	RTB at the I/O Module End
1492-CABLExU	20	0.326 mm^2 (22 AWG)	9.0 mm (0.36 in.)	1756-TBNH
1492-CABLExV				
1492-CABLExW				
1492-CABLExX				
1492-CABLExY	40		11.7 mm (0.46 in.)	1756-TBCH
1492-CABLExZ				

(1) Cables are available in lengths of 0.5 m (1.6 ft), 1.0 m (3.3 ft), 2.5 m (8.2 ft), and 5.0 m (16.4 ft). To order, insert the code for the desired cable length into the catalog number in place of the x: 005=0.5 m (1.6 ft), 010=1.0 m (3.3 ft), 025=2.5 m (8.2 ft), 050=5 m (16.4 ft). Build-to-order cable lengths are also available.

Table 77 - Module Connectors

Cat. No.(1)	No. of Conductors	Conductor Size	Nominal Outer Diameter	RTB at the I/O Module End
1492-CABLExTBNH	20	0.823 mm^2 (18 AWG)	11.4 mm (0.45 in.)	1756-TBNH
1492-CABLExTBCH	40(2)		14.1 mm (0.55 in.)	1756-TBCH

(1) Cables are available in lengths of 0.5 m (1.6 ft), 1.0 m (3.3 ft), 2.5 m (8.2 ft), and 5.0 m (16.4 ft). To order, insert the code for the desired cable length into the catalog number in place of the x: 005=0.5 m (1.6 ft), 010=1.0 m (3.3 ft), 25=2.5 m (8.2 ft), 050=5 m (16.4 ft). Build-to-order cable lengths are also available.
(2) Four conductors are not connected to the RTB.

Notes:

ControlNet Communication

Rack-optimized Connections

When a digital I/O module is in a remote chassis with respect to its owner-controller, you may be able to choose Rack Optimization or Listen-only Rack Optimization during module configuration. The option that you choose depends on the communication module configuration. If the communication module uses Listen-only Rack Optimization, then the I/O module must also use Listen-only Rack Optimization.

A rack-optimized connection economizes bandwidth between owner-controllers and digital I/O modules in the remote chassis. Rather than having several direct connections with individual RPI values, an owner-controller has a single rack connection with a single RPI value. That RPI value accommodates all digital I/O modules in the remote chassis.

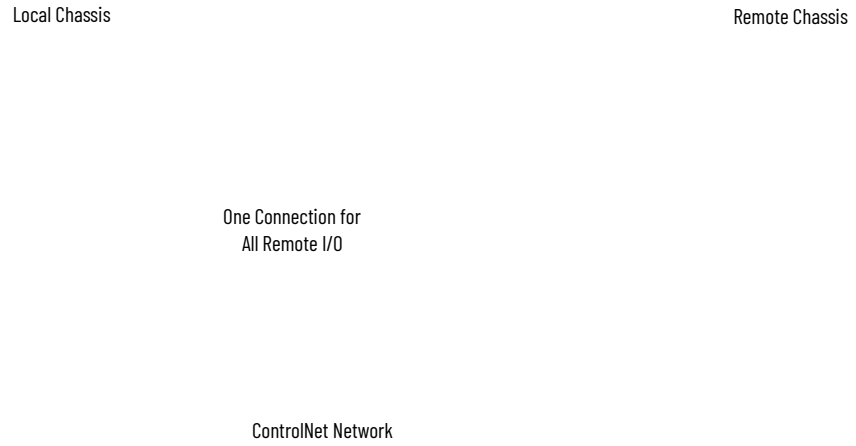
IMPORTANT	Because rack-optimized connections are applicable only in applications that use a remote chassis, you must configure the communication format, as described in Chapter 4, for both the remote I/O module and the remote 1756-CNB module or EtherNet/IP™ module. Make sure you configure both modules for rack optimization. If you choose another communication format for each module, the controller makes two connections to the same chassis (one for each format) and the same data travels across the ControlNet® network. If you use rack optimization for both modules, you preserve bandwidth and configure your system to operate more efficiently.

The input, or data echo, information is limited to general faults and data. No additional status, such as diagnostic information, is available.

IMPORTANT	Each controller can establish connections, in any combination of direct or rack-optimized. In other words, you can use a rack-optimized connection between an owner-controller and multiple remote I/O modules while simultaneously using a direct connection between that same controller and any other I/O modules in the same remote chassis.

This figure shows how a rack-optimized connection eliminates the need for three separate connections. The owner-controller in the local chassis communicates with all the I/O modules in the remote chassis but uses only one connection. The ControlNet communication module sends data from the modules simultaneously at the RPI.

Figure 25 - Rack-optimized Connection



Recommendations for Rack-optimized Connections

We recommend that you use a rack-optimized connection for these applications:

- Standard digital I/O modules
- Non-fused digital output modules
- Owner-controllers running low on connections

IMPORTANT	Rack-optimized connections are available only to digital I/O modules. However, do not use a rack-optimized connection for diagnostic I/O modules or fused output modules. Diagnostic and fused output data is not transferred over a rack-optimized connection. This defeats the purpose of using those modules.

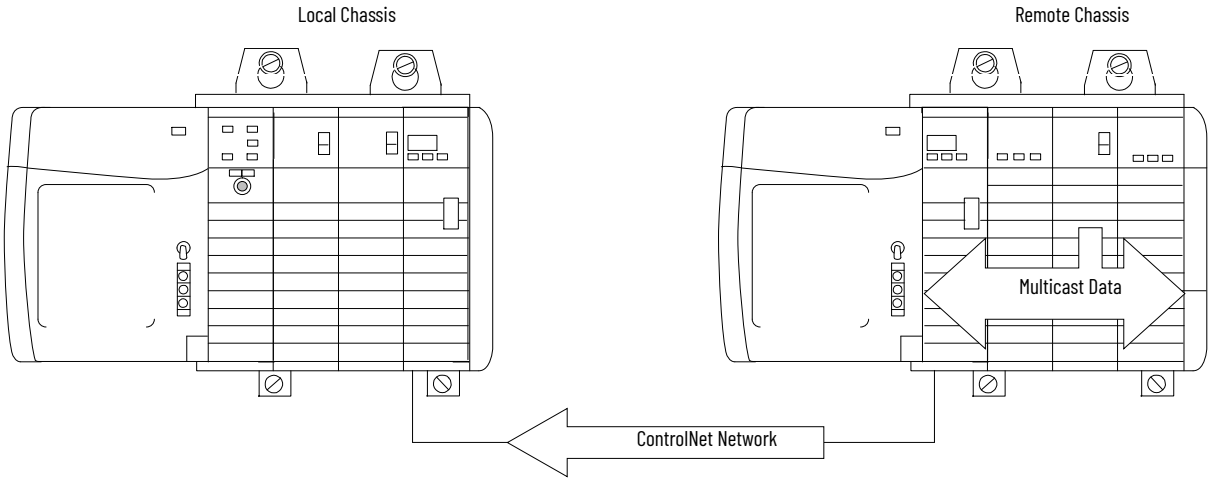
Remote Input Modules Connected Via the ControlNet Network

When an RPI value is specified for an input module in a remote chassis that is connected by a scheduled ControlNet network, in addition to instructing the module to multicast data within its own chassis, the RPI also reserves a spot in the stream of data flowing across the ControlNet network.

The timing of this reserved spot may or may not coincide with the exact value of the RPI. But, the control system guarantees that the owner-controller receives data at least as often as the specified RPI.

As shown in this figure, the input data within the remote chassis is multicast at the configured RPI. The ControlNet communication module sends input data back to the owner-controller at least as often as the RPI.

Figure 26 - Remote Input Modules on ControlNet Network



The module RPI and reserved spot on the network are asynchronous to each other. This means that there are best and worst case scenarios as to when the owner-controller receives updated data from the module in a remote chassis.

Best Case RPI Multicast Scenario

In the best case scenario, the module performs an RPI multicast with updated channel data just before the reserved network spot is made available. In this case, the remotely located owner receives the data almost immediately.

Worst Case RPI Multicast Scenario

In the worst case scenario, the module performs an RPI multicast just after the reserved network slot has passed. In this case, the owner-controller does not receive data until the next available network slot.

IMPORTANT	Enabling the COS feature on an input module in a remote chassis lets the module multicast data at both the RPI rate and when the input changes state. This helps to reduce the worst case time.

When selecting values for the remote module RPI, system throughput is optimized when its RPI value is a power of two times the current NUT running on the ControlNet network.

This table shows recommended RPI values for a system by using a NUT of 5 ms.

Table 78 - Recommended RPI Values for System by Using NUT of 5 ms

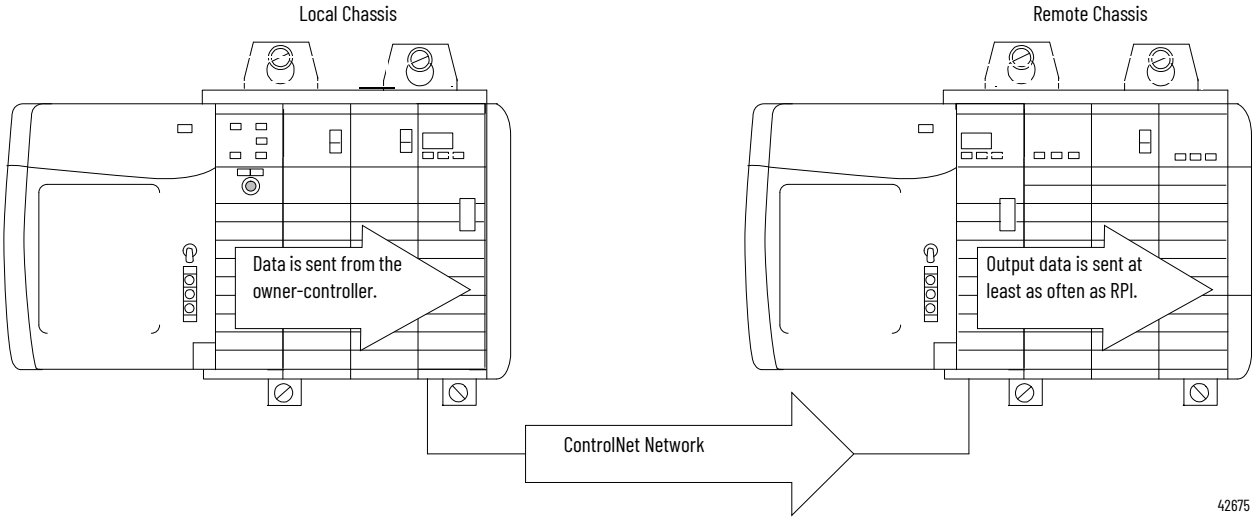
NUT=5 ms	$x2^0$	$x2^1$	$x2^2$	$x2^3$	$x2^4$	$x2^5$	$x2^6$	$x2^7$
Optimal RPI Values (ms)	5 ms	10 ms	20 ms	40 ms	80 ms	160 ms	320 ms	640 ms

Remote Output Modules Connected Via the ControlNet Network

When an RPI value is specified for an output module in a remote chassis that is connected to the owner-controller by a scheduled ControlNet network, in addition to instructing the owner-controller to multicast the output data within its own chassis, the RPI also reserves a spot in the stream of data flowing across the ControlNet network.

The timing of this reserved spot may or may not coincide with the exact value of the RPI. But, the control system guarantees that the output module receives data **at least as often** as the specified RPI, as shown in this figure.

Table 79 - Remote Output Modules on ControlNet Network



The reserved spot on the network and the output data sent by the controller are asynchronous to each other. This means that there are best and worst-case scenarios as to when the owner-controller receives updated data from the module in a remote chassis.

Best Case RPI Multicast Scenario

In the best case scenario, the owner-controller sends the output data just before the reserved network slot is made available. In this case, the remote output module receives the data almost immediately.

Worst Case RPI Multicast Scenario

In the worst case scenario, the owner-controller sends the output data just after the reserved network slot has passed. In this case, the output module does not receive data until the next available network slot.

IMPORTANT These best and worst-case scenarios indicate the time that is required for output data to transfer from the owner-controller to the module once the owner-controller has produced it. They do not take into account the user program time in the owner-controller.

The receipt of new data is a function of the length of the user program and its asynchronous relationship with the RPI.

The owner-controller updates remote output modules at the end of each task and at the RPI, as described earlier in this section, if your application uses these components:

- 1756-CNB/D or 1756-CNBR/D modules
- Studio 5000 Logix Designer® application

Use the System Clock to Timestamp Inputs and Schedule Outputs

The CST is a chassis-specific time that is not synchronized with, or in any way that is connected to, the time that is generated over the ControlNet network to establish a network update time (NUT).

Create a New Module

If you plan to add the I/O module to a remote chassis, add ControlNet modules to both the local and remote chassis in the I/O Configuration tree.

- For more information on ControlLogix® ControlNet modules, see ControlNet Modules in Logix5000™ Control Systems User Manual, publication CNET-UM001.

Notes:

History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

Change Log

1756-UM058J-EN-P, September 2023

Change
Moved all ControlNet®-related content to Appendix G
Added Inclusive Language Statement
Removed Catalog Number 1756-OB8I
Added Catalog Numbers: 1756-IB16K, 1756-IB16DK, 1756-IB16IK, 1756-IB16IFK, 1756-IB32K, 1756-IG16K, 1756-IH16IK, 1756-IN16K, 1756-IV16K, 1756-IV32K, 1756-OA16K, 1756-OA16IK, 1756-OB16DK, 1756-OB16EK, 1756-OB16IEFSK, 1756-OB8EIK, 1756-OB8K, 1756-OB32K, 1756-OC8K, 1756-OG16K, 1756-ON8K, 1756-OV32EK, 1756-OW16IK, 1756-OX8IK
This publication was reformatted and updated to the most current template.

1756-UM058I-EN-P, December 2017

Change
Information added about how to configure the 1756-OB16IEF redundant owner

1756-UM058H-EN-P, May 2015

Change
Updated the Electronic Keying section
Updated the Attention text on RIUP support in the Install the Module section
Updated the MainTask tag name in Create a New Tag
Updated the use of the Browse button in the Communication Tab section
Updated Number of Motor Starters to be Used table

1756-UM058G-EN-P, November 2012

Change
Studio 5000 Logix Designer® application is the rebranding of RSLogix 5000® software
Added the 1756-OB16IEFS module to the list of I/O modules
Added content to describe when output data is sent to the 1756-OB16IEFS module in motion applications
Added the 1756-OB16IEFS module to the CIP Sync™ time section
Added the 1756-OB16IEFS module to sections about electronic fusing, diagnostic latching, and time-scheduled output control
Added the 1756-OB16IEFS module to the list of fast I/O modules
Added software version requirements for the 1756-OB16IEFS module
Added the 1756-OB16IEFS module to the table of connection formats
Added the wiring diagram for the 1756-OB16IEFS module
Added status indicators for the 1756-OB16IEFS module
Added tag definitions for the 1756-OB16IEFS module
Added the 1756-OB16IEFS module to the list of IFMs

1756-UM058F-EN-P, April 2012

Change
Added sections about using CIP Sync time
Added 1756-OB16IEF module to the list of modules with electronic fusing
Added a chapter to describe features of the 1756-IB16IF and 1756-OB16IEF modules
Added connection formats for the 1756-IB16IF and 1756-OB16IEF modules
Added leakage resistor sizing and supply voltage chart for the 1756-IB16D modules
Added wiring diagrams for the 1756-IB16IF and 1756-OB16IEF modules
Added new tags for the 1756-IB16IF and 1756-OB16IEF modules
Added a section about timestamped inputs and scheduled outputs for fast I/O modules

1756-UM058E-EN-P, August 2010

Change
Added Information for scheduling I/O modules on the ControlNet® network and setting up modules to trigger event-based tasks
Features and module-specific information for mosuled 1756-IA32, 1756-IG16, 1756-OB8I, 1756-OB16IS, 1756-OG16, 1756-OV32E
Added Using electronic keying with examples of Exact Match, Compatible, and Disabled Keying
Added new digital I/O specifications
Requirements for firmware updates for Major Revision 3.*x*
Updated information on Interface Modules (IFMs) and pre-wired cables that are available with digital I/O modules

1756-UM058D-EN-P, October 2004

Change
Added Event-based tasks information to Chapter 2
Features description and module-specific information (wiring diagrams) for modules 1756-IA32, 1756-IG16, 1756-OB16IS, 1756-OG16, 1756-OV32E added to Chapter 3
Added Using the Motion Axis Output Cam (MAOC) Instructions with Time Scheduled Output Control
Added Scheduled output data per point communications format - module 1756-OB16IS only
Revised Updated Environmental Condition Specifications
Added Using 1492 Wiring Systems with Your Digital I/O Module
New and revised terms in Glossary

1756-UM058C-EN-P, March 2001

Change
New section added — Internal Module Operations
Chapter 2 revised for Connections
Chapters 3 and 4 revised for Electronic Keying and Output Data Echo
New information about 1756-IV16 Module added in Chapter 3 and 7
New information about 1756-IV32 Module added in Chapter 3 and 7
New information about 1756-OV16E Module added in Chapter 3 and 7
Index updated with new terms

1756-UM058B-EN-P, July 1999

Change
Chapter 7 contains updated backplane current and simplified schematic information for some I/O modules where noted
Appendix D contains information on driving motor starters with ControlLogix® I/O modules
Chapter arrangement modified; Chapter 4 diagnostic modules added

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Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Technical Data

Original Instructions

1756 ControlLogix Communication Modules Specifications

Catalog Numbers Standard ControlLogix Catalog Numbers: 1756-CN2, 1756-CN2R, 1756-CNB, 1756-CNBR, 1756-DNB, 1756-DHRIO, 1756-DH485, 1756-EN2F, 1756-EN2T, 1756-EN2TP, 1756-EN2TR, 1756-EN3TR, 1756-EN4TR, 1756-ENBT, 1756-EWEB, 1756-RIO, 1756-SYNCH, 1756-TIME

ControlLogix 1756 Communication Module Conformal Coated Catalog Numbers: 1756-CN2RK, 1756-EN2FK, 1756-EN2TK, 1756-EN2TPK, 1756-EN2TRK, 1756-EN4TRK, 1756-ENBTK, 1756-TIMEK

ControlLogix Extended Environment Module Catalog Numbers: 1756-CN2RXT, 1756-DHRIOXT, 1756-EN2TPXT, 1756-EN2TXT, 1756-EN2TRXT, 1756-EN4TRXT

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EtherNet/IP Network	4
EtherNet/IP Network Specifications	4

Available Communication Modules

Network	Cat. No.	Description	Page
EtherNet/IP™	1756-EN2F, 1756-EN2T, 1756-EN2TK, 1756-EN2TP, 1756-EN2TPK, 1756-EN2TR, 1756-EN2TRK, 1756-EN3TR, 1756-EN3TRK, 1756-EN4TR, 1756-EN4TRK, 1756-ENBT	EtherNet/IP bridge	4
	1756-EN2TPXT, 1756-EN2TXT, 1756-EN2TRXT, 1756-EN4TRXT	ControlLogix-XT™ Ethernet/IP bridge	4

Communication Connections

A ControlLogix® system uses connections to establish communication links between devices. The types of connections include the following:

- Controller-to-local I/O modules or local communication modules
- Controller-to-remote I/O or remote communication modules
- Controller-to-remote I/O (rack-optimized) modules
- Produced and consumed tags
- Messages
- Controller access with the Studio 5000® environment
- Controller access with RSLinx® software for HMI or other applications

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. The limit of connections ultimately resides in the communication module you use for the connection. If a message path routes through a communication module, the connection that is related to the message also counts towards the connection limit of that communication module.

EtherNet/IP Network

The Ethernet Industrial (EtherNet/IP) network protocol is an open industrial-networking standard that supports both real-time I/O messaging and message exchange. The EtherNet/IP network uses off-the-shelf Ethernet communication chips and physical media.

For these requirements	Select this interface
Control I/O modules and drives Act as an adapter for I/O on remote EtherNet/IP links Communicate with other EtherNet/IP devices (messages and HMI) Bridge EtherNet/IP links to route messages to devices on other networks	1756-EN2F, 1756-EN2FK 1756-EN2T, 1756-EN2TK, 1756-EN2TXT 1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT 1756-EN2TR, 1756-EN2TRK, 1756-EN2TRXT 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT 1756-ENBT, 1756-ENBTK
Support Device Level Ring (DLR) and linear topologies	1756-EN2TR, 1756-EN2TRK, 1756-EN2TRXT 1756-EN3TR, 1756-EN3TRK 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT
Support Parallel Redundancy Protocol (PRP)	1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT 1756-EN4TR(1), 1756-EN4TRK(1), 1756-EN4TRXT(1)
Support redundant adapters(2)	1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT
Provide control in environments where temperatures range from -25...+70 °C (-13...+158 °F)	1756-EN2TPXT 1756-EN2TRXT 1756-EN2TXT 1756-EN4TRXT
Secure access to a control system from within the plant network	1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT

(1) 1756-EN4TR supports PRP with revision 4.001 and higher firmware.
(2) Redundant adapters require version 3.x and higher firmware.

For more information on redundant adapters and Ethernet, see the ControlLogix EtherNet/IP Network User Manual, publication 1756-UM004.

EtherNet/IP Network Specifications

Table 1 - ControlLogix EtherNet/IP Connections Specifications(1)

Cat. No.	Connections		CIP Unconnected Messages (backplane + Ethernet)
	TCP	CIP(2)	
1756-ENBT	64	128	64 + 64
1756-EN2F	128	256	128 + 128
1756-EN2T	128	256	128 + 128
1756-EN2TP	128	256	128 + 128
1756-EN2TR	128	256	128 + 128
1756-EN3TR	128	256	128 + 128
1756-EN4TR	512	1000 I/O 528 (3)	256+256

(1) There are 1000 CIP™ I/O connections and 528 CIP messaging connections.
(2) CIP connections can be used for all explicit or all implicit applications. For example, a 1756-ENBT module has a total of 128 CIP connections that can be used for any combination of connections.
(3) There are 1000 explicit connections and 528 implicit connections.

Table 2 - ControlLogix EtherNet/IP Data Specifications[1]

Cat. No.	Produced/Consumed Tags		Socket Services	SNMP Support (password required)	Duplicate IP Detection (starting revision)
	Number of Multicast Tags, Max[2]	Unicast Available in RSLogix 5000 Software			
1756-EN2F	32	Version 16.03.00 or later	Yes	Yes	All Revisions
1756-EN2T		Version 16.03.00 or later	Yes		
1756-EN2TP		Version 24.00.00 or later	Yes		
1756-EN2TR		Version 17.01.02 or later	Yes		
1756-EN3TR		Version 18.02.00 or later	Yes		
1756-EN4TR		Version 24.00.00 or later	Yes		
1756-ENBT		Version 16.03.00 or later	No		Revision 3.3

(1) Includes the K conformal coating catalog numbers and the XT extreme environment catalog numbers.
(2) Each controller can send a maximum of 32 multicast produced tags to one single consuming controller. If these same tags are sent to multiple consumers, the maximum number is 31.

Table 3 - ControlLogix EtherNet/IP Specifications[1]

Cat. No.	Firmware Revision	RSLogix 5000® Software Version	RSLinx® Software Version	Packet Rate Capacity (packets/ second)[2]		Support for Extended Environment[3]	Integrated Motion on the EtherNet/IP Network Axes
				I/O	HMI/MSG		
1756-ENBT	Any	8.02.00 or later	2.30 or later	5000	900	No	—
1756-EN2F	2.x	15.02.00 or later	2.51 or later	10,000	2000	No	—
	3.6 or later	18.02.00 or later[4]		25,000[5]			Up to 8 axes supported[5]
1756-EN2T	2.x or earlier	15.02.00 or later	2.51 or later	10,000		No	—
	3.6 or later	18.02.00 or later[4]		25,000[5]			Up to 8 axes supported[5]
1756-EN2TXT	2.x	15.02.00 or later	2.51 or later	10,000		Yes	—
	3.6 or later	18.02.00 or later[4]		25,000[5]			Up to 8 axes supported[5]
1756-EN2TP	Any	24.00.00 or later[4]	4.10 or later	25,000[5]		No	Up to 8 axes supported[5]
1756-EN2TPXT	10.x or later	24.00.00 or later	4.10 or later	25,000[5]		Yes	Up to 8 axes supported[5]
1756-EN2TR	2.x	17.01.02 or later	2.55 or later	10,000		No	—
	5.x or later	18.02.00 or later[4]	2.56 or later	25,000[5]			Up to 8 axes supported[5]
1756-EN2TRXT	5.028 or later	20.01.00 or later	2.56 or later	25,000[5]		Yes	Up to 8 axes supported[5]
1756-EN3TR	3.6 or later	18.02.00 or later[4]	2.56 or later	25,000[5]		No	Up to 128 axes supported[5]
1756-EN4TR	Any	24.00.00 or later[6]	4.10 or later	• 50,000 without CIP Security™ • 25,000 with integrity • 15,000 with integrity and confidentiality	• 3700 without CIP Security • 2700 with integrity • 1700 with integrity and confidentiality	No	Up to 256 axes supported[5]
1756-EN4TRXT	Any	24.00.00 or later[6]	4.10 or later	• 50,000 without CIP Security • 25,000 with integrity • 15,000 with integrity and confidentiality	• 3700 without CIP Security • 2700 with integrity • 1700 with integrity and confidentiality	Yes	Up to 256 axes supported[5]

(1) Includes the K conformal coating catalog numbers.
(2) I/O numbers are maximums; they assume no HMI/MSG. HMI/MSG numbers are maximums, they assume no I/O. Packet rates vary depending on packet size. For more details, see Troubleshoot EtherNet/IP Application Technique, publication ENET-AT003, and the EDS file for a specific catalog number.
(3) Module operates in a broad temperature spectrum, -20…70 ºC (-4…158 ºF), and meets ANSI/ISA-S71.04-1985 Class G1, G2 and G3, as well as cULus, Class 1 Div 2, C-Tick, CE, ATEX Zone 2 and SIL 2 requirements for increased protection against salts, corrosives, moisture/condensation, humidity, and fungal growth.
(4) This version is required to use CIP Sync™ technology, Integrated Motion on the EtherNet/IP Network, or Exact Match keying.
(5) This value assumes the use of a1756-L8x or 1756-L7x ControlLogix controller. For a 1756-L6x ControlLogix controller, see ControlLogix Controllers User Manual, publication 1756-UM001.
(6) CIP Security requires FactoryTalk® Linx version 6.11.00 or later.

Table 4 - Technical Specifications - 1756 EtherNet/IP Modules[1]

Attribute	1756-EN2F/B 1756-EN2F/C	1756-EN2T/D, 1756-EN2TP/A	1756-EN2TR/C, 1756-EN3TR/B	1756-EN4TR/A	1756-ENBT/A
EtherNet/IP communication rate	100 Mbps, no auto-negotiation	10/100 Mbps		10/100 Mbps 1 Gbps	10/100 Mbps
Current draw @ 5.1V DC	1.2 A	1 A		1.2 A	700 mA
Current draw @ 24V DC	3 mA				
Power dissipation	6.2 W	5.1 W		6.12 W	3.7 W
Thermal dissipation	21.28 BTU/hr	17.4 BTU/hr		20.9BTU/Hr	12.6 BTU/hr
Isolation voltage	30V (continuous), basic insulation type, USB to backplane Type tested at 980V AC for 60 s	30V (continuous), basic insulation type, Ethernet to backplane, USB to Backplane, and USB to Ethernet[2] Type tested at 980V AC for 60 s		30V (continuous), basic insulation type, Ethernet to backplane, USB to backplane, and USB to Ethernet Type tested at 860V AC for 60 s	30V (continuous), basic insulation type, Ethernet network to backplane Type tested @ 707V DC for 60 s
Slot width	1				
Module location	Chassis-based, any slot				
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17				
Power supply, standard	1756-PA72, 1756-PA75, 1756-PB72, 1756-PB75, 1756-PC75, 1756-PH75				
Power supply, redundant	1756-PA75R, 1756-PB75R, 1756-PSCA2				
Ethernet port	1 Ethernet fiber	1 Ethernet RJ45 Category 5	2 Ethernet RJ45 Category 5	2 Ethernet RJ45 Category 5E	1 Ethernet RJ45 Category 5
Ethernet cable	Multimode fiber, LC connector	802.3 compliant shielded or unshielded twisted-pair			
USB port[3]	USB full speed (12 Mbps)				—
Wiring category[4]	3 - on USB ports	2 - on Ethernet ports 3 - on USB ports			2 - on Ethernet ports
North American temp code	T4A				
ATEX temp code	T4				
IECEx temp code	T4				
Enclosure type rating	None (open-style)				
Transmitter launch power at Beginning of Life (BOL), min Allow -1 dB at End of Life (EOL)	-19 dBm into 62.5/125 µm fiber, — = 0.275 -22.5 dBm into 50/125 µm fiber, — = 0.20	—			

(1) Includes the K conformal coating catalog numbers.
(2) Applies only to these modules/series: 1756-EN2T/D, 1756-EN2TR/C,1756-EN3TR/B.
(3) The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.
(4) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 5 - Environmental Specifications - 1756 EtherNet/IP Modules[1]

Attribute	1756-EN2F/B 1756-EN2F/C	1756-EN2T/D, 1756-EN2TP/A	1756-EN2TR/C, 1756-EN3TR/B	1756-EN4TR/A	1756-ENBT/A
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold) IEC 60068-2-2 (Test Bd, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C < Ta < 60 °C (32 °F < Ta < 140 °F)			Series C Chassis: 0 ≤ Ta ≤ +60 °C (+32 ≤ Ta ≤ +140 °F) Series B Chassis: 0 ≤ Ta ≤ +50 °C (+32 ≤ Ta ≤ +122 °F)	0 °C < Ta < 60 °C (32 °F < Ta < 140 °F)
Temperature, surrounding air, max	60 °C (140 °F)			Series C Chassis: 60 °C (140 °F) Series B Chassis: 50 °C (122 °F)	60 °C (140 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold) IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat) IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40 °C< Ta < 85 °C (-40 °F < Ta < 185 °F)				
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing				
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10...500 Hz				
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g				
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	30 g[2]	30 g[2]	30 g	50 g
Emission CISPR 11 (IEC 61000-6-4)	Class A				
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges				
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz	10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine wave 80% AM from 2000...6000 MHz			10V/m with 1 kHz sine wave 80% AM from 80...2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 1V/m with 1 kHz sine wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	—	±3 kV at 5 kHz on Ethernet ports[2]		±3 kV at 5 kHz on Ethernet ports	±2 kV at 5 kHz on Ethernet ports
Surge transient immunity IEC 61000-4-5	—	±2 kV line-earth (CM) on Ethernet ports			
Conducted RF immunity IEC 61000-4-6	10V rms with 1 kHz sine wave 80% AM from 150 kHz...80 MHz				

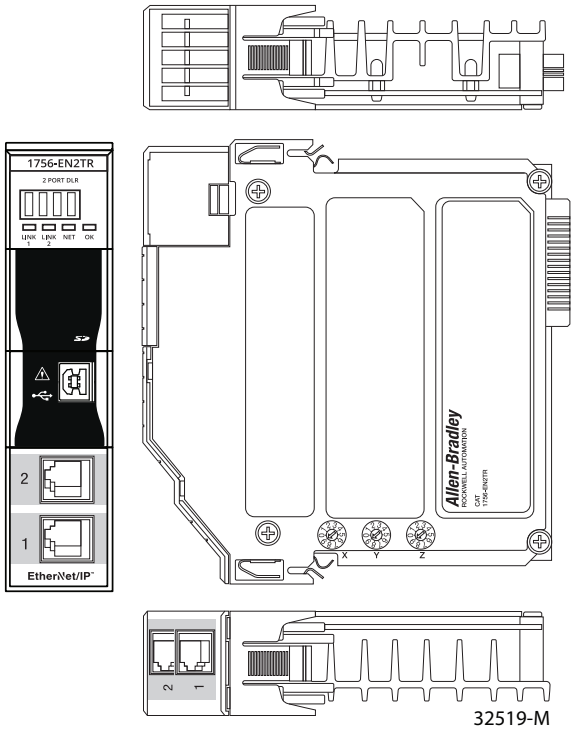
(1) Includes the K conformal coating catalog numbers.
(2) Applies only to these modules/series: 1756-EN2T/D, 1756-EN2TR/C,1756-EN3TR/B.

Table 6 - Certifications - 1756 EtherNet/IP Modules[1]

Certification [2]	1756-EN2T/D 1756-EN2TP/A	1756-EN2F/B 1756-EN2F/C	1756-EN2TR/C, 1756-EN3TR/B	1756-ENBT/A	1756-EN4TR/A
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.				UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.				–
CE	European Union 2004/108/IEC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)				
RCM	Australian Radiocommunications Act, compliant with EN 61000-6-4; Industrial Emissions				
ATEX	European Union 94/9/EC ATEX Directive, compliant with the following: EN 60079-15; Potentially Explosive Atmospheres, Protection “n” EN 60079-0; General Requirements II 3 G Ex nA IIC T4 Gc X DEMKO13ATEX1325026X (1756-EN2T/C only)				European Union 2014/34/EU ATEX Directive, compliant with the following: EN IEC 60079-0 General Requirements; EN 60079-7 Explosive Atmospheres, Protection “e”; II 3 G Ex EC IIC T4 Gc DEMKO18ATEX2139X
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations				
IECEx	–	IECEx System, compliant with: IEC 60079-15; Potentially Explosive Atmospheres, Protection “n” IEC 60079-0; General Requirements II 3 G Ex nA IIC T4 Gc IECEx UL 14.0008X	–	IECEx System, compliant with: IEC 60079-0; General Requirements IEC 60079-15; Potentially Explosive Atmospheres, Protection “n” IEC 60079-0; General Requirements II 3 G Ex nA IIC T4 Gc IECEx UL 14.0008X	IECEx System, compliant with the Standards IEC 60079-0, Edition 7 General Requirements, and 60079-7, Edition 5.1, Explosive Atmospheres, Protection “e”; II 3 G Ex EC IIC T4 Gc IECExUL 18.0130X
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3				
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation				
EtherNet/IP	ODVA conformance tested to EtherNet/IP specifications				

(1) Includes the K conformal coating catalog numbers.
(2) When product is marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Figure 3 - 1756-EN2TR, 1756-EN3TR



Accessories—Ethernet Network

Cat. No.	Description	Specifications
1585J-M8PBJM-*x*	Ethernet RJ45 patchcord *x* = 2 (2 m), 5 (5 m), or 10 (10 m)	8-conductor, teal riser PVC cable (flex-rated cable also available)
1585J-M8CC-H	RJ45 insulation displacement connector (IDC)	0.128…0.325 mm^2 (26…22 AWG), Cat. 6, IDC, no tool required
1585J-M8CC-C	RJ45 crimp connector with boot, qty = 50 pieces	0.128…0.205 mm^2 (26…24 AWG), Cat. 5e, requires crimp tool for assembly
1585A-JCRIMP	Crimp tool	—
9300-RADES	Remote access dial-in kit	56 Kbps modem connection to devices on an Ethernet network

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 EtherNet/IP Communication Modules Installation Instructions, publication 1756-IN050	Provides information on installing EtherNet/IP™ modules.
ControlLogix EtherNet/IP Network Devices User Manual, publication 1756-UM004	Describes how you can use ControlLogix® EtherNet/IP communication modules with a Logix 5000® controller and communicate with various devices on the Ethernet/IP network.
ControlNet Modules Installation Instructions, publication CNET-IN005	Provides instructions for installing ControlNet® modules.
ControlLogix System User Manual, publication 1756-UM001	Provides information on system architecture, configuring secure communication, and diagnostics.
ControlLogix Time Synchronization Module - Series B User Manual, publication 1756-UM542	Describes the functionality, installation, configuration, and operation of the 1756-TIME module.
DeviceNet Network Configuration User Manual, publication DNET-UM004	Provides information on system architecture, configuring communication, and diagnostics.
EtherNet/IP Network Devices User Manual, publication ENET-UM006	Describes how to use EtherNet/IP communication modules in Logix 5000 control systems
ControlLogix DH-485 Communication Module User Manual, publication 1756-UM532	Provides information on system architecture, configuring communication, and diagnostics.
ControlLogix Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514	Provides information about programming, messaging, applying, and connecting the module.
ControlLogix SynchLink Module User Manual, publication 1756-UM521	Provides information about topologies, configurations, planning, and installing a Synchlink™ module.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
UL Standards Listing for Industrial Control Products, publication CMPNTS-SR002	Assists original equipment manufacturers (OEMs) with construction of panels, to help ensure that they conform to the requirements of Underwriters Laboratories.
American Standards, Configurations, and Ratings: Introduction to Motor Circuit Design, publication IC-AT001	Provides an overview of American motor circuit design based on methods that are outlined in the NEC.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Installation Instructions

Original Instructions

Allen-Bradley
by ROCKWELL AUTOMATION

1756 EtherNet/IP Communication Module

Catalog Number 1756-EN2T, 1756-EN2TK, 1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT, 1756-EN2TR, 1756-EN2TRK, 1756-EN2TRXT, 1756-EN2TXT, 1756-EN3TR, 1756-EN3TRK, 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT

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Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

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ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “其他资源” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable. Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

설치 , 조정 , 가동 , 사용 , 조립 , 분해 , 유지보수 등 모든 작업은 관련 규정에 따라 적절한 교육을 받은 사용자를 통해서만 수행해야 합니다 .

본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於 「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安裝、調整、交付使用、使用、組裝、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

Product Advisories

ATTENTION:
- Read this document and the documents listed in the Additional Resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice. In case of malfunction or damage, no attempts at repair should be made. The module should be returned to the manufacturer for repair. Do not dismantle the module.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- This equipment is certified for use only within the surrounding air temperature range of 0…60 °C (32…140 °F) [1756-EN2T, 1756-EN2TP, 1756-EN2TPK, 1756-EN2TR, 1756-EN3TR, 1756-EN4TR, 1756-EN4TRK] or -25…+70 °C (-13…+158 °F) [1756-EN2TXT, 1756-EN2TRXT, 1756-EN2TPXT, 1756-EN4TRXT]. The equipment must not be used outside of this range.
- Use only a soft dry anti-static cloth to wipe down equipment. Do not use any cleaning agents.
- The USB port is intended for temporary local programming purposes only and not intended for permanent connection.
- The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

IMPORTANT Any illustrations, charts, sample programs, and layout examples that are shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements that are associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use based on the examples that are shown in this publication.

Environment and Enclosure

ATTENTION: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC/EN 60664-1), at altitudes up to 2000 m (6562 ft) without derating.
This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to help prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain more information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:
- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for more installation requirements.
- NEMA Standard 250 and IEC/EN 60529, as applicable, for explanations of the degrees of protection provided by enclosures.

Multi-point Network Communication

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

UK and European Hazardous Location Approval

The following applies to products marked , II 3 G. Such modules:

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to EU Directive 2014/34/EU and Schedule 1 of the UKEX Regulation 2016 No. 1107. See the UKEX and EU Declaration of Conformity at rok.auto/certifications for details.
- The type of protection is <Ex ec IIC T4 Gc> Equipment protection by increased safety "e".
- Equipment protection by increased safety "e", reference certificate number UL22ATEX2818X and UL22UKEX2604X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to UKEX Regulation 2016 No. 1107 and ATEX directive 2014/34/EU.

Special Conditions for Safe Use

WARNING:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an UKEX/ATEX/IECEx Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (in accordance with EN/IEC 60079-0) and used in an environment of not more than Pollution Degree 2 (as defined in EN/IEC 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage at the supply terminals to the equipment.
- The instructions in the user manual shall be observed.
- This equipment must be used only with UKEX/ATEX/IECEx certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- The USB port is intended for temporary local programming purposes only and not intended for permanent connection. Do not use the USB port in hazardous locations.

IEC Hazardous Location Approval

The following applies to products with IECEx certification. Such products:

- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification.
- The type of protection is <Ex ec IIC T4 Gc>.
- IECEx certificate number IECEx UL 22.0063X.

Prevent Electrostatic Discharge

ATTENTION:
This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Removal and Insertion Under Power (RIUP)

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electric arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Network Connector and Cable Requirements

This product includes a USB port.

WARNING: The USB ports are intended only for temporary use and must not be connected or disconnected unless the area is nonhazardous. Do not use the USB port in hazardous locations. The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

ATTENTION: The 1756 EtherNet/IP Communication Modules that are listed on page 1 of this document that end with a "K" or "XT" are shipped with port protection plugs installed to provide a layer of protection from corrosive atmospheres. Port plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating. If temporary access is required, plugs can be removed, and should be reinserted after temporary access is complete.

Modules	Ports	Requirements
EtherNet/IP	Copper Ethernet	Connector/cable: RJ45 connector according to IEC 60603-7, 2 or 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3. Connector/cable: For 1756-EN4TR, 1756-EN4TRK, and 1756-EN4TRXT, RJ45 connector according to IEC 60603-7, 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3.

Install the Module

You can install or remove a module while chassis power is applied.

WARNING: When you insert or remove the module while backplane power is on, an electric arc can occur. The insertion or removal of the module while the backplane power is on can cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electric arcs can cause excessive wear to contacts on both the module and its mating connector. Worn contacts can create electrical resistance that can affect module operation.

For equipment with multi-point network communication connections.

WARNING: If you connect or disconnect the communication cable with power that is applied to this module or any device on the network, an electric arc can occur. This connection or disconnection of the module with applied power can cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

Follow these steps to install the module.

1. Set the network IP address on a module.

   For more information about how to configure an EtherNet/IP™ network, see the *EtherNet/IP Network Devices*, publication ENET-UM006.

   Depending on the 1756 EtherNet/IP communication module, you can use some or all of these tools to set the network Internet Protocol (IP) address:

   - Rotary switches
   - Bootstrap Protocol (BOOTP)/Dynamic Host Configuration Protocol (DHCP) server
   - RSLinx® Classic or FactoryTalk® Linx software
   - The Studio 5000® environment

   The module uses these tools sequentially to set the IP address.

2. Use the Mode Rotary Switch to set the mode on the 1756-EN4TR module.

   The rotary switch in the upper left corner of the module is reserved for DLR, PRP, and redundancy features. The default position of the switch is 0.

Switch Position	Capability
9	DLR or Single-port
8	PRP or Single-port
7	Redundant Adapter and DLR or single-port topologies
6	Redundant Adapter and PRP

ATTENTION: If the mode rotary switch is set to 9 (DLR), and you insert the module into a PRP network, it can disable the network because it will directly connect PRP LAN A and PRP LAN B.

IMPORTANT If you use a redundant adapter pair, the mode rotary switches on each of the two modules in the pair must be set to the same value.

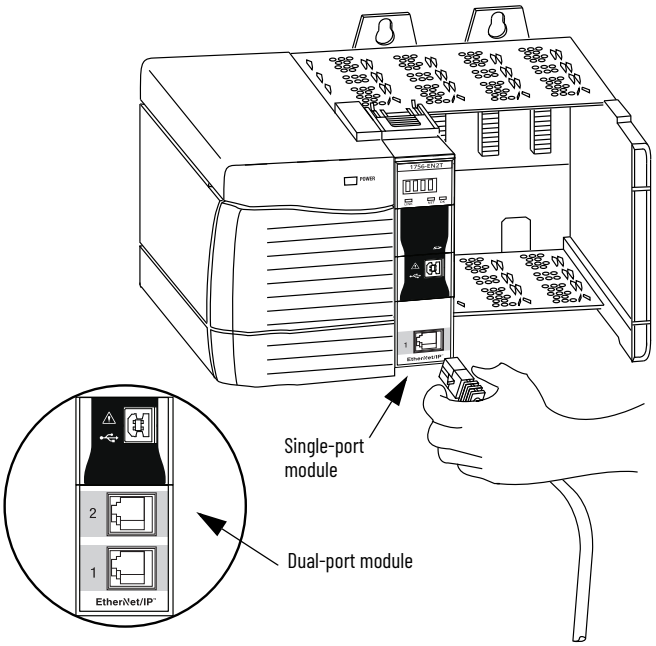
For more information on the mode rotary switch, see the *ControlLogix® EtherNet/IP Network Devices User Manual*, publication 1756-UM004.

3. Determine module slot location.
4. Install the module.
   a. Align the circuit board with top and bottom guides in the chassis.
   b. Slide the module into the chassis.

      Make sure that the module backplane connector properly connects to the chassis backplane. The module is properly installed when it is flush with the power supply or other installed modules.
5. Connect the module to an EtherNet/IP network via an RJ45 connection.

Connector Number	Color	1585J 8-pin Cables with Support for 10/100/1000 Mbps	1585J 8-pin Cables with Support for 10/100 Mbps	1585J 4-pin Cables with Support for 10/100 Mbps
1	White/ Orange	BI_DA+	TxData +	
2	Orange	BI_DA-	TxData -	
3	White/ Green	BI_DB+	Recv Data +	
4	Blue	BI_DC+	Unused	N/A
5	White/ Blue	BI_DC-	Unused	N/A
6	Green	BI_DB-	Recv Data -	
7	White/ Brown	BI_DD+	Unused	N/A
8	Brown	BI_DD-	Unused	N/A

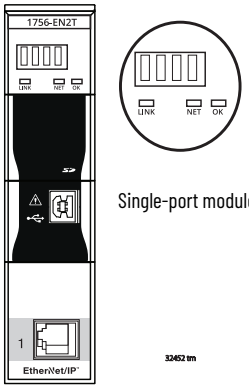
6. Attach the cable with the RJ45 connector to the Ethernet port on the module as shown.



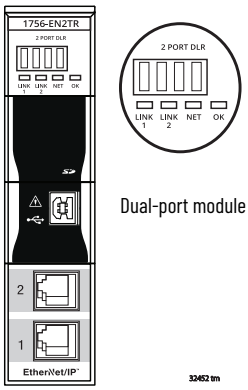
7. Download the Add-on Profile from the Product Compatibility and Download website at rok.auto/pcdc.
8. Connect to the module via the USB port (if the module is equipped with a USB port).
9. Download the firmware from the Product Compatibility and Download website at rok.auto/pcdc.
10. Apply chassis power and check status indicators.

Status Indicators

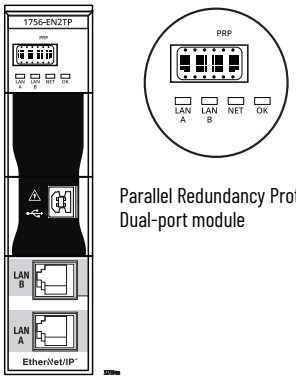
These 1756 EtherNet/IP communication modules feature the same status indicators. This graphic shows the front of each of these modules. (Extended-temperature modules are not shown.)



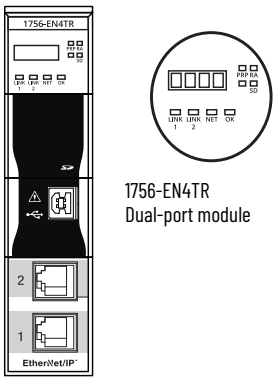
Single-port module



Dual-port module



Parallel Redundancy Protocol Dual-port module



1756-EN4TR Dual-port module

For more information on the status indicators, see the *ControlLogix EtherNet/IP Network Devices User Manual*, publication 1756-UM004.

Specifications

Attribute	1756-EN2T, 1756-EN2TK, 1756-EN2TP, 1756-EN2TPK, 1756-EN2TR, 1756-EN2TRK, 1756-EN3TR, 1756-EN3TRK	1756-EN4TR, 1756-EN4TRK	1756-EN2TXT, 1756-EN2TRXT, 1756-EN2TPXT	1756-EN4TRXT
Voltage and current ratings	5.1V DC, 1 A	5.1V DC, 1.2 A	5.1V DC, 1 A	5.1V DC, 1.2 A
Temperature, operating • IEC 60068-2-1 (Test Ad, Operating Cold) • IEC 60068-2-2 (Test Bd, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 ≤ Ta ≤ +60 °C (+32 ≤ Ta ≤ +140 °F)		-25 ≤Ta ≤ +70 °C (-13 ≤ Ta ≤ +158 °F)	
Temperature, surrounding air	60 °C (140 °F)		70 °C (158 °F)	
Corrosive Atmosphere(1) • ASTM B845-97 Method H Accelerated Test (20-Day Exposure)	Severity Level G3(2) per ANSI/ISA 71.04-2013, Airborne Contaminants - Gases Severity Level CX(2)(3) per IEC 60721-3-3:2019, Chemically Active Substances			
Enclosure type rating	None (open-style)			
Isolation voltage	30V (continuous), Basic Insulation Type, Ethernet to Backplane, USB to Backplane, and USB to Ethernet Type tested at 860V AC for 60 s			
Wire size	Ethernet connections: RJ45 connector according to IEC 60603-7, 2 or 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3.	Ethernet connections: RJ45 connector according to IEC 60603-7, 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3.	Ethernet connections: RJ45 connector according to IEC 60603-7, 2 or 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3.	Ethernet connections: RJ45 connector according to IEC 60603-7, 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 11801-3.
Temperature code	T4			

(1) Only applicable to modules that end with a "K" or "XT".
(2) Port Plugs must remain installed in unused ports at all times during storage and operation for the product to meet its corrosive atmosphere rating.
(3) Up to 9.6 microns per year, corrosion rate of copper.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Provides details about how to use EtherNet/IP communication modules with Logix 5000™ controllers and communicate with other devices on the EtherNet/IP network.
EtherNet/IP Network Devices, publication ENET-UM006.	Describes how you can use EtherNet/IP communication modules with your Logix 5000 controller and communicate with various devices on the Ethernet network.
EtherNet/IP Secure Communication User Manual, publication ENET-UM003	Provides information on system architecture, configuring secure communication, and diagnostics.
ControlLogix EtherNet/IP Network Devices User Manual, publication 1756-UM004	Describes how you can use ControlLogix EtherNet/IP communication modules with a Logix 5000 controller and communicate with various devices on the Ethernet/IP network.
EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007.	Provides details about how to install, configure, and maintain linear and Device Level Ring (DLR) networks by using Rockwell Automation EtherNet/IP devices that are equipped with embedded switch technology.
EtherNet/IP Media Planning and Installation Manual, available from the Open DeviceNet® Vendor Association (ODVA) at http://www.odva.org	Provides details about how to use the required media components and provides information on how to plan for, install, verify, troubleshoot, and certify your EtherNet/IP network.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

Rockwell Otomasyon Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400 EEE Yönetmeliğine Uygundur

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ControlLogix EtherNet/IP Network Devices

Catalog Numbers 1756-EN2F, 1756-EN2FK, 1756-EN2T, 1756-EN2TK, 1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT, 1756-EN2TR, 1756-EN2TRK, 1756-EN2TXT, 1756-EN2TRXT, 1756-EN3TR, 1756-EN3TRK, 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT, 1756-ENBT, 1756-ENBTK, 1756-EWEB

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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About This Publication

This manual describes how you can use ControlLogix® EtherNet/IP™ communication modules with a Logix 5000® controller and communicate with various devices on the Ethernet/IP network.

Use this manual if you program applications that use EtherNet/IP networks with ControlLogix controllers.

Conventions

Be sure to understand these concepts and tools:

- FactoryTalk® Linx
- Studio 5000 Logix Designer® application
- ControlFLASH Plus™
- HMIs
- SNMP tools

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as Add-on Profiles, Electronic Data Sheets, Device Type Manager), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

This manual was revised to add or update the information that is listed in this table.

Topic	Page
Added chapter on Concurrent Communication.	23

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 EtherNet/IP Communication Modules Installation Instructions, publication 1756-IN050	Provides information on how to install EtherNet/IP™ modules.
1756 ControlLogix Communication Modules Specifications, publication 1756-TD003	Specifications for ControlLogix communication modules.
Redundancy Systems User Manual, publication 1756-UM015	Describes how to set up, configure, program, monitor, and troubleshoot Logix SIS, ControlLogix 5580, and ControlLogix 5570 redundancy systems.
Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture Design and Implementation Guide, publication ENET-TD015	Highlights the key IACS application requirements, technology, and supporting design considerations to help with the successful design and deployment of these specific use cases within the CPwE framework.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Provides details about how to use EtherNet/IP communication modules with Logix 5000 controllers and communicate with other devices on the EtherNet/IP network.
EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007	Describes DLR network operation, topologies, configuration considerations, and diagnostic methods.
EtherNet/IP Media Planning and Installation Manual This manual is available from the Open DeviceNet® Vendor Association (ODVA) at: http://www.odva.org.	Provides details about how to install, configure, and maintain linear and Device Level Ring (DLR) networks by using Rockwell Automation EtherNet/IP devices that are equipped with embedded switch technology.
EtherNet/IP Network Devices User Manual, publication ENET-UM006	Describes how to use EtherNet/IP communication modules in Logix 5000 control systems.
EtherNet/IP Parallel Redundancy Protocol Application Technique, publication ENET-AT006	Describes how you can configure a Parallel Redundancy Protocol (PRP) network with a compatible device or switch.
EtherNet/IP Socket Interface Application Technique, publication ENET-AT002	Describes the socket interface that you can use to program MSG instructions to communicate between a Logix 5000 controller via an EtherNet/IP module and Ethernet devices that do not support the EtherNet/IP application protocol, such as barcode scanners, RFID readers, or other standard Ethernet devices.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.
Troubleshoot EtherNet/IP Networks Application Technique, publication ENET-AT003	Provides details about how to assign IP addresses to and how to troubleshoot EtherNet/IP networks and devices.

You can view or download publications on Literature Library: rok.auto/literature.

ControlLogix EtherNet/IP Network Device Overview

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Overview

EtherNet/IP™ networks are communication networks that offer a comprehensive suite of messages and services for many automation applications.

This open network standard uses commonly available Ethernet communication products to support real-time I/O messaging, information exchange, and general messaging.

ControlLogix Network Device Features

The ControlLogix® EtherNet/IP network devices:

- Facilitate high-speed data transfer between Logix 5000® controllers and remote I/O modules.
- Connect to multiple EtherNet/IP network topologies.

Figure 1 shows how Rockwell Automation EtherNet/IP communication modules fit into a control system.

Figure 1 - EtherNet/IP Communication Modules in a Control System

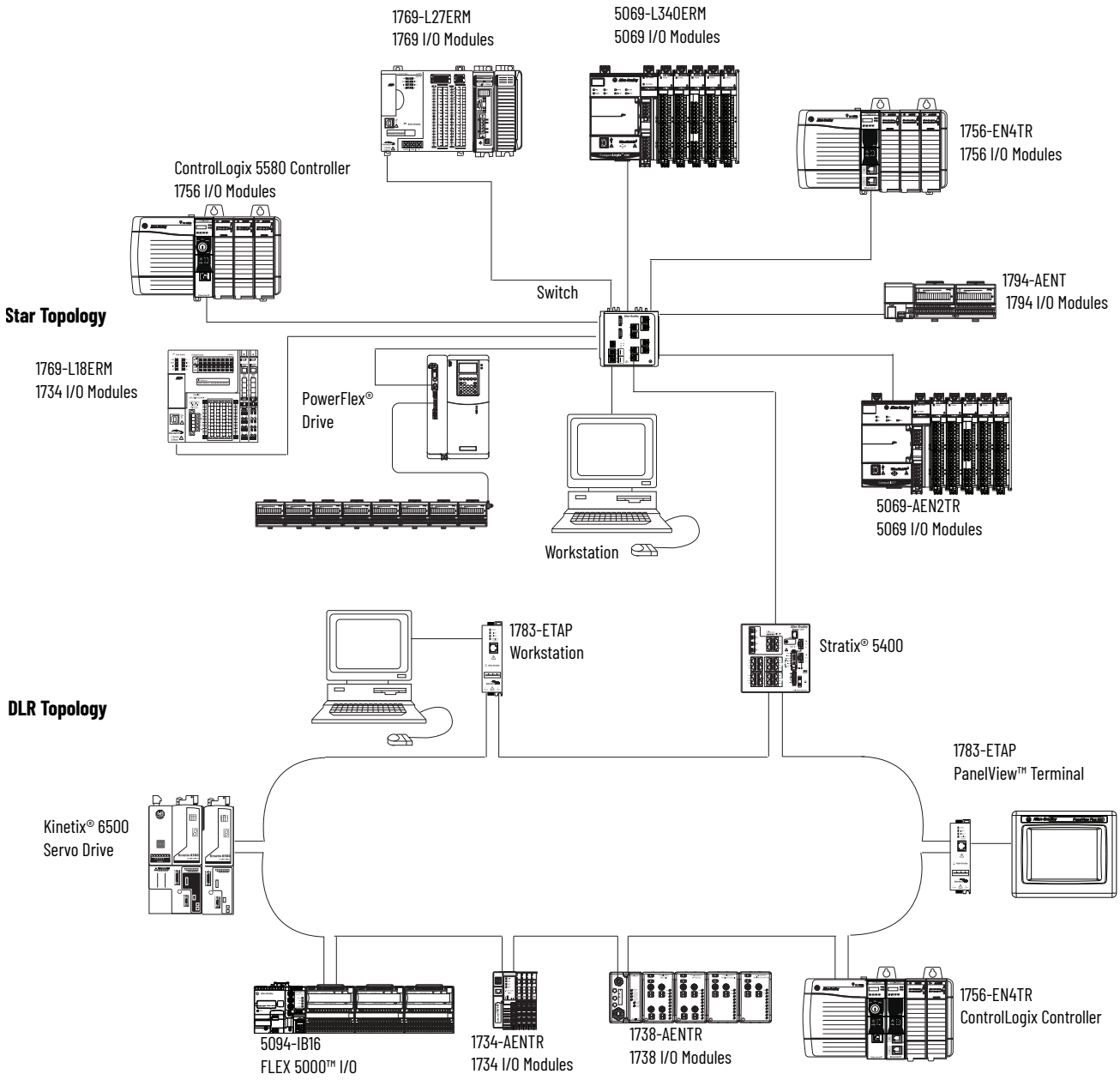


Table 1 - EtherNet/IP Communication Modules

Cat. No.[1]	Description	Media	Communication Rate
1756-EN2F, 1756-EN2FK	EtherNet/IP bridge, fiber	Fiber	100 Mbps, no auto-negotiation.
1756-EN2T 1756-EN2TK	EtherNet/IP bridge, copper	Copper	10/100 Mbps
1756-EN2TP, 1756-EN2TPK	EtherNet/IP bridge, PRP support, copper	Dual Copper	10/100 Mbps
1756-EN2TPXT	ControlLogix-XT™, extended temperature EtherNet/IP bridge, PRP support	Dual Copper	10/100 Mbps
1756-EN2TR, 1756-EN2TRK	EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps
1756-EN2TXT	ControlLogix-XT, extended temperature EtherNet/IP bridge, copper, for extreme environments	Copper	10/100 Mbps
1756-EN2TRXT	ControlLogix-XT, extended temperature EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps
1756-EN3TR, 1756-EN3TRK	EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps
1756-EN4TR, 1756-EN4TRK	EtherNet/IP bridge, embedded switch, copper	Dual Copper	10/100 Mbps 1 Gbps
1756-EN4TRXT	ControlLogix-XT, extended temperature EtherNet/IP bridge, embedded switch, copper	Dual Copper	10/100 Mbps 1 Gbps
1756-ENBT, 1756-ENBTK	EtherNet/IP bridge, copper	Copper	10/100 Mbps
1756-EWEB	Ethernet web server module	Copper	10/100 Mbps

(1) A catalog number ending in a K denotes a conformal coating.

EtherNet/IP Network Specifications

Table 2 - ControlLogix EtherNet/IP Connections Specifications[1]

Cat. No.	Connections		CIP™ Unconnected Messages (backplane + Ethernet)
	TCP	CIP[2]	
1756-ENBT	64	128	64 + 64
1756-EN2F	128	256	128 + 128
1756-EN2T	128	256	128 + 128
1756-EN2TP	128	256	128 + 128
1756-EN2TR	128	256	128 + 128
1756-EN3TR	128	256	128 + 128
1756-EN4TR	512	1000 I/O, 528 messaging/HMI	256+256
1756-EWEB	64	128	128 + 128

(1) Includes the K conformal coating catalog numbers and the XT extreme environment catalog numbers.
(2) Except for the 1756-EN4TR, which has separate I/O and messaging/HMI CIP connections, these connections can be used for any combination of I/O and messaging/HMI.

Table 3 - ControlLogix EtherNet/IP Data Specifications[1]

Cat. No.	Produced/Consumed Tags		Socket Services	Duplicate IP Detection (starting revision)
	Number of Multicast Tags, Max[2]	Unicast Available in RSLogix 5000® Software		
1756-EN2F	32	Version 16.03.00 or later	Yes	All Revisions
1756-EN2T		Version 16.03.00 or later	Yes	
1756-EN2TP		Version 24.00.00 or later	Yes	
1756-EN2TR		Version 17.01.02 or later	Yes	
1756-EN3TR		Version 18.02.00 or later	Yes	
1756-EN4TR		Version 24.00.00 or later	Yes	
1756-ENBT		Version 16.03.00 or later	No	Revision 3.3
1756-EWEB	N/A		Yes	Revision 2.2

(1) Includes the K conformal coating catalog numbers and the XT extreme environment catalog numbers.
(2) Each controller can send a maximum of 32 multicast produced tags to one single consuming controller. If these same tags are sent to multiple consumers, the maximum number is 31.

Table 4 - ControlLogix EtherNet/IP Specifications(1)

Cat. No.	Firmware Revision	RSLogix 5000 Software Version	RSLinx® Software Version	Packet Rate Capacity (packets/second)(2)		Support for Extended Environment(3)	Integrated Motion on the EtherNet/IP Network Axes
				I/O	HMI/MSG		
1756-ENBT	Any	8.02.00 or later	2.30 or later	5000	900	No	N/A
1756-EN2F	2.x	15.02.00 or later	2.51 or later	10,000	2000	No	N/A
	3.6 or later	18.02.00 or later(4)		25,000(5)			Up to 8 axes supported(5)
1756-EN2T	2.x or earlier	15.02.00 or later	2.51 or later	10,000	2000	No	N/A
	3.6 or later	18.02.00 or later(4)		25,000(5)			Up to 8 axes supported(5)
1756-EN2TXT	2.x	15.02.00 or later	2.51 or later	10,000	2000	Yes	N/A
	3.6 or later	18.02.00 or later(4)		25,000(5)			Up to 8 axes supported(5)
1756-EN2TP	Any	24.00.00 or later(4)	4.10 or later	25,000(5)	2000	No	Up to 8 axes supported(5)
1756-EN2TPXT	10.x or later	24.00.00 or later	4.10 or later	25,000(5)	2000	Yes	Up to 8 axes supported(5)
1756-EN2TR	2.x	17.01.02 or later	2.55 or later	10,000	2000	No	N/A
	5.x or later	18.02.00 or later(4)	2.56 or later	25,000(5)			Up to 8 axes supported(5)
1756-EN2TRXT	5.028 or later	20.01.00 or later	2.56 or later	25,000(5)	2000	Yes	Up to 8 axes supported(5)
1756-EN3TR	3.6 or later	18.02.00 or later(4)	2.56 or later	25,000(5)	2000	No	Up to 256 axes supported(5)
1756-EN4TR	Any	24.00.00 or later(6)	4.10 or later	• 50,000 without CIP Security™ • 25,000 with integrity • 15,000 with integrity and confidentiality	• 3,700 without CIP Security • 2,700 with integrity • 1,700 with integrity and confidentiality	No	Up to 256 axes supported(5)
1756-EN4TRXT	Any	24.00.00 or later(6)	4.10 or later	• 50,000 without CIP Security • 25,000 with integrity • 15,000 with integrity and confidentiality	• 3,700 without CIP Security • 2,700 with integrity • 1,700 with integrity and confidentiality	Yes	Up to 256 axes supported(5)

(1) Includes the K conformal coating catalog numbers.

(2) I/O numbers are maximums; they assume no HMI/MSG. HMI/MSG numbers are maximums, they assume no I/O. Packet rates vary depending on packet size. For more details, see Troubleshoot EtherNet/IP Application Technique, publication ENET-AT003, and the EDS file for a specific catalog number.

(3) Module operates in a broad temperature spectrum, -20…+70 ºC (-4…+158 ºF), and meets ANSI/ISA-S71.04-1985 Class G1, G2 and G3, and cULus, Class 1 Div 2, C-Tick, CE, ATEX Zone 2 and SIL 2 requirements for increased protection against salts, corrosives, moisture/condensation, humidity, and fungal growth.

(4) This version is required to use CIP Sync™ technology, Integrated Motion on the EtherNet/IP Network, or Exact Match keying.

(5) This value assumes the use of a 1756-L8x or a 1756-L7x ControlLogix controller. For a 1756-L6x ControlLogix controller, see ControlLogix Controllers User Manual, publication 1756-UM001.

(6) CIP Security requires FactoryTalk® Linx version 6.11.00 or later.

EtherNet/IP Network

The Ethernet Industrial (EtherNet/IP) network protocol is an open industrial-networking standard that supports both real-time I/O messaging and message exchange. The EtherNet/IP network uses off-the-shelf Ethernet communication chips and physical media.

If you need to	Select this interface
Control I/O modules and drives Act as an adapter for I/O on remote EtherNet/IP links Communicate with other EtherNet/IP devices (messages and HMI) Bridge EtherNet/IP links to route messages to devices on other networks	1756-EN2F, 1756-EN2FK 1756-EN2T, 1756-EN2TK, 1756-EN2TXT 1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT 1756-EN2TR, 1756-EN2TRK, 1756-EN2TRXT 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT 1756-ENBT, 1756-ENBTK
Support Device Level Ring (DLR) and linear topologies	1756-EN2TR, 1756-EN2TRK, 1756-EN2TRXT 1756-EN3TR, 1756-EN3TRK 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT
Support for Parallel Redundancy Protocol	1756-EN2TP, 1756-EN2TPK, 1756-EN2TPXT 1756-EN4TR(1), 1756-EN4TRK(1), 1756-EN4TRXT(1)
Support for Redundant Adapters(2)	1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT
Provide control in environments where temperatures range from -25...+70 °C (-13...+158 °F)	1756-EN2TPXT 1756-EN2TRXT 1756-EN2TXT 1756-EN4TRXT
Secure access to a control system from within the plant network	1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT
Use an Internet browser to access tags remotely in a ControlLogix controller Communicate with other EtherNet/IP or generic Ethernet devices (messaging only; no I/O control) Bridge EtherNet/IP links to route messages to devices on other networks	1756-EWEB, 1756-EWEBK web server

(1) Starting with firmware revision 4.001.

(2) Redundant Adapters require version 3.001 and higher firmware. See the Product Compatibility and Download Center (PCDC) for that firmware.

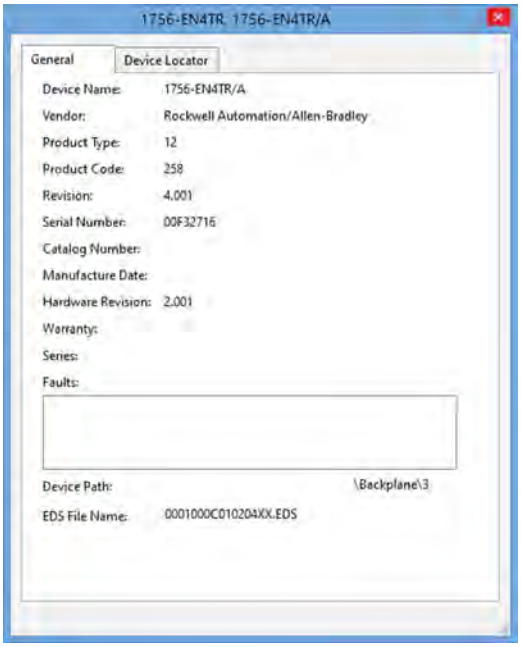
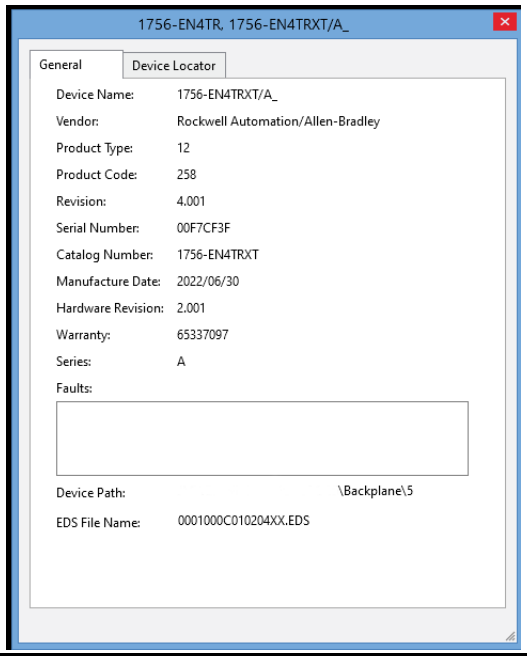
Device Properties Information

You can use FactoryTalk Linx Network Browser to view:

- Catalog Number
- Manufacture Date
- Warranty Number
- Series

This applies to:

- 1756-EN2x modules manufactured with firmware revision 12.001 or later.
- 1756-EN4TR modules manufactured in July 2022 or later with firmware revision 4.001 or later.

Example Module Manufactured with Earlier Firmware	Module Manufactured with Later Firmware
	

Simple Network Management Protocol (SNMP)

SNMP enables the device to be remotely managed through other network management software. SNMP defines the method of communication among the devices and also denotes a manager for the monitoring and supervision of the devices. For more information about SNMP, see the Ethernet Reference Manual, publication ENET-RM002.

Cat. No.	Default Status	Ability to Disable SNMP
1756-EN2F	**Off** with firmware revision 12.001 or later **On** with firmware revision 11.004 or earlier	**Yes** with firmware revision 12.001 or later **No** with firmware revision 11.004 or earlier
1756-EN2T		
1756-EN2TP		
1756-EN2TR		
1756-EN3TR		
1756-EN4TR	Off	Yes

SNMP Passwords for these modules can be changed. For information on how to change the SNMP Password, see the Knowledgebase Technote *SNMP Password and MIB Configuration*.

Disable SNMP

To disable SNMP, see Disable/Enable Simple Network Management Protocol (SNMP) on page 74.

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device that is defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared in the following table.

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The following Electronic Keying options are available.

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics: • Same catalog number • Same or higher Major Revision • Minor Revision as follows: – If the Major Revision is the same, the Minor Revision must be the same or higher. – If the Major Revision is higher, the Minor Revision can be any number.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **ATTENTION**: Be cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We strongly recommend that you do not use Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken.

If an I/O connection to a device is interrupted, the result can be a loss of data.

For more detailed information on Electronic Keying, see Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001.

Protected Mode

The 1756-EN2F, 1756-EN2T, 1756-EN2TP, 1756-EN2TR, 1756-EN3TR, and 1756-EN4TR support explicit protected mode.[1] When in this mode, the module does not allow any configuration changes.

The only exception is for CIP Security devices such as the 1756-EN4TR. For those, if a security policy has already been deployed to the module, then that security policy can be modified while in explicit protected mode. If a security policy has not yet been deployed to the module, then explicit protected mode w prevents an initial policy from being deployed.

Enabling Explicit Protected Mode

To enable the module in an "explicit protected mode state", follow these steps.

1. Set the rotary switches to position '900'.
2. Power up the device, and wait for the display to scroll, "Protected Mode – Change Switch Settings".
3. Power down the device.
4. Set the switches for normal operation.
5. Power up the device.
6. The device is now in Explicit Protected Mode.

Operation in Explicit Protected Mode

While operating in protected mode, the module rejects any CIP explicit messages that would change the configuration of the module. For example, you cannot change the IP address, speed, or duplex settings when the module had Explicit Protected Mode enabled.

IMPORTANT	When used in a Redundant Chassis Pair (RCP) with ControlLogix controllers, the 1756-EN2x/1756-EN4x EtherNet/IP communication modules have a special case for the Time Sync object, where the PTP_Enable attribute is allowed to be set from the backplane. This is needed to allow the controller to set the PTP enable using unconnected messaging in the secondary (it is set via a class 1 connection in the primary controller, and in non-RCP cases).

Disabling Explicit Protected Mode

To disable the "explicit protected mode state", follow these steps.

1. Set the rotary switches on position '000'.
2. Power up the device, and wait for the display to scroll, "Unprotected Mode – Change Switch Settings".
3. Power down the device.
4. Set the switches for normal operation.
5. Power up the device.
6. The device is now in Unprotected Mode.

(1) For 1756-EN2F, 1756-EN2T, EN3TR, and 1756-EN2TR Versions 11.001 and later.
For 1756-EN2TP and 1756-EN4TR all versions

Protected Mode in a Redundant Adapter Pair

The 1756-EN4TR supports explicit protected mode in a redundant adapter pair. In this mode, the module does not allow any configuration changes.

Enabling Explicit Protected Mode in a Redundant Adapter Pair (RAP)

To enable the module in an "explicit protected mode state in RAP", follow these steps.

1. Put your system in a qualified state.
2. Remove the secondary device from the chassis, put it in explicit mode using the methods that are found on page 16, and insert the module back into the chassis.

   The system is qualified with the message "Explicit Protected Mode Mismatch" on the module display.
3. Force a switchover either using AOP service or disconnect the cable.
4. Remove secondary (previous primary) device, put it in explicit mode and insert module back.

   The system has enabled explicit protected mode.

Disabling Explicit Protected Mode in a Redundant Adapter Pair

To disable the module in an "explicit protected mode state in RAP", follow these steps.

1. Put your system in a qualified state.
2. Remove the secondary device from the chassis, put it in non-protected mode using the methods that are found on page 16, and insert the module back into the chassis.

   The system is qualified with the message "Explicit Protected Mode Mismatch" on the module display.
3. Force a switchover either using AOP service or disconnect the cable.
4. Remove secondary (previous primary) device, put it in non-protected mode and insert module back.

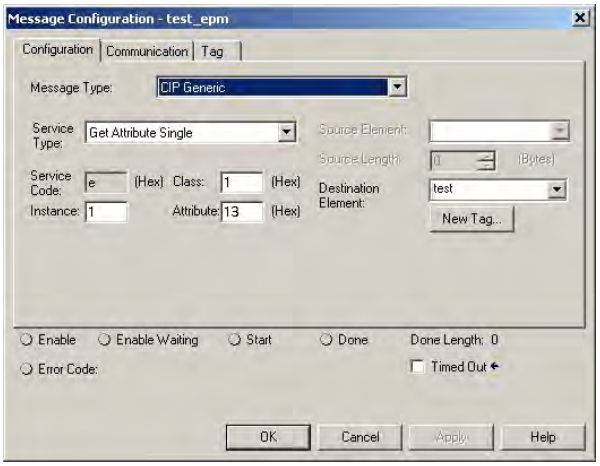
   The system has disabled explicit protected mode.

How to Determine if the Module is in Explicit Protected Mode

To determine if your module is in explicit protected mode, either view the AOP Module information page, or create a Generic CIP message. Set the following parameters:

- Service Type: Get Single Attribute
- Class = 1
- Instance = 1
- Attribute = 13(Hex)

The Destination Element Tag must be the INT type. Bit 3 is explicit protected mode and a value of 1 indicates that protected mode is enabled.



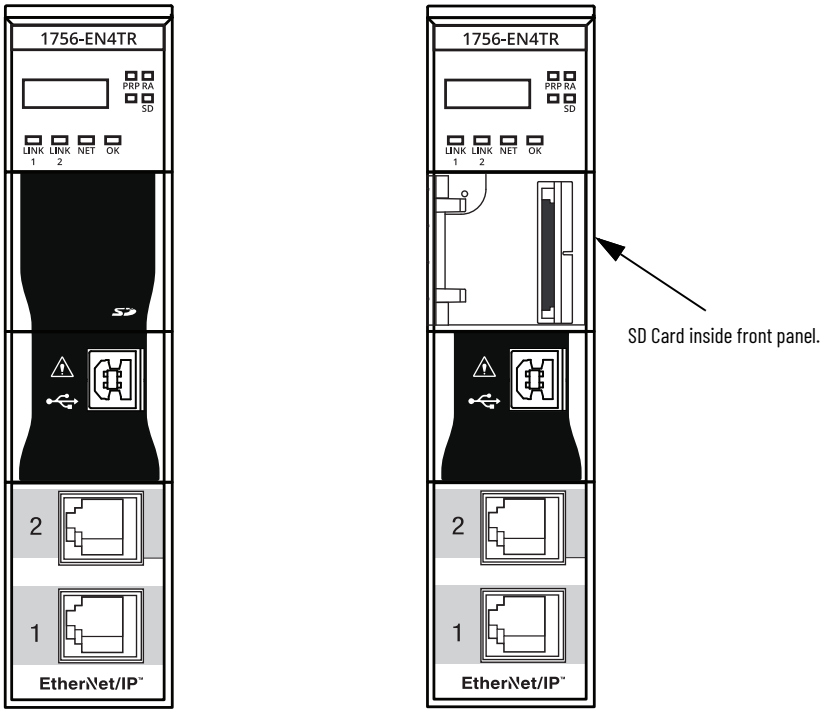
Secure Digital Card

The 1756-EN4TR uses a Secure Digital (SD) card to store:

- Module firmware
- Module configuration
- Fault logs

  You can provide the fault logs to technical support rather than shipping then entire module.

The SD card slot is inside the front panel of the module.



When the device is powered up, the device uses the configuration from the SD card if the configuration does not exist in the device. When a blank SD card is inserted, or powered up, the configuration is copied from the device to the SD card that was inserted.

If the module powers up with a configuration that does not match the configuration on the already inserted SD card, the configuration on the SD card is used and copied to the module.

IMPORTANT	The 1756-EN4TR does not save the CIP Security configuration information to the SD card. On power-up, the CIP Security setting returns to the module default setting.

If the module is already powered, and an SD card is inserted, a warning message is displayed.

To see other potential error messages, see Table 12 on page 80.

To change these results, do one of two things. One option is to do an out of box reset on the module, if you want to use the configuration on the SD card. A second option is to modify one of the configuration settings on the device, if you want to use the configuration on the device.

IMPORTANT	If an SD card with a valid configuration is inserted into a 1756-EN4TR module that does not match, an error is displayed on the status display on the front of the module warning of this mis-configuration. If the SD card is intended to be used in the 1756-EN4TR module it must be cleared by external means and reinserted. If this is not done before the next power cycle of the 1756-EN4TR with the non-matching configuration, this configuration is copied to the 1756-EN4TR with all settings including the IP address from the original module. This can possibly cause an IP address conflict.

The 1756-EN4TR supports the use of a 1784-SD1 (1 GB) and 1784-SD2 (2 GB) card. You can use third-party SD cards with the device. You can use SD cards with as much as 32 GB of memory.

IMPORTANT	Rockwell Automation does not test the use of third-party SD cards with the device.

If you use an SD card other than those cards that are available from Rockwell Automation, unexpected results can occur. For example, you can experience data corruption or data loss.

SD cards that are not provided by Rockwell Automation can have different industrial, environmental, and certification ratings as those cards that are available from Rockwell Automation. These cards can have difficulty with survival in the same industrial environments as the industrially rated versions available from Rockwell Automation.

Disable Secure Digital Card

To disable the SD card, see Disable/Enable the SD Card on page 68.

CIP Security

CIP Security™ is a standard, open communication mechanism that is defined by the Open DeviceNet® Vendors' Association (ODVA) that helps to provide a secure data transport across an EtherNet/IP™ network. It lets CIP-connected devices authenticate each other before transmitting and receiving data.

CIP Security uses the following security properties to help devices protect themselves from malicious communication:

- Device Identity and Authentication
- Data Integrity and Authentication
- Data Confidentiality

Rockwell Automation uses the following products to implement CIP Security:

- FactoryTalk Services Platform, version 6.11 or later, with the following components enabled:
  - FactoryTalk Policy Manager
  - FactoryTalk System Services
- FactoryTalk Linx, version 6.11 or later
- Studio 5000® Design Environment, version 31.00.00 or later
- CIP Security-enabled Rockwell Automation products, for example, the product described in this publication

For more information on CIP Security, including which products support CIP Security, see the CIP Security with Rockwell Automation Products Application Technique, publication SECURE-AT001.

IMPORTANT

Redundant Chassis Pair

1756-EN4TR modules with firmware revision 4.001 support CIP Security when used in a **redundant chassis pair** with ControlLogix 5580 controllers that have firmware revision 34.011 or later. This supports program upload/download/monitor/HMI (not I/O).

- The 1756-EN4TR pair must be configured for non-IP address swapping.
- The 1756-EN4TR pair cannot be configured for redundant adapter mode while used in a **redundant chassis pair** with ControlLogix 5580 controllers.
- The 1756-EN4TR pair that is configured for CIP security cannot be used to communicate with remote I/O, because I/O in ControlLogix redundancy requires multi-cast. A second 1756-EN4TR pair is required for I/O.

Redundant Adapter Mode

CIP Security is not yet supported when the 1756-EN4TR is in **redundant adapter mode** for remote I/O.

If a 1756-EN4TR is installed and using CIP Security, and it is reconfigured to be part of a **redundant adapter pair** for remote I/O, the module loses its CIP Security configuration. When this occurs, the I/O chassis will lose communication with the controller. At this point, the CIP Security policy must be redeployed.(1)

(1) CIP Security is not supported in redundant adapters. See Chapter 4 on page 45.

Syslog Event Logging

The 1756-EN4TR module supports syslog event logging. Do not use FactoryTalk AssetCentre for logging if you want to use a syslog collector.

Choose a syslog collector that supports the following:

- RFC-5424 syslog protocol
- Ability to receive messages from the 1756-EN4TR module

To set the IP address of the syslog collector, use FactoryTalk Policy Manager software.

IMPORTANT The 1756-EN4TR module must be connected to the same network as the syslog collector.

For more information, see:

- CIP Security with Rockwell Automation Products Application Technique, publication SECURE-AT001.
- Logix 5000 Controller and I/O Fault Codes and Syslog Messages, publication 1756-RD001.

Parallel Redundancy Protocol

Parallel Redundancy Protocol (PRP) is defined in international standard IEC 62439-3 and provides high-availability in Ethernet networks. PRP technology creates seamless redundancy by sending duplicate frames to two independent network infrastructures, which are known as LAN A and LAN B.

A PRP network includes the following components.

Component	Description
LAN A and LAN B	Redundant, active Ethernet networks that operate in parallel.
Double attached node (DAN)	An end device with PRP technology that connects to both LAN A and LAN B.
Single attached node (SAN)	An end device without PRP technology that connects to either LAN A or LAN B. A SAN does not have PRP redundancy.
Redundancy box (RedBox)	A switch with PRP technology that connects devices without PRP technology to both LAN A and LAN B.
Virtual double attached node (VDAN)	An end device without PRP technology that connects to both LAN A and LAN B through a RedBox. A VDAN has PRP redundancy and appears to other nodes in the network as a DAN.
Infrastructure switch	A switch that connects to either LAN A or LAN B and is not configured as a RedBox.

For more information about PRP, see the EtherNet/IP Parallel Redundancy Protocol Application Technique, publication ENET-AT006.

Device Level Ring (DLR)

Device Level Ring (DLR) is an EtherNet/IP protocol that is defined by the Open DeviceNet® Vendors' Association (ODVA). DLR provides a means to detect, manage, and recover from single faults in a ring-based network.

A DLR network includes the following types of ring nodes.

Table 5 -

Node	Description
Ring supervisor	A ring supervisor provides these functions: Manages traffic on the DLR network Collects diagnostic information for the network A DLR network requires at least one node to be configured as ring supervisor. By default, the supervisor function is disabled on supervisor-capable devices.
Ring participants	Ring participants provide these functions: Process data that is transmitted over the network. Pass on the data to the next node on the network. Report fault locations to the active ring supervisor. When a fault occurs on the DLR network, ring participants reconfigure themselves and relearn the network topology.
Redundant gateways (optional)	Redundant gateways are multiple switches that are connected to one DLR network and also connected together through the rest of the network. Redundant gateways provide DLR network resiliency to the rest of the network.

Depending on their firmware capabilities, both devices and switches can operate as supervisors or ring nodes on a DLR network. Only switches can operate as redundant gateways.

For more information about DLR, see the EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007.

Notes:

Concurrent Communication

Concurrent communication is available with FLEXHA 5000™ I/O modules and FLEX 5000® safety I/O modules with redundant ControlLogix® 5580 or with Logix SIS controllers, respectively. Concurrent communication provides for **seamless failover** for any redundant pair of hardware components.

You must configure a 1756-EN4TR EtherNet/IP™ communication module in each Logix 5000® controller redundant chassis pair to use concurrent communication and not to use IP swapping mode.

With concurrent communication, data transmission between redundant ControlLogix 5580 and FLEXHA 5000 I/O modules or Logix SIS controllers and FLEX 5000 safety I/O modules is redundant at the logical and physical levels.

There are differences to how concurrent communication works with FLEXHA 5000 I/O module and FLEX 5000 safety I/O modules.

Concurrent Communication with FLEXHA 5000 I/O Modules

You can only use concurrent communication with FLEXHA 5000 I/O modules if you use the following components in your system.

Component		Software Version	Firmware Revision
Software	Studio 5000 Logix Designer® application	**Version 37.00.00 or later**	–
	FactoryTalk® Linx software	Version 6.31.00 or later	–
	ControlFLASH Plus™ software	Version 5.00.00 or later	–
ControlLogix 5580 System	ControlLogix 5580 controllers	–	Revision 37.xxx or later
	1756-EN4TR ControlLogix EtherNet/IP Communication Modules	–	Revision 7.001 or later
FLEXHA 5000 I/O System	FLEXHA 5000 EtherNet/IP adapter	–	Revision 3.011 or later
	FLEXHA 5000 I/O Modules	–	Revision 3.011 or later

Logical Level

Concurrent communication uses one logical CIP connection with two legs to the fault-tolerant I/O modules. Duplicate copies of the I/O data are transmitted across both legs. That is, there is one duplicated packet for each I/O module.

Redundant ControlLogix 5580 controllers operate in parallel to synchronize the data. As a result, the same output values occur simultaneously. The controllers open the concurrent communication path to the FLEXHA 5000 I/O modules.

Via a 1756-EN4TR EtherNet/IP communication module, ControlLogix 5580 controllers send duplicate data to the FLEXHA 5000 I/O modules that work as a redundant pair.

Each duplicate is targeted for one of the FLEXHA 5000 I/O modules in the redundant pair. The paired I/O modules receive duplicate data, compare the data, and establish one signal value that is set on the terminal screws.

A similar pattern is followed for input data that is transmitted from the paired FLEXHA 5000 I/O modules to the redundant ControlLogix 5580 controllers. Both of the controllers and I/O modules process the same data in parallel. Consequently, a failure and dropout of one device does not require a switchover and synchronization of the partner device.

Physical Level

During transmission, the duplicated data passes along physical connections from the 1756-EN4TR EtherNet/IP communication modules and the FLEXHA 5000 EtherNet/IP adapter. Physical network redundancy is provided whether the system is operating in a PRP or DLR topology. Thus, the system has increased resiliency.

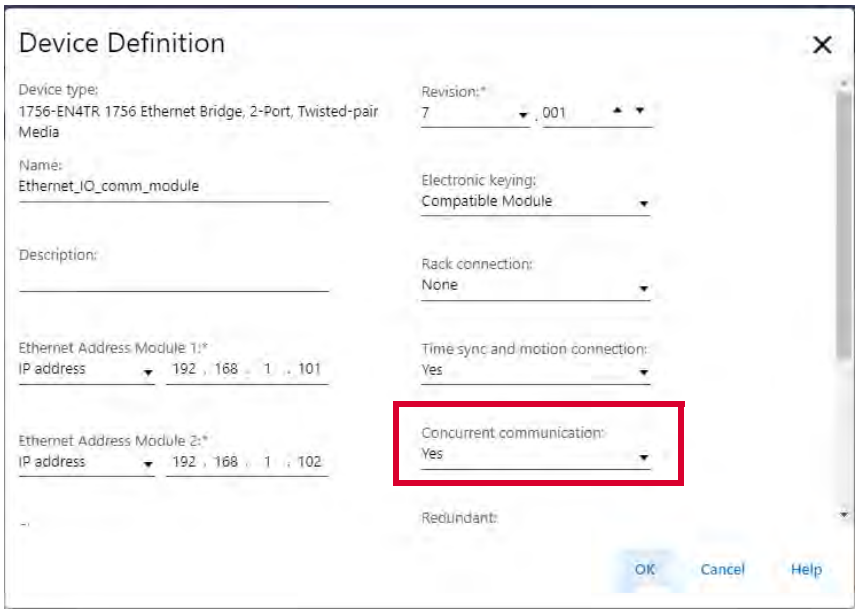
The physical network redundancy is achieved via redundant paths between the 1756-EN4TR EtherNet/IP communication module and the FLEXHA 5000 EtherNet/IP adapter as follows:

- PRP network - Duplicated data at the physical level for each path.
- DLR network - Providing redundant paths.

Communication Module Configuration

To use concurrent communication with FLEXHA 5000 I/O modules, you must configure the 1756-EN4TR ControlLogix EtherNet/IP communication module on the Device Definition dialog box in your Studio 5000 Logix Designer application project to use concurrent communication.

1756-EN4TR Communication Module Configuration



IMPORTANT	You can configure the 1756-EN4TR EtherNet/IP communication module for concurrent communication, to use with I/O modules such as FLEXHA 5000 I/O modules. Or you can configure the 1756-EN4TR EtherNet/IP communication module for standard I/O, for example, remote 1756 ControlLogix I/O modules. You can only configure the module for one or the other. If the 1756-EN4TR EtherNet/IP communication module is configured for concurrent communication, you can still use it for class 3 communications, for example, HMI, program upload/download/monitor. You must disable IP address swapping in the 1756-EN4TR EtherNet/IP communication modules in the redundant chassis pair.

Concurrent Communication in a PRP Topology

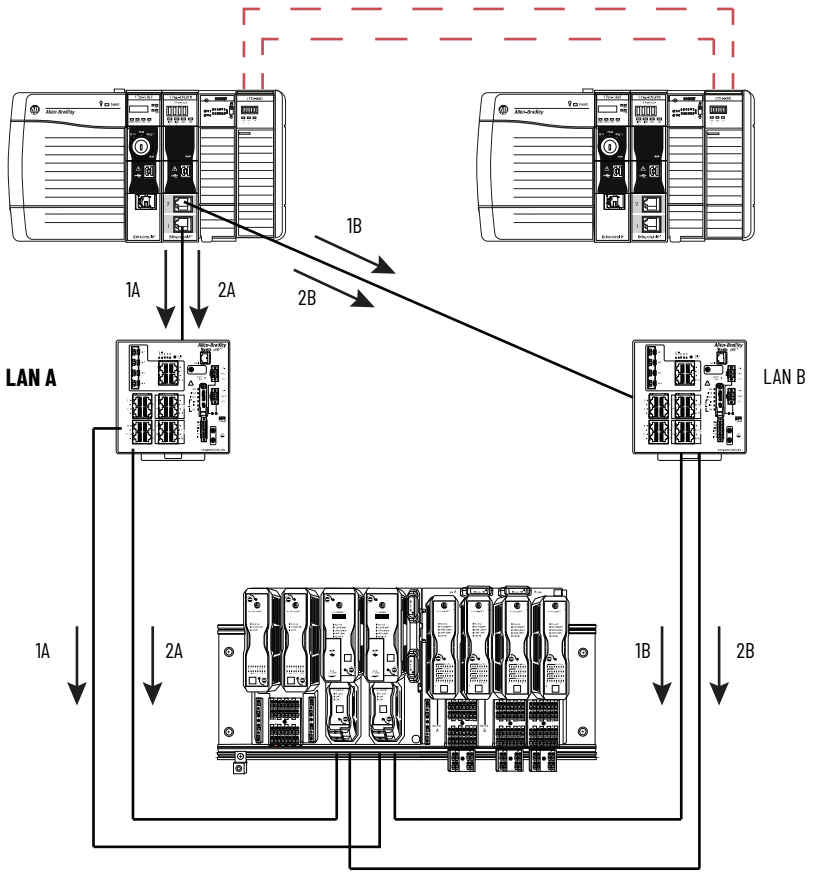
This section shows how data is transmitted from one ControlLogix 5580 controller in a redundant controller pair to a duplex pair of FLEXHA 5000 I/O modules.

In this scenario, concurrent communication transmits data as follows.

1. The controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis.

   At this point, the communication is not redundant.
2. Redundant communication starts at the communication module. The communication module opens two legs of the concurrent communication and transmits duplicates of the data across those legs.

   Additionally, the communication module is connected to a redundant PRP network, that is, LAN A and LAN B. The PRP network redundancy introduces further data duplication.
   - Numbers 1A and 2A represent the two legs of the concurrent communication on one physical cable between the communication module and the LAN A switch.
   - Numbers 1B and 2B represent the physical duplication of the two legs of the concurrent communication between the communication module and the LAN B switch.
3. Duplicate data is transmitted across the two legs, and physical duplication of these legs, to the FLEXHA 5000 EtherNet/IP adapters.



This section expands on the previous section to show that the same data is transmitted from the secondary ControlLogix 5580 controller in the redundant controller pair to the duplex pair of FLEXHA 5000 I/O modules. Data is transmitted from the secondary controller based on the logic state cross loaded from the primary controller.

In this scenario, concurrent communication transmits data as follows.

1. The ControlLogix 5580 controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis.

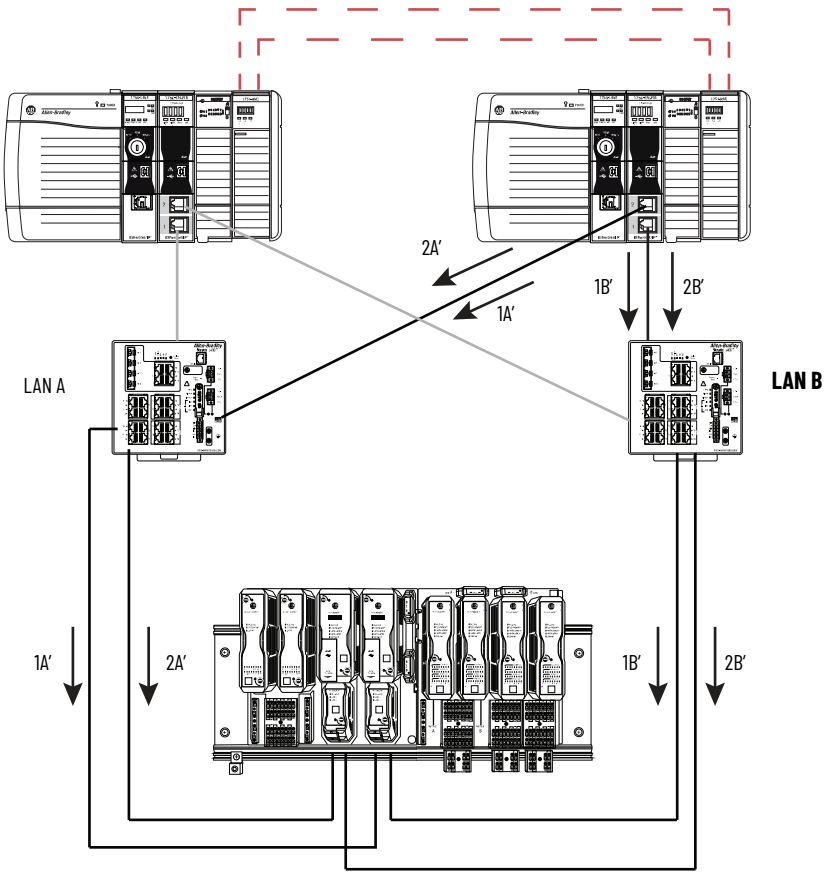
   At this point, the communication is not redundant.

2. Redundant communication starts at the 1756-EN4TR EtherNet/IP communication module. The 1756-EN4TR EtherNet/IP communication module opens two legs of the concurrent communication and transmits duplicates of the data across those legs.

   Additionally, the 1756-EN4TR EtherNet/IP communication module is connected to a redundant PRP network, that is, LAN A and LAN B. The PRP network redundancy introduces further data duplication.

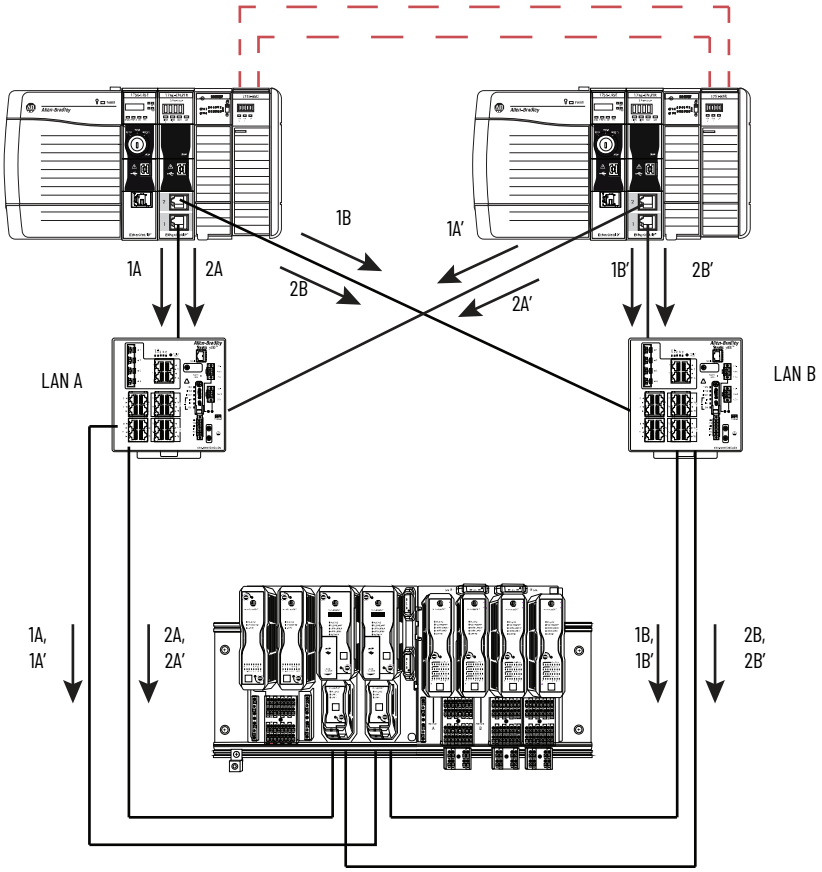
   - Numbers 1B′ and 2B′ represent the two legs of the concurrent communication on one physical cable between the 1756-EN4TR EtherNet/IP communication module and the LAN B switch.
   - Numbers 1A′ and 2A′ represent the physical duplication of the two legs of the concurrent communication between the 1756-EN4TR EtherNet/IP communication module and the LAN A switch.

3. Duplicate data is transmitted across the two legs, and physical duplication of these legs, to the FLEXHA 5000 EtherNet/IP adapters.



The following graphic shows how duplicate data is transmitted from each controller across LANs A and B, respectively, simultaneously. That is, this shows what is happening when you consider both of the previous sections.

Concurrent Communication in a PRP Topology



IMPORTANT:

- Each 1756-EN4TR EtherNet/IP communication module in the redundant chassis pair sends duplicated data on each LAN simultaneously.
- Data with the similar designations, for example, 1A and 1A', are the same but from different controllers with the only difference being a small identifier. In this case, it is the prime (') designation.

This occurs because the controllers work as a redundant pair that is synchronized via ControlLogix Redundancy Modules.

- All data transmission starts simultaneously. The duplicated data that reaches the adapters first is what's used in the FLEXHA 5000 I/O system. The other data is disregarded.

When duplicate data arrives at a FLEXHA 5000 EtherNet/IP adapter, the adapter combines the PRP duplicates and accepts the first uncorrupted PRP duplicate. The second PRP duplicate is rejected.

So from each pair of data duplicates 1A/1B, 2A/2B and 1A'/1B', 2A'/2B' become only 1/1', 2/2'.

The FLEXHA 5000 I/O adapters combine the concurrent communication legs' duplicates and only accept the first valid duplicates from the pair of 1/1' and 2/2'. After that, each adapter only processes the single packet.

The FLEXHA 5000 EtherNet/IP adapters then function in the same way as the 1756-EN4TR EtherNet/IP communication modules. The FLEXHA 5000 EtherNet/IP adapter transmits duplicated data across two legs of the concurrent communication to the FLEXHA 5000 I/O modules.

Additionally, the backplane physical redundancy establishes additional duplication of the data, in a similar way to how the PRP does it for the network. Each adapter transmits four identical data packets, one to each of two I/O modules across each of the two redundant backplanes.

The following graphic presents the idea of concurrent backplane communication. Numbers 1, 1' and 2, 2' represent the concurrent connection duplicates. Postfixes A and B are related to physical duplication.

The I/O modules receive repeated data packets. The physical redundancy layer of the slot 0 I/O module combines the duplicates and accepts the first uncorrupted duplicate of 1A, 1B to 1 and 1A', 1B' to 1'. The concurrent communication layer combines the duplicates, accepting the first uncorrupted packets. The 1 and 1' is reduced to 1.

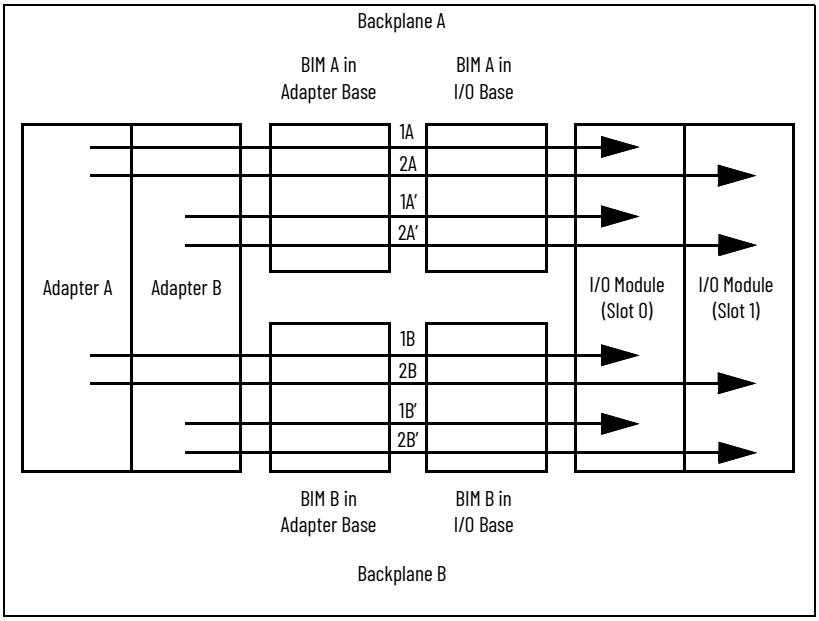
The slot 1 I/O module executes an identical process. The redundant data are reduced to a single instance, that is, 2.

Once one or both I/O modules receive valid data, the data is applied to the terminal.

Data Transmission in FLEXHA 5000 I/O System

IMPORTANT: This graphic shows how data is transmitted from FLEXHA 5000 EtherNet/IP adapters to the I/O module duplex pair. Remember, only one packet is selected per adapter from the network. From there the adapters distribute that packet information as shown.

Adapter	Transmits Across	Number of Data Packets	
		I/O Module (Slot 0)	I/O Module (Slot 1)
A	BIM A/ Backplane A	1	-
		-	1
	BIM B/ Backplane B	1	-
		-	1
B	BIM A/ Backplane A	1	-
		-	1
	BIM B/ Backplane B	1	-
		-	1
Number of instances of the same data received: 8		4	4



Concurrent Communication in a DLR Topology

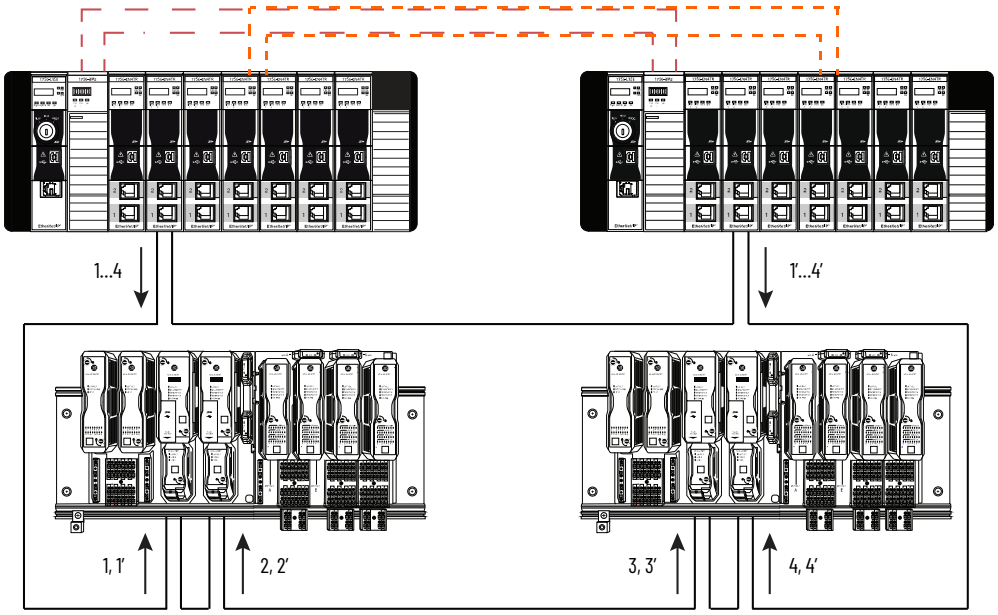
A DLR topology provides a means to detect, manage, and recover from single faults in a ring-based network. The following graphic shows a DLR network in which redundant ControlLogix 5580 controllers provide high availability when they are connected to FLEXHA 5000 I/O systems in a DLR network.

In this scenario, concurrent communication transmits data as follows.

1. The ControlLogix 5580 controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis. At this point, the communication is not redundant.
2. The 1756-EN4TR EtherNet/IP communication module then transmits duplicate data across two legs of the concurrent communication to the FLEXHA 5000 EtherNet/IP adapters.

   Numbers 1...4 and 1'...4' represents four concurrent communications opened to four I/O modules in two pairs in two separate chassis (1, 2 and 3, 4). Each of these communications has two redundant legs. All this occurs on single cable.

Concurrent Communication in a DLR Topology



When duplicate data arrives at the FLEXHA 5000 EtherNet/IP adapters, the adapters combine concurrent communication leg duplicates, accepting only the first valid duplicates from the pair—in the first chassis 1/1' and 2/2', and in the second chassis 3/3' and 4/4'.

After that, each adapter only processes the single packet that is targeted for every I/O module in the chassis. It is packets 1 and 2 in first chassis. Packet 1 is targeted to the first I/O in the redundant I/O module pair. Packet 2 is targeted to the second I/O in the redundant I/O module pair.

The FLEXHA 5000 EtherNet/IP adapters then function in the same way as the 1756-EN4TR EtherNet/IP communication modules. The FLEXHA 5000 EtherNet/IP adapters transmit duplicated data across two legs of the concurrent communication to the FLEXHA 5000 I/O modules.

Additionally, the backplane physical redundancy establishes additional duplication of the data in a similar way to how the PRP does it for the network. Each adapter transmits four identical data packets, one to each of two I/O modules across each of the two redundant backplanes.

The following graphic presents the idea of concurrent backplane communication. Numbers 1, 1' and 2, 2' represent the concurrent connection duplicates. Postfixes A and B are related to physical duplication.

The I/O modules receive repeated data packets. The physical redundancy layer of the slot 0 I/O module combines the duplicates and accepts the first uncorrupted duplicate of 1A, 1B become 1. Also, 1A', 1B' become 1'. The concurrent communication layer combines the duplicates, accepting the first uncorrupted packets. The 1 and 1' become 1.

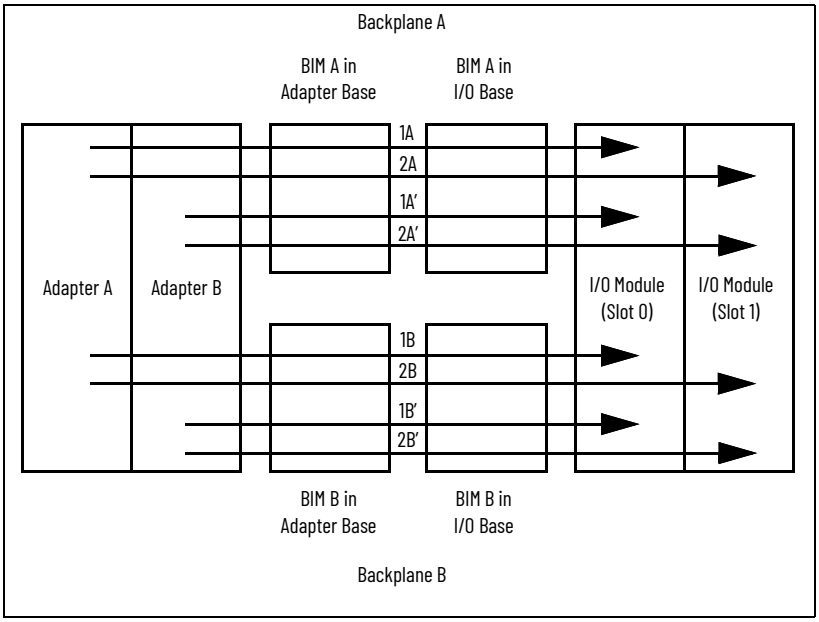
The slot 1 I/O module executes an identical process. The redundant data are reduced to a single instance, that is, 2.

Once one or both I/O modules receive valid data, the data is applied to the terminal.

Data Transmission in Each FLEXHA 5000 I/O System

IMPORTANT: This graphic shows how data is transmitted from FLEXHA 5000 EtherNet/IP adapters to the I/O module duplex pair. Remember, only one packet is selected per adapter from the network. From there the adapters distribute that packet information as shown.

Adapter	Transmits Across	Number of Data Packets	
		I/O Module (Slot 0)	I/O Module (Slot 1)
A	BIM A/ Backplane A	1	-
		-	1
	BIM B/ Backplane B	1	-
		-	1
B	BIM A/ Backplane A	1	-
		-	1
	BIM B/ Backplane B	1	-
		-	1
Number of instances of the same data received: 8		4	4



Concurrent Communication with FLEX 5000 Safety I/O Modules

Concurrent communication is available with FLEX 5000 safety I/O modules. It occurs between Logix SIS controllers and the I/O modules via an EtherNet/IP network.

IMPORTANT The only safety I/O modules that Logix SIS controllers can communicate with are FLEX 5000 safety I/O modules.

You must configure a 1756-EN4TR EtherNet/IP communication module in each redundant chassis to use concurrent communication and not to use IP swapping mode.

With concurrent communication, data transmission between 1756-EN4TR EtherNet/IP communication modules and the FLEX 5000 EtherNet/IP adapter is redundant at the logical and physical levels.

IMPORTANT FLEX 5000 I/O systems can include a mix of safety and standard I/O modules. FLEX 5000 standard I/O modules **don't support** concurrent communication, but Logix SIS controllers can still communicate with them.

The first part of this section focuses on concurrent communication. For more information on how Logix SIS controllers communicate with FLEX 5000 standard I/O modules, see page 37.

You can only use concurrent communication with FLEX 5000 safety I/O modules if you use the following components in your system.

Component		Software Version	Firmware Revision
Software	Studio 5000 Logix Designer application	**Version 37.00.00 or later**	–
	FactoryTalk Linx software	Version 6.31.00 or later	–
	ControlFLASH Plus software	Version 5.00.00 or later	–
Logix SIS Components	GuardLogix® 5580 controllers	–	Revision 37.xxx or later
	1756-EN4TR ControlLogix EtherNet/IP Communication Modules	–	Revision 7.001 or later
FLEX 5000 Safety I/O System Components	FLEX 5000 EtherNet/IP adapter	–	Revision 6.011 or later
	FLEX 5000 Safety I/O Modules	–	Any

Logical Level

Concurrent communication uses a logical CIP connection to the I/O module. Logix SIS controllers open the concurrent communication path to the FLEX 5000 EtherNet/IP adapter.

The controllers operate in parallel to synchronize the data. Each controller sends a data packet to the 1756-EN4TR EtherNet/IP adapter in its local chassis. The data packets are identical. The adapters transmit the data on the EtherNet/IP network. As a result, the same output values occur simultaneously. Thus, data is duplicated.

When data arrives at the FLEX 5000 EtherNet/IP adapter, it converts the concurrent communication to standard communication and sends one data packet to the I/O module. The I/O module establishes a signal value that is set on the terminal screws.

A similar pattern is followed for input data that is transmitted from the FLEX 5000 safety I/O module to the Logix SIS controllers. The I/O module sends one data packet to the FLEX 5000 EtherNet/IP adapter, the adapter then sends identical data packets onto the 1756-EN4TR EtherNet/IP adapters in the redundant chassis. Thus, the data is duplicated. Each adapter then sends a single data packet to the GuardLogix 5580 controller in its chassis.

Physical Level

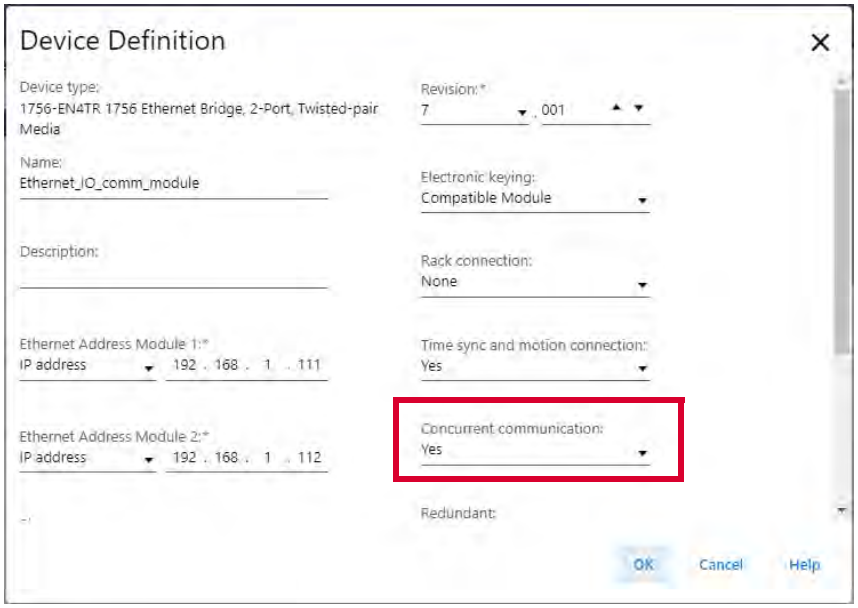
During transmission, the duplicated data passes along physical connections between the 1756-EN4TR EtherNet/IP communication modules and the FLEX 5000 EtherNet/IP adapter. The physical network redundancy is achieved via redundant paths between the 1756-EN4TR EtherNet/IP communication module and the FLEX 5000 EtherNet/IP adapter as follows:

- PRP network - Duplicated data at the physical level for each path.
- DLR network - Providing redundant paths.

Communication Module Configuration - FLEX 5000 Safety I/O Modules

To use concurrent communication with FLEX 5000 safety I/O modules, you must configure the 1756-EN4TR ControlLogix EtherNet/IP communication module on the Device Definition dialog box in your Studio 5000 Logix Designer application project to use concurrent communication.

1756-EN4TR Communication Module Configuration - Communicate with FLEX 5000 Safety I/O Modules



IMPORTANT	You can configure the 1756-EN4TR EtherNet/IP communication module for concurrent communications, to use with I/O modules such as FLEX 5000 safety I/O modules. Or you can configure the 1756-EN4TR EtherNet/IP communication module for standard I/O, for example, remote 1756 ControlLogix I/O modules. You can only configure the module for one or the other. If the 1756-EN4TR EtherNet/IP communication module is configured for concurrent communication, you can still use it for class 3 communications, for example, HMI, program upload/download/monitor. You must disable IP address swapping in the 1756-EN4TR EtherNet/IP communication modules in the redundant chassis pair.

Concurrent Communication in a PRP Topology

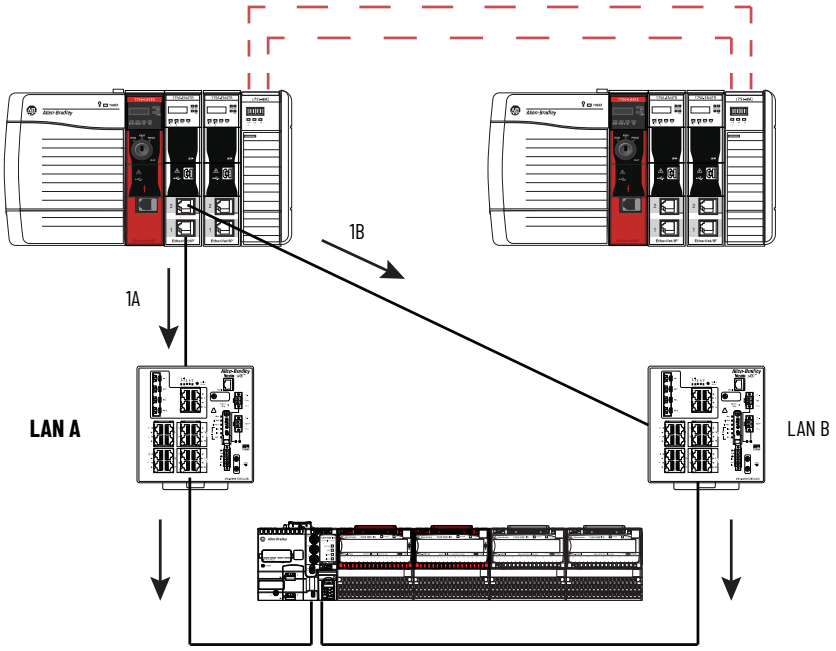
This section shows how data is transmitted from one controller in a Logix SIS to a FLEX 5000 safety I/O module.

In this scenario, concurrent communication transmits data as follows.

1. The controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis.

   At this point, the communication is not redundant.
2. Redundant communication starts at the communication module. The communication module opens a leg of the concurrent communication.

   The communication module is connected to a redundant PRP network, that is, LAN A and LAN B. The PRP network redundancy introduces data duplication.
   - Number 1A represents the leg of the concurrent communication on one physical cable between the communication module and the LAN A switch.
   - Number 1B represents the physical duplication of the leg of the concurrent communication between the communication module and the LAN B switch.
3. Duplicate data is transmitted to the FLEX 5000 EtherNet/IP adapter.



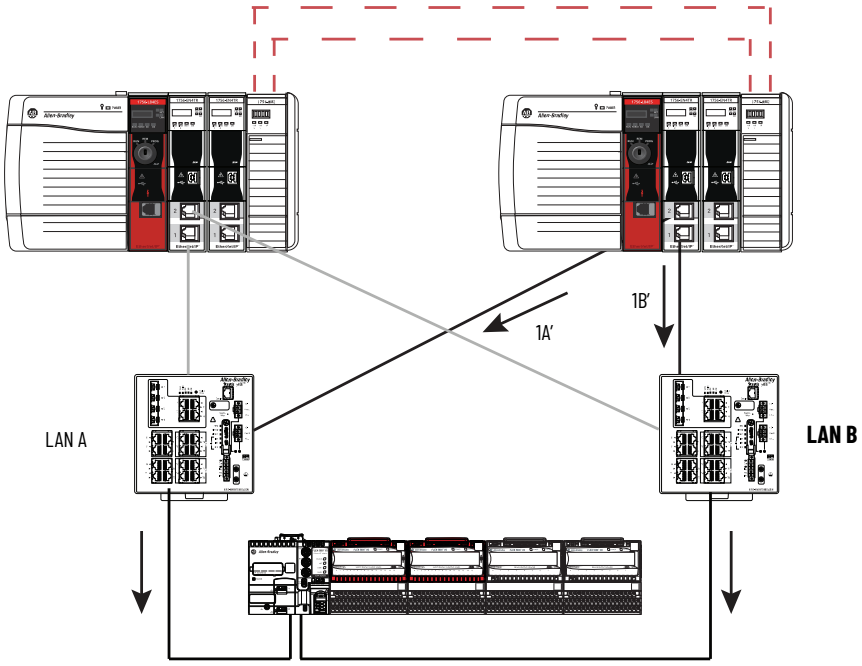
This section expands on the previous section to show that the same data is transmitted from the secondary controller in the Logix SIS to the FLEX 5000 safety I/O module. Data is transmitted from the secondary controller based on the logic state cross loaded from the primary controller.

In this scenario, concurrent communication transmits data as follows.

1. The controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis.

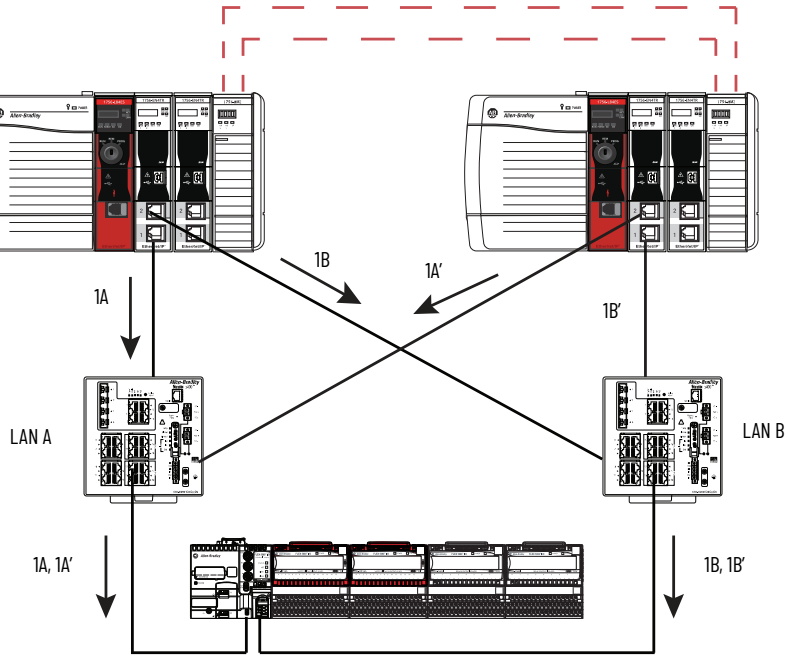
   At this point, the communication is not redundant.
2. Redundant communication starts at the communication module. The communication module opens a leg of the concurrent communication.

   The communication module is connected to a redundant PRP network, that is, LAN A and LAN B. The PRP network redundancy introduces data duplication.
   - Number 1B' represents the leg of the concurrent communication on one physical cable between the 1756-EN4TR EtherNet/IP communication module and the LAN B switch.
   - Number 1A' represents the physical duplication of the leg of the concurrent communication between the 1756-EN4TR EtherNet/IP communication module and the LAN A switch.
3. Duplicate data is transmitted to the FLEX 5000 EtherNet/IP adapter.



The following graphic shows how duplicate data is transmitted from each controller across LANs A and B, respectively, simultaneously. That is, this shows what is happening when you consider both of the previous sections.

Concurrent Communication to FLEX 5000 Safety I/O Modules in a PRP Topology



IMPORTANT:

- Each 1756-EN4TR EtherNet/IP communication module in the redundant chassis pair sends duplicated data on each LAN simultaneously.
- Data with the similar designations, for example, 1A and 1A', are the same but from different controllers with the only difference being a small identifier. In this case, it is the prime (') designation.

This occurs because the controllers work as a redundant pair that is synchronized via ControlLogix Redundancy Modules.

- All data transmission starts simultaneously. The duplicated data that reaches the adapters first is what's used in the FLEX 5000 I/O system. The other data is disregarded.

When the data arrives at the FLEX 5000 EtherNet/IP adapter, it converts the concurrent communication to standard communication and sends one data packet to the safety I/O module.

Concurrent Communication in a DLR Topology

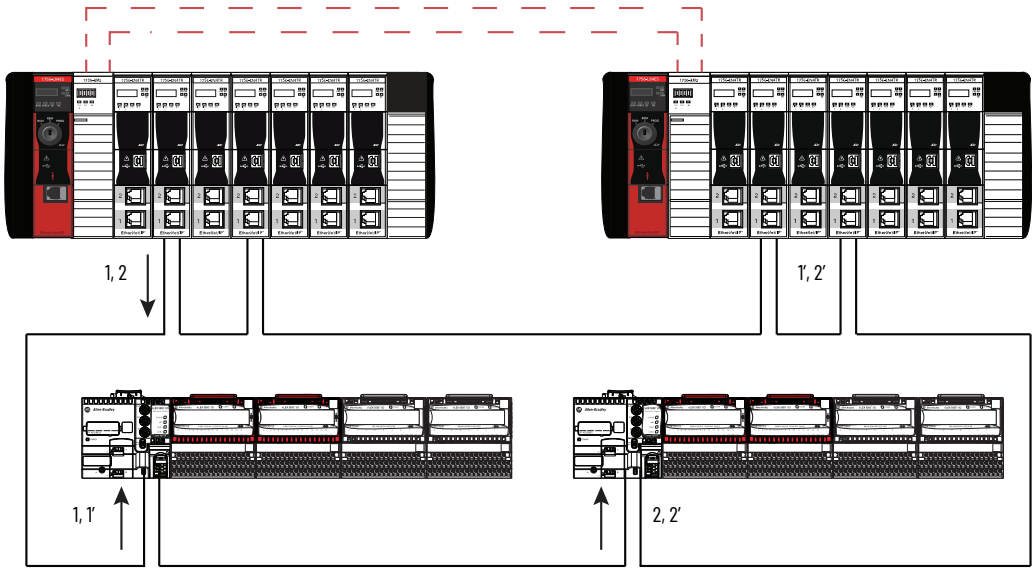
A DLR topology provides a means to detect, manage, and recover from single faults in a ring-based network. The following figure shows a DLR network in which Logix SIS controllers provide high availability when they are connected to FLEX 5000 I/O systems in a DLR network.

In this scenario, concurrent communication transmits data as follows.

1. The controller establishes concurrent communication to the 1756-EN4TR EtherNet/IP communication module in the same chassis. At this point, the communication is not redundant.
2. The 1756-EN4TR EtherNet/IP communication modules then transmit duplicate data across a leg of the concurrent communication to the FLEX 5000 EtherNet/IP adapters.

   Numbers 1 and 1' represent concurrent communication opened to the adapter in the first FLEX 5000 I/O system. Number 2 and 2′ represent concurrent communication opened to the adapter in the second FLEX 5000 I/O system. Each of these communications has two redundant legs. All this occurs on single cable.

Concurrent Communication to FLEX 5000 Safety I/O Modules in a DLR Topology



When the data arrives at the FLEX 5000 EtherNet/IP adapter in each system, it converts the concurrent communication to standard communication and sends one data packet to the I/O module.

Standard Communication Between Logix SIS Controllers and FLEX 5000 Standard I/O Modules

FLEX 5000 I/O systems can include a mix of safety and standard I/O modules. FLEX 5000 standard I/O modules don't support concurrent communication. However, Logix SIS controllers can still communicate with FLEX 5000 standard I/O modules in the FLEX 5000 I/O system that includes safety I/O modules.

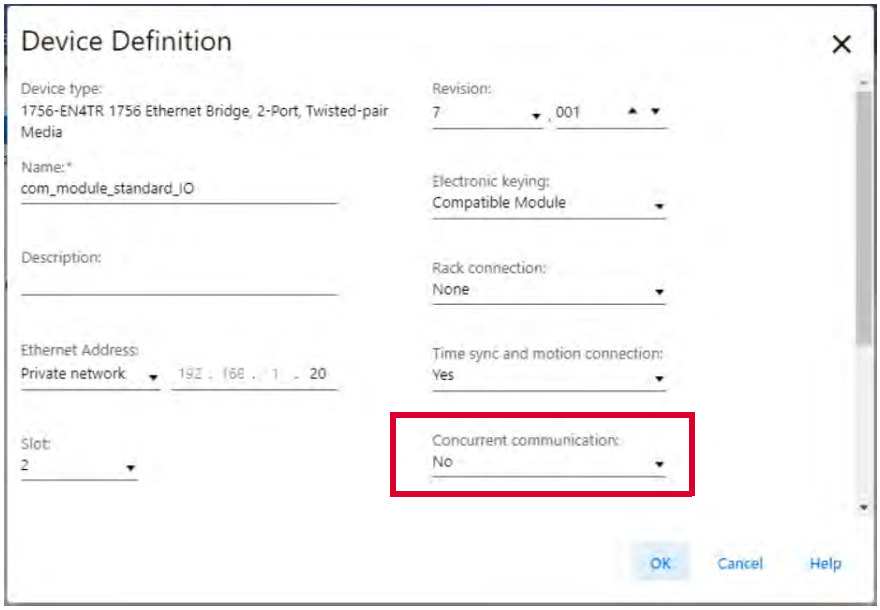
The Logix SIS controllers communicate with the FLEX 5000 standard I/O modules via a second 1756-EN4TR EtherNet/IP communication module in each redundant chassis.

Communication Module Configuration - FLEX 5000 Standard I/O Modules

You must configure the second 1756-EN4TR EtherNet/IP communication module in each chassis to not use concurrent communication on the Device Definition dialog box and to use IP swapping.

To use IP Swapping, assign the same IP address and Subnet mask values to the partnered 1756-EN4TR EtherNet/IP communication modules in the redundant chassis. When the redundancy system begins operating, the primary module uses the assigned IP address and the secondary module changes its IP address to the next highest value.

1756-EN4TR Communication Module Configuration - Communicate with FLEX 5000 Standard I/O Modules



The following graphic shows the standard communication in a PRP topology from the Logix SIS controllers to the FLEX 5000 standard I/O modules via a 1756-EN4TR EtherNet/IP communication module in each redundant chassis.

IMPORTANT In a redundancy system that includes FLEX 5000 standard I/O modules, only the primary controller sends data to the FLEX 5000 standard I/O modules. The second controller doesn't send data. It only sends data if there is a switchover and it becomes the primary controller.

Both controllers receive data from the I/O modules.

The standard communication passes along the physical connection from the redundant chassis to the switches.

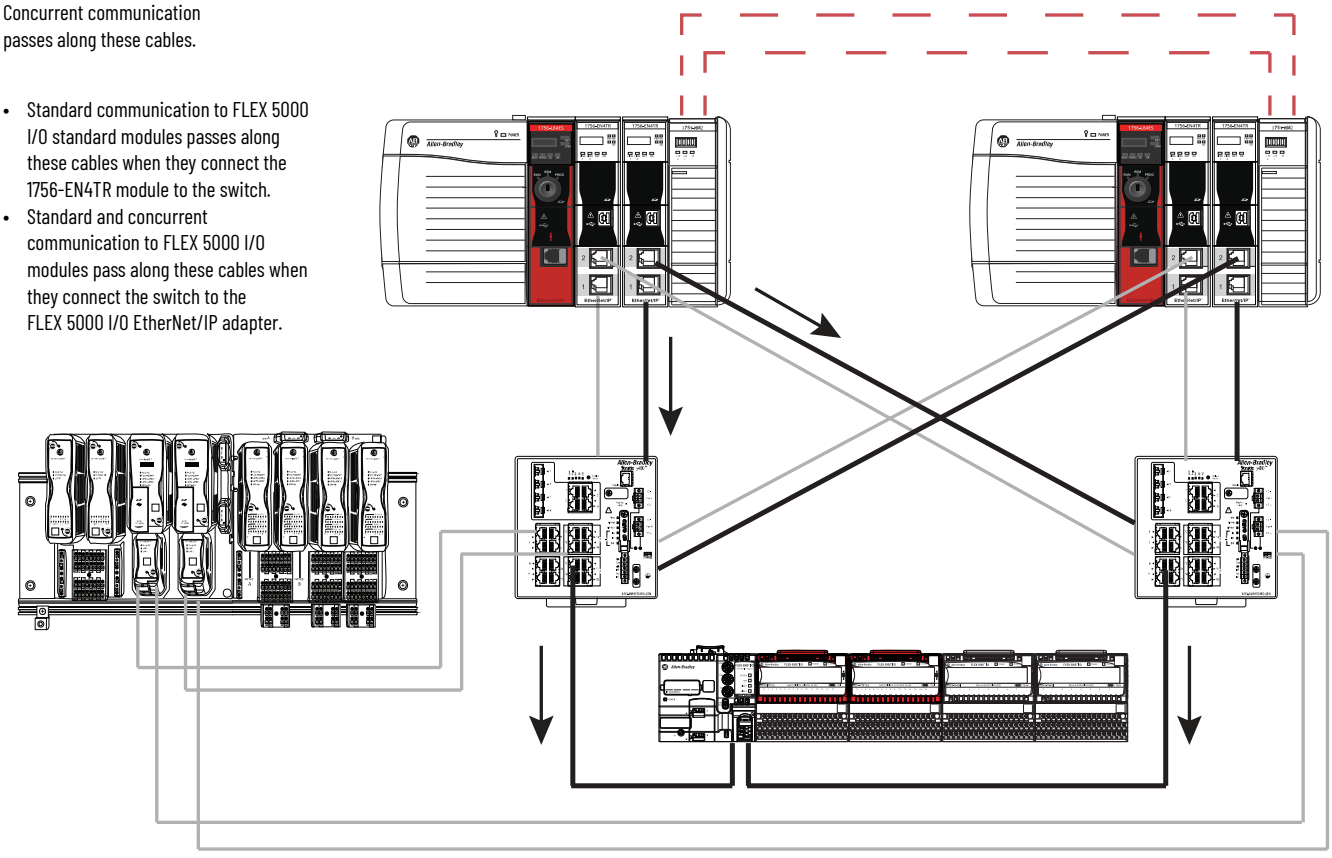
The concurrent communication and the standard communication to the FLEX 5000 I/O modules share the same EtherNet/IP network. Concurrent communication to the FLEX 5000 safety I/O modules and standard communication to the FLEX 5000 standard I/O modules pass along the same cable from the switches to the FLEX 5000 I/O system.

At that point, data is passed along the FLEX 5000 I/O system backplane to the safety I/O modules and standard I/O modules separately.

Communication to FLEX 5000 Safety I/O and Standard I/O Modules and FLEXHA 5000 I/O Modules in a PRP Topology

Concurrent communication passes along these cables.

- Standard communication to FLEX 5000 I/O standard modules passes along these cables when they connect the 1756-EN4TR module to the switch.
- Standard and concurrent communication to FLEX 5000 I/O modules pass along these cables when they connect the switch to the FLEX 5000 I/O EtherNet/IP adapter.



IMPORTANT:

- The 1756-EN4TR module in slot 1 of the ControlLogix chassis can only be used for concurrent communication.

This example include FLEXHA 5000 I/O modules to illustrate that the concurrent communication with FLEX 5000 safety I/O modules and FLEXHA 5000 I/O modules passes along the same cable between the 1756-EN4TR module and the switch.

- The 1756-EN4TR module in slot 2 of the ControlLogix chassis can only be used for standard communication.
- The controllers use concurrent communication with the FLEX 5000 safety I/O modules in slots 1 and 2 of the FLEX 5000 I/O system.
- The controllers use standard communication with the FLEX 5000 I/O standard modules in slots 3 and 4 of the FLEX 5000 I/O system.

The following graphic shows the standard communication in a DLR topology from the Logix SIS controllers to the FLEX 5000 standard I/O modules via the second 1756-EN4TR EtherNet/IP communication module in the chassis.

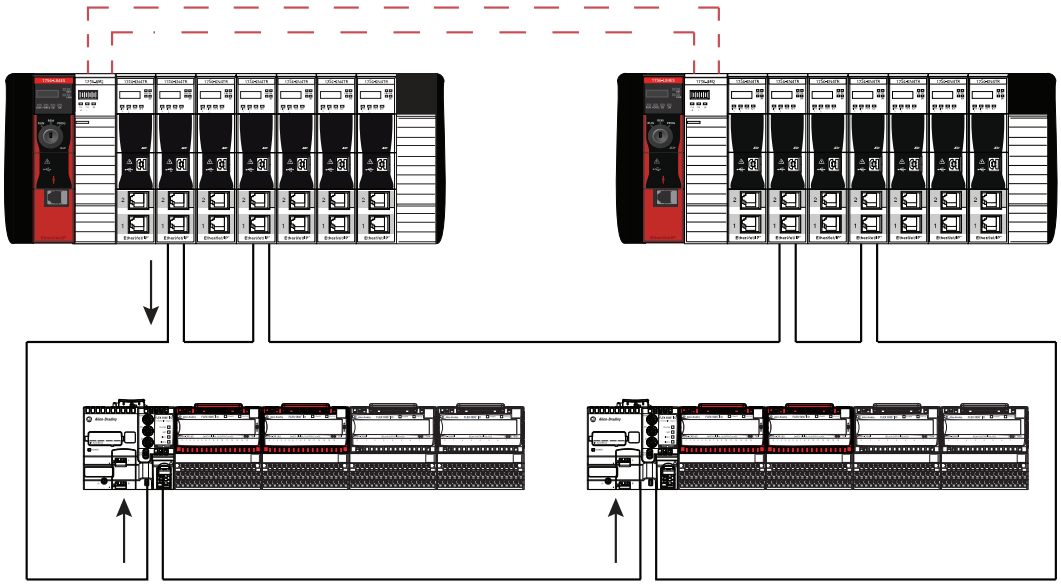
IMPORTANT	In a redundancy system that includes FLEX 5000 standard I/O modules, only the primary controller sends data to the FLEX 5000 standard I/O modules. The second controller doesn't send data. It only sends data if there is a switchover and it becomes the primary controller. Both controllers receive data from the I/O modules.

The standard communication passes along the physical connection from the redundant chassis to the switches.

The concurrent communication and the standard communication to the FLEX 5000 I/O modules share the same EtherNet/IP network. Concurrent communication to the FLEX 5000 safety I/O modules and standard communication to the FLEX 5000 standard I/O modules pass along the same cable from the switches to the FLEX 5000 I/O system.

At that point, data is passed along the FLEX 5000 I/O system backplane to the safety I/O modules and standard I/O modules separately.

Communication to FLEX 5000 Safety I/O and Standard I/O Modules in a DLR Topology



IMPORTANT:

- The 1756-EN4TR module in slot 1 of the ControlLogix chassis can only be used for concurrent communication.
- The 1756-EN4TR module in slot 2 of the ControlLogix chassis can only be used for standard communication.
- The controllers use concurrent communication with the FLEX 5000 safety I/O modules in slots 1 and 2 of the FLEX 5000 I/O systems.
- The controllers use standard communication with the FLEX 5000 I/O standard modules in slots 3 and 4 of the FLEX 5000 I/O systems.

Notes:

Connect to the EtherNet/IP Network

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Set the IP Address with Rotary Switches	42
Other Methods to Set the Address	43
Reset the Module to Factory Default Value	43
Redundant Adapter Considerations Setting the IP Address	44

EtherNet/IP™ networks are communication networks that offer a comprehensive suite of messages and services for many automation applications.

The following are examples of applications that use EtherNet/IP networks:

- Real-Time Control
- Time Synchronization
- Motion

This open network standard uses commonly available Ethernet communication products to support real-time I/O messaging, information exchange, and general messaging.

EtherNet/IP networks also support CIP Safety™, which makes the simultaneous transmission of safety and standard control data and diagnostics information over a common network possible.

Set the IP Address

The following conditions are required to set the IP address.

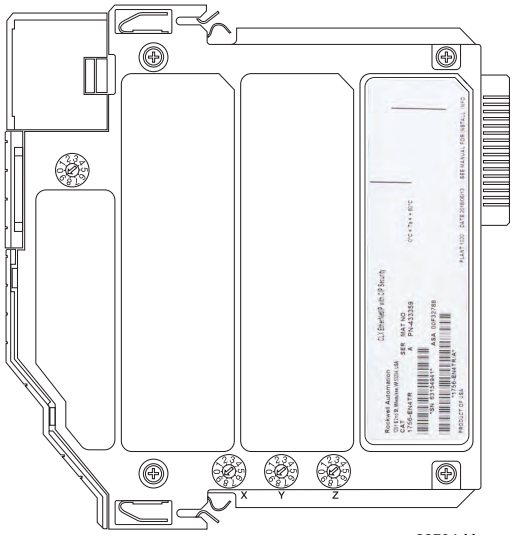
Requirements

To set the IP address, have the following:

- EtherNet/IP or USB drivers that are installed on the programming workstation
- MAC ID from the device, which is on the label on the side of the device
- Recommended IP address for the device

Set the IP Address with Rotary Switches

This graphic shows the rotary switches on a 1756 EtherNet/IP communication module. The three rotary switches at the bottom of the module, labeled X, Y, and Z, can be used for setting the IP address. If the rotary switches are not set to a valid number, the module attempts to use the BOOTP/DHCP server to set the IP address.



At power-up, the module reads the rotary switches to determine if they are set to a valid number for the last portion of the IP address. Valid numbers range from 001...254.

If the settings are a valid number, these conditions result:

- IP address = 192.168.1.xxx (where xxx represents the switch settings)
- Subnet mask = 255.255.255.0
- Gateway address = 192.168.1.1

Some modules now provide a gateway address of 0.0.0.0 when the network address is set with rotary switches.

- The module does not have a host name that is assigned to it, nor does it use any Domain Name System

We recommend that you set the rotary switches to a valid number before installing the module.

IMPORTANT	For more information on how to use the BOOTP/DHCP server to set the IP address, see EtherNet/IP Network Configuration Manual, publication ENET-UM006

1756-EN4TR Mode Rotary Switch

The rotary switch in the upper left corner of the module is reserved for DLR, PRP, and redundancy features.

- For modules built with firmware revision 4.001 or later, the default position of the switch is 0.
- For modules built with firmware revision 3.002 and earlier, the default position of the switch set to 9 for DLR, linear, or star topologies.

ATTENTION: If the mode rotary switch is set to 9 (DLR), and you insert the module into a PRP network, it can disable the network because it will directly connect PRP LAN A and PRP LAN B.

- The switch must be set to 7 for a redundant adapter with DLR or star topologies.
- The switch must be set to 6 for a redundant adapter with PRP.
- Set the switch to the appropriate mode according to Table 6.

  If the switch is in a position that is not implemented, the module displays the message "Unsupported mode. Change rotary switch setting" on the status display. The module does not respond on any port until the mode switch is set to the correct position and is power-cycled.

Table 6 shows the capabilities of the mode rotary switch.

Table 6 - Mode Rotary Switch Capabilities

Switch Position	Capability
9	DLR or Single-port
8	PRP or Single-port
7	Redundant Adapter and DLR or single-port topologies
6	Redundant Adapter and PRP or single-port topologies

IMPORTANT If you use a redundant adapter pair, the mode rotary switches of both modules in the redundant adapter pair must be set to the same value.

Other Methods to Set the Address

The modules support the following additional methods to change the IP address:

- RSLinx® Classic software
- EtherNet/IP Commissioning Tool
- FactoryTalk® Linx Network Browser software
- Studio 5000 Logix Designer® Application
- Using Secure Digital Card (1756-EN4TR only)
- For more information on how to use these methods, see EtherNet/IP Network Configuration Manual, publication ENET-UM006.

Reset the Module to Factory Default Value

You can reset the configuration of the module to its factory default value with the following method.

If the module has rotary switches, set the switches to 888 and cycle power.

Redundant Adapter Considerations Setting the IP Address

The following are considerations when using two 1756-EN4TR modules as a Redundant Adapter Pair.

- DHCP is not supported in Redundant Adapter Mode.
- Default Class C addresses like 192.168.1.x can be set using rotary switches on the module in any mode.
- IP address assignments other than default Class C can only be set in non-redundant adapter mode, where the switch is set to 8 or 9.
- Both 1756-EN4TR modules must be set to the same IP address before switching to Redundant Adapter Mode, where the switch is set to 6 or 7.
- You must reserve an IP+1 address that is taken automatically by the secondary.

  For example, if the primary address is 192.168.1.1, the address 192.168.1.2 must be reserved.

To set the IP address for redundant adapters use the following steps.

1. Insert one module into the chassis in the standard mode (rotary mode switch set to 8 or 9).
2. Set the IP address on the module.
3. Remove the module from the chassis.
4. Insert a second module into the chassis.
5. Set the same IP address on the second module as you set on the first module.
6. Set the rotary mode switches to 6 or 7 on both modules to put the modules in redundant adapter mode, and put the modules in slots 0 and 1.

Connect Redundant EtherNet/IP Adapters

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Redundant 1756-EN4TR adapters can be used for added resiliency at the adapter level. One adapter acts as the primary and controls the I/O, while the other adapter acts as a secondary and can take over as the primary if needed. Redundant Adapter functionality is available starting in revision 3.001 firmware.

Redundant Design Considerations

There are some details and rules to consider with redundant design considerations in the following list.

- Do not exceed 80% of the maximum allowed packet rate capacity (max: 50,000 pps).
- Only I/O modules are supported in the redundant adapter chassis. The redundant chassis does not support the following.
  - motion modules
  - communication modules such as DHRIO and DeviceNet®
  - controllers
- Redundant adapters must reside in slots 0 and 1 only.
- The fourth rotary switch on the redundant 1756-EN4TR adapter must be set to number 7 for a redundant adapter with DLR, or 6 for a redundant adapter with PRP. Note that PRP is available starting with firmware revision 4.001.

ATTENTION: For redundant adapter functionality, two 1756-EN4TR adapters must have configurations that match, including IP addresses and rotary switches, in both slot 0 and 1.
If you are using one 1756-EN4TR adapter, it functions as one adapter.

If a redundant adapter is in slot 0 or slot 1, then both of those slots must contain a redundant adapter. No other types of modules can be part of the pair.

Redundant System Components

The following features are supported with the 1756-EN4TR redundant adapter pair in firmware revision 4.001 or later:

- PRP

The following features are not currently supported with the 1756-EN4TR redundant adapter pair.

- CIP Safety™ modules
- CIP Security™

Redundant adapters can be used with redundant controllers or one controller.

For more information on redundancy, see the Redundancy Systems User Manual, publication 1756-UM015.

Redundant Switchovers

During redundant adapter operation, if certain conditions occur to the primary adapter, control is switched to the secondary adapter. These conditions cause a switchover:

- Major fault/assert on the adapter
- Failure of the adapter
- Removal of the adapter
- A program-prompted command to switchover
- An AOP-prompted command to switchover
- The adapter loses both Ethernet links

Switchover Considerations

Each 1756-EN4TR adapter uses one IP address as the primary IP address for all communication on the EtherNet/IP™ network. The redundant adapter pair consists of one active and one stand-by adapter.

The two adapters negotiate which is the primary, depending on the status of the system. If the primary adapter is unable to perform its role, for example, if a fault occurs in the primary adapter, then the secondary adapter becomes the new primary, assuming the IP address of the first primary adapter and taking over the role of communication. The primary adapter is the only adapter of the pair that produces data on the EtherNet/IP network.

On power-up, the primary is chosen from a pair of devices. The secondary adapter uses the primary IP address +1. For example, if the primary adapter has an IP address of 'N', then the secondary adapter has an IP address of 'N+1'.

The primary adapter is always active and is responsible for monitoring all inputs and outputs, monitoring diagnostics in the system, and reading and writing data to and from I/O simultaneously. The secondary adapter is waiting to take over communication, if the primary switches over.

If there is a switchover, the IP address swapping between the primary adapter and the secondary adapter takes no longer than 50 ms from the time of the initiating fault. The secondary adapter is the new primary and handles all communication. Depending on the RPIs configured, the observed switchover time can appear longer. Transmission time that is imposed by network infrastructure has to be considered when calculating overall switchover time. No connection drops occur during this switchover process.

This IP address swap is transparent to the user. You can detect which adapter the primary adapter is by examining the four character display indicator near the top of each adapter. On the primary adapter, the network status indicator is steady green. On the secondary adapter, the network status indicator flashes green.

Once a swap occurs, the 'new' primary adapter remains the primary unless there is a reason to swap over again. When the previous primary adapter is reinserted or reconnected, both adapters start the qualification process again with the adapter that was reconnected becoming the new qualified secondary.

Status Display Codes

Table 7 shows the different Redundant Adapter status codes that can appear on the adapter.

Table 7 - Primary and Secondary Operation Modes

Status Code	Description
PwrUp	Power Up/ Unknown
DS	Disqualified secondary
QS	Qualified secondary
PwQs	Primary with qualified secondary partner
PwDS	Primary with disqualified secondary
PwNS	Primary with no secondary
DSwP	Disqualified secondary with primary

Adapter Qualification

In a Redundant Adapter configuration, one adapter takes the Primary role and a second adapter becomes the Qualified Secondary ready to take I/O control when the primary becomes disqualified.

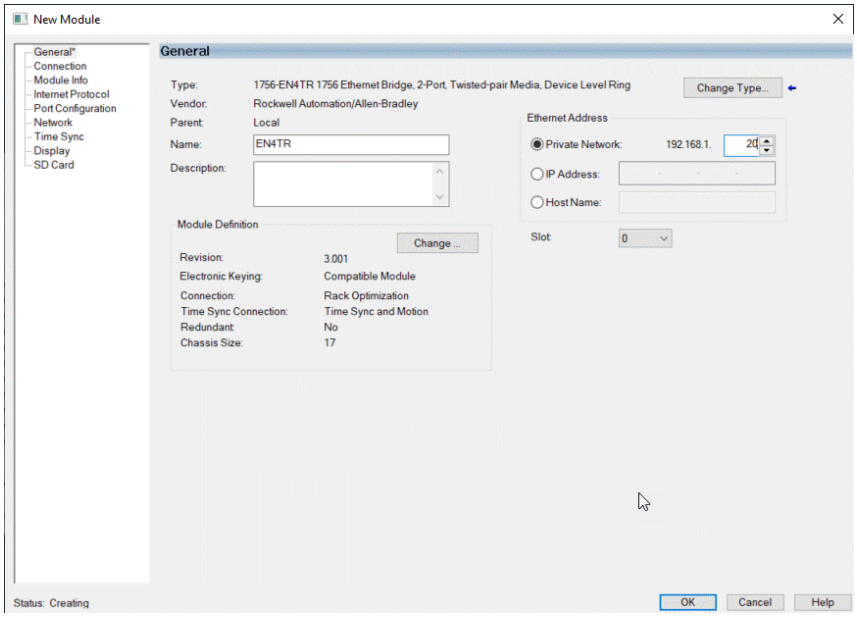
To complete the qualification process the following conditions must be met. The modules must:

- have the same firmware revision.
- reside in slots 0 and 1 of the same chassis.
- be initially set to the same IP address.
- have at least one Ethernet port link active.
- be connected to the same Ethernet network.

Configure a 1756-EN4TR Redundant Adapter Pair

To configure a 1756-EN4TR redundant adapter pair, use the following steps.

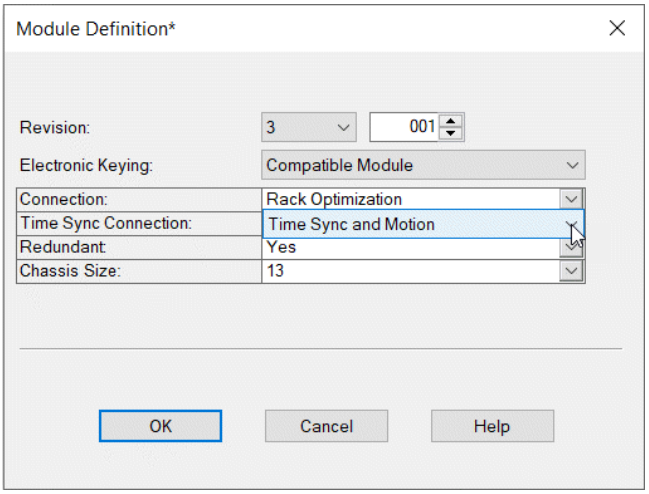
1. To set the IP address, see page 44.
2. Make sure you are using the Studio 5000 Logix Designer® application in offline mode.
3. In the I/O configuration tree, add the 1756-EN4TR in slot 0.
4. Name your module and enter the IP address.



IMPORTANT Do not put any devices in slot 1 in the I/O configuration tree.

5. Click change under the module definition pane, and select "Yes" for redundancy.
6. If you have one of the following modules in your chassis, Select Time Sync and Motion.
   - 1756-IB16IF
   - 756-OB16IEF
   - 1756-OB16IEFS

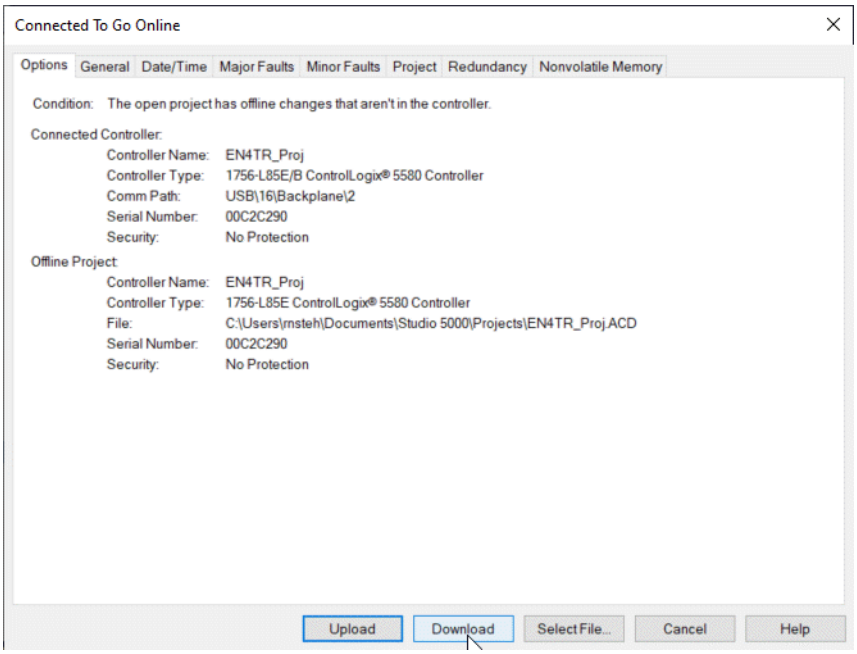
   When a chassis is configured for a 1756-EN4TR redundant adapter pair and the I/O chassis contains any of the preceding modules, then the 1756-EN4TR modules must be configured as Time Sync and Motion or unexpected connection drops can occur.



7. Power the adapters, and the synchronization process starts. Once synchronization has completed, one adapter reports as PwQS and the other adapter reports as QS. This status displays on the adapter.

   The adapter that reports as QS has an IP address that was incremented by one, which was incremented by the firmware in the module.

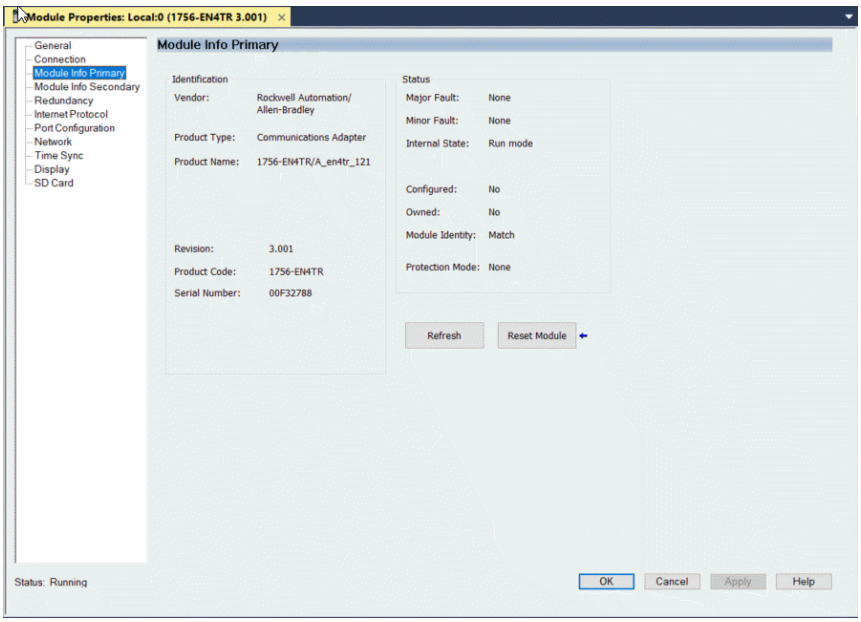
8. Go online with the project and click Download.



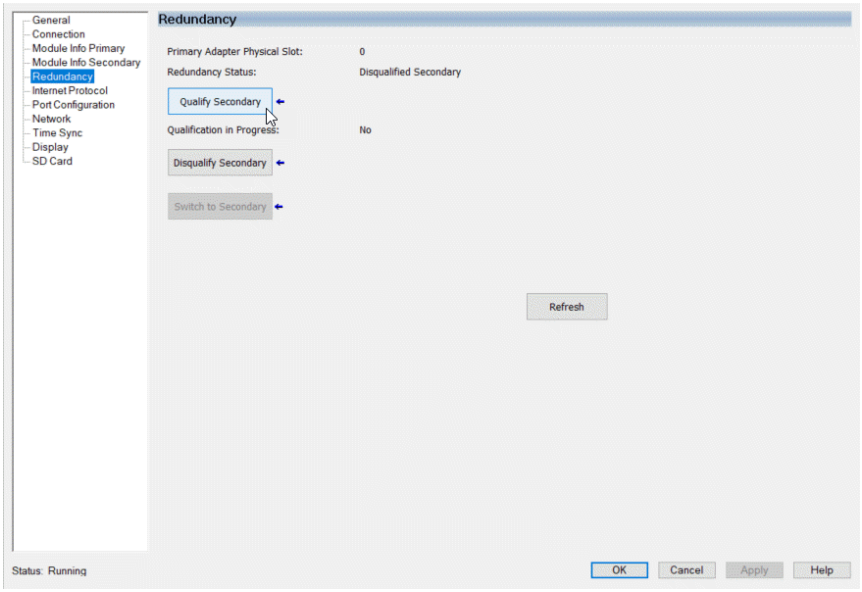
9. Examine the AOP screens by right-clicking on the module and select Properties.

You can now see options in your configuration tree for Module Info Primary, Module Info Secondary, and Redundancy.

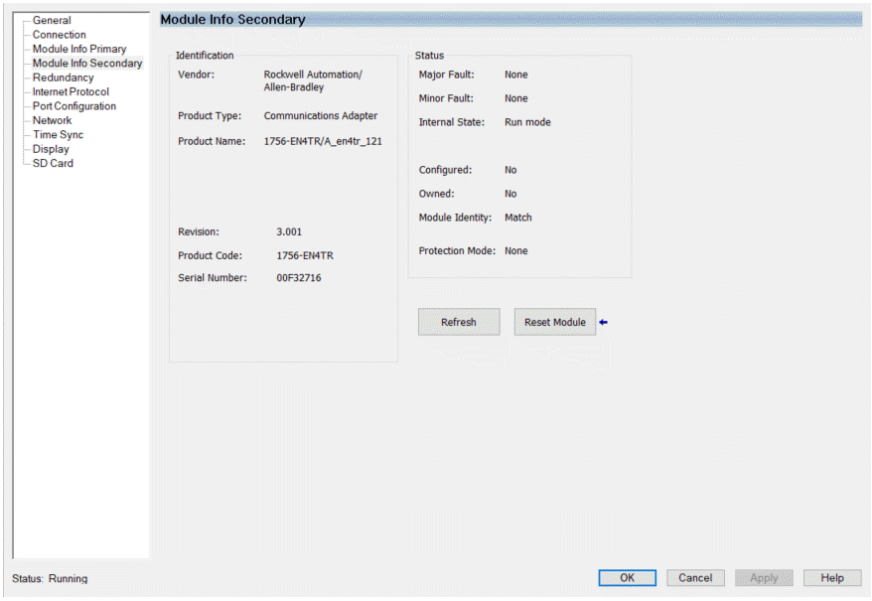
The image below shows the Module Info Primary Tab.



10. Under the Redundancy tab, click Qualify Secondary.

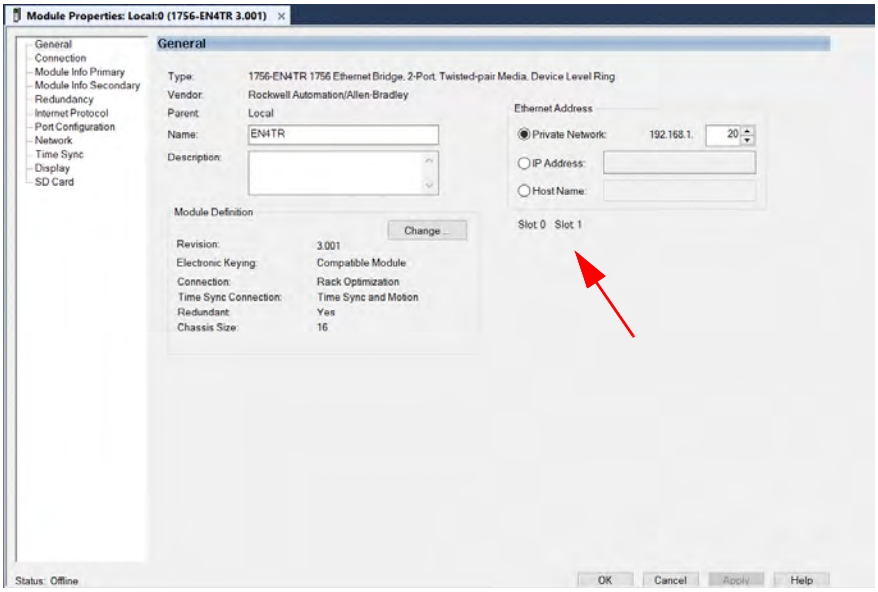


11. Click the Module Info Secondary page and examine the information.
In the Status table, the Configured section says "No" if it is not qualified.

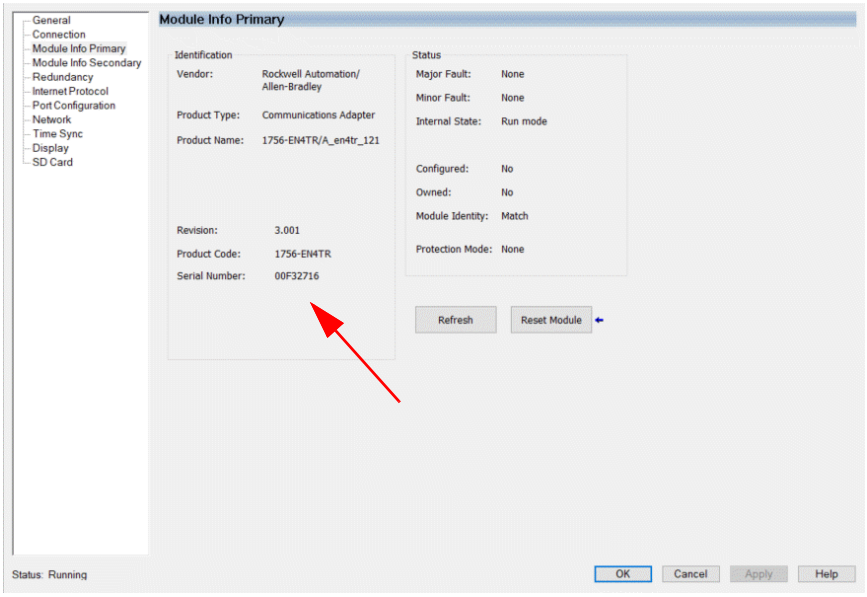


12. To verify that the redundancy feature created a redundant adapter system, click the General tab.

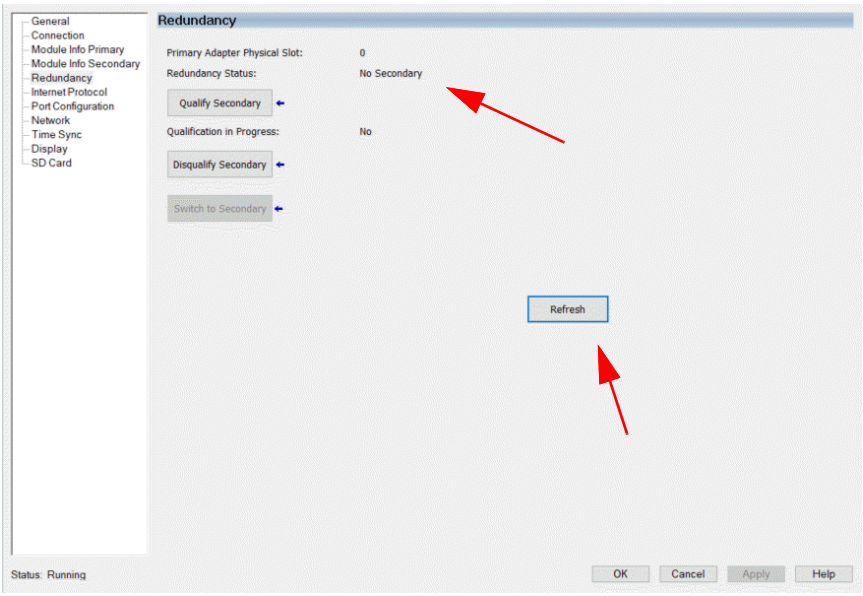
    You should see the properties for the module defined with both Slot 0 and Slot 1.



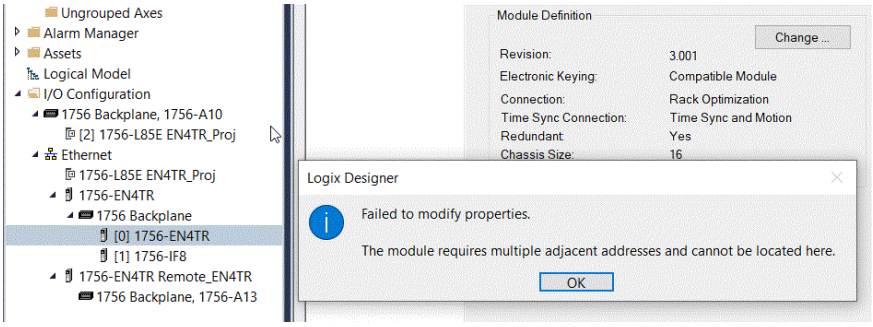
    If the primary module was in slot 1 and a switchover occurred, you can see a change in the serial number of the module to match the module in slot 1.



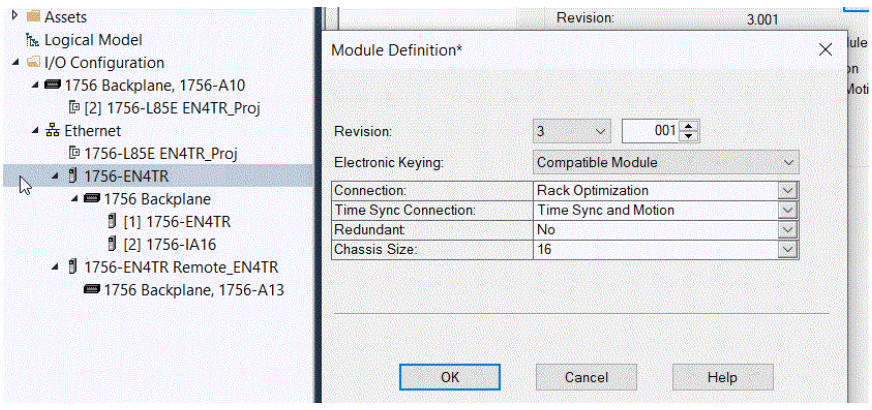
13. To confirm that a switchover occurred and there is no longer a secondary, on the redundancy page, click refresh. You should see "No Secondary" appear.



In the following figure, there is an example of an I/O module in slot 1. Even with a 1756-EN4TR in slot 0, with any other module apart from a second 1756-EN4TR in slot 1 (in this example it is the 1756-IF8) you cannot enable redundancy. On the module redundancy page, any attempt that is made to change the redundant function to "yes" results in the following error.



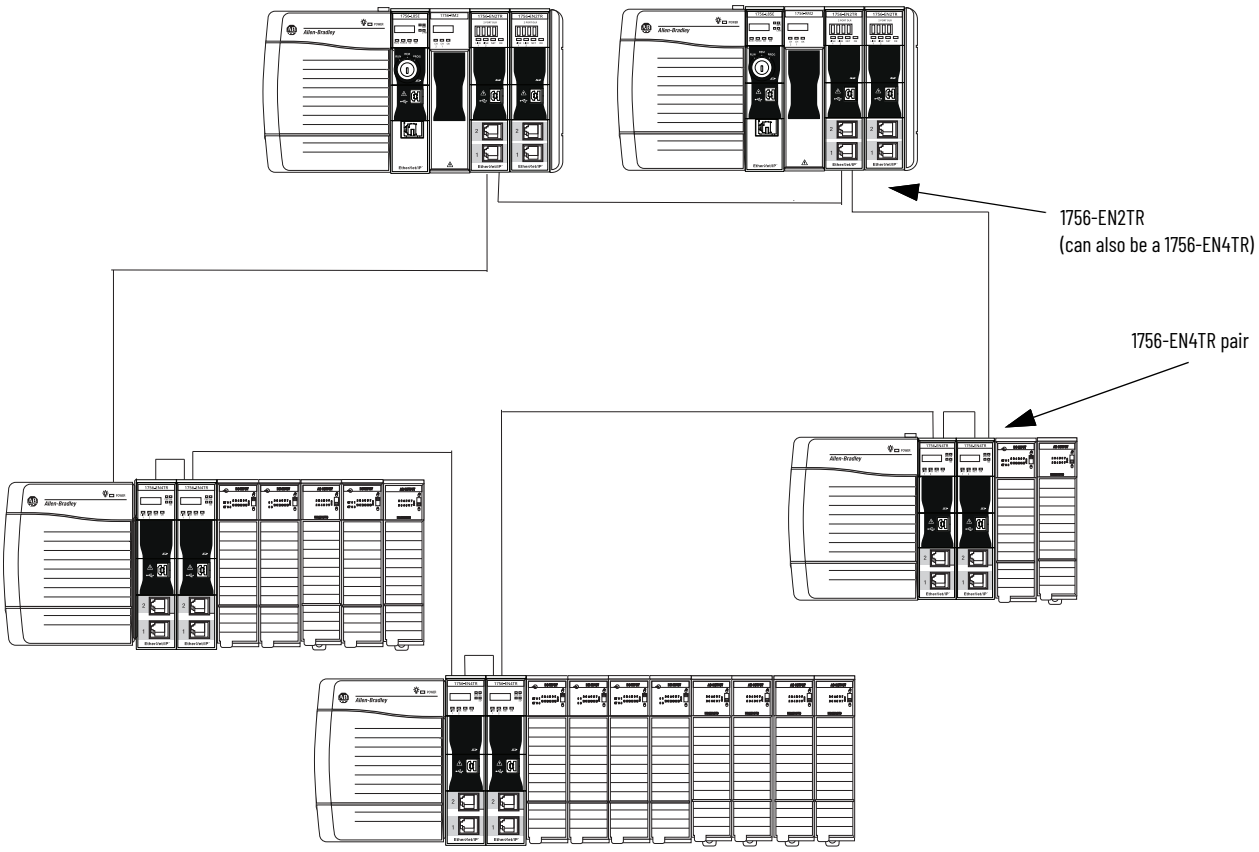
If you try to make a redundancy system starting in any other slot in the chassis other than slot 0, the redundancy option will not be available on the module definition configuration screen. The redundant adapter must be present in slot 0.



Redundant Architecture

The following figures show DLR and Star Topology with the 1756-EN4TR module. DLR provides higher resiliency than a single star. Linear topologies are not recommended because any break or firmware updating of devices in the line causes loss of communications to downstream devices.

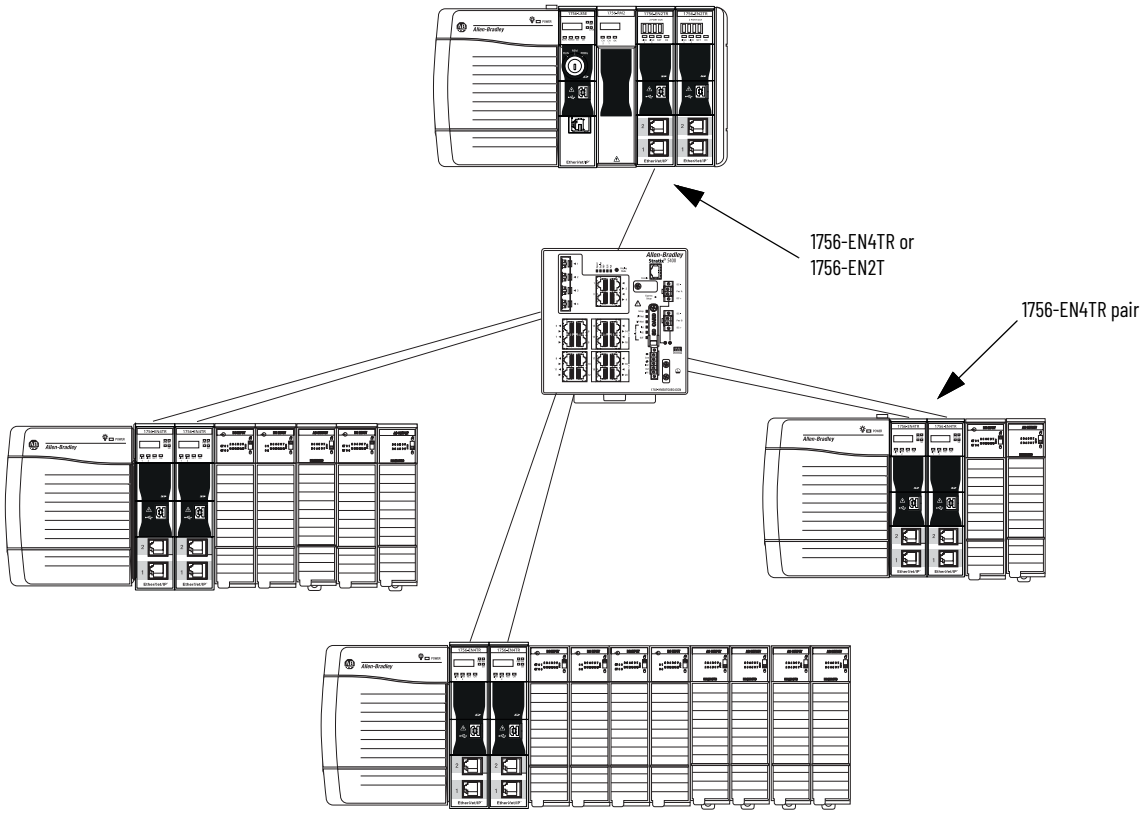
Figure 2 - Redundant 1756-EN4TR Adapters in DLR Topology



Configure all DLR devices on the ring to be at the same speed on all links as defined in the Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture design and implementation guide, ENET-TD015.

Redundant adapters can be used in a star configuration, as shown in Figure 3. However, the switch at the center of the star is a single point of failure. DLR provides for higher resiliency.

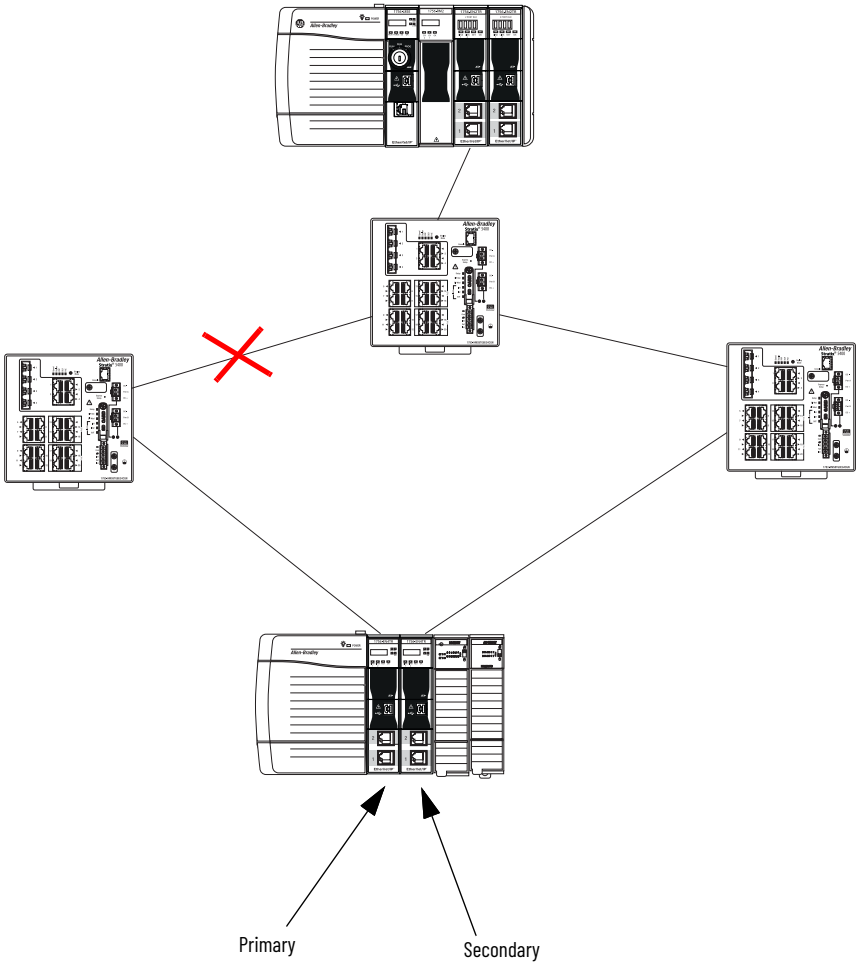
Figure 3 - Redundant 1756-EN4TR Adapters in Star Topology with a Single Switch



Redundant Architecture Network Considerations

In a star topology with a single switch, if a link is broken between the switch and the primary redundant adapter, a switchover occurs. With multiple switches, for example as shown in Figure 4, if a link is broken between two switches, a switchover does not occur because the link to the redundant adapter is still in place.

Figure 4 - Invalid Topology: Network Break Does not Cause Switchover

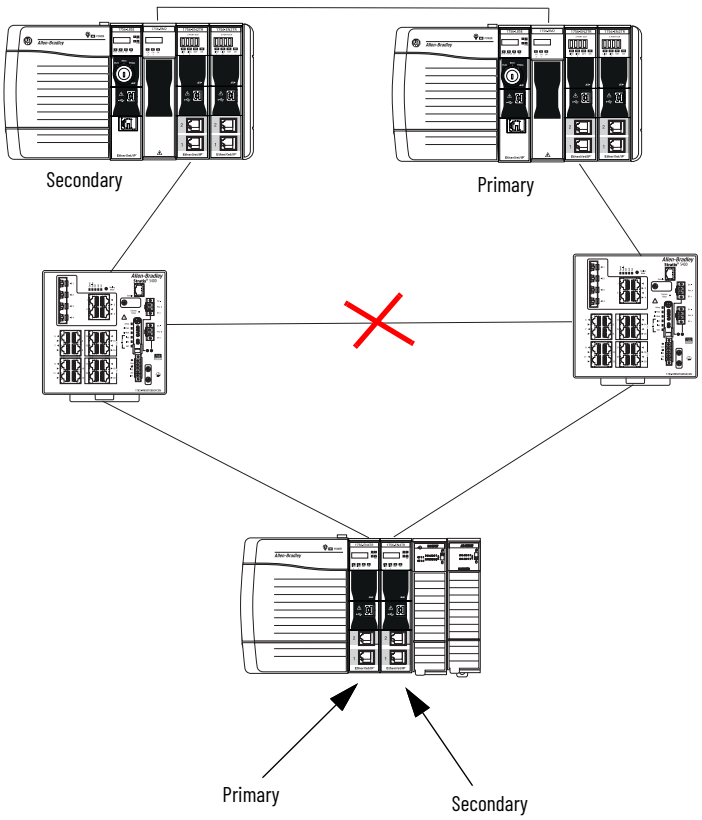


The Primary Adapter does not detect data connection loss on non-directly connected links. For example in Figure 5, the secondary adapter disqualifies because it cannot detect the primary adapter.

This action occurs even though the secondary adapter still has a healthy path to the primary controller.

Similarly, the secondary controller in the redundant controller pair disqualifies because it cannot detect the primary.

Figure 5 - Invalid Topology: Network Break Results in Loss of Control



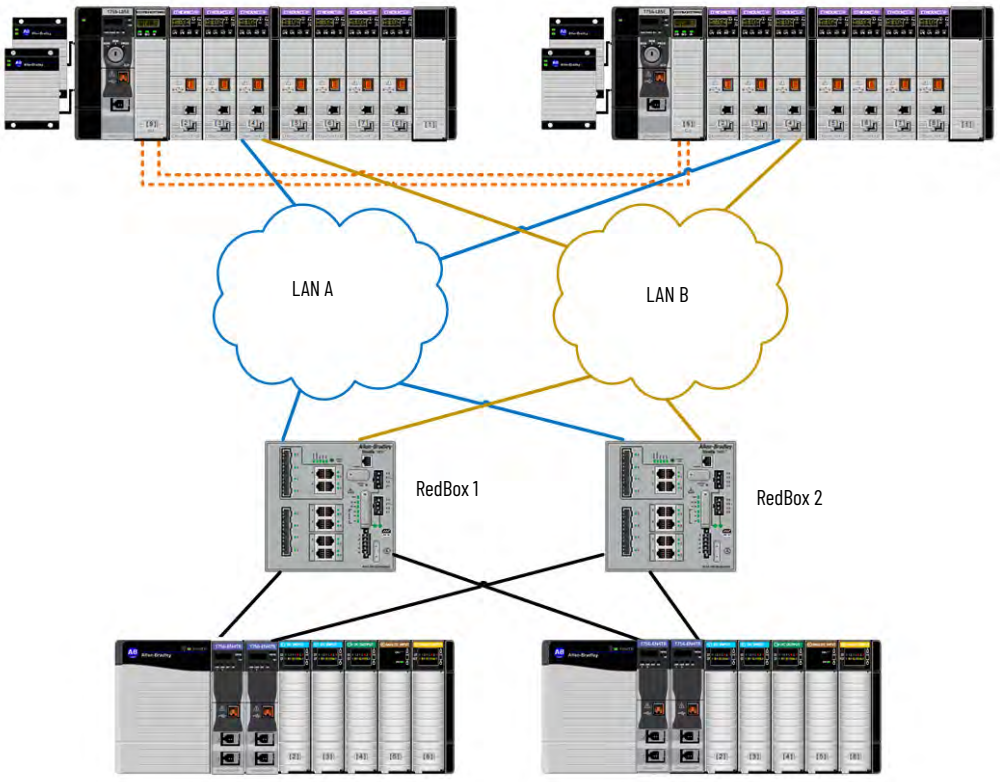
PRP Architecture with RedBox Switches

PRP, including RedBox switches, must be properly designed, built, and configured based on CPwE guidelines. For more information, see the Deploying Parallel Redundancy Protocol within a Converged Plantwide Ethernet Architecture Technical Data.

With Logix Designer application version 33 and 1756-EN4TR firmware 3.001, you can use 1756-EN4TR redundant adapters in the I/O chassis with PRP as shown in Figure 6.

- The 1756-EN4TR firmware 3.001 does not natively support PRP, which is why the 1756-EN4TRs must be connected to RedBox switches.
- The 1756-EN4TR firmware 3.001 does not support the 1756-EN4TR being placed in the redundant chassis pair, so the 1756-EN2TP is the module being used to connect the redundant chassis pair to the PRP LAN A and LAN B.

Figure 6 - PRP Network with RedBox Switches and Redundant Adapters



PRP Architecture without RedBox Switches

PRP must be properly designed, built, and configured based on CPwE guidelines. For more information, see the Deploying Parallel Redundancy Protocol within a Converged Plantwide Ethernet Architecture Technical Data.

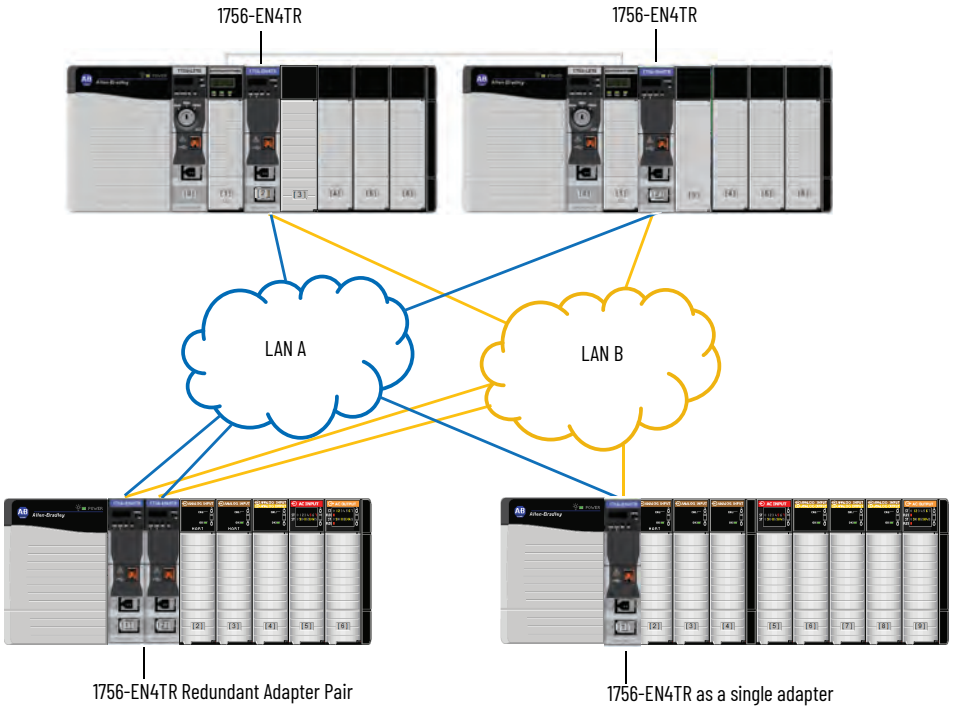
With Studio 5000 Logix Designer application version 34 and later, and 1756-EN4TR firmware 4.001 and later, the 1756-EN4TR can be used in the ControlLogix® 5580 redundant chassis pair.

- The 1756-EN4TR cannot be placed in a ControlLogix 5570 redundant chassis pair.
- Redundant 1756-EN4TR adapters can also be placed in the remote I/O chassis, as they could starting with firmware 3.001.
- RedBox switches are no longer needed because the 1756-EN4TR natively supports PRP with firmware 4.001 and later.

Follow these guidelines:

- Use EtherNet/IP modules that support the redundant adapter feature.
- Connect the redundant adapters in the I/O chassis to LAN A and LAN B.

Figure 7 - PRP Network with Redundant Adapters



Security Options

Topic	Page
MSG Instruction	59
Disable/Enable an Ethernet Port	61
Disable the CIP Security Ports	64
Disable/Enable LLDP	66
Disable the USB Port	67
Disable/Enable the SD Card	68
Disable/Enable the 4-character Status Display	70
Disable/Enable the Webpages	72
Disable/Enable Simple Network Management Protocol (SNMP)	74
Disable the Socket Object	76
Disable the Email Object	76

For enhanced security, you can disable specific functionalities on an Ethernet communication module as desired.

MSG Instruction

You can use a CIP™ Generic MSG to disable many of the functionalities on a module. This CIP Generic MSG originates in the controller and is sent to the communication module receiving the change.

Configure the MSG Communication Path

While the Configuration tab on the Message Configuration dialog requires specific information to disable or enable a specific feature, the method for configuring the message communication path is the same for all features.

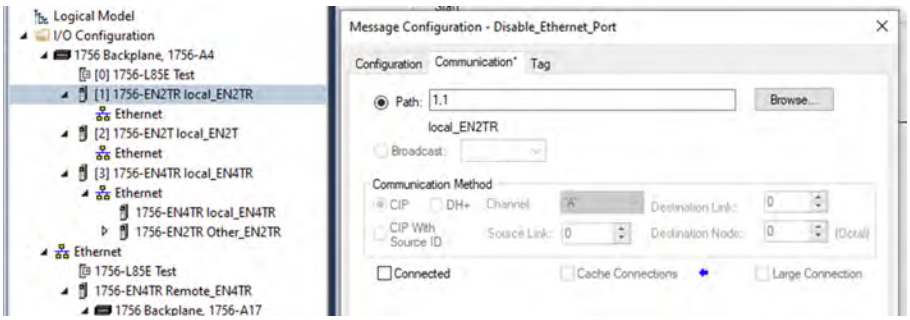
Communication goes through the backplane and Ethernet ports. When you configure the communication path, the values in the path specify backplane or Ethernet port:

- 1 - Backplane
- 2 - Ethernet port

Module In The Local Chassis

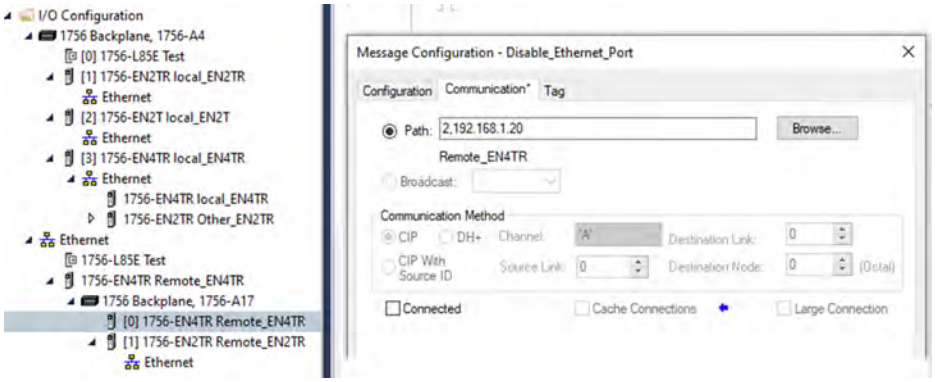
To disable or enable functionality in a module in the Local Chassis, the path is:
1, slot number of local module.

The path below is 1,1 denoting that the message originating in the controller is going to the backplane (the first 1) over to slot 1 (the second 1), which is the location of the local_EN2TR module that is receiving the change.



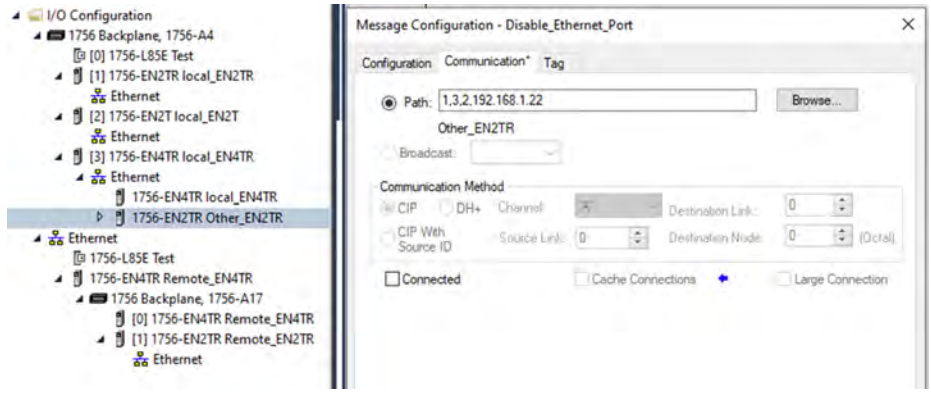
Remote Module Connected Through A Controller Ethernet Port

To disable or enable functionality in a module in a remote chassis that is connected through the front port of a controller, the path is:
2 (denoting out the Ethernet port), IP address of the remote module that is receiving the change.



Remote Module Connected to Controller Through a Module in the Local Chassis

To disable or enable functionality in a module in a remote chassis that is connected through an Ethernet module in the local chassis, the path is:
1 (denoting from the controller to the backplane), slot number of local communication module, 2 (denoting out the Ethernet port of the communication module), IP address of remote module that is receiving the change.



Disable/Enable an Ethernet Port

Applies to these modules:
1756-EN2x
1756-EN4x

You can disable or enable an Ethernet port three ways:

- Disable/Enable an Ethernet Port with FactoryTalk Linx Network Browser on page 61
- Disable/Enable an Ethernet Port on the Port Configuration Tab on page 62
- Disable an Ethernet Port with a MSG Instruction on page 63

Ethernet ports return to the default setting after the module is reset to factory defaults. You must reconfigure the settings to disable an Ethernet port after the port returns to its default settings.

IMPORTANT Remember the following:

- Once a port is disabled, you lose any connection that is established through the controller Ethernet port.
- You cannot disable Ethernet ports if the controller keyswitch is in Run mode or if the FactoryTalk® Security settings deny this editing option.

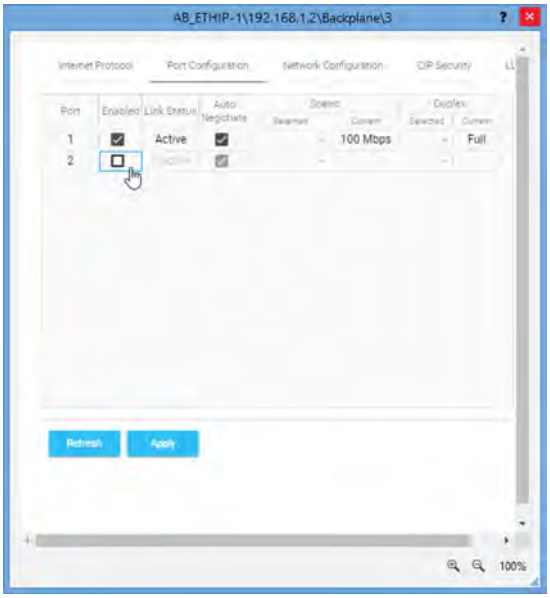
Disable/Enable an Ethernet Port with FactoryTalk Linx Network Browser

You can disable or enable an Ethernet port with FactoryTalk® Linx software, version 6.30.00 or later.

1. On the Factory Talk Linx Network Browser, select the Ethernet module, and click Configure Device.

2. On the Port Configuration category:

- To disable an Ethernet port, clear the Enabled checkbox.
- To enable an Ethernet port, select the Enabled checkbox.



3. Click Apply.
4. Click Yes on the confirmation messages that appear. The change takes effect immediately.
5. Click Refresh.

Disable/Enable an Ethernet Port on the Port Configuration Tab

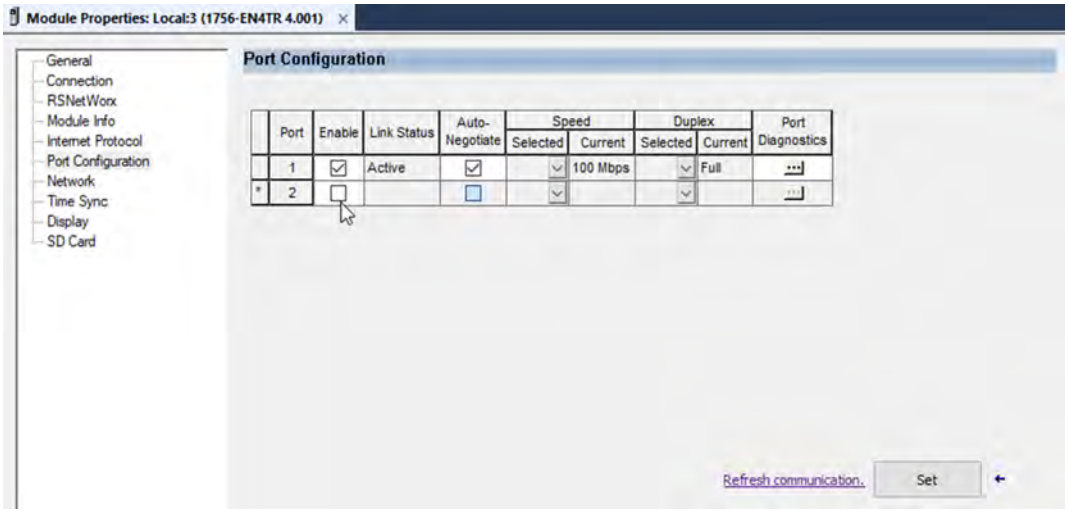
You can disable or enable an Ethernet port with the Studio 5000 Logix Designer® application, version 28.00.00 or later.

IMPORTANT To disable an Ethernet port, the Link Status for one port must be Active.

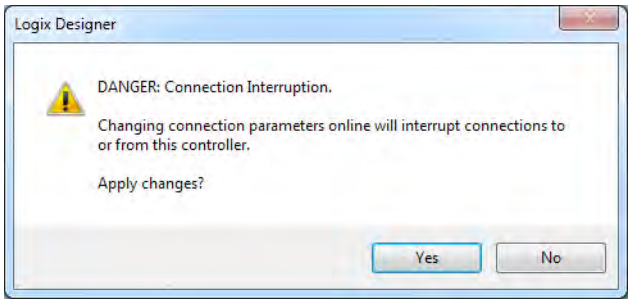
This method retains the setting in the project every time you download the project to the controller.

1. Go online with the controller.
2. To open the module properties, double-click the Ethernet module.
3. On the Port Configuration category:

- To disable an Ethernet port, clear the Enable checkbox.
- To enable an Ethernet port, select the Enable checkbox.



4. On the Port Configuration tab, click Set.
5. On the dialog box, click Yes. The change takes effect immediately.



6. On the Port Configuration category, click OK.

Disable an Ethernet Port with a MSG Instruction

You can disable an Ethernet port with the Studio 5000 Logix Designer application, version 28.00.00 or later. You cannot use this MSG instruction to disable the Ethernet port on a different controller.

1. Add a MSG instruction to your program.

   This message only has to execute once, it does not need to execute with every program scan.

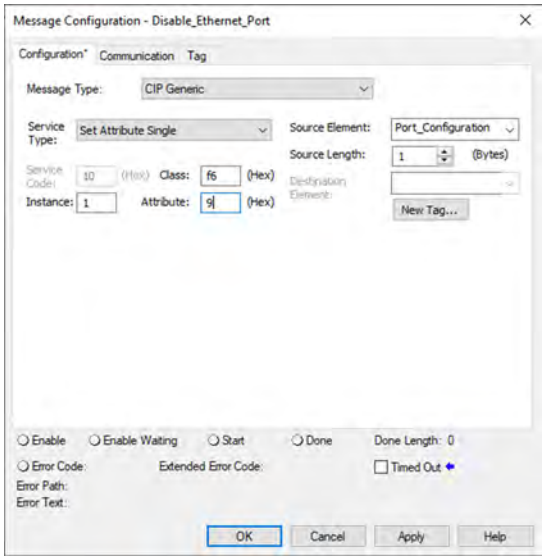
IMPORTANT

- These values are stored to NVS memory in such a way that the MSG instruction is not required to execute each time the controller powers up.
- You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 1 - Disable an Ethernet Port

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Instance:	1 for single port modules 1 for Port 1, 2 for Port 2 on dual-port modules
Class:	f6
Attribute:	9
Source Element:	Controller tag of SINT data type. In this example, the controller tag is named Port_Configuration.
Source Length:	1



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.
4. Before you enable the MSG instruction, make sure that the Source Element tag value is 2.

   To re-enable the port, complete the steps that are described in this section. Before you enable the MSG instructions, however, make sure that the Source Element tag value is 1.

Disable the CIP Security Ports

Applies to these modules:
1756-EN4x

There are two ways to disable CIP Security™ ports:

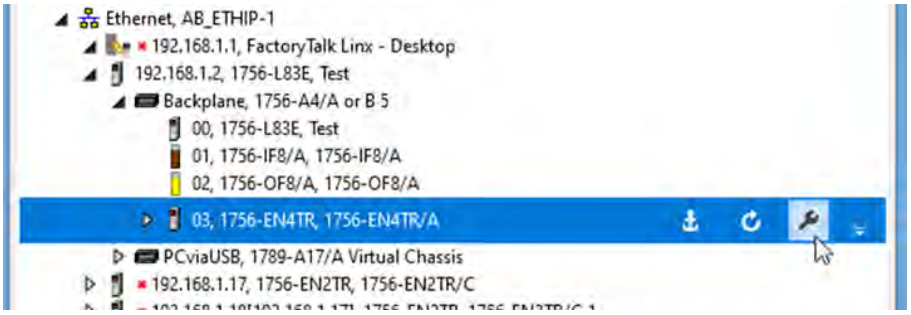
- Use the Disable CIP Security checkbox in FactoryTalk Linx software, version 6.30.00 or later. See Disable the CIP Security Ports with FactoryTalk Linx Network Browser on page 64
- Disable the CIP Security Ports with a MSG Instruction on page 65

IMPORTANT These procedures disable the CIP Security ports. To re-enable the ports, you must use the rotary switches to return the controller to a factory default state. See Reset the Module to Factory Default Value on page 43.

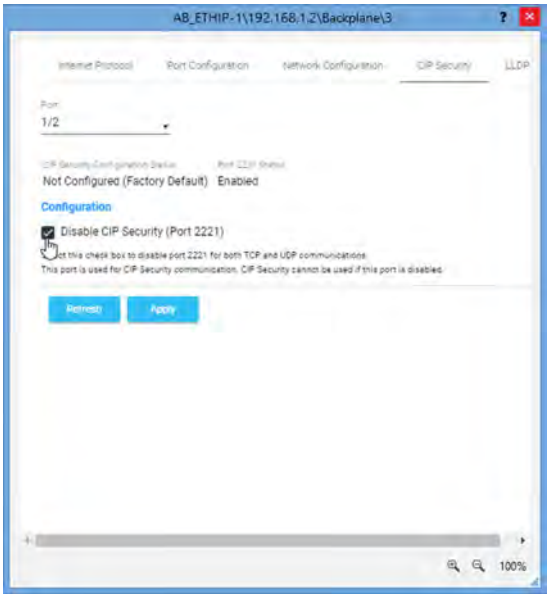
Disable the CIP Security Ports with FactoryTalk Linx Network Browser

You can disable the CIP Security ports with FactoryTalk Linx Network Browser, version 6.30.00 or later.

1. On the Factory Talk Linx Network Browser, select 1756-EN4TR, and click Configure Device.



2. Click CIP Security.
3. Select the Disable CIP Security (Port 2221) checkbox.



4. Click Apply.
5. Click Yes on the confirmation messages that appear.

Disable the CIP Security Ports with a MSG Instruction

With the Studio 5000 Logix Designer application, version 32.00.00 or later, use a CIP Generic MSG to execute this option. The message only has to execute once, it does not need to execute with every program scan.

1. Create a controller tag of SINT[9] data type.

   In this example, the controller tag is named CIPSEC_DISABLE and must match the following graphic.

Name	Value	Style	Data Type
CIPSEC_DISABLE	{...}	Hex	SINT[9]
CIPSEC_DISABLE[0]	16#02	Hex	SINT
CIPSEC_DISABLE[1]	16#ad	Hex	SINT
CIPSEC_DISABLE[2]	16#08	Hex	SINT
CIPSEC_DISABLE[3]	16#11	Hex	SINT
CIPSEC_DISABLE[4]	16#00	Hex	SINT
CIPSEC_DISABLE[5]	16#ad	Hex	SINT
CIPSEC_DISABLE[6]	16#08	Hex	SINT
CIPSEC_DISABLE[7]	16#06	Hex	SINT
CIPSEC_DISABLE[8]	16#00	Hex	SINT

   Before you enable the MSG instruction, consider the following:

   - The element CIPSEC_DISABLE[4] is responsible for disabling UDP port 2221 and EtherNet/IP™ over DTLS, transport class 0/1.
   - The element CIPSEC_DISABLE[8] is responsible for disabling TCP port 2221 and EtherNet/IP over TLS, UCMM, and transport class 3.
   - To disable the controller CIP Security™ ports, the elements CIPSEC_DISABLE[4] and CIPSEC_DISABLE[8] in the SINT array for the Source Element CIPSEC_DISABLE must be 0.

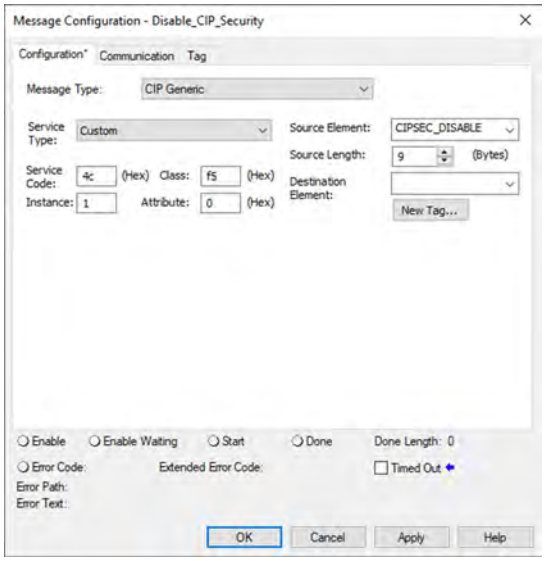
2. Add a MSG instruction to your program.

IMPORTANT	You cannot add a MSG instruction to your program if the controller keyswitch is in RUN mode, or if the FactoryTalk Security settings deny this editing option.

3. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 2 - Disable the CIP Security Ports

Message Type:	CIP Generic
Service Type:	Custom
Service Code:	4c
Instance:	1
Class:	f5
Attribute:	0
Source Element:	Controller tag of SINT[9] data type. This is the controller tag that you created in step 1.
Source Length:	9



4. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.
5. Cycle power on the controller for the configuration to take effect.

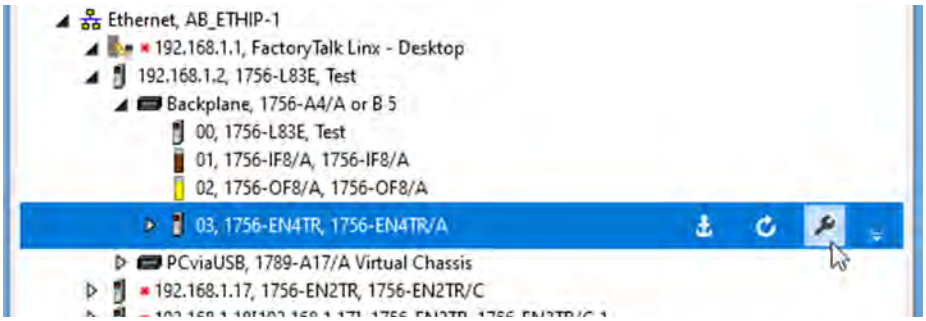
Disable/Enable LLDP

Applies to these modules:
1756-EN2x
1756-EN4x

Link Layer Discovery Protocol (LLDP) is used by network devices to advertise their identity, capabilities, and neighbors on a local area network.

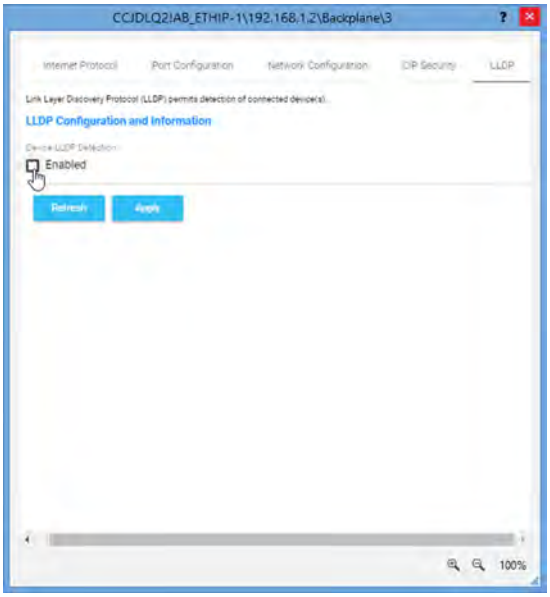
You can disable or enable LLDP with FactoryTalk Linx Network Browser, version 6.30.00 or later.

1. On the Factory Talk Linx Network Browser, select the module, and click Configure Device.



2. On the LLDP category:

- To disable LLDP, clear the Enabled checkbox.
- To enable LLDP, select the Enabled checkbox..



3. Click Apply.
4. Click Yes on the confirmation messages that appear.

Disable the USB Port

Applies to these modules:
1756-EN2x
1756-EN4x

With the Studio 5000 Logix Designer application, version 32.00.00 or later, use a CIP Generic MSG to execute this option.

1. Add a MSG instruction to your program.

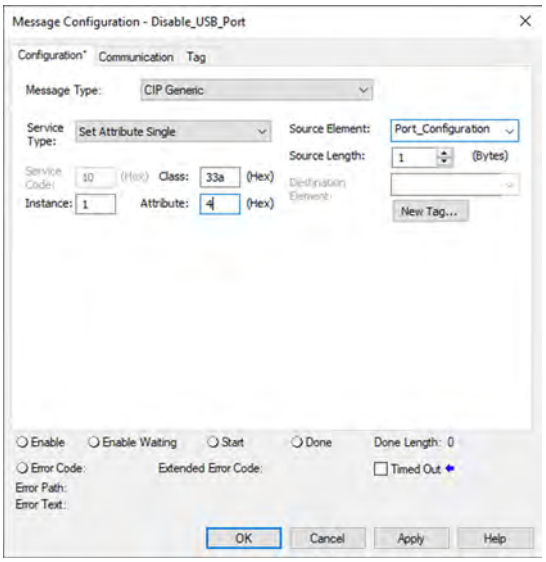
   This message only has to execute once, it does not need to execute with every program scan.

IMPORTANT
- These values are stored to NVS memory in such a way that the MSG instruction is not required to execute each time the controller powers up.
- You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 3 - Disable the USB Port

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Instance:	1
Class:	33a
Attribute:	4
Source Element:	Controller tag of SINT data type. In this example, the Source Element is named Port_Configuration.
Source Length:	1



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

Disable/Enable the SD Card

Applies to these modules:
1756-EN4x

You can disable or enable the SD card two ways:

- Disable/Enable the SD Card on the Module Properties Dialog on page 68
- Disable/Enable the SD Card with a MSG Instruction on page 69

IMPORTANT Remember the following:

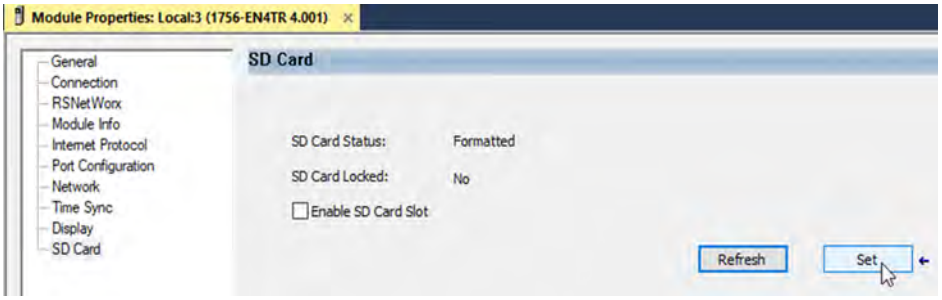
- Once an SD Slot is disabled, you lose all and any ability to communicate to an SD Card inserted into the slot. This includes any diagnostic information.
- To re-enable the SD card again:
  - Use the rotary switches to rest the module to factory defaults.
  - Use a MSG instruction.

Disable/Enable the SD Card on the Module Properties Dialog

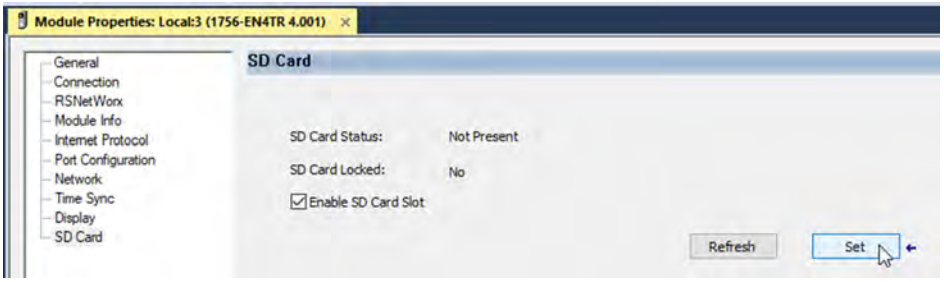
This method retains the setting in the project every time you download the project to the controller.

On the SD Card category in the module properties dialog:

- To disable the SD card, clear the Enable SD Card checkbox and click Set.



- To enable the SD card, select the Enable SD Card checkbox and click Set.



Disable/Enable the SD Card with a MSG Instruction

1. Add a MSG instruction to your program.

   This message only has to execute once, it does not need to execute with every program scan.

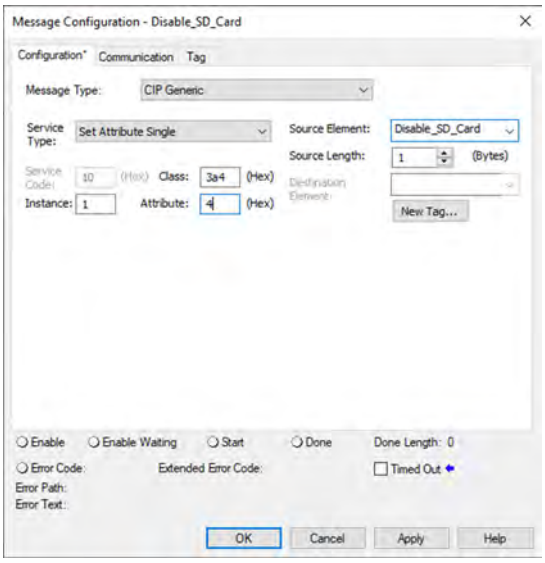
IMPORTANT

- These values are stored to NVS memory in such a way that the MSG instruction is not required to execute each time the controller powers up.
- You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:
   - To Enable: set source tag value to 0
   - To Disable: set source tag value to 1

Table 4 - Disable/Enable the SD Card

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Instance:	1
Class:	3a4
Attribute:	4
Source Element:	Controller tag of SINT Array. In this example, the Source Element is named src_array.
Source Length:	1



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

Disable/Enable the 4-character Status Display

Applies to these modules:
1756-EN4x

With the Studio 5000 Logix Designer application, version 29.00.00 or later, you can disable or enable certain categories of messages on the 4-character status display:

- Disable/Enable All Categories of Messages on page 70
- Disable/Enable Individual Categories of Messages on page 71

You use a CIP Generic MSG to execute each option.

IMPORTANT You cannot disable these system messages, and they always display:

- Power-up messages (such as TEST, PASS, CHRG)
- Catalog number message
- Firmware revision message
- Major / Critical failure messages

The 4-character status display returns to the default setting after the module is reset to factory defaults. You must reconfigure the settings to disable the 4-character status display after it returns to its default settings.

Disable/Enable All Categories of Messages

When you disable all categories of messages, this information no longer shows:

- Link status
- Port status
- IP address

Complete these steps.

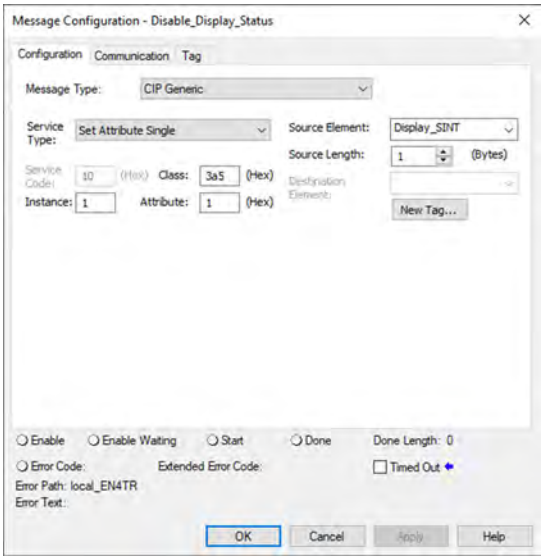
1. Add a MSG instruction to your program.

IMPORTANT You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box:

Table 5 - Disable/Enable All Categories of Messages

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Instance:	1
Class:	3a5
Attribute:	1
Source Element:	Controller tag of SINT data type. In this example, the controller tag is named Display_SINT.
Source Length:	1



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.
4. Before you enable the MSG instruction, make sure that the Source Element tag value is 1.

IMPORTANT You can re-enable the 4-character display after it is disabled.

To re-enable the 4-character display, complete the steps that are described in this section. Before you enable the MSG instructions, however, make sure that the Source Element tag value is 0.

Disable/Enable Individual Categories of Messages

You can disable a subset of the information that scrolls across the 4-character display. You can disable these subsets:

- Link status
- Port status and IP address

Complete these steps.

1. Add a MSG instruction to your program.

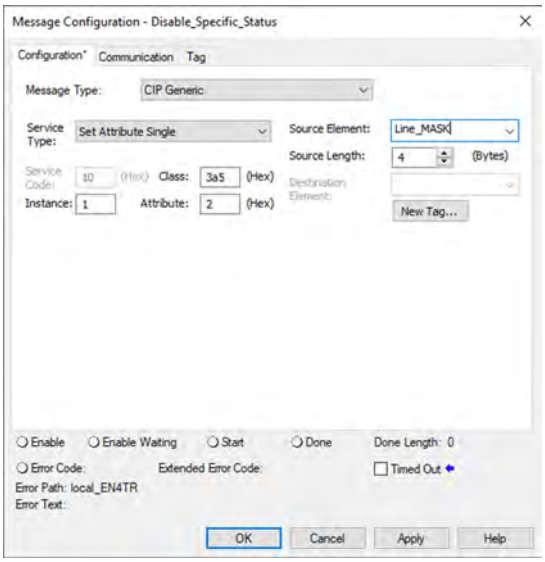
   This message only has to execute once, it does not need to execute with every program scan.

IMPORTANT You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 6 - Disable/Enable Individual Categories of Messages

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Instance:	1
Class:	3a5
Attribute:	2
Source Element:	Controller tag of DINT data type. In this example, the controller tag is named Line_MASK.
Source Length:	4



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.
4. Before you enable the MSG instruction, make sure that the Source Element uses one of the following tag values that are based on what information that you want to disable:
   - Link status - Bit 0 of the Source Element = 1
   - Port status and IP address - Bit 1 of the Source Element = 1

IMPORTANT You can re-enable the subsets of information on the 4-character display after they are disabled.

To re-enable the subsets, complete the steps that are described in this section. Before you enable the MSG instructions, however, make sure the appropriate bit in the Source Element tag value is 0.

Disable/Enable the Webpages

Applies to these modules:
1756-EN2x
1756-EN4x

You can disable or enable the module webpages.

Use a CIP Generic MSG to Disable the Webpages

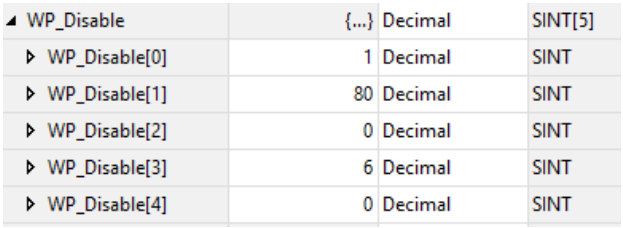
IMPORTANT If you use FactoryTalk Policy Manager to disable the webpages in a CIP Security application, the CIP generic message-to-self overrides the FactoryTalk Policy Manager setting.

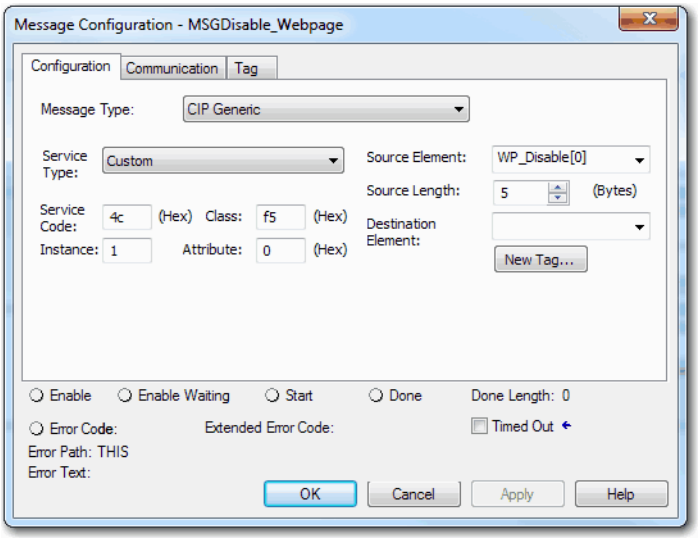
1. Add a MSG instruction to your program.

IMPORTANT You cannot add a MSG instruction to your program if the controller keyswitch is in RUN mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 7 - Disable the Webpages

Message Type:	CIP Generic
Service Type:	Custom
Service Code:	4c
Instance:	1
Class:	f5
Attribute:	0
Source Element:	Controller tag of SINT[5] data type. In this example, the controller tag is named WP_Disable and must match the following graphic:  **IMPORTANT:** The Source Element tag in your Logix Designer application project must match the values that are shown in the graphic. If you use values that are different than the ones shown, the controller webpages are not disabled.
Source Length:	5



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

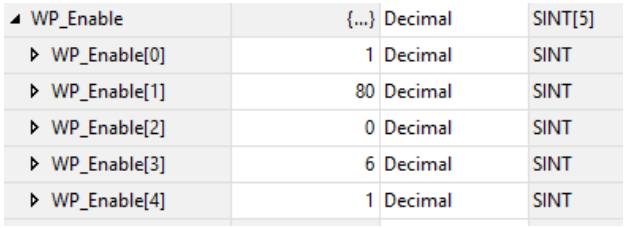
Use a CIP Generic MSG to Enable the Webpages

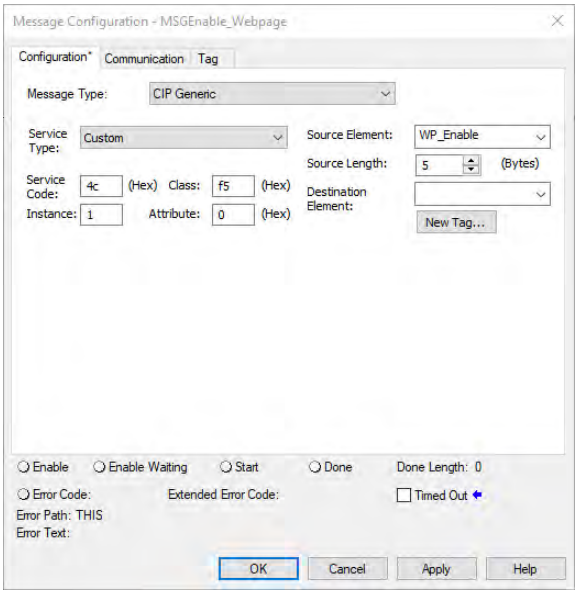
1. Add a MSG instruction to your program.

IMPORTANT	You cannot add a MSG instruction to your program if the controller keyswitch is in RUN mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 8 - Enable the Webpages

Message Type:	CIP Generic
Service Type:	Custom
Service Code:	4c
Instance:	1
Class:	f5
Attribute:	0
Source Element:	Controller tag of SINT[5] data type. In this example, the controller tag is named WP_Enable and must match the following graphic:  **IMPORTANT:** The Source Element tag in your Logix Designer application project must match the values that are shown in the graphic. If you use values that are different than the ones shown, the controller webpages are not enabled.
Source Length:	5



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

Disable/Enable Simple Network Management Protocol (SNMP)

Applies to these modules:
1756-EN2x
1756-EN4x

SNMP enables the module to be remotely managed through other network management software. SNMP defines the method of communication among the devices and also denotes a manager for the monitoring and supervision of the devices.

- For 1756-EN2x modules: With firmware revision 12.001 or later, SNMP is disabled on the Ethernet module by default.
- For 1756-EN4x modules: SNMP is disabled on the Ethernet module by default will all firmware revisions

For more information about SNMP, see the Ethernet Reference Manual, publication ENET-RM002.

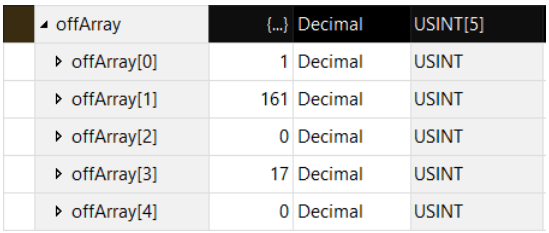
Use a CIP Generic MSG to Disable SNMP

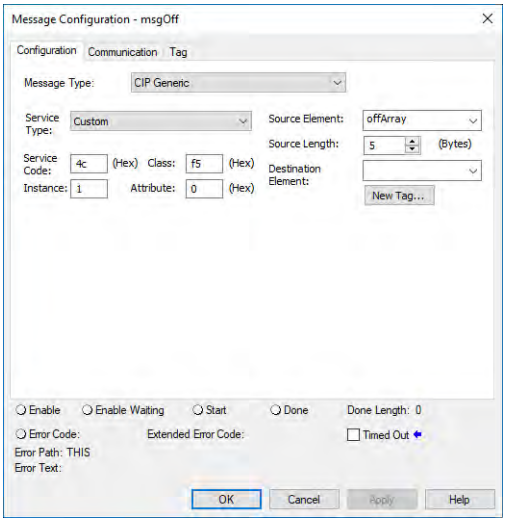
1. Add a MSG instruction to your program.

IMPORTANT You cannot add a MSG instruction to your program if the controller keyswitch is in RUN mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 9 - Disable SNMP

Message Type:	CIP Generic
Service Type:	Custom
Service Code:	4c
Instance:	1
Class:	f5
Attribute:	0
Source Element:	Controller tag of USINT[5] data type. In this example, the controller tag is named offArray and must match this graphic:  **IMPORTANT:** The Source Element tag in your Logix Designer application project must match the values that are shown in the graphic. If you use values that are different than the ones shown, SNMP will not be disabled.
Source Length:	5



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

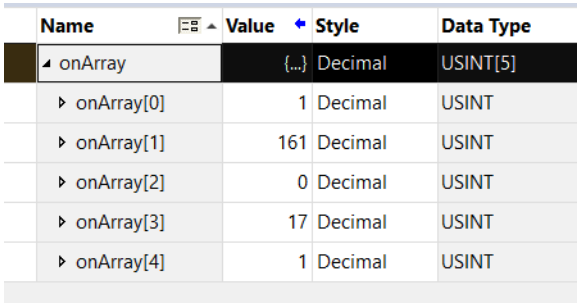
Use a CIP Generic MSG to Enable SNMP

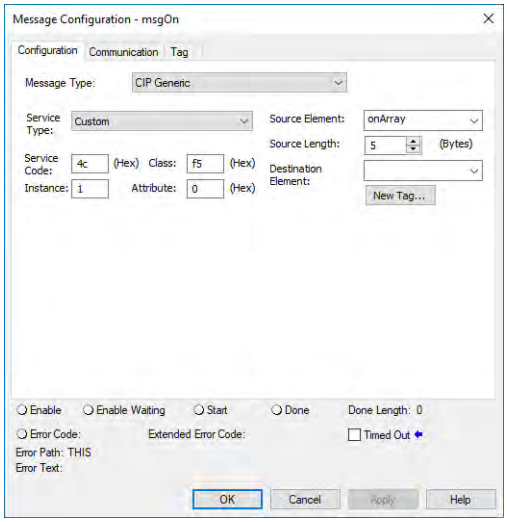
1. Add a MSG instruction to your program.

IMPORTANT	You cannot add a MSG instruction to your program if the controller keyswitch is in RUN mode, or if the FactoryTalk Security settings deny this editing option.

2. Configure the Configuration tab on the Message Configuration dialog box as follows:

Table 10 - Enable SNMP

Message Type:	CIP Generic
Service Type:	Custom
Service Code:	4c
Instance:	1
Class:	f5
Attribute:	0
Source Element:	Controller tag of USINT[5] data type. In this example, the controller tag is named onArray and must match this graphic:  **IMPORTANT:** The Source Element tag in your Logix Designer application project must match the values that are shown in the graphic. If you use values that are different than the ones shown, SNMP will not be enabled.
Source Length:	5



3. On the Communication tab, configure the Path. See Configure the MSG Communication Path on page 59.

There are two additional tables to store the result of the IANA port administrator state change operation.

Figure 8 - onArrayOut

Disable the Socket Object

Applies to these modules:
1756-EN2x
1756-EN4x

The module can use socket interfaces to communicate with Ethernet devices that do not support the EtherNet/IP application protocol. The socket interface is implemented via the Socket Object. The socket object is enabled by default. You can use a CIP Generic MSG instruction to disable the socket object.

For more information on the socket interface, see EtherNet/IP Socket Interface Application Technique, publication ENET-AT002.

Disable the Email Object

Applies to these modules:
1756-EN2x
1756-EN4x

A Logix controller can send a generic CIP™ message instruction to the EtherNet/IP communication module that instructs the module to send an email message to an SMTP mail relay server that uses the standard SMTP protocol. This process automatically communicates controller data and application conditions to appropriate personnel.

The controller communicates with the Email Object via MSG instructions.

For more information on the Email Object, see EtherNet/IP Network Devices User Manual, publication ENET-UM006.

ControlLogix Network Device Status Indicators

Topic	Page
Status Indicators	77
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Access the Diagnostic Web Pages	82

Status Indicators

The following graphics show the status indicators for these modules (extended-temperature versions not shown).

Figure 9 - 1756-EN2F, 1756-EN2T (Single-port Modules)

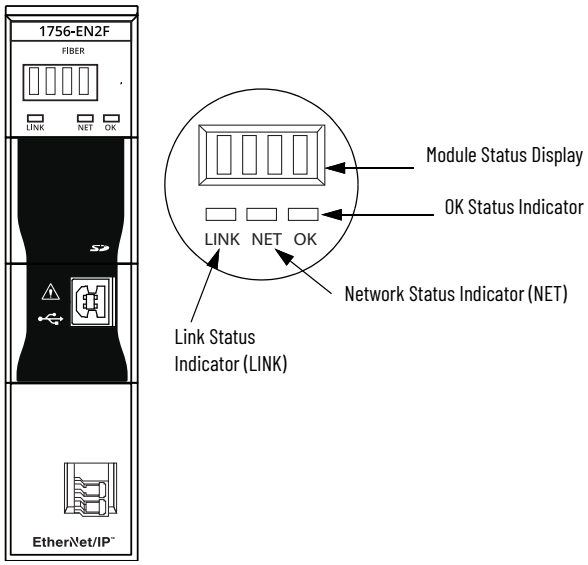


Figure 10 - 1756-EN2TR, 1756-EN3TR (Dual-port Modules)

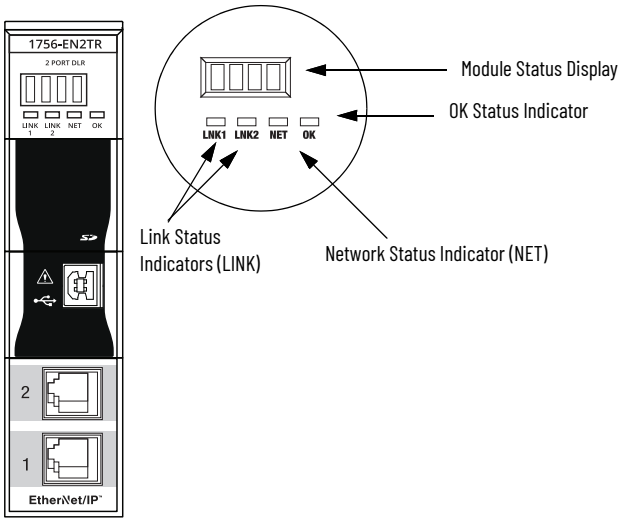


Figure 11 - 1756-EN2TP (Dual-port Module)

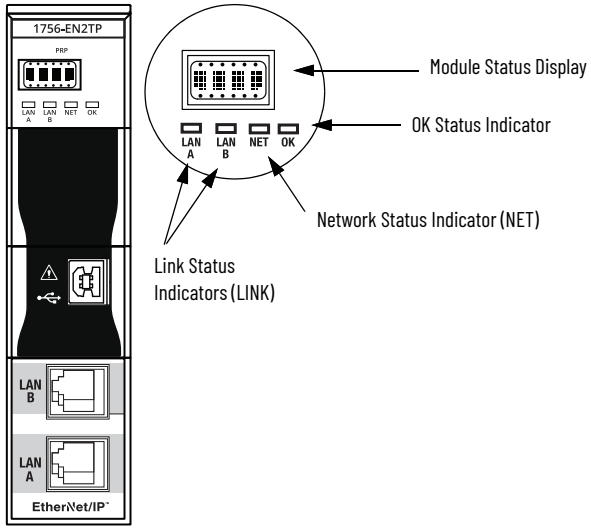


Figure 12 - 1756-EN4TR (Dual-port Module)[1]

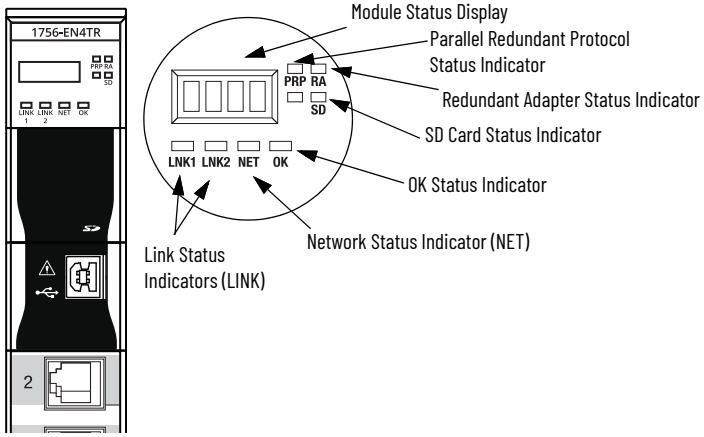


Figure 13 - 1756-ENBT (Single-port Module)

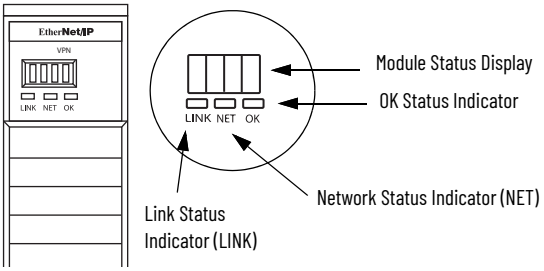
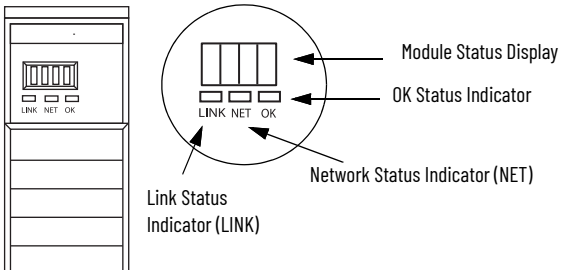


Figure 14 - 1756-EWEB (Single-port Module)



(1) Parallel Redundant Protocol and Redundant Adapter features are not available in the initial release. Check the Product Compatibility and Download Center (PCDC) to see if it is available in your firmware revision.

Single-Port Module Status Indicators

Table 11 - Single-port Module Status Indicators

Status Indicator	Description	Status	State
Module Status Display	Alphanumeric display that scrolls messages. For example, when a module is operating normally, the display scrolls the module's IP address.	–	–
Link Status (LINK)	Indicates the current state of the module regarding transmission of data on the EtherNet/IP™ network.	Off	One of these conditions exists: • The module is not powered. – Verify that there is chassis power. – Verify that the module is completely inserted into the chassis and backplane. – Make sure that the module has been configured. • No link exists on the port.
		Flashing green	Activity exists on the port.
		Green	The port is active, but not receiving traffic.
OK Status (OK)	Indicates the current state of the module. For example, this status indicator indicates if the module is executing power-up testing, in the process of a firmware update or operating normally.	Off	The module is not powered. • Verify that there is chassis power. • Verify that the module is completely inserted into the chassis and backplane. • Make sure that the module has been configured.
		Flashing green	The module is not configured. The Module Status display scrolls: BOOTP or DHCP<Mac_address_of_module> For example: BOOTP 00:0b:db:14:55:35 Configure the module.
		Green	The module is operating correctly. The IP address scrolls across the Module Status display.
		Flashing red	The module detected a recoverable minor fault. Check the module configuration. If necessary, reconfigure the module.
		Red	The module detected an unrecoverable major fault. Cycle power to the module. If this power cycle does not clear the fault, replace the module.
Network Status (NET)	Indicates if CIP™ connections are established.	Off	One of these conditions exists: • The module is not powered. – Verify that there is chassis power. – Verify that the module is completely inserted into the chassis and backplane. – Make sure that the module has been configured. • The module is powered but does not have an IP address. Assign an IP address to the module.
		Flashing green	The controller has an IP address and one of these conditions exists: • The module has not established any CIP connections. If connections are configured for this module, check the connection originator for the connection error code. • All connections to the device have timed out or been closed.
Network Status (NET)	Indicates if CIP connections are established.	Green	The module has established at least 1 CIP connection and is operating properly. The IP address scrolls across the Module Status display.
		Red	The module is in conflict mode. It shares an IP address with another device on the network. The current IP address scrolls across the Module Status display. The display scrolls: OK <IP_address_of_this_module> Duplicate IP <Mac_address_of_duplicate_node_detected> For example: OK 10.88.60.196 Duplicate IP - 00:00:BC:02:34:B4 Change the IP address of the module.
		Flashing green/flashing red	The module is performing its power-up testing.

Dual-Port Module Status Indicators

Table 12 - Dual-port Module Status Indicators

Status Indicator	Description	Status	State
Module Status Display	Alphanumeric display that scrolls messages. For example, when a module is operating normally, the display scrolls the module's IP address.	—	—
OK	Indicates the current state of the module. For example, this status indicator indicates if the module is executing power-up testing, in the process of a firmware update or operating normally.	Off	The module is not powered. • Verify that there is chassis power. • Verify that the module is completely inserted into the chassis and backplane. • Make sure that the module has been configured.
		Flashing green	The module is not configured. The Module Status display scrolls: BOOTP or DHCP<Mac_address_of_module> For example: BOOTP 00:0b:db:14:55:35 Configure the module.
		Green	The module is operating correctly. The Module Status display scrolls: OK <IP_address_of_this_module> For example: OK 10.88.60.160
		Flashing red	The module detected a recoverable minor fault. Check the module configuration. If necessary, reconfigure the module.
		Red	The module detected an unrecoverable major fault. Cycle power to the module. If this power cycle does not clear the fault, replace the module.
		Both of these conditions exist: • Status Indicator is Red • Module Status Display is scrolling: Image Update Needed	The module's main firmware image must be updated. Follow these steps: 1. Update the firmware image. 2. Cycle power to the module.
		Flashing red and green	The module is performing its power-up testing.
Network Status (NET)	Indicates if CIP connections are established. **IMPORTANT:** The new-series 1756-EN2TR and 1756-EN3TR modules have a NET status indicator. The older-series 1756-EN2TR and 1756-EN3TR modules do not have a NET status indicator.	Off	One of these conditions exists: • The module is not powered. – Verify that there is chassis power. – Verify that the module is completely inserted into the chassis and backplane. – Make sure that the module has been configured. • The module is powered but does not have an IP address. Assign an IP address to the module.
		Flashing green	The controller has an IP address and one of these conditions exists: • The module has not established any CIP connections. If connections are configured for this module, check the connection originator for the connection error code. • All connections to the device have timed out or been closed.
		Green	The module has established at least 1 CIP connection and is operating properly. The IP address scrolls across the Module Status display.
		Red	The module is in conflict mode. It shares an IP address with another device on the network. The module's current IP address scrolls across the Module Status display. The display scrolls: OK <IP_address_of_this_module> Duplicate IP <Mac_address_of_duplicate_node_detected> For example: OK 10.88.60.196 Duplicate IP - 00:00:BC:02:34:B4 Change the module's IP address.
		Flashing green/flashing red	The module is performing its power-up testing.

Table 12 - Dual-port Module Status Indicators (Continued)

Status Indicator	Description	Status	State
Link Status (LINK 1, LINK 2)		Off	One of these conditions exists: • The module is not powered. – Verify that there is chassis power. – Verify that the module is completely inserted into the chassis and backplane. – Make sure that the module has been configured. • No link exists on the port. • The port is administratively disabled. • The port is disabled due to rapid ring faults (LNK2).
		Flashing green	Activity exists on the port.
		Green	One of these conditions exists: • A link exists on the port, but no traffic is being received. • The ring network is operating normally on active ring supervisor (LNK2). • A ring partial network fault was detected on the active ring supervisor (LNK2).
Link Status (LAN A, LAN B)		Flashing red	When the corresponding LAN A/B Parallel Redundancy Protocol (PRP) Warning bit is set.
SD[1]	The SD indicator shows if the SD card is in use	Off	No activity is occurring with the SD card. You can safely remove the card, if necessary.
		Flashing green	The module is reading from or writing to the SD card. **IMPORTANT**: Do not remove the SD card while the module is reading or writing. Let the read/write complete without interruption. If you interrupt the read/write, data corruption or loss can occur.
		Solid green	
		Flashing red	One of the following exists: • The SD card does not have a valid file system. • The SD card drew excessive current and power has been removed from the card.
		Solid red	The module does not recognize the SD card.
Parallel Redundancy Protocol (PRP)[1]	Check Firmware Revision for availability of this feature.		
Redundant Adapter (RA)[1]	Major revision 3.001 or higher.		

(1) Status indicators only available on the 1756-EN4TR, 1756-EN4TRK, 1756-EN4TRXT.

Diagnostic Web Pages

The number and type of diagnostic fields vary by module catalog number, series, and revision number.

IMPORTANT The diagnostic web pages have many fields that you can use to monitor the operating state of your EtherNet/IP module.

To troubleshoot problems, you diagnose as a result of monitoring the diagnostic web pages of the EtherNet/IP modules, see Troubleshoot EtherNet/IP Networks, publication ENET-AT003.

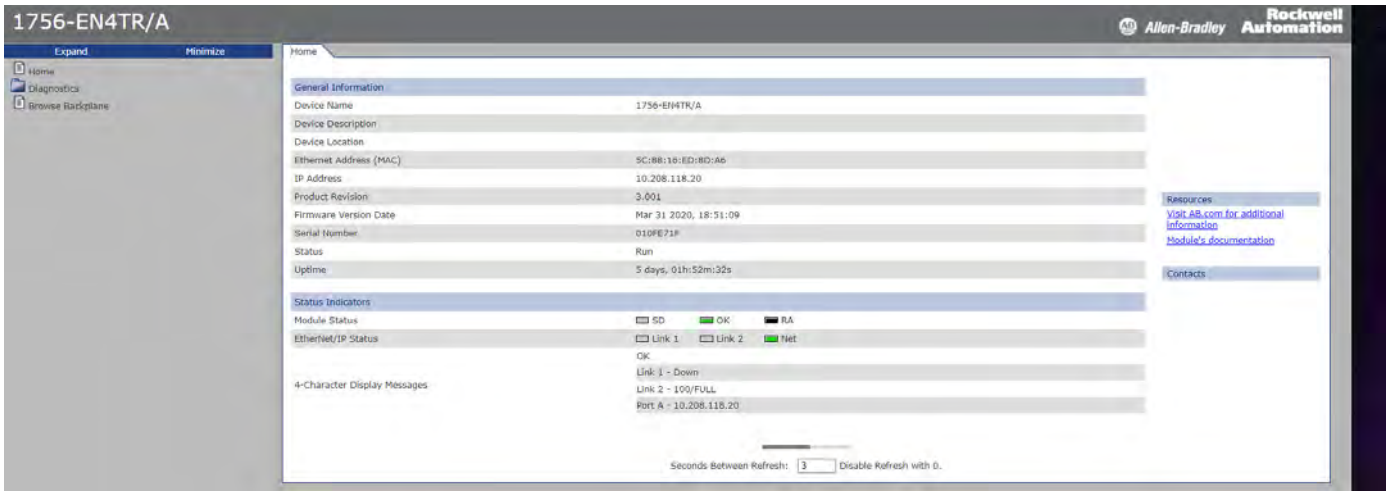
Access the Diagnostic Web Pages

To troubleshoot most possible problems with your EtherNet/IP communication module, you must access the diagnostic web pages for the module.

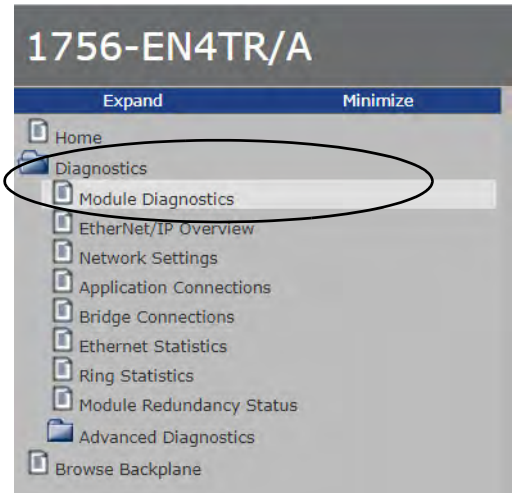
To access the EtherNet/IP communication module diagnostic web pages, follow these steps.

1. Open your web browser.
2. In the Address field, type your EtherNet/IP communication module Internet Protocol (IP) address and press Enter.

   The diagnostic web home page appears.



3. Open the Diagnostics folder in the left-most navigation bar and click the link for each diagnostic web page you must monitor.



For more information on diagnostics, see Troubleshoot EtherNet/IP Networks, publication ENET-AT003.

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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Technical Data

Original Instructions

Switched Mode Power Supply Specifications

Bulletin 1606

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Product Overview

- Quick mounting and connecting, DIN rail mount, smallest in class
- UL Listed NEC Class 2 'Limited Power' options; Class 1, Div. 2; Semi F47; ODVA Approved
- Low inrush current limiting
- PFC Active or Passive
- Wide range input; auto-select input
- Enhanced overload design (continuous current, no hiccup)
- Selectable operating mode (single/parallel)
- Excellent efficiency and temperature rating

Special Modules

- Buffer Modules
- Redundancy Modules (1+1 or N+1 redundancies)
- DC UPS
  - Traditional UPS with battery
  - Capacitor-based UPS without batteries - Electrochemical Double Layer Capacitors (EDLC)

Power Supply Family/ Attributes[1]	**Performance Power Supply 1606-XLS**				
Input Voltage	Single/multi-phase				
Watt Range	80...960 W				
Multiple Output Voltages	12, 24, 30, 36, 48V DC				
Terminations	Screw, Cam Lock Spring				
Auto Select Input	Yes				
Power Boost	150%/ 5 s				
DC OK Relay Output	Yes				
DC OK Status Indicator	Yes				
Wide Range	Yes				
Product Selection Page	5				
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(1) Not all features apply to all power supplies; see individual power supply descriptions for specifics.

Catalog Number Explanation

1606	-	XLE	480	E	P	-	D
		a	b	c	d		e

a	
Power Supply Type	
Code	**Description**
XLB	Basic Power Supply
XLD	DC-DC Converter
XLE	Essential Power Supply
XLP	Compact Power Supply
XLS	Performance Power Supply

e	
Multi-phase Variations	
Code	**Description**
blank	—
2	Two-phase
3	Three-phase
3C	Three-phase, conformal coating
3E	Three-phase, input voltage 400V AC
3N	Three-phase, input voltage 480V AC
D	360...900V DC Only

b	
Rated Output	
Code	**Description**
15	15 W
25	25 W
30	30 W
36	36 W
40	40 W
50	50 W
60	60 W
72	72 W
80	80 W
90	90 W
95	95 W
100	100 W
120	120 W
180	180 W
192	192 W
240	240 W
260	260 W
480	480 W
720	720 W
960	960 W

c	
Output Voltage	
Code	**Description**
A	5V DC
B	10...12 or 12...15V DC
C	Dual ± 12V and 15V DC
D	24V
E	24...28V DC
F	48...56V DC
G	36...43V DC
M	48V DC

d	
Special Features	
Code	**Description**
blank	No special features
A	ATEX
C	Conformal Coated
CH	Push-in Terminal, Conformal Coated
CL	Spring Terminals, Conformal Coated
CR	Screw Terminals, Conformal Coated, Redundancy Built-in
CRH	Push-in Terminal, Conformal Coated, Redundancy Built-in
CRL	Spring Terminals, Conformal Coated, Redundancy Built-in
CRZ	Plug/Removable, Conformal Coated, Redundancy Built-in
CZ	Plug/Removable, Conformal Coated
D	Extended DC Input
DRZ	Plug/Removable, Redundancy Built-in, Extended DC input
E	Regional Unit - Europe
H	Push-in Terminals
L	Spring-clamp Terminals
M	Remote Shutdown
N	Regional Unit - North America
P	Power Factor Correction
Q	NEC Class 2
R	Redundancy Built-in
RH	Push-in Terminal, Redundancy built-in
RL	Spring Terminals, Redundancy built-in
RZ	Plug / Removable, Redundancy built-in
S	Output Signal
T	Extended Temperature
X	Semi-regulated
Y	Load Sharing
Z	Plug / Removable Terminals

1606-XLS Performance Power Supplies

Output		Power	Input AC	Input DC	Special Features	Catalog Number
100...240V AC/DC Converters						
12V	15 A	180 W	AC 100...240V	DC 110...150V	–	1606-XLS180B
24V	3.4 A	80 W	AC 100...240V	DC 110...300V	–	1606-XLS80E
24V	3.8 A	91 W	AC 100...240V	DC 110...300V	DeviceNet/NEC Class 2	1606-XLSDNET4
24V	5 A	120 W	AC 100...240V	DC 110...300V	–	1606-XLS120E
24V	8 A	192 W	AC 100...240V	DC 110...150V	DeviceNet/NEC Class 1	1606-XLSDNET8
24V	10 A	240 W	AC 100...240V	DC 110...150V	–	1606-XLS240E
24V	10 A	240 W	AC 100...240V	DC 110...150V	–	1606-XLS240EC(1)
24V	10 A	240 W	AC 100...240V	DC 110...300V	–	1606-XLS240E-D
24V	20 A	480 W	AC 200...240V	–	–	1606-XLS480EE
24V	20 A	480 W	AC 100...240V	DC 110...150V	–	1606-XLS480E
24V	20 A	480 W	AC 100...240V	DC 110...150V	–	1606-XLS480EC(1)
24V	40 A	960 W	AC 100...240V	–	–	1606-XLS960E
24V	40 A	960 W	AC 200...240V	–	–	1606-XLS960EE
30V	8 A	240 W	AC 100...240V	DC 110...150V	–	1606-XLS240K
36V	13.3 A	480 W	AC 100...240V	DC 110...150V	–	1606-XLS480G
48V	5 A	240 W	AC 100...120V/AC 200...240V	DC 110...150V	–	1606-XLS240F
48V	5 A	240 W	AC 100...240V	DC 110...300V	Extended DC input	1606-XLS240F-D
48V	10 A	480 W	AC 100...240V	DC 110...150V	–	1606-XLS480F
48V	20 A	960 W	AC 100...240V	–	–	1606-XLS960F
48V	20 A	960 W	AC 200...240V	–	–	1606-XLS960FE

(1) Conformal Coated Power Supply

Diode Redundancy Modules

Output		Input DC	Description	Catalog Number
DC 12...48V	20 A	DC 12...48V	Dual-input diode redundancy module	1606-XLSRED

MOSFET Redundancy Modules

Output		Input DC	Special Features	Catalog Number
DC 12…28V	40 A	DC 12…28V, 2x 20 A	Dual-input MOSFET redundancy module	1606-XLSRED4HE
DC 12…28V	40 A	DC 24…28V, 2x 20 A	Dual-input MOSFET redundancy module	1606-XLSRED40
DC 12…28V	40 A	1 x 40 A	Dual-input MOSFET redundancy module	1606-XLSREDS40HE
DC 12…28V	80 A	DC 24…28V, 2x 40 A	Dual-input MOSFET redundancy module	1606-XLSRED80
DC 12…28V	80 A	DC 12…28V, 2x 20 A	Single input MOSFET redundancy module	1606-XLSRED80HE
DC 24…56V	40 A	DC 24…56V, 2x 20 A	Dual-input MOSFET redundancy module	1606-XLSRED40HF

1606-XLS Performance Power Supplies

100....240V AC/DC

Catalog Number	1606-XLS180B	1606-XLS80E	1606-XLSDNET4	1606-XLS120E 1606-XLS120EA	1606-XLSDNET8	1606-XLS240E 1606-XLS240EA 1606-XLS240EC 1606-XLS240E-D
Output Voltage, Nom	12V	24V	24V	24V	24V	24V
Output Current, Nom	15 A	3.4 A	3.8 A	5 A	8 A	10 A
Adjustment Range	12...15V	24...28V	24V	24...28V	24...24.5V	24...28V
Output Current Range	15...13.5 A	3.4...3A	3.8 A	5...4.5 A	8 A	10...9A
Output Power	180 W	80 W	91 W	120 W	192 W	240 W
Power Reserves	50%	50%	–	50%	–	50%
Ripple and Noise Max [mVPP]	50 mV	50 mV	50 mV	50 mV	50 mV	50 mV
AC Input Voltage	AC 100...240V	AC 100...240V	AC 100...240V	AC 100...240V	AC 100...240V	AC 100...240V
DC Input Voltage	DC 110...150V	DC 110...300V	DC 110...300V	DC 100...300V	DC 110...150V	DC 110...300V (-XLS240ED) DC 110...150V(-XLS240E, -XLS240EA, -XLS240EC)
Power Factor, Typ	0.92	0.47	0.90	0.91	0.92	0.92
Input Inrush Current Limiter	Active	Active	Active	Active	Active	Active
Input Inrush Current(1)	4 A/7 A	5A/10 A	9A/11A	9 A/11 A	4 A/7 A	4 A/7A
External Input Fuse, Min	B-6 A or C-4 A	B-6A or C-6A	B-6A or C-3A	B-6 A or C-3 A	B-6 A or C-4 A	B-6 A or C-4 A
Efficiency, Typ	91.8%	90.0%	92.0%	92.7%	93.4%	93.5%
Power Losses, Typ	16.1 W	9.1 W	7.9 W	9.4 W	13.6 W	16.7 W
MTBF(2)	631 kh	1451 kh	831 kh	831 kh	581 kh	581 kh
Lifetime Min (+40 °C...104 °F)	76 kh	79 kh	94 kh	89 kh	81 kh	71 kh
Temperature, operating	-25...+70 °C (-13...+158 °F)	-25...+70 °C (-13...+158 °F)	-25...+70 °C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)
Derating (3)	5 W/°C	2W/°C	2W/°C	3 W/ °C	5W/°C	6 W/ °C
Connection Terminals	Spring	Spring	Spring	Spring	Spring	Spring
Dimensions W x H x D	60 x 124 x 117 mm (2.36 x 4.88 x 4.61 in.)	32 x 124 x 102 mm (1.26 x 4.88 x 4.02 in.)	40 x 124 x 117 mm (1.57 x 4.88 x 4.61 in.)	40 x 124 x 117 mm (1.57 x 4.88 x 4.61 in.)	60 x 124 x 117 mm (2.36 x 4.88 x 4.61 in.)	60 x 124 x 117 mm (2.36 x 4.88 x 4.61 in.)
Weight	930 g (2.05 lb)	440 g (0.97 lb)	620 g (1.37 lb)	620 g (1.37 lb)	900 g (1.98 lb)	900 g (1.98 lb)
DC OK Relay Contact	Yes	–	Yes	Yes	Yes	Yes
Special Features	–	–	DeviceNet approved	ATEX Approved (1606-XLS120EA)	DeviceNet approved	–

(1) Output transient current
(2) +40 °C (104 °F), SN29500
(3) From 60...70 °C (140...158 °F).

100....240V AC/DC, Continued

Catalog Number	1606-XLS480E 1606-XLS480EA 1606-XLS480EC	1606-XLS480EE	1606-XLS960E	1606-XLS960EE	1606-XLS240K
Output Voltage, Nom	24V	24V	24V	24V	28V
Output Current, Nom	20 A	20 A	40 A	40 A	8.6 A
Adjustment Range	24...28V	24...28V	24...28V	24...28V	28...32V
Output Current Range	20...17A	20...17A	40...34.3A	40...34.3A	8.6...7.5A
Output Power	480 W	480 W	960 W	960 W	240 W
Power Reserves	50%	50%	50%	50%	50%
Ripple and Noise, Max [mVPP]	100 mV	100 mV	100 mV	100 mV	50 mV
AC Input Voltage	AC 100...240V	AC 200...240V	AC 100...240V	AC 200...240V	AC 100...240V
DC Input Voltage	DC 110...150V	–	–	–	DC 110...150V
Power Factor, Typ	0.90	0.50	0.99	0.96	0.92
Input Inrush Current Limiter	Active	Active	Active	Active	Active
Input Inrush Current(1)	9 A/7 A	40 A	17 A/11 A	14 A	4 A/7 A
External Input Fuse, Min	B-10 A or C-10 A	B-10 A or C-6 A	B-16 A or C-16 A	B-10 A or C-8 A	B-6 A or C-4 A
Efficiency, Typ	93.9%	94.5%	94.6%	94.6%	93.5%
Power Losses, Typ	31.4 W	28.3 W	54.8 W	54.8 W	16.7 W
MTBF(2)	469 kh	577 kh	300 kh	366 kh	581 kh
Lifetime, Min (+40 °C)	71 kh	62 kh	84 kh	59 kh	71 kh
Temperature, operating	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)
Derating(3)	12 W/ °C	12 W/ °C	24 W/ °C	24 W/ °C	6 W/ °C
Connection Terminals	Spring	Spring	Screw	Screw	Spring
Dimensions W x H x D	82 x 124 x 127 mm (3.23 x 4.88 x 5 in.)	70 x 124 x 127 mm (2.76 x 4.88 x 5 in.)	125 x 124 x 127 mm (3.23 x 4.88 x 5 in.)	125 x 124 x 127 mm (4.92 x 4.88 x 5 in.)	60 x 124 x 117 mm (2.36 x 4.88 x 4.6 in.)
Weight	1200 g (2.65 lb)	880 g (1.94 lb)	1900 g (4.19 lb)	1800 g (3.97 lb)	900 g (1.98 lb)
DC OK Relay Contact	Yes	Yes	Yes	Yes	Yes

(1) Output transient current
(2) +40 °C (104 °F), SN29500
(3) From 60...70 °C (140...158 °F).

100....240V AC/DC, Continued

Catalog Number	1606-XLS480G	1606-XLS240F 1606-XLS240F-D	1606-XLS480F	1606-XLS960F	1606-XLS960FE
Output Voltage, Nom	36V	48V	48V	48V	48V
Output Current, Nom	13.3 A	5 A	10 A	20 A	20 A
Adjustment Range	36...42V	48...56V	48...55V	48...54V	48...54V
Output Current Range	13.3...11.4 A	5...4.3 A	10...8.7 A	20...17.8 A	20...17.8 A
Output Power	480 W	240 W	480 W	960 W	960 W
Power Reserves	50%	50%	50%	50%	50%
Ripple and Noise, Max [mVPP]	100 mV	100 mV	100 mV	150 mV	150 mV
AC Input Voltage	AC 100...240V	AC 100...240V	AC 100...240V	AC 100...240V	AC 200...240V
DC Input Voltage	DC 110...150V	DC 110...150V (-XLS240F) DC110...300V (-XLS240F-D)	DC 110...150V	–	–
Power Factor, Typ	0.90	0.92	0.90	0.99	0.96
Input Inrush Current(1)	9 A/7 A	4 A/7 A	9A/7A	17A/11A	14 A
Recommended External Input Fuse, Min	B-10 A or C-10 A	B-6 A or C-4 A	B-10 A or C-10 A	B-16 A or C-16 A	B-10 A or C-8 A
Efficiency, Typ	94.0%	92.0%	94.3%	95.0%	95.0%
Power Losses, Typ	30.6 W	20.9 W	29.0 W	50.5 W	50.5 W
MTBF(2)	469 kh	606 kh	469 kh	300 kh	392 kh
Lifetime, Min (+40 °C)	84 kh	81 kh	92 kh	90 kh	65 kh
Temperature, operating	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)	-25...+70°C (-13...+158 °F)
Derating(3)	12 W / °C	6 W / °C	12 W/°C	24 W/°C	24 W/°C
Connection Terminals	Spring	Spring	Spring	Screw	Screw
Dimensions W x H x D	82 x 124 x 127 mm (3.23 x 4.88 x 5 in.)	60 x 124 x 117 mm (2.36 x 4.88 x 4.61 in.)	82 x 124 x 127 mm (3.23 x 4.88 x 5 in.)	125 x 124 x 127 mm (4.92 x 4.88 x 5 in.)	125 x 124 x 127 mm (4.92 x 4.88 x 5 in.)
Weight	1200 g (2.65 lb)	900 g (1.98 lb)	1200 g (2.65 lb)	1900 g (4.19 lb)	1800 g (3.97 lb)
DC-OK Relay Contact	Yes	Yes	Yes	Yes	Yes

(1) Output transient current
(2) +40 °C (104 °F), SN29500
(3) From 60...70 °C (140...158 °F).

Redundancy Modules

Catalog Number	1606-XLSRED	1606-XLSRED40HE	1606-XLSRED40	1606-XLSREDS40HE	1606-XLSRED80	1606-XLSRED80HE	1606-XLSRED40HF
Voltage, Nom	DC 12...48V	DC 12...28V	DC 12...28V	DC 12...28V	DC 12...28V	DC 12...28V	DC 24...56V
Input/output	2x 10 A / 20 A	2x 20 A / 40 A	2x 20 A / 40 A	1x 40 A / 40 A	2x 40 A / 80 A	2x 40 A / 80 A	2x 20 A / 40 A
Input Voltage Range	DC 9...60V	DC 8.4...36.4 V	DC 8.4...36.4V	DC 8.4...36.4V	DC 8.4...36.4V	DC 8.4...36.4V	DC 20.4...64.4V
Current, Nom per Input[1]	10 A	20 A	20 A	40 A	40 A	40 A	20 A
Output Current Nom Current Short Circuit	20 A 25 A max	40 A 26 A max	40 A 65 A max	40 A 22 A max	80 A 130 A max	80 A 44 A max	40 A 45 A max
Voltage Drop In-/ Output	800 mV	72 mV	72 mV	80 mV (at 1x20 A) 150 mV (at 40 A)	49 mV	65 mV	60 mV
Decoupling	Diode	MOSFET	MOSFET	MOSFET	MOSFET	MOSFET	MOSFET
Power Losses No Load Load Nom[2]	0 W 17.0 W	0.2 W 1.7 W	0.7 W 2.2 W	0.1 W 1.8 W (at 1x20A) 6.2 W (at 40 A)	0.7 W 2.7 W	0.2 W 2.9 W	0.62 W 1.8 W
MTBF[3]	47 Mio. h	4.5 Mio. h	2.7 Mio. h	6.4 Mio. h	2.1 Mio. h	2.5 Mio. h	4.1 Mio. h
Lifetime Min (+40	218 kh	255 kh	246 kh	134 kh	143 kh	85 kh	222 kh
Temperature, Operating	-40...+70°C (-40...+158 °F)	-40...+70°C (-40...+158 °F)	-40...+ 70 °C (-40...+ 158 °F)	-40...+ 70 °C (-40...+ 158 °F)	-40...+ 70 °C (-40...+ 158 °F)	-40...+ 70 °C (-40...+ 158 °F)	-40...+ 70 °C (-40...+ 158 °F)
Derating[4]	12 W/°C	1 W/°C	Not required	1 A/°C	Not required	2 W/°C	1 W/°C
Dimensions W x H x D	32 x 124 x 102 mm (1.26 x 4.88 x 4.02 in.)	36 x 124 x 127 mm (1.42 x 4.88 x 5 in.)	36 x 124 x 127 mm (1.42 x 4.88 x 5 in.)	46 x 124 x 127 mm (1.81 x 4.88 x 5 in.)	46 x 124 x 127 mm (1.81 x 4.88 x 5 in.)	46 x 124 x 127 mm (1.81 x 4.88 x 5 in.)	46 x 124 x 127 mm (1.81 x 4.88 x 5 in.)
Weight	290 g (0.64 lb)	280 g (0.62 lb)	340 g (0.75 lb)	340 g (0.75 lb)	440 g (0.97 lb)	370 g (0.82 lb)	360 g (0.79 lb)
Connection Terminals	Spring	Screw	Screw	Screw, plug connection	Screw	Screw	Screw

(1) 50% higher currents are allowed up to 55 s
(2) 1+1-redundancy (= 50% of the nominal current) and symmetrical input currents
(3) +40 °C (104 °F), SN29500
(4) From 60...70 °C (140...158 °F).

Standards Compliance and Certifications

Catalog Number	CE	UL 61010-2-201	IECEx	ATEX	Class I Div. 2 HazLoc	DNV GL Marine	EAC Registration	NEC Class 2
1606-XLS Performance Power Supplies								
1606-XLS80E	✓	✓			✓	✓	✓	
1606-XLS120E	✓	✓			✓	✓	✓	
1606-XLS120EA	✓	✓	✓	✓	✓	✓	✓	
1606-XLSDNET4	✓	✓			✓	✓	✓	✓
1606-XLS180B	✓	✓			✓	✓	✓	
1606-XLS240E	✓	✓			✓	✓	✓	
1606-XLS240EA	✓	✓	✓	✓	✓	✓	✓	
1606-XLS240EC	✓	✓			✓	✓	✓	
1606-XLS240E-D	✓	✓					✓	
1606-XLS240K	✓	✓			✓	✓	✓	
1606-XLS240F	✓	✓			✓	✓	✓	
1606-XLS240F-D	✓	✓					✓	
1606-XLSDNET8	✓	✓			✓	✓	✓	
1606-XLS480E	✓	✓			✓	✓	✓	
1606-XLS480EA	✓	✓	✓	✓		✓	✓	
1606-XLS480EC	✓	✓			✓		✓	
1606-XLS480EE	✓	✓			✓	✓	✓	
1606-XLS480G	✓	✓			✓	✓	✓	
1606-XLS480F	✓	✓			✓	✓	✓	
1606-XLS960E	✓	✓	✓	✓	✓	✓	✓	
1606-XLS960EE	✓	✓			✓	✓	✓	
1606-XLS960F	✓	✓	✓	✓	✓	✓	✓	
1606-XLS960FE	✓	✓			✓	✓	✓	

Catalog Number	CE	UL 61010-2-201	IECEx	ATEX	Class I Div. 2 HazLoc	DNV GL Marine	EAC Registration	NEC Class 2
1606-XLSRED	✓	✓	✓	✓	✓	✓	✓	
1606-XLSRED40	✓	✓	✓	✓	✓	✓	✓	
1606-XLSRED40HE	✓	✓	✓	✓	✓	✓	✓	
1606-XLSREDS40HE	✓	✓	✓	✓	✓	✓	✓	
1606-XLSRED40HF	✓	✓	✓	✓	✓	✓	✓	
1606-XLSRED80	✓	✓	✓	✓	✓	✓	✓	
1606-XLSRED80HE	✓	✓	✓	✓	✓	✓	✓	

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at rok.auto/literature.

Resource	Description
Power Supply Reference Manuals, publication 1606-RM___	Provides detailed specifications on specific power supply or accessory.
Power Supply Installation Instructions, publication 1606-IN___	Provides product description, installation instructions, functional descriptions and wiring diagrams.
EtherNet/IP Network Devices User Manual, publication ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, publication ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, publication SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
UL Standards Listing for Industrial Control Products, publication CMPNTS-SR002	Assists original equipment manufacturers (OEMs) with construction of panels, to help ensure that they conform to the requirements of Underwriters Laboratories.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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1606-XLS240E 24V, 10A; Single Phase Input

1606-XLS240E

24V,10A Single Phase Input

POWER SUPPLY

- Ultra-small size
- Extra-low inrush current
- Active power factor correction
- Wide range AC/DC input; auto select input
- Superior reserve power (can support 150% rated power for five seconds)
- Superior efficiency and temperature rating
- DC-OK and overload LED

1. GENERAL DESCRIPTION

The most outstanding features of this 1606-XLS DIN-rail power supply are the high efficiency and the small size, which are achieved by a synchronous rectification and further novel design details.

With short-term peak power capability of 150% and built-in large sized output capacitors, these features help start motors, charge capacitors and absorb reverse energy and often allow a unit of a lower wattage class to be used.

High immunity to transients and power surges as well as low electromagnetic emission makes usage in nearly every environment possible.

The integrated output power manager, a wide range input voltage design and virtually no input inrush current make installation and usage simple. Diagnostics are easy due to the dry DC-ok contact, a green DC-ok LED and red overload LED.

Unique quick-connect spring-clamp terminals allow a safe and fast installation and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

2. SPECIFICATION QUICK REFERENCE

Output voltage	DC 24V	
Adjustment range	24-28V	
Output current	10A	continuous, 24V
	15A	for typ. 4s, 24V
Output power	240W	continuous, 24V
	360W	for typ. 4s, 24V
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	±15%
Line frequency	50-60Hz	±6%
AC Input current	2.22 / 1.22A	at 120 / 230Vac
Power factor	0.98 / 0.92	at 120 / 230Vac
AC Inrush current	typ. 4 / 7A peak	at 120 / 230Vac
DC Input voltage	DC 110-300V	-20%/+25%
DC Input current	2.37 / 0.87A	at 110 / 300Vdc
Efficiency	92.3 / 93.0%	at 120 / 230Vac
Losses	20.0 / 18.1W	at 120 / 230Vac
Temperature range	-25°C to +70°C	operational
Derating	6W/°C	+60 to +70°C
Hold-up time	typ. 27 / 28ms	at 120 / 230Vac
Dimensions	60x124x117mm	WxHxD

3. AGENCY APPROVALS

c UL US LISTED IND. CONT. EQ. UL 508	c UL US UL 60950-1
c UL US Class I Div 2	
CE EMC, LVD	N223

4. RELATED PRODUCTS

1606-XLS240EC	Conformal coated unit
1606-XLB	Wall mount bracket
1606-XLSRED	Redundancy Module
1606-XLBUFFER	Buffer unit

1606-XLS240E 24V, 10A; Single Phase Input

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INTENDED USE

Those responsible for the application and use of the products must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including and applicable laws, regulation , codes, and standards.

TERMINOLOGY AND ABBREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term “earth” which is the same as the U.S. term “ground”.
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±20%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V) As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.
230Vac	A figure with the unit (VAC) at the end is a value without any additional tolerances included.
PELV	Protective Extra Low Voltage
SELV	Safety Extra Low Voltage

DISCLAIMER

The information presented in this document is believed to be accurate and reliable and may change without notice.

1606-XLS240E 24V, 10A; Single Phase Input

5. AC-INPUT

AC input	nom.	AC 100-240V	wide-range input, see **Fig. 5-1**
AC input range	min.	85-276Vac	continuous operation
	min.	60-85Vac	full power for 200ms, no damage between 0 and 85Vac
	min.	276-300Vac	< 500ms
Input frequency	nom.	50 – 60Hz	±6%
Turn-on voltage	typ.	81Vac	steady-state value, see **Fig. 5-1**
Shut-down voltage	typ.	63Vac	steady-state value, see **Fig. 5-1**
	typ.	55Vac	dynamical value

		AC 100V	AC 120V	AC 230V	
Input current	typ.	2.65A	2.22A	1.22A	at 24V, 10A, see **Fig. 5-3**
Power factor *	typ.	0.99	0.98	0.92	at 24V, 10A, see **Fig. 5-4**
Crest factor **	typ.	1.65	1.67	1.85	at 24V, 10A
Start-up delay	typ.	800ms	650ms	340ms	see **Fig. 5-2**
Rise time	typ.	8ms	8ms	8ms	0mF, 24V, 10A, see **Fig. 5-2**
	typ.	15ms	15ms	15ms	10mF, 24V, 10A, see **Fig. 5-2**
Turn-on overshoot	max.	20mV	20mV	20mV	see **Fig. 5-2**

* The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
** The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 5-1 **Input voltage range**

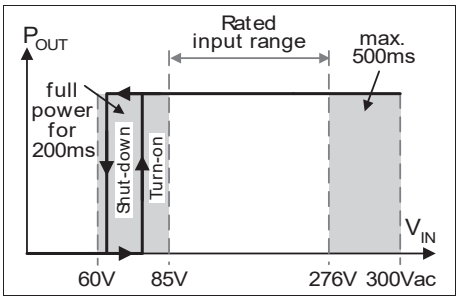


Fig. 5-2 **Turn-on behavior, definitions**

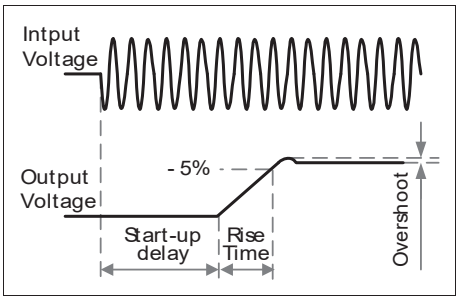


Fig. 5-3 **Input current vs. output load at 24V**

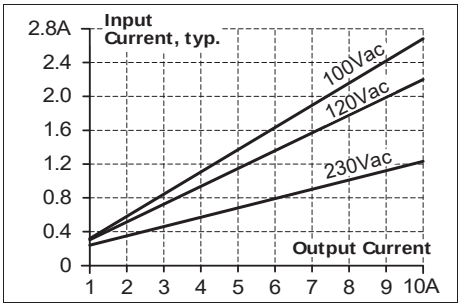
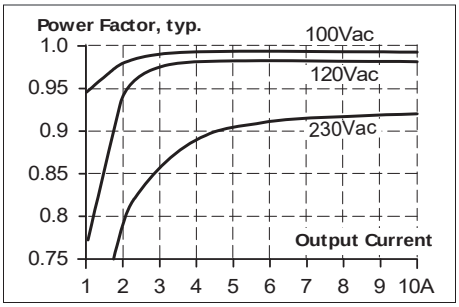


Fig. 5-4 **Power factor vs. output load**



1606-XLS240E 24V, 10A; Single Phase Input

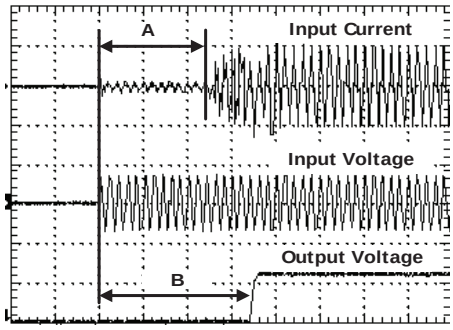
6. INPUT INRUSH CURRENT

An active inrush limitation circuitry limits the input inrush current after turn-on of the input voltage and after short input voltage interruptions.

The charging current into EMI suppression capacitors is disregarded in the first milliseconds after switch-on.

		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$10A_{peak}$	$10A_{peak}$	$10A_{peak}$	-25°C to +70°C
	typ.	$5A_{peak}$	$4A_{peak}$	$7A_{peak}$	-25°C to +70°C
Inrush energy	max.	$1A^2s$	$1A^2s$	$1A^2s$	-25°C to +70°C
Inrush delay	typ.	650ms	520ms	250ms	

Fig. 6-1 **Input inrush current, typical behavior**



A: Inrush delay
B: Start-up delay

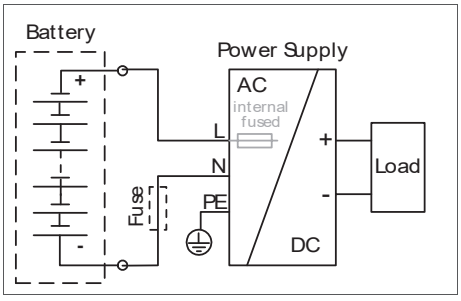
Input: 230Vac
Output: 24V, 10A
Ambient: 25°C

Upper curve: Input current 2A / DIV
Medium curve: Input voltage 500V / DIV
Lower curve: Output voltage 20V / DIV
Time basis: 100ms / DIV

7. DC-INPUT

DC input	nom.	DC 110-300V	
DC input range	min.	88-375Vdc	continuous operation
DC input current	typ.	2.37A / 0.87A	110Vdc / 300Vdc, 24V, 10A
Turn-on voltage	typ.	80Vdc	steady state value
Shut-down voltage	typ.	55Vdc	steady state value

Fig. 7-1 **Wiring for DC Input**



Instructions for DC use:

a) Use a battery or similar DC source.
b) Connect +pole to L and –pole to N.
c) Connect the PE terminal to a earth wire or to the machine ground.

When the –pole of the battery is not connected to earth, use an appropriate fuse to protect the N terminal.

1606-XLS240E 24V, 10A; Single Phase Input

8. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed, multi turn potentiometer
	max.	30V	at clockwise end position of potentiometer
Factory setting		24.1V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	60 to 300Vac
Load regulation	max.	100mV	static value, 0A → 10A → 0A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	7 000µF	

Continuous power capability

Output current	nom.	10A	at 24V, see **Fig. 8-1**
	nom.	9A	at 28V, see **Fig. 8-1**
Output power	nom.	240W	24V, continuous
	nom.	252W	28V, continuous
Short-circuit current	min.	8A	load impedance 100mOhm, see **Fig. 8-1**
	max.	12.5A	load impedance 100mOhm, see **Fig. 8-1**

Power-Boost, short term power capability (up to typ. 4s)

The power supply is designed to support loads with a higher short-term power requirement without damage or shutdown. The short-term duration is hardware controlled by an output power manager. The Power-Boost is repeatedly available. Detailed information can be found in section 27.1 .

Once Power-Boost has been stopped by the output power limiter, a timer disables the next Power-Boost capability. The recovery timer will start as soon as the output voltage reaches the adjusted value again, which usually happens after the load has been reduced.

Output current	nom.	15A	at 24V, see **Fig. 8-1**
	nom.	13.5A	at 28V, see **Fig. 8-1**
Output power	nom.	360W	24V, short term
	nom.	378W	28V, short term
Short-circuit current	min.	21A	load impedance 100mOhm, see **Fig. 8-1**
	max.	27A	load impedance 100mOhm, see **Fig. 8-1**
Power- Boost time	typ.	4s	at 24V, 15A, duration until the output voltage dips,
	min	3s	see **Fig. 8-2**
	max.	5s	
Power-Boost recovery time	typ.	7s	overload free time to reset power manager, see **Fig. 8-3**

Peak current capability (up to several ms)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 27.2.

Peak current voltage dips	typ.	from 24V to 20V	at 20A for 20ms
	typ.	from 24V to 22V	at 40A for 2ms
	typ.	from 24V to 15V	at 40A for 5ms

1606-XLS240E 24V, 10A; Single Phase Input

Fig. 8-1 **Output voltage vs. output current, typ.**

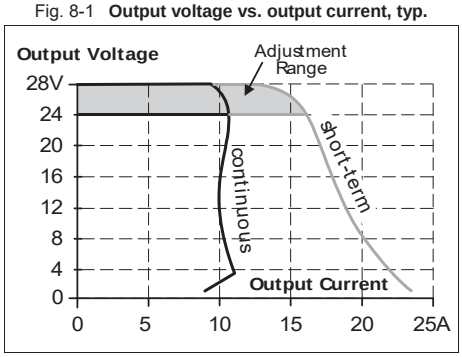


Fig. 8-2 **Power-Boost time vs. output power**

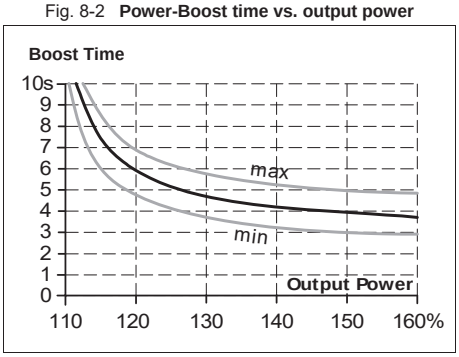
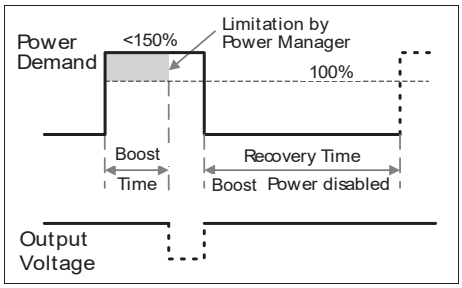


Fig. 8-3 **Power-Boost recovery time**



Power-Boost is available as soon as power comes on and immediately after the end of an output short circuit.

Fig. 8-4 **Power-Boost after input turn-on**

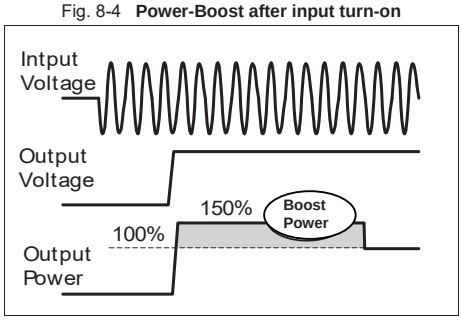
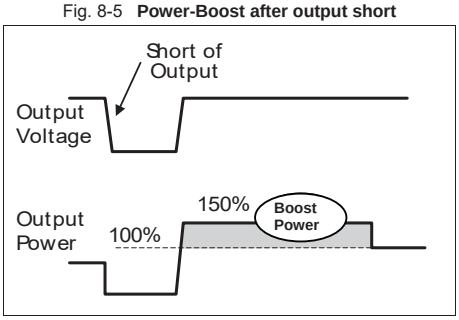


Fig. 8-5 **Power-Boost after output short**



1606-XLS240E 24V, 10A; Single Phase Input

9. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	26ms	27ms	28ms	10A, 24V, see **Fig. 9-1**
	typ.	51ms	53ms	55ms	5A, 24V, see **Fig. 9-1**

Fig. 9-1 **Hold-up time vs. input voltage**

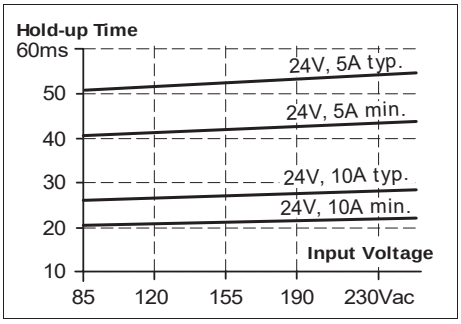
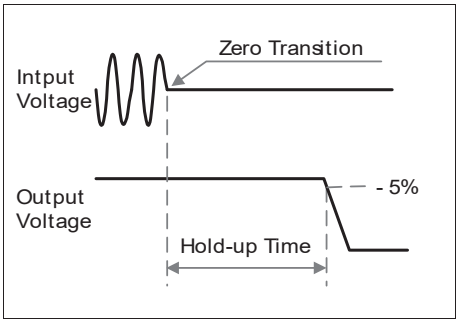


Fig. 9-2 **Shut-down behavior, definitions**



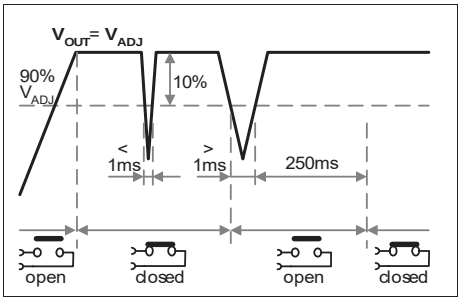
Note: At no load, the hold-up time can be up to one minute. The green DC-ok lamp is on during this time.

10. DC-OK RELAY CONTACT

This feature monitors the output voltage, which is produced by the power supply itself. It is independent of a back-fed voltage from a unit which is connected in parallel to the power supply output.

Contact closes	As soon as the output voltage reaches the adjusted output voltage.		
Contact opens	As soon as the output voltage dips more than 10% below the adjusted output voltage. Short dips will be extended to a signal length of 250ms. Dips shorter than 1ms will be ignored.		
Contact re-closes	As soon as the output voltage exceeds 90% of the adjusted voltage.		
Contact ratings	max	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min	1mA at 5Vdc	min. permissible load
Isolation voltage	See dielectric strength table in section 20		

Fig. 10-1 **DC-ok relay contact behavior**



Note:
The DC-ok feature requires that the output voltage reaches the nominal (=adjusted) level after turn-on in order to function according to specification. If this level cannot be achieved, the overload lamp will be on and the DC-ok contact will be open. The overload signal will only shut off as soon as the adjusted voltage is reached. This is an important condition to consider particularly, if the load is a battery, the power supply is used in parallel or the power supply is used for N+1 redundant systems.

1606-XLS240E 24V, 10A; Single Phase Input

11. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	91.2%	92.3%	93.0%	10A, 24V
Power losses	typ.	23.1W	20.0W	18.1W	10A, 24V
	typ.	5.6W	5.7W	5.9W	0A

Fig. 11-1 **Efficiency vs. output current at 24V**

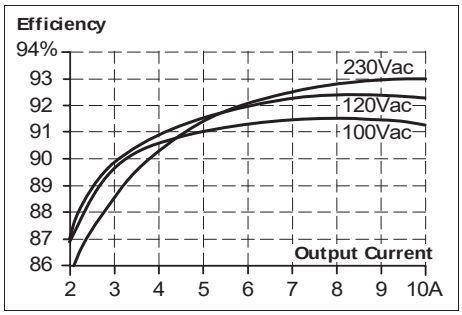


Fig. 11-2 **Losses vs. output current at 24V**

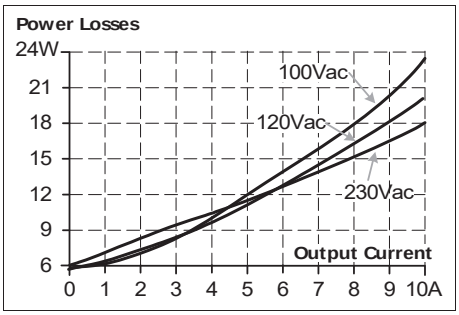


Fig. 11-3 **Efficiency vs. input voltage, 24V, 10A**

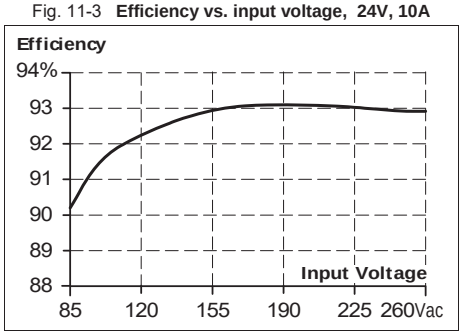
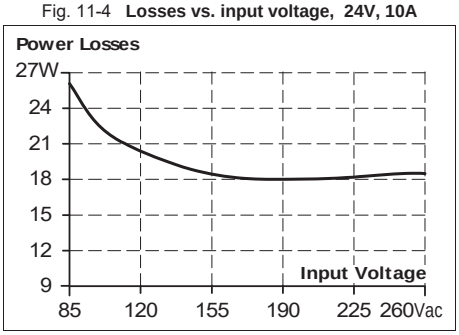


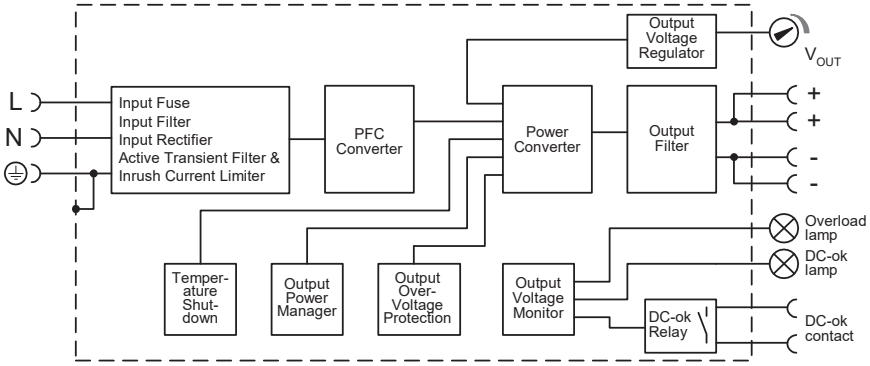
Fig. 11-4 **Losses vs. input voltage, 24V, 10A**



1606-XLS240E 24V, 10A; Single Phase Input

12. FUNCTIONAL DIAGRAM

Fig. 12-1 **Functional diagram**



13. PRODUCT FACE LABEL

Fig. 13-1 Front side

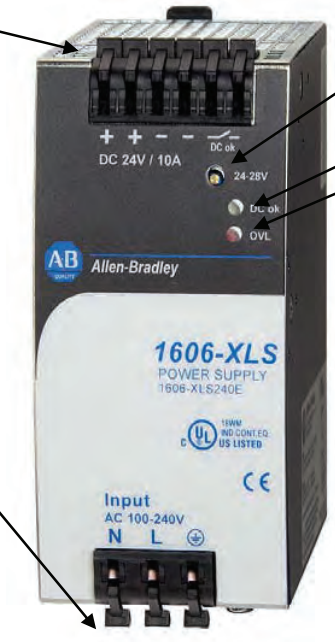
Output Terminals
Quick-connect spring-clamp terminals, no tools required

+ Positive output
- Negative (return) output
Dual pins per pole
DC ok Relay contact (NO-contact)

240W Continuous power /
360W Peak power

Input Terminals
Quick-connect spring-clamp terminals, no tools required
N … Neutral input
L … Line (hot) input
⏚ … PE (Protective Earth) input

See section 14 “Terminals and Wiring” to choose appropriate wire gauges



Output voltage potentiometer
(multi turn potentiometer)
Open the flap to tune the output voltage.
Factory setting: 24.1V

DC-ok lamp (green)
Overload lamp (red)

	Overload LED	DC-ok LED	DC-ok contact
Normal mode	OFF	ON	Closed
Power-Boost mode	OFF	ON	Closed
Overload (V_{OUT} < 90%)	ON	OFF	Open
Short-circuit (V_{OUT} = ca. 0V)	ON	OFF	Open
Over-temperature	Intermitted	OFF	Open
No input power	OFF	OFF	Open

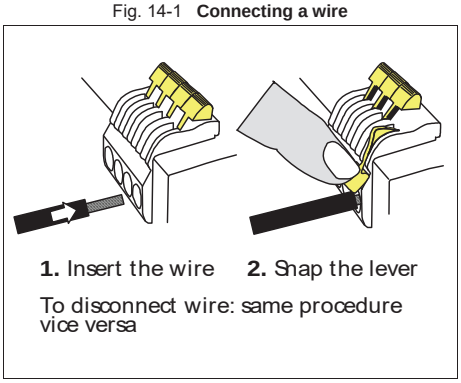
DC-ok lamp and DC-ok contact function synchronized

1606-XLS240E 24V, 10A; Single Phase Input

14. TERMINALS AND WIRING

Type	Bi-stable, quick-connect spring clamp terminals. IP20 Finger safe construction. Suitable for field- and factory installation. Shipped in open position.
Solid wire	0.5-6mm^2
Stranded wire	0.5-4mm^2
American wire gauge	20-10 AWG
Ferrules	allowed, but not required
Wire stripping length	10mm / 0.4inch
Pull-out force	10AWG:80N, 12AWG:60N, 14AWG:50N, 16AWG:40N (according to UL486E)

Fig. 14-1 **Connecting a wire**



Instructions:

a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C minimum.

b) Follow national installation codes and installation regulations!

c) Ensure that all strands of a stranded wire enter the terminal connection!

d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).

e) Do not use the unit without PE connection.

15. RELIABILITY

		AC 100V	AC 120V	AC 230V	
Lifetime expectancy	min.	40 000h	50 000h	57 000h	40°C, 24V, 10A
	min.	93 000h	100 000h	97 000h	40°C, 24V, 5A
	min.	114 000h	15 years	15 years	25°C, 24V, 10A
MTBF SN 29500, IEC 61709		478 000h	535 000h	581 000h	40°C, 24V, 10A
		827 000h	926 000h	1 005 000h	25°C, 24V, 10A
MTBF MIL HDBK 217F		334 000h	340 700h	345 000h	40°C, 24V, 10A, Ground Benign GB40
		460 000h	469 300h	474 000h	25°C, 24V, 10A, Ground Benign GB25

The **Lifetime expectancy** shown in the table indicates the operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors.

Lifetime expectancy is specified in operational hours. Lifetime expectancy is calculated according to the capacitor's manufacturer specification. The prediction model allows a calculation of up to 15 years from date of shipment.

MTBF stands for **M**ean **T**ime **B**etween **F**ailure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of the unit to fail and does not necessarily represent the life of a product.

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16. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. CE mark is in conformance with EMC guideline 89/336/EEC and 93/68/EEC and the low-voltage directive (LVD) 73/23/EWG.

EMC Immunity	EN 61000-6-1 EN 61000-6-2		Generic standards	
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-1GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N / L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	500V 500V	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	70% of 100Vac 40% of 100Vac 40% of 100Vac	70Vac, 10ms 40Vac, 100ms 40Vac, 1000ms	Criterion A Criterion C Criterion C
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Voltage sags	SEMI F47 0200		96Vac, 1000ms 84Vac, 500ms 60Vac, 200ms	Criterion A Criterion A Criterion A
Input voltage swells	RA internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criteria:
A: Power supply shows normal operation behavior within the defined limits.

C: Temporary loss of function is possible. Power supply might shut-down and restarts by itself. No damages or hazards for the power supply occur.

EMC Emission	EN 61000-6-3 and EN 61000-6-4	Generic standards
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
	EN 55022	Class B, output lines
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Fulfilled, active PFC
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled

This device complies with FCC Part 15 rules.
Operation is subjected to following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Switching Frequencies	The power supply has three converters with three different switching frequencies included. Two are nearly constant. The other one is input voltage and load dependent.	
Switching frequency 1	35kHz	nearly constant
Switching frequency 2	105kHz	nearly constant
Switching frequency 3	40kHz to 220kHz	input voltage and load dependent

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17. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	reduce output power above +60°C
Output de-rating	6W/°C	60-70°C (140°F to 158°F), see **Fig. 17-1**
Storage temperature	-40 to +85°C (-40°F to 185°F)	storage and transportation
Humidity	5 to 95% r.H.	IEC 60068-2-30 Do not energize while condensation is present
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Vibration random	$0.5m^2(s^3)$ 2 hours / axis	IEC 60068-2-64
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20 000ft)	Reduce output power or ambient temperature above 2000m sea level.
Output de-rating (for altitude)	15W/1000m or 5°C/1000m	above 2000m (6500ft), see **Fig. 17-2**
Over-voltage category	III	EN 50178, altitudes up to 2000m
	II	Altitudes from 2000m to 6000m
Degree of pollution	2	EN 50178, not conductive

Fig. 17-1 **Output current vs. ambient temp.,**

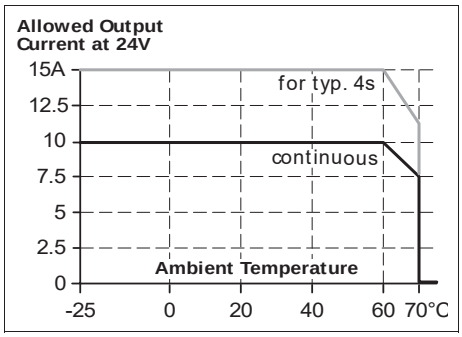
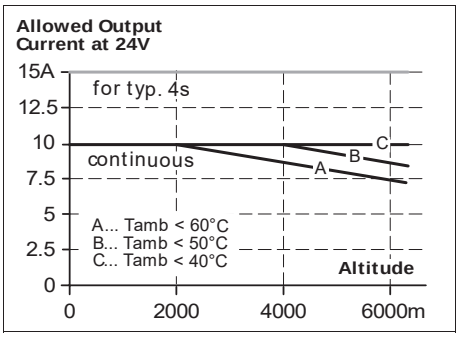


Fig. 17-2 **Output current vs. altitude**



The ambient temperature is defined as the air temperature 2cm below the unit.

1606-XLS240E 24V, 10A; Single Phase Input

18. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits	
Output over-voltage protection	typ. 35Vdc max. 39Vdc	In case of an internal power supply defect, a redundant circuitry limits the maximum output voltage. The output shuts-down and automatically attempts to restart.
Output over-current protection	Electronically limited	See **Fig. 8-1**
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.5mm	e.g. screws, small parts
Over-temperature protection	yes	output shut-down with automatic restart
Input transient protection	MOV (Metal Oxide Varistor) and active transient filter	
Internal input fuse	T6.3A H.B.C.	not user replaceable

Note: In case of a protection event, audible noise may occur.

19. SAFETY

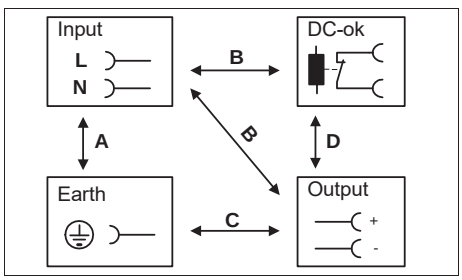
Input / output separation	SELV	IEC/EN 60950-1
	PELV	EN 60204-1, EN 50178, IEC 60364-4-41
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
PE resistance	< 0.1Ohm	between housing and PE terminal
Touch current (leakage current)	typ. 0.19mA	100Vac, 50Hz, TN mains
	typ. 0.29mA	120Vac, 60Hz, TN mains
	typ. 0.53mA	230Vac, 50Hz, TN mains
	< 0.25mA	110Vac, 50Hz, TN mains
	< 0.38mA	132Vac, 60Hz, TN mains
	< 0.74mA	264Vac, 50Hz, TN mains

20. DIELECTRIC STRENGTH

⚠WARNING

To fulfill the PELV requirements according to EN60204-1 § 6.4.1, we recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the protective earth system. This helps to avoid situations in which a load starts unexpectedly or can not be switched off any more when unnoticed earth faults occur.

Fig. 20-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac

Type tests and factory tests:
Conducted by the manufacturer. Do not repeat test in field!
Rules for field test:
Use appropriate test equipment which applies the voltage with a slow ramp! Connect L and N together as well as all output poles.

The output voltage is floating and has no ohmic connection to ground.

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21. APPROVALS

IEC 60950-1	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL us LISTED IND. CONT. EQ.	LISTED E198865 listed for use in U.S.A. (UL 508) and Canada (C22.2 No. 14-95) Industrial Control Equipment
UL 60950-1	c UL us	RECOGNIZED E137006 recognized for the use in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950) Information Technology Equipment, Level 5
UL 1604	c UL us	RECOGNIZED E246877 recognized for use in U.S.A. (UL 1604) and Canada (C22.2 No. 213-M1987) Hazardous Location Class I Div 2 T4 Groups A,B,C,D and Class I Zone 2 Groups IIA, IIB and IIC
	The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations as well as for Class I Zone 2 Groups IIA, IIB and IIC locations. Substitution of components may impair suitability for Class I Division 2 environment. Do not disconnect equipment unless power has been switched off. Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes.	
SEMI F47	SEMI F47 EPRI PEAC	SEMI F47-0200 Power Quality Star Ride-through compliance for semiconductor industry. Full SEMI range compliance (Input: 120Vac or 208Vac, output: 240W)

22. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN/IEC 61131-2	Programmable Controllers
EN 50178	Electronic Equipment in Power Installations

23. USED SUBSTANCES

The unit does not release any silicone and is suitable for use in paint shops.

Electrolytic capacitors included in this unit do not use electrolytes such as Quaternary Ammonium Salt Systems.

Plastic housings and other molded plastic materials are free of halogens, wires and cables are not PVC insulated.

The production material within our production does not include following toxic chemicals:
Polychlorized Biphenyl (PCB), Polychlorized Terphenyl (PCT), Pentachlorophenol (PCP), Polychlorinated naphthalene (PCN), Polybrom Biphenyll (PBB), Polybrom Bipheny-oxyd (PBO), Polybrominated Diphenylether (PBDE), Polychlorinated Diphenylether (PCDE), Polydibromphenyl Oxyd (PBDO), Cadmium, Asbest, Mercury, Silicia

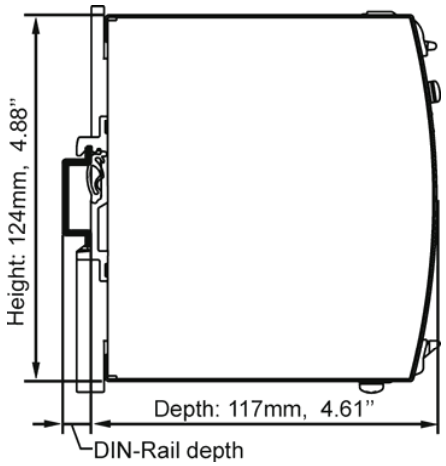
1606-XLS240E 24V, 10A; Single Phase Input

24. Physical Dimensions and Weight

Weight	900g / 1.98lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the depth (117mm) to calculate the total required installation depth.

Fig. 24-1 **Front view**

Fig. 24-2 **Side view**



25. Installation and Operation Instructions

⚠WARNING

Hazardous voltage inside device. Risk of electric shock, severe burns, or death.

- Do not use the unit without proper earth connection (Protective Earth). Use the pin on the terminal block for earth connection and not one of the screws on the housing.
- Turn power off before working on the power supply. Protect against inadvertent re-powering.
- Make sure the wiring is correct by following all local and national codes.
- Do not open, modify or repair the unit.
- Use caution to prevent any foreign objects from entering into the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
-

Mounting Orientation:
Output terminal must be located on top and input terminal on the bottom. For other orientations see section 27.14.

Cooling:
Convection cooled, no forced cooling required. Do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Installation clearances:
40mm on top, 20mm on the bottom, 5mm on the left and right side are recommended when loaded permanently with full power. In case the adjacent device is a heat source, 15mm clearance is recommended.

Service parts:
The unit does not contain any serviceable parts. The tripping of an internal fuse is caused by an internal defect.

1606-XLS240E 24V, 10A; Single Phase Input

26. ACCESSORIES

1606-XLB Wall mounting bracket

This bracket is used to mount Dimension units onto a flat surface without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the two steel brackets can be mounted.

Fig. 26-1 **1606-XLB Wall Mounting Bracket**

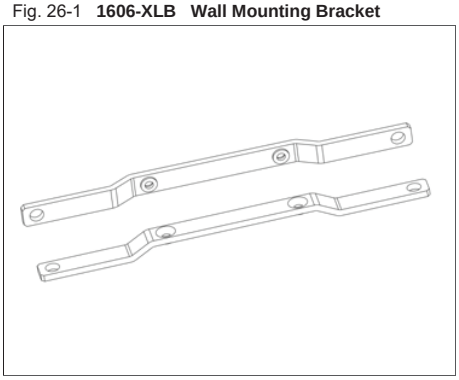
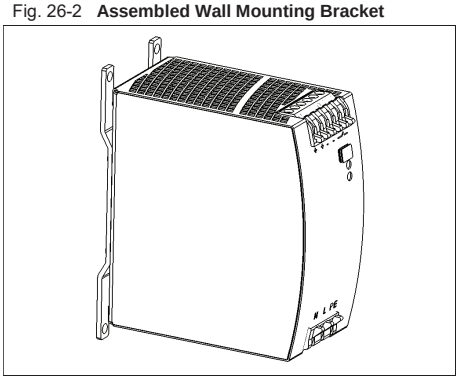


Fig. 26-2 **Assembled Wall Mounting Bracket**



27. APPLICATION NOTES

27.1. REPETITIVE PULSE LOADING

Typically, a load current is not constant. It varies over time. For pulse load compatibility, following rules must be met:

a) The pulse power demand must be below 150% of the nominal power.
b) The duration of the pulse power must be shorter than the allowed Power Boost Time. (see output section)
c) The average (R.M.S.) output current must be below the specified continuous output current.
If the R.M.S. current is higher, the unit will respond with a thermal shut-down after a while. Use the max. duty cycle curve (Fig. 27-2) to check if the average output current is below the nominal current.
d) For altitudes higher than 2000m reduce the pulse loading (15W/1000m) or the ambient temperature (5°C/1000m)

Fig. 27-1 **Repetitive pulse loads, definitions**

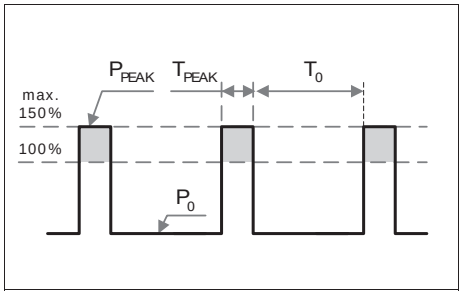
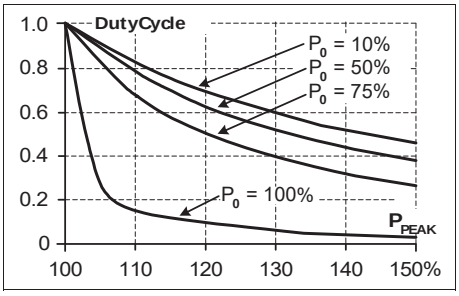


Fig. 27-2 Max. Duty Cycle Curve



1606-XLS240E 24V, 10A; Single Phase Input

P_0	Base load (W)
P_{PEAK}	Pulse load (above 100%)
T_0	Duration between pulses (s)
T_{PEAK}	Pulse duration (s)

$$DutyCycle = \frac{T_{peak}}{T_{peak} + T_0}$$

$$T_0 = \frac{T_{peak} - (DutyCycle \times T_{peak})}{DutyCycle}$$

Utilizing the Max. Duty Cycle Curve:

Example to determine the repetition rate of pulses without dipping of the output voltage:

Parameters of application:

Pulse length is T_{PEAK} = 1s

Steady state load P_0=120W (= 50% of I_{RATED})

Peak load P_{PEAK} = 360W (= 150% of I_{RATED})

Determining the repetition rate:

1) make a vertical line at P_{PEAK} = 150%
2) make a horizontal line where the vertical line crosses the P_0 = 50% curve
3) Read the Max. Duty Cycle from the Duty Cycle-axis (= 0.37)
4) Calculate the min. pause (base load) length T_0 :

$$T_0 = \frac{T_{peak} - (DutyCycle \times T_{peak})}{DutyCycle} = \frac{1s - (0.37 \times 1s)}{0.37} = \underline{\mathbf{1.7s}}$$

5) Pulse length = 1s, min. pause length = 1.7s
6) Max. repetition rate = pulse length +pause length = **2.7s**

More examples for pulse load compatibility:

P_{PEAK}	P_0	T_{PEAK}	T_0
360W	240W	1s	>25s
360W	0W	1s	>1.3s
300W	120W	1s	> 0,75s

P_{PEAK}	P_0	T_{PEAK}	T_0
360W	120W	0.1s	>0.16s
360W	120W	1s	>1.6s
360W	120W	3s	>4.9s

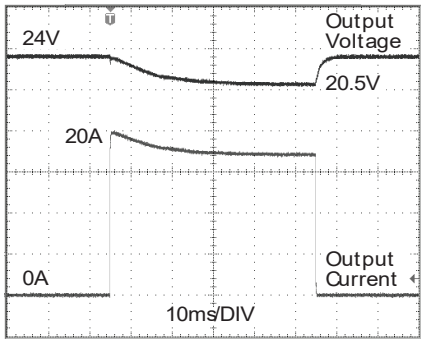
27.2. Peak Current Capability

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady state current and usually exceeds the nominal output current (including the Power Boost) The same situation applies, when starting a capacitive load.

Branch circuits are often protected with circuit breakers or fuses. In case of a short or an overload in the branch circuit, the fuse needs a certain amount of over-current to trip or to blow. The peak current capability ensures the safe operation of subsequent circuit breakers.

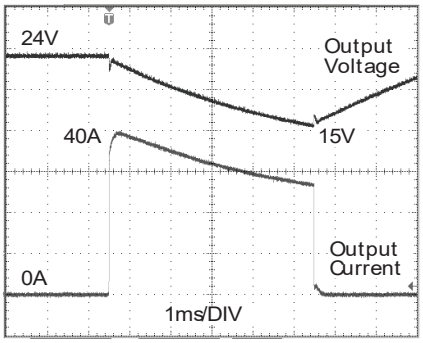
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 27-3 **Peak load 20A for 50ms, typ.**



Peak load 20A (resistive) for 50ms
Output voltage dips from 24V to 20.5V.

Fig. 27-4 **Peak load 40A for 5ms, typ.**



Peak load 40A (resistive) for 5ms
Output voltage dips from 24V to 15V.

Please note: The DC-OK relay triggers when the voltage dips more than 10% for longer than 1ms.

1606-XLS240E 24V, 10A; Single Phase Input

27.3. Back-feeding Loads

Loads such as decelerating motors and inductors can feed voltage back to the power supply. This feature is also called return voltage immunity or resistance against Back- E.M.F. (Electro Magnetic Force).

This power supply is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter whether the power supply is on or off.

The maximum allowed feed back voltage is 35Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 8.

27.4. Charging of Batteries

The power supply can be used for float-charging of lead-acid or maintenance free 24V VRLA batteries.

Instructions for charging batteries:

a) Set the output voltage, at disconnected load, very precisely to the end-of-charge voltage according to the expected battery temperature.

End-of-charge voltage	27.8V	27.5V	27.15V	26.8V
Battery temperature	10°C	20°C	30°C	40°C

b) Use a 15A or16A circuit breaker (or blocking diode) between the power supply and the battery.

c) Ensure that the output current of the power supply is below the allowed charging current of the battery.

d) Use only matched batteries when putting 12V types in series.

e) The return current to the power supply is typ. 3mA at 25Vdc when the power supply is switched off (except in case a blocking diode is utilized).

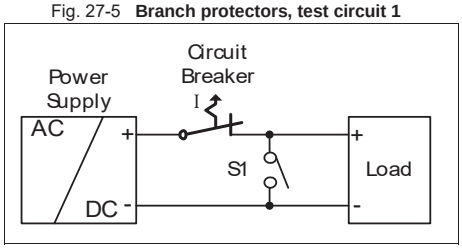
27.5. Output Circuit Breakers

Standard miniature circuit breakers (MCBs) can be used for branch protection. Ensure that the MCB is rated for DC voltage, too. The following tests show which circuit breakers the power supply typically trips.

Circuit breakers have huge tolerances in their tripping behavior. Therefore, these typical tests can only be used as a recommendation or for comparing two different power supplies. Furthermore, the loop impedance has a major influence on whether a breaker trips or not. Two tests were performed, representing typical situations:

Test 1: Short circuit with S1 on the power supply end of the cable (loop impedance approx. 20mOhm)

Fig. 27-5 **Branch protectors, test circuit 1**



Parameters:

Input voltage: 230Vac, load current: 0A
Tripping time shorter than 5s.

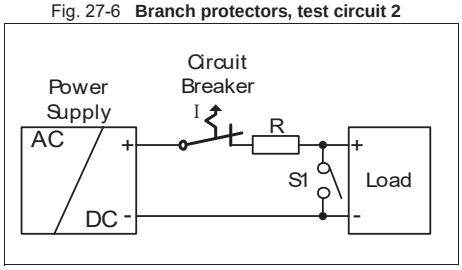
The following circuit breaker tripped during the test:

A- or **Z**- Characteristic:: equal or smaller 25A
B- Characteristic: equal or smaller 16A
C- Characteristic: equal or smaller 13A

1606-XLS240E 24V, 10A; Single Phase Input

Test 2: Short circuit with S1 on the load end (additional impedance included; represents longer load wire length).

Fig. 27-6 **Branch protectors, test circuit 2**



Parameters:

Input voltage: 230Vac, load current: 0A
Tripping time shorter than 5s.

The following circuit breaker tripped during the test:

A- or **Z**- Characteristic:: ≤ 16A and R< 82mOhm
B- Characteristic: ≤ 6A and R< 180mOhm
C- Characteristic: ≤ 4A and R< 220mOhm

What does this resistance mean in wire length?

	0.5mm²	0.7mm²	1.0mm²	1.5mm²	2.5mm²	4.0mm²
82mOhm	2.3m	3.2m	4.6m	6.9m	11.4m	18.3m
180mOhm	5.0m	7.0m	10.0m	15.0m	25.1m	40.1m
220mOhm	6.1m	8.6m	12.3m	18.4m	30.6m	49.0m

Example:
Which wire gauge must be used to trip a B-Characteristic circuit breaker with a rating of 6A? The load wire length is 21m.

Answer: A 6A B-Characteristic circuit breaker requires a loop impedance of less than 180mOhm (test results). The wire length table shows that up to 25.1m wire with a cross section of 2.5mm^2 are below 180mOhm. A wire not smaller than 2.5mm^2 shall be used.

27.6. External Input Protection

The unit is tested and approved for branch circuits up to 20A. External protection is only required if the supplying branch has an ampacity greater than this. In some countries local regulations might apply. Check also local codes and local requirements.

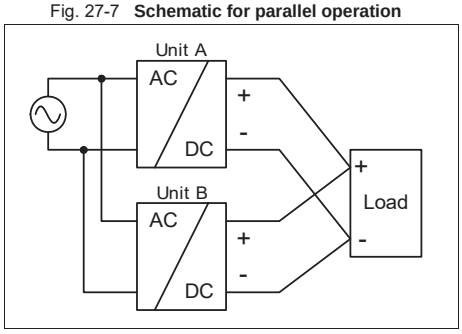
If an external fuse is necessary or utilized, a minimum value is required to avoid undesired tripping of the fuse.

		B-Characteristic	C-Characteristic
Ampacity	max.	20A	20A
	min.	6A	4A

27.7. Parallel Use to Increase Output Power

Power supplies can be paralleled to increase the output power.

Fig. 27-7 **Schematic for parallel operation**



Instructions for parallel use:

a) Use only power supplies from the same series (XLS).
b) Adjust the output voltages of all power supplies to approximately the same value (±500mV). Otherwise, the DC-ok signal might not work properly.
c) A fuse (or diode) on the output is only required if more than three units are connected in parallel.
d) Do not load terminals with more than 25A. Follow wiring instructions according to section 27.9
e) Keep an installation clearance of 15mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

1606-XLS240E 24V, 10A; Single Phase Input

27.8. Parallel Use for Redundancy

Power supplies can be paralleled for redundancy to gain a higher system availability. Redundant systems require a certain amount of extra power to support the load in case one power supply unit fails. The simplest way is to put two XLS power supplies in parallel. This is called a 1+1 redundancy. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. Five power supplies, each rated for 10A are paralleled to build a 40A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a - virtually nearly impossible - case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the decoupling module 1606-XLSRED.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.
b) Monitor the individual power supply units. A DC-ok lamp and a DC-ok contact is already included in the units This feature reports a faulty unit.
c) When possible, connect each power supply to different phases or circuits.
d) It is desirable to set the output voltages of all power supplies to the same value to avoid a false DC-ok signal.

27.9. Daisy Chaining of Outputs

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the maximum current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block.

Fig. 27-8 **Daisy chaining of outputs**

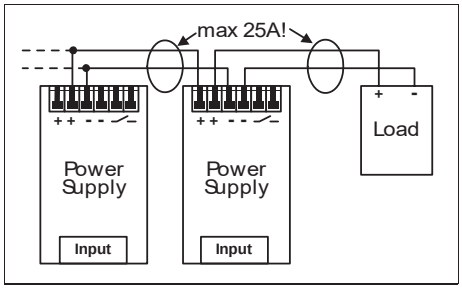
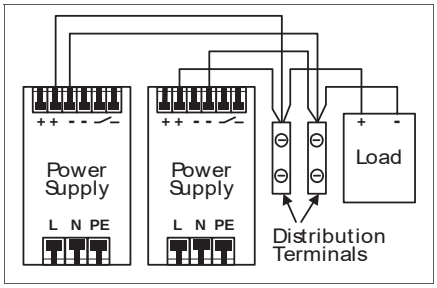


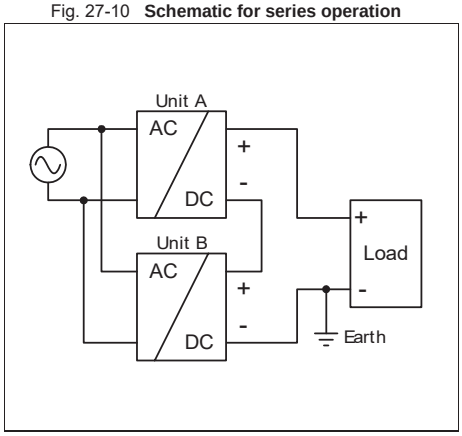
Fig. 27-9 **Using distribution terminals**



27.10. Series Operation

The power supply can be put in series to increase the output voltage.

Fig. 27-10 **Schematic for series operation**



Instructions for use in series:

a) It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc.
b) **Warning !** Voltages with a potential above 60Vdc are not SELV any more and can be dangerous. Such voltages must be installed with a protection against touching.
c) For serial operation use power supplies of the same type.
d) Earthing of the output is required when the sum of the output voltage is above 60Vdc.
e) Keep an installation clearance of 15mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

Note: Avoid return voltage (e.g. from a decelerating motor or battery) which is applied to the output terminals.

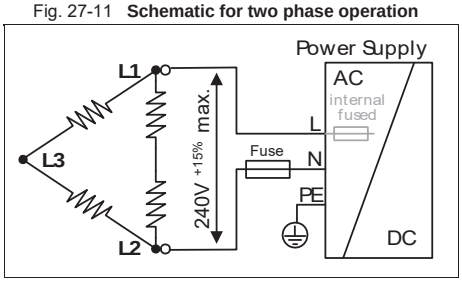
1606-XLS240E 24V, 10A; Single Phase Input

27.11. Inductive and Capacitive Loads

The unit is designed to supply any kind of load, including unlimited capacitive and inductive loads.

27.12. Operation on Two Phases

Fig. 27-11 **Schematic for two phase operation**



Instructions for two phase operation:

a) A phase to phase connection is allowed as long as the supplying voltage is below 240V(+15%)

b) Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire.

Appropriate fuses or circuit breakers are specified in section 27.6 “External Input Protection”.

27.13. Use in a Tightly Sealed Enclosure

When the power supply is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. The inside temperature defines the ambient temperature for the power supply.

Results from such an installation:

Power supply is placed in the middle of the box, no other heat producer inside the box

Enclosure:	Typ IP66 Box PK 9519 100, plastic, 180x180x165mm
Load:	24V, 8A; (=80%) load is placed outside the box
Input:	230Vac
Temperature inside enclosure:	48°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside enclosure:	27°C
Temperature rise:	21°C

1606-XLS240E 24V, 10A; Single Phase Input

27.14. Mounting Orientations

Mounting orientations other than input terminals on the bottom and output on the top require a reduction in continuous output power or a limitation in the max. allowed ambient temperature. The amount of reduction influences the lifetime expectancy of the power supply. Therefore, two different derating curves for continuous operation can be found below:

Curve A1 Recommended output current.
Curve A2 Max allowed output current (results approx. in half the lifetime expectancy of A1).

Fig. 27-12
Mounting Orientation A
Standard Orientation

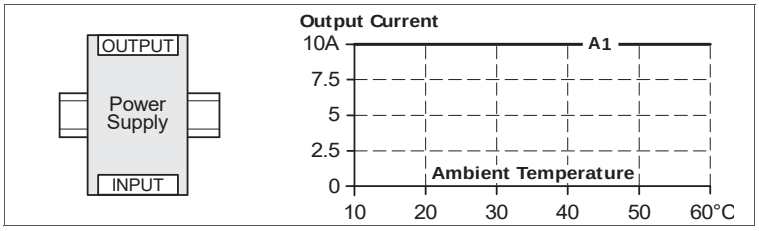


Fig. 27-13
Mounting Orientation B
(Upside down)

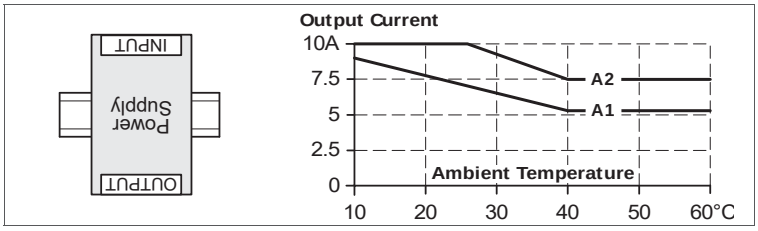


Fig. 27-14
Mounting Orientation C
(Table-top mounting)

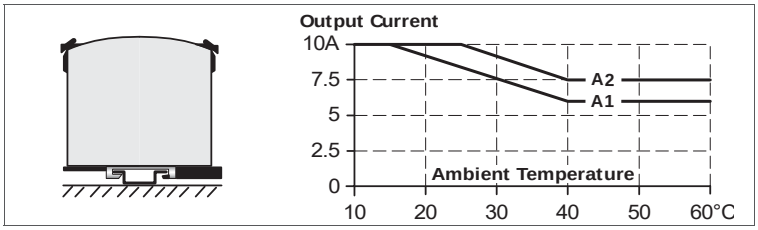


Fig. 27-15
Mounting Orientation D
(Horizontal cw)

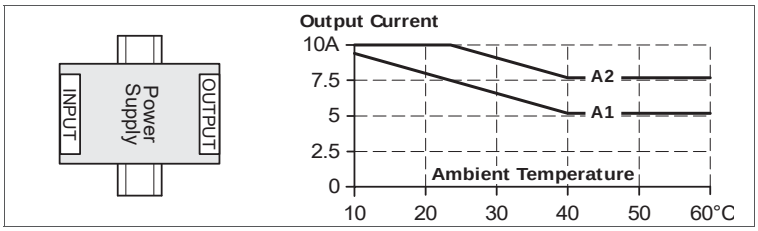
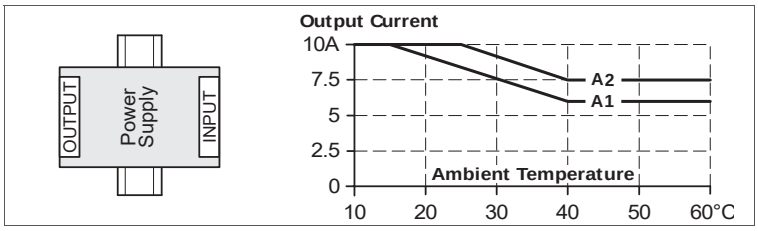


Fig. 27-16
Mounting Orientation E
(Horizontal ccw)



1 EN **Instruction Manual** **DC Power Supply**
2 DE **Bedienungsanleitung** **DC Stromversorgung**
3 FR **Manual d'instructions** **DC Alimentation d'Énergie**
4 ES **Manual de instrucciones** **DC Fuente De Alimentación**
5 IT **Manuale di Istruzione** **DC Gruppo di alimentazione**
6 PT **Manual de Instruções** **DC Fonte De Alimentação**

Rockwell Automation

1606-XLS180
1606-XLS240

Read this first! English 1

Before operating this unit please read this manual thoroughly and retain this manual for future reference! This device may only be installed and put into operation by qualified personnel. If damage or malfunction should occur during operation, immediately turn power off and send unit to the factory for inspection. The unit does not contain serviceable parts. The tripping of an internal fuse (if included) is caused by an internal defect. The information presented in this document is believed to be accurate and reliable and may change without notice. For any clarifications the English translation will be used.

Intended Use: This power supply is designed for installation in an enclosure and is intended for general use such as in industrial control, office, communication, and instrumentation equipment. Do not use this power supply in aircraft, trains and nuclear equipment where malfunction may cause severe personal injury or threaten human life.

⚠ WARNING

Risk of electrical shock, fire, personal injury or death.
1) Do not use the power supply without proper grounding (Protective Earth).
2) Turn power off before working on the device. Protect against inadvertent re-powering.
3) Make sure that the wiring is correct by following all local and national codes.
4) Do not modify or repair the unit.
5) Do not open the unit as high voltages are present inside.
6) Use caution to prevent any foreign objects from entering the housing.
7) Do not use in wet locations or in areas where moisture or condensation can be expected.
8) Do not touch during power-on, and immediately after power-off. Hot surfaces may cause burns.

CAUTION

Reduction of output current may be necessary when:
1) Minimum installation clearance can not be met.
2) Altitude is higher than 2000m.
3) Device is used above +60°C ambient.
4) Mounting orientation is other than input terminal located at the bottom and output at the top.
5) Airflow for convection cooling is obstructed.

Details for de-rating can be found in this manual and in the datasheet of the unit..

WARNING EXPLOSION HAZARDS (Notes for use in hazardous locations only)
Units which are marked with "Class I Div 2" are suitable for use in non-hazardous or Class I Division 2 Groups A, B, C, D locations only. Substitution of components may impair suitability for Class I Division 2 environment. Do not disconnect equipment unless power has been switched off. Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes. Units which are marked with "**EX (Hexagon Symbol) II 3G Ex nA nC IIC T4** are suitable for use in Class 1 Zone 2 Groups IIa, IIb and IIc locations and must be built-in in an IP54 enclosure. Number of ATEX certificate: EPS 09 ATEX 1 236 X

Vor Inbetriebnahme lesen! Deutsch 2

Bitte lesen Sie diese Warnungen und Hinweise sorgfältig durch, bevor Sie das Gerät in Betrieb nehmen. Bewahren Sie die Anleitung zum Nachlesen auf. Das Gerät darf nur durch fachkundiges und qualifiziertes Personal installiert werden. Bei Funktionsstörungen oder Beschädigungen schalten Sie sofort die Versorgungsspannung ab und senden das Gerät zur Überprüfung ins Werk. Das Gerät beinhaltet keine Servicebauteile. Interne Sicherungen (falls vorhanden) lösen nur bei Gerätedefekt aus. Die angegebenen Daten dienen allein der Produktbeschreibung und sind nicht als zugesicherte Eigenschaften im Rechtssinne aufzufassen. Im Zweifelsfall gilt der englische Text.

Bestimmungsgemäßer Gebrauch: Diese Stromversorgung ist für den Einbau in ein Gehäuse konzipiert und zur Verwendung für allgemeine elektronische Geräte, wie z.B. Industriesteuerungen, Bürogeräte, Kommunikationsgeräte oder Messgeräte geeignet. Benutzen Sie diese Stromversorgung nicht in Steuerungsanlagen von Flugzeugen, Zügen oder nuklearen Einrichtungen, in denen eine Funktionsstörung zu schweren Verletzungen führen oder Lebensgefahr bedeuten kann.

⚠ WARNUNG

Missachtung nachfolgender Punkte kann einen elektrischen Schlag, Brände, schwere Unfälle oder Tod zur Folge haben.
1) Betreiben Sie die Stromversorgung nie ohne Schutzleiter.
2) Schalten Sie die Eingangsspannung vor Installations-, Wartungs- oder Änderungsarbeiten ab und sichern Sie diese gegen unbeabsichtigtes Wiedereinschalten.
3) Sorgen Sie für eine ordnungsgemäße und fachgerechte Verdrahtung.
4) Führen Sie keine Änderungen oder Reparaturversuche am Gerät durch.
5) Gerät niemals öffnen. Im Inneren befinden sich gefährliche Spannungen.
6) Verhindern Sie das Eindringen von Fremdkörpern, wie z.B. Büroklammern und Metallteilen.
7) Betreiben Sie das Gerät nicht in feuchter Umgebung oder in einer Umgebung, bei der mit Betauung oder Kondensation zu rechnen ist.
8) Gehäuse nicht während des Betriebes oder kurz nach dem Abschalten berühren. Heiße Oberflächen können Verletzungen verursachen.

VORSICHT

Rücknahme der Ausgangsleistung kann erforderlich sein:
1) wenn die minimalen Einbauabstände nicht eingehalten werden können.
2) bei Aufstellhöhen über 2000m.
3) Betrieb bei Umgebungstemperaturen über +60°C.
4) bei Einbaulagen abweichend von der Standardeinbaulage (Eingang unten, Ausgang oben).
5) bei behinderter Luftzirkulation.

Details zur Leistungsrücknahme befinden sich in dieser Betriebsanleitung oder im Datenblatt des Gerätes.

ACHTUNG EXPLOSIONSGEFAHR! (Hinweise für den Betrieb in explosionsgefährdeter Umgebung)
Geräte, die am Leistungsschild mit "Class I Div 2" gekennzeichnet sind, sind für den Einsatz in Klasse I Division 2 Gruppen A,B,C,D oder für nicht explosionsgefährdete Aufstellorte geeignet. Veränderungen an Bauteilen können die Tauglichkeit für Klasse I Division 2 beeinträchtigen. Anschlüsse nicht trennen, solange Spannung anliegt. Anschluss muss unter Berücksichtigung der Anforderungen nach Klasse I Division 2 Artikel 501-4(b) des National Electrical Code, NFPA 70, erfolgen. Geräte, die am Leistungsschild mit "**EX (Hexagon Symbol) II 3G Ex nA nC IIC T4** gekennzeichnet sind, können an Klasse 1 Zone 2 Gruppe IIa, IIb and IIc Aufstellorten verwendet werden. Die Stromversorgungen müssen in ein IP54 Gehäuse eingebaut werden. Nummer des Zertifikates: EPS 09 ATEX 1 236 X.

A lire avant mise sous tension! Français 3

Merci de lire ces instructions de montage et d'entretien avant de mettre l'alimentation sous tension. Conservez ce manuel qui vous sera toujours utile. Cette alimentation doit être installée par du personnel qualifié et compétent. Le déclenchement du fusible interne traduit très probablement un défaut au niveau de l'appareil. Si un défaut quelconque apparaît en cours de fonctionnement, débrancher au plus vite l'alimentation. Dans ce deux cas de figure, il convient de faire contrôler l'alimentation en usine! Les données indiquées dans ce document servent uniquement à donner une description du produit et n'ont aucune valeur juridique. En cas de divergences, le texte anglais fait foi.

Utilisation: Cet appareil est conçu pour être installé dans une armoire et pour tous les équipements électroniques, tel que l'équipement industriel de commande, l'équipement de bureau, le matériel de communication et les instruments de mesures. N'utilisez pas cet appareil pour l'équipement de commandes dans les avions, les trains et l'équipement atomique où un problème de fonctionnement de l'alimentation pourrait causer des blessures graves ou menacer la vie humaine.

⚠ AVERTISSEMENT

Prendre en compte les points suivants, afin d'éviter toute détérioration électrique, incendie, dommage aux personnes ou mort.
1) ne jamais faire fonctionner l'alimentation sans raccordement à la terre !
2) débrancher l'installation avant toute intervention sur l'alimentation (ou démontage) et s'assurer qu'il n'y a pas risque de redémarrage.
3) s'assurer que le câblage a été fait selon les prescriptions
4) ne pas effectuer de réparations ou modifications sur l'alimentation
5) ne pas ouvrir l'appareil. Des tensions importantes passent à l'intérieur.
6) veiller à ce qu'aucun objet ne rentre en contact avec l'intérieur de l'alimentation (trombones, pièces métalliques)
7) ne pas faire fonctionner l'appareil dans un environnement humide ou à l'extérieur, non protégé. Ne pas utiliser l'appareil dans un environnement où il peut y avoir de la condensation.
8) ne pas toucher le carter pendant le fonctionnement ou après la mise sous tension. Surface chaude risquant d'entraîner des blessures.

ATTENTION

Des limitations de puissance de sortie peuvent apparaître si :
1) les distances d'installation mini. ne peuvent être observées
2) installation à une altitude > 2000 m
3) pour des fonctionnements en charge et avec une température ambiante > 60°C
4) pour des positions de montage différentes de la préconisation standard (entrée dessous, sortie en haut).
5) lorsque la circulation d'air est gênée

D'autres informations sont disponibles dans la documentation de mise en service

ATTENTION RISQUE D' EXPLOSION (Utilisation Class I Div 2)
Les appareils portant la marque 'Class I Div 2' au niveau de la plaque signalétique sont prévus pour fonctionner en Classe I, Division 2, Groupes A,B,C,D ou pour un environnement non explosif et non dangereux. Le remplacement de composants peut rendre le matériel impropre à une utilisation en Classe 1, Division 2. Ne déconnecter l'équipement qu' hors tension ou en zone connue comme non dangereuse. Le raccordement doit obligatoirement tenir compte des exigences de la classe 1, division 2, article 501-4(b) du National Electrical Code, NFPA 70.

Lea primero! Español 4

Conserve este manual como referencia para futuras consultas. La fuente de alimentación solo puede ser instalada y puesta en funcionamiento por personal cualificado. Por favor lea detenidamente este manual antes de conectar la fuente de alimentación. Cuando se funde un fusible interno, existe gran probabilidad de un fallo interno en el equipo.Si se produce un fallo o mal funcionamiento durante la operación, desconecte inmediatamente la tensión de alimentación. En ambos casos, el equipo debe ser inspeccionado en fábrica. La información presentada en este documento es exacta y fiable en cuanto a la descripción del producto y puede cambiar sin aviso. En casa de duda, prevalece el texto inglés.

Uso apropiado: Este equipo ha sido diseñado para su instalación en un ambiente cerrado y ha sido concebido para uso general en instalaciones de control industrial, oficinas, comunicaciones y equipos de instrumentación. No emplee este equipo en aeronaves, trenes e instalaciones atómicas, donde un mal funcionamiento de la fuente de alimentación puede ocasionar lesiones graves o riesgo mortal.

⚠ ADVERTENCIA

Riesgo de descarga eléctrica, incendio, accidente grave o muerte.

1) No conectar nunca la unidad sin conexión de puesta a tierra.
2) Desconectar la tensión de red antes de trabajar en la fuente de alimentación. Evite una posible reconexión involuntaria.
3) Asegurarse de que el cableado es correcto de acuerdo a los códigos locales y nacionales.
4) No realizar ninguna modificación o reparación de la unidad.
5) No abrir nunca la unidad. En el interior existe riesgo de altas tensiones.
6) Evitar la introducción en la carcasa de objetos extraños.
7) No usar el equipo en ambientes húmedos. No operar el equipo en ambientes donde se espere la formación de rocío o condensación.
8) No tocar durante el funcionamiento ni inmediatamente después del apagado. El calor de la superficie puede causar quemaduras graves

ATENCIÓN

La deriva en la tensión de salida se produce:

1) cuando no pueden mantenerse las distancias mínimas de montaje.
2) en caso de que el montaje se realice en altitudes superiores a los 2000 m.
3) en caso de funcionamiento a plena carga y temperaturas ambientales superiores a +60ºC.
4) en caso de posiciones de montaje diferentes a la posición de montaje estándar (terminales de entrada abajo y terminales de salida arriba).
5) en caso de que la circulación de aire para la refrigeración por conducción esté obstruida.

Puede encontrar más detalles del caso de deriva en este manual.

ATENCIÓN PELIGRO DE EXPLOSIÓN! (Uso apropiado Class I Div 2)
Los equipos marcados con la expresión "Class I Div 2" son adecuados para su uso en ambientes no peligrosos y en entornos con la Clase I División 2 Grupos A, B, C, D. La sustitución de componentes puede perjudicar la idoneidad para la Clase I División 2. No desconecte el equipo a menos que la tensión de alimentación esté desconectada.
El conexionado debe cumplir con la Clase I División 2 métodos de conexión del Código Nacional Eléctrico NFPA 70 o con el resto de códigos locales o nacionales.

Leggere prima questa parte! Italiano 5

Prima di collegare il sistema di alimentazione elettrica si prega di leggere attentamente le seguenti avvertenze. Conservare le istruzioni per la consultazione futura. Il sistema di alimentazione elettrica deve essere installato solo da personale competente e qualificato. In caso di intervento del fusibile interno, molto probabilmente l'apparecchio è guasto. Se durante il funzionamento si verificano anomalie o guasti, scollegare immediatamente la tensione di alimentazione. In entrambi i casi è necessario far controllare l'apparecchio dal produttore! I dati sono indicati solo a scopo descrittivo del prodotto e non vanno considerati come caratteristiche garantite dell'apparecchio.In caso di differenze o problemi è valido il testo inglese

Uso previsto: Questo apparecchio è previsto per il montaggio in un rack per moduli elettronici, ad esempio per controllori industriali, apparecchiature per ufficio, unità di comunicazione o apparecchi di misura. Non utilizzare l'apparecchio in impianti di controllo di aerei, di treni o di impianti nucleari in cui il suo eventuale guasto può comportare gravi lesioni o la morte di persone.

⚠ AVVERTENZA

Il mancato rispetto delle seguenti norme può provocare folgorazione elettrica, incendi, gravi incidenti e perfino la morte.

1) Non far funzionare in nessun caso il sistema di alimentazione elettrica senza conduttore di protezione!
2) Prima di eseguire interventi di installazione, di manutenzione o di modifica scollegare la tensione di rete ed adottare tutti i provvedimenti necessari per impedirne il ricollegamento non intenzionale.
3) Assicurare un cablaggio regolare e corretto.
4) Non tentare di modificare o di riparare da soli l'apparecchio.
5) Non aprire l'apparecchio. Al suo interno sono applicate tensioni elettriche pericolose.
6) Impedire la penetrazione di corpi estranei nell'apparecchio, ad esempio fermagli o altri oggetti metallici.
7) Non far funzionare l'apparecchio in un ambiente umido. Non far funzionare l'apparecchio in un ambiente soggetto alla formazione di condensa o di rugiada.
8) Non toccare quando acceso e subito dopo lo spegnimento. La superficie calda può causare scottature.

ATTENZIONE

È necessario ridurre la potenza di uscita se:

1) non è possibile rispettare le distanze minime di montaggio;
2) l'apparecchio viene installato in un luogo di altitudine maggiore di 2000 m;
3) il funzionamento è a pieno carico a temperatura ambiente maggiore di +60°C;
4) la posizione di montaggio differisce da quella standard (ingresso in basso, uscita in alto).
5) è ostacolata la libera circolazione dell'aria.

Ulteriori informazioni sono riportate in questo manuale.

ATTENZIONE: PERICOLO DI ESPLOSIONE! (Uso previsto Class I Div 2)
Gli apparecchi la cui targhetta riporta "Class I Div 2" sono adatti per l'impiego in ambienti di classe I, divisione 2, gruppi A, B, C e D o non soggetti al pericolo di esplosione. La modifica dei componenti possono influenzare negativamente l'idoneità per ambienti di classe I, divisione 2.Non aprire i morsetti con tensione di alimentazione collegata. Il collegamento deve essere eseguito nel rispetto dei requisiti previsti dalla classe I, divisione 2, articolo 501-4(b) del National Electrical Code, NFPA 70.

Leia primeiro! Português 6

Recomendamos a leitura cuidadosa das seguintes advertências e observações, antes de colocar em funcionamento a fonte de alimentação. Guarde as Instruções para futura consulta, em casos de dúvida. A fonte de alimentação deverá ser instalada apenas por profissionais da área, tecnicamente qualificados. Se o fusível interno se fundir, é grande a possibilidade de existir um defeito no aparelho. Se por acaso, durante a utilização ocorrer algum defeito de funcionamento ou dano, desligue imediatamente a tensão de alimentação. Em ambos os casos, será necessária uma verificação na Fábrica! Os dados mencionados têm como finalidade somente a descrição do produto, e não devem ser interpretados como propriedades garantidas no sentido jurídico. Em caso de duvidas aplica-se o texto em inglês.

Utilize: Apenas para o fim pré-estabelecido. Este aparelho foi concebido para ser montado dentro de invólucros, caixas ou armários para aparelhos eletrônicos em geral, como, por exemplo, comandos de instalações industriais, aparelhos para escritórios, aparelhos de comunicação ou instrumentos de medida e quadros eléctricos. Não utilize este aparelho em sistemas de comando de aviões, de comboios ou em instalações movidas por energia nuclear, nos quais um defeito de funcionamento poderá causar danos graves ou significar risco de morte.

⚠ ATENÇÃO

A não observância ou o incumprimento dos pontos a seguir mencionados, poderá causar uma descarga elétrica, incêndios, acidentes graves ou morte.

1) Não use a fonte de alimentação sem o condutor de proteção terra!
2) Antes de trabalhos de instalação, manutenção ou modificação, desligue a tensão de alimentação, protegendo-a contra uma nova ligação involuntária.
3) As ligações devem ser efectuadas apenas por profissionais competentes.
4) Não efectue nenhuma modificação ou tentativa de reparação no aparelho. Quando necessário contacte o seu distribuidor.
5) Não abra o aparelho mesmo quando desligado. No seu interior existem condensadores que podem estar carregados electricamente.
6) Proteger a fonte de alimentação contra a introdução inadvertida de corpos metálicos, como por ex., clipes ou outras peças de metal.
7) Não usar o aparelho em ambientes húmidos. Não usar o aparelho em ambientes propensos a condensações.
8) Não tocar enquanto estiver em funcionamento, nem após a desligar. A superficie poderá estar quente e provocar lesões.

CUIDADO

Será necessário reduzir a potência de saída nos seguintes casos:

1) Quando não forem observadas as distâncias mínimas de montagem.
2) Quando instaladas a altitudes superiores a 2000m.
3) Existencia de temperatura ambiente superior a +60ºC, em plena carga do aparelho.
4) Montagem invertida do aparelho (Entrada em baixo, saída em cima).
5) Montagem em ambiente sem ventilação.

No presente manual de funcionamento encontram-se ainda outras informações.

ATENÇÃO, RISCO DE EXPLOSÃO! (Utilize Class I Div2)
Aparelhos que contêm na sua placa de dados elétricos o texto “Class I Div 2” são apropriados para a aplicação na Classe I, divisão 2, Grupos A, B, C, D ou também para locais de instalação isentos de riscos de explosão. Modificações efetuadas em componentes podem restringir ou reduzir a adequação para aplicação na Classe I, Divisão 2. As ligações não devem ser separadas enquanto estiverem ligadas a uma fonte de alimentação elétrica. As ligações devem ser efetuadas levando-se em consideração as exigências normativas da Classe I, Divisão 2.

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1606-XLS180, 1606-XLS240 1-Phase Power Supply Instruction Manual
1606-XLS180, 1606-XLS240 Bedienungsanleitung für 1-Phasen Stromversorgung

Rockwell Automation

Technical Data [1]		Technische Daten [1]			1606-XLS180B	1606-XLS240E 1606-XLS240EC[11] 1606-XLS240EA[11]	1606-XLS240K	1606-XLS240F
Output Voltage		**Ausgangsspannung**		nom.	DC 12-15V	DC 24-28V	DC 28-32V	DC 48-56V
Factory Setting at Full Load		**Werkseinstellung bei Nennlast**		typ.	12.0V	24.1V	30.0V	48.0V
Output Current	continuous	**Ausgangsstrom**	dauernd	nom.	15A at 12V 13.5A at 15V	10A at 24V 9A at 28V	8.5A at 28V 7.5A at 32V	5A at 48V 4.3A at 56V
	for typical 4s		für typisch 4s	nom.	22.5A at 12V 18A at 15V	15A at 24V 13.5A at 28V	12.75A at 28V 11.25A at 32V	7.5A at 48V 6.5A at 56V
Output Power	continuous	**Ausgangsleistung**	dauernd	nom.	180W	240W	240W	240W
	for typical 4s		für typisch 4s	nom.	270W	360W	360W	360W
Output Ripple & Noise Voltage [2]		**Ausgangswelligkeit** [2]		max.	50mVpp	50mVpp	50mVpp	100mVpp
AC Input Voltage		**AC Eingangsspannung**		nom.	AC 100-240V ±15%	AC 100-240V ±15%	AC 100-240V ±15%	AC 100-240V ±15%
Input Frequency		**Eingangsfrequenz**		nom.	50-60Hz	50-60Hz	50-60Hz	50-60Hz
AC Input Current [3]		**AC Eingangsstrom** [3]		typ.	1.65A / 0.93A	2.22A / 1.22A	2.22A / 1.22A	2.22A / 1.22A
Power Factor [3]		**Leistungsfaktor** [3]		typ.	0.98 / 0.92	0.98 / 0.92	0.98 / 0.92	0.98 / 0.92
Allowed Voltage L or N to Earth		**Erlaubte Spannung L oder N zu Erde**		max.	300Vac	300Vac	300Vac	300Vac
EN 61000-3-2		**EN 61000-3-2**		PFC-Norm	Yes / Ja	Yes / Ja	Yes / Ja	Yes / Ja
Input Inrush Current [4]		**Einschaltspitzenstrom** [4]		typ.	7A peak	7A peak	7A peak	7A peak
Hold-up Time [3]		**Pufferzeit** [3]		typ.	32ms / 32ms	27ms / 28ms	22ms / 23ms	27ms / 28ms
Efficiency [3]		**Wirkungsgrad** [3]		typ.	91.5% / 91.8%	92.3% / 93.0%	92.3% / 93.0%	91.2% / 92.0%
Power Losses [3]		**Verlustleistung** [3]		typ.	16.7W / 16.1W	20.0W / 18.1W	20.0W / 18.1W	23.2W / 20.9W
Operational Temperature Range		**Betriebstemperaturbereich**		nom.	-25°C - +70°C	-25°C - +70°C	-25°C - +70°C	-25°C - +70°C
Output Derating		**Leistungsrücknahme**		+60°C to +70°C	6W/°C	6W/°C	6W/°C	6W/°C
Storage Temperature Range		**Lagertemperaturbereich**		nom.	-40°C - +85°C	-40°C - +85°C	-40°C - +85°C	-40°C - +85°C
Humidity [5]		**Feuchte** [5]		IEC 60068-2-30	5 - 95% r.H.	5 - 95% r.H.	5 - 95% r.H.	5 - 95% r.H.
Vibration		**Schwingen**		IEC 60068-2-6	2g	2g	2g	2g
Shock		**Schocken**		IEC 60068-2-27	30g 6ms, 20g 11ms	30g 6ms, 20g 11ms	30g 6ms, 20g 11ms	30g 6ms, 20g 11ms
Degree of Pollution (non-conductive)		**Verschmutzungsgrad** (nicht leitend)		EN 50178 / IEC 62103	2	2	2	2
Degree of Protection		**Schutzart**		EN 60529	IP20	IP20	IP20	IP20
Class of Protection		**Schutzklasse**		IEC 61140	I 6)	I 6)	I 6)	I 6)
Over-temperature Protection		**Übertemperaturschutz**		OTP	Yes / Ja	Yes / Ja	Yes / Ja	Yes / Ja
Output Over-voltage Protection		**Überspannungsschutz am Ausgang**		OVP, max.	20Vdc	39Vdc	45Vdc	60Vdc
Touch (Leakage) Current [7]		**PE- Ableitstrom** [7]		max.	0.38mA / 0.74mA	0.38mA / 0.74mA	0.38mA / 0.74mA	0.38mA / 0.74mA
Return Voltage Resistance [8]		**Rückspeisefestigkeit** [8]		max.	18Vdc	35Vdc	35Vdc	58Vdc
Parallel Use [12]		**Parallelschaltbar** [12]		-	Yes / Ja	Yes / Ja	Yes / Ja	Yes / Ja
Serial Use [13]		**Serienschaltbar** [13]		-	Yes / Ja	Yes / Ja	Yes / Ja	Yes / Ja
Dimensions [9] (WxHxD)		**Abmessungen** [9] (BxHxT)		nom.	60x124x117mm	60x124x117mm	60x124x117mm	60x124x117mm
Weight		**Gewicht**		max.	930g, 2.05lb	900g, 1.98lb	900g, 1.98lb	900g, 1.98lb
Approvals		**Zulassungen**		-	→ 10)	→10)	→10)	→10)

1) All parameters are specified at 230Vac input voltage, nominal output current, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.
2) 50 Ohm measurement, bandwidth 20MHz
3) At 120Vac / 230Vac
4) Input inrush current electronically limited and is temperature independent.
5) Do not energize while condensation is present.
6) PE connection required (Ground).
7) Leakage current at 132Vac, 60Hz / 264Vac, 50Hz
8) Loads such as decelerating motors and inductors can feed voltage back to the output of the power supply. The figure represents the maximum allowed feed back voltage
9) Depth without DIN-rail.
10) See datasheet or markings on the unit.
11) 1606-XLS240EC with conformal coated PC-board
1606-XLS240EA with ATEX approval
12) A fuse (or diode) on the output is only required if more than three units are paralleled.
13) Use only power supplies of the same type. The total voltage should not exceed 150Vdc.

1) Alle Werte gelten bei 230Vac Eingangsspannung, Nennausgangsstrom, 25°C Umgebungstemperatur und nach einer Aufwärmzeit von 5 Minuten, wenn nichts anderes angegeben ist.
2) 50 Ohm Messung, Bandbreite 20MHz
3) Bei 120Vac / 230Vac
4) Der Einschaltstromstoß ist elektronisch begrenzt und temperaturunabhängig.
5) Nicht betreiben, solange das Gerät Kondensation aufweist.
6) PE Verbindung erforderlich.
7) Ableitstrom bei 132Vac, 60Hz / 264Vac, 50Hz
8) Bremsende Motoren oder Induktivitäten können Spannung zum Ausgang des Netzteils rückspeisen. Der Wert gibt die max. zulässige Rückspeisespannung an.
9) Tiefe ohne DIN-Schiene
10) Siehe Datenblatt oder Prüfzeichen auf dem Gerät.
11) 1606-XLS240EC mit schutzlackierter Leiterplatte1606-XLS240EC
1606-XLS240EA mit ATEX Zulassung
12) Bei mehr als drei Geräten wird eine Sicherung oder eine Diode zur Entkopplung benötigt.
13) Nur gleiche Geräte bis zu einer Gesamtspannung von 150Vdc

Installation

Use DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. Mounting orientation must be output terminals on top and input terminals on the bottom. For other orientations see datasheet. Do not obstruct air flow as the unit is convection cooled. Ventilation grid must be kept free of any obstructions. The following installation clearances must be kept when power supplies are permanently fully loaded:

Left / right: 5mm (15mm in case the adjacent device is a heat source)
40mm on top, 20mm on the bottom of the unit.

Input Fuses

Internal input fuse: T6.3A (H.B.C.), not user accessible. The unit is tested and approved for branch circuits up to 20A. An external protection is only required if the supplying branch has an ampacity greater than this, however, in some countries local regulations might apply. Check local codes and requirements. If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 6A B- or 4A C-Characteristic breaker should be used.

Terminals and Wiring (see Fig. 6)

Use appropriate copper cables that are designed for a minimum operating temperature of 60°C (for ambient up to 45°C) and 75°C (for ambient up to 60°C). Follow national installation codes and regulations! Ensure that all strands of a stranded wire enter the terminal connection! Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire). Ferrules are allowed, but not required.

Solid wire	0.5-6mm^2
Stranded wire	0.5-4mm^2
American wire gauge	20-10 AWG
Wire stripping length	7mm / 0.28inch

Installation

Geeignet für DIN-Schienen entsprechend EN 60715 oder EN 50022 mit einer Höhe von 7,5 oder 15mm. Der Einbau hat so zu erfolgen, dass sich die Eingangsklemmen unten und die Ausgangsklemmen oben befinden. Für andere Einbaulagen siehe Datenblatt. Luftzirkulation nicht behindern! Das Gerät ist für Konvektionskühlung ausgelegt. Es ist für ungehinderte Luftzirkulation zu sorgen. Folgende Einbauabstände sind bei dauerhafter Volllast einzuhalten:

Links / rechts: 5mm (15mm bei benachbarten Wärmequellen)
Oben: 40mm, unten 20mm vom Gerät.

Sicherungen am Eingang

Das Gerät besitzt eine T6,3A (H.B.C.) Eingangssicherung, die nicht anwenderzugänglich ist. Das Gerät ist geprüft und zugelassen zum Anschluss an Stromkreisen bis max. 20A. Ein zusätzlicher externer Schutz ist nur erforderlich, wenn der Speisestromkreis mit einem höheren Wert abgesichert ist oder nationale Richtlinien es vorschreiben. Falls ein externes Schutzelement verwendet wird, soll dieses nicht kleiner als 6A B- oder 4A C-Charakteristik sein, um ein fehlerhaftes Auslösen zu vermeiden.

Anschlussklemmen und Verdrahtung (siehe Bild 6)

Verwenden Sie geeignete Kupferkabel, die mindestens für 60°C bei einer Umgebungstemperatur bis zu 45°C und 75°C bei einer Umgebungstemperatur bis zu 60°C zugelassen sind. Beachten Sie nationale Bestimmungen und Installationsvorschriften! Stellen Sie sicher, dass keine einzelnen Drähte von Litzen abstehen. Bis zu zwei Leiter mit gleichem Querschnitt sind in einem Anschlusspunkt zulässig (außer Schutzleiter). Aderendhülsen sind erlaubt, aber nicht erforderlich.

Starrdraht	0,5-6mm^2
Litze	0,5-4mm^2
AWG	20-10 AWG
Abisolierlänge	7mm / 0,28inch

1606-XLS180, 1606-XLS240 1-Phase Power Supply Instruction Manual
1606-XLS180, 1606-XLS240 Bedienungsanleitung für 1-Phasen Stromversorgung

EMC Electromagnetic Compatibility

These power supplies are suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. These devices comply with FCC Part 15 rules.

CE mark is in conformance with EMC directive 2004/108/EC as well as the low-voltage directive (LVD) 2006/95/EC.

EMC Immunity: EN 61000-6-1, EN 61000-6-2
EMC Emission EN 61000-6-3, EN 61000-6-4, FCC Part 15 Class B

Indicators, LEDs

	Overload LED	DC-OK LED	DC-OK Contact
Normal mode	OFF	ON	Closed
During BonusPower®	OFF	ON	Closed
Overload (Vout < 90%)	ON	OFF	Open
Output short circuit	ON	OFF	Open
Temperature Shut-down	flashing	OFF	Open
No input power	OFF	OFF	Open

DC-OK Relay Contact (see Fig. 1)

This feature monitors the output voltage, which is produced by the power supply, and is independent of a return voltage from a unit which is connected in parallel.

Contact closes when the output voltage reaches the adjusted value after turn-on of the power supply or when the output voltage reaches 90% after a dip in the output.

Contact opens when the output voltage dips more than 10%. Short dips will be extended to a length of 250ms. Dips shorter than 1ms will be ignored.

Contact ratings: max.: 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load, min. current 1mA

Output- and Overload Characteristic

The unit is designed to support loads with a continuous power demand of up to 240W (1606-XLS180B: 180W) and a short-term power demand of up to 360W (1606-XLS180B: 270W) without damage or shut-down.

Output characteristic (see Fig. 2)
The curve in this figure is a typical curve for 24V unit. The other output voltages have an equivalent and proportional performance.

BonusPower® time (see Fig. 3)
The curve in this figure shows the duration until the output voltage starts dipping when more than 240W (1606-XLS180B: 180W) is drawn (controlled by software).

Dielectric Strength (see Fig. 4)

The output voltage is floating and separated from the input according to SELV (IEC/EN 60950-1) and PELV (EN 60204-1, EN 50178; IEC 62103, IEC 60364-4-41) requirements. Type and factory tests are conducted by the manufacturer. Field tests may be conducted in the field using the appropriate test equipment which applies the voltage with a slow ramp (2s up and 2s down). Connect all phase-terminals together as well as all output poles before the test is conducted. When testing, set the cut-off current settings to the value in the table below.

	A	B	C	D
Type Test (60s)	2500Vac	3000Vac	500Vac	500Vac
Factory Test (5s)	2500Vac	2500Vac	500Vac	500Vac
Field Test (5s)	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting	>10mA	>10mA	>20mA	>1mA

EMV Elektromagnetische Verträglichkeit

Diese Stromversorgungen erfüllen die Anforderungen für Anwendungen in industrieller Umgebung und für den Wohn-, Geschäfts- und Gewerbebereich ohne Einschränkungen. Die Geräte erfüllen auch die Anforderungen der FCC Teil 15.
Das CE Zeichen ist angebracht und erklärt die Erfüllung der EMV Richtlinie 2004/108/EG wie auch der Niederspannungsrichtlinie 2006/95/EG.

Störfestigkeit: EN 61000-6-1, EN 61000-6-2
Störaussendung: EN 61000-6-3, EN 61000-6-4, FCC Part 15 Klasse B

Anzeigelampen

	Overload LED	DC-OK LED	DC-OK Contact
Normalbetrieb	AUS	EIN	geschlossen
Während BonusPower®	AUS	EIN	geschlossen
Überlast (Vout < 90%)	EIN	AUS	offen
Ausgangskurzschluss	EIN	AUS	offen
Temperaturabschaltung	blinken	AUS	offen
Keine Eingangsspannung	AUS	AUS	offen

DC-OK Relais Kontakt (siehe Bild 1)

Diese Funktion überwacht die vom Gerät erzeugte Ausgangsspannung und lässt sich von einer rückwärts eingespeisten Spannung nicht beeinflussen (z.B.: bei Parallelschaltung)

Kontakt schließt sobald nach dem Einschalten der Ausgang den eingestellten Wert erreicht oder wenn nach Einbruch des Ausgangs die Spannung wieder >90% des eingestellten Wertes wird.

Kontakt öffnet sobald der Ausgang um mehr als 10% einbricht. Kurze Einbrüche werden auf 250ms verlängert. Einbrüche kürzer 1ms werden ignoriert.

Kontakt Belastbarkeit: max.: 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, (R-Last), min. Strom 1mA

Ausgangs- und Überlastverhalten

Die Stromversorgung ist zur Versorgung von Lasten mit einem Dauerleistungsbedarf bis zu 240W (1606-XLS180B: 180W) und einem kurzzeitigem Leistungsbedarf bis 360W (1606-XLS180B: 270W) konstruiert ohne dabei Schaden zu nehmen.

Ausgangskennlinie (siehe Bild 2)
Die Kennlinie in diesem Bild ist die Kennlinie eines typischen 24V Gerätes. Die anderen Ausgangsspannungen zeigen ein proportional vergleichbares Verhalten.

BonusPower® Zeit (siehe Bild 3)
Die Kennlinie in diesem Bild gibt die Dauer an bis die Ausgangsspannung sinkt, wenn mehr als 240W (1606-XLS180B: 180W) entnommen werden (softwaregesteuert).

Isolationsfestigkeit (siehe Bild 4)

Die Ausgangsspannung hat keinen Bezug zur Erde oder Schutzleiter und ist zum Eingang nach den SELV (IEC/EN 60950-1) und PELV (EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41) Standards getrennt. Typ- und Stückprüfungen werden beim Hersteller durchgeführt. Wiederholungsprüfungen dürfen mittels geeigneten Prüfgenerators mit langsam (2s) ansteigenden und abfallenden Spannungsrampen in der Anwendung erfolgen. Vor den Tests sind alle Phasen wie auch alle Ausgangspole miteinander zu verbinden. Während der Tests darf die Strom-Abschaltschwelle nicht kleiner als der in der Liste angegebene Wert sein.

	A	B	C	D
Typprüfung (60s)	2500Vac	3000Vac	500Vac	500Vac
Stückprüfung (5s)	2500Vac	2500Vac	500Vac	500Vac
Wiederholungsprüfung (5s)	2000Vac	2000Vac	500Vac	500Vac
Strom- Abschaltschwelle	>10mA	>10mA	>20mA	>1mA

Fig. 1 / Bild 1
DC-OK-Signal

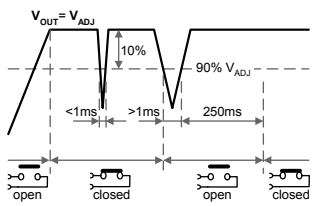


Fig. 2 / Bild 2
Output Characteristic /Ausgangskennlinie

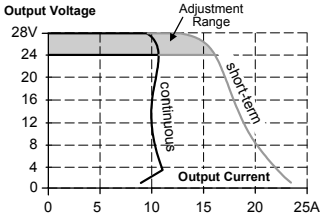


Fig. 3 / Bild 3
BonusPower® Time / Zeit

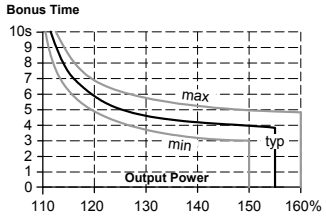


Fig. 4 / Bild 4
Insulation / Isolation

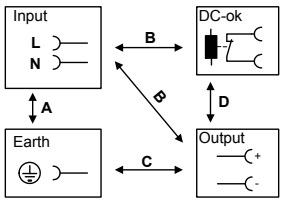
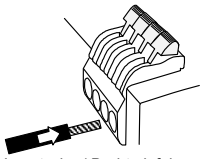
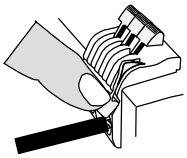


Fig. 5 / Bild 5
Terminals / Anschlüsse



Insert wire / Draht einführen



Snap the lever / Hebel schließen

Fig. 6 / Bild 6
Functional Diagram / Funktionsschaltbild

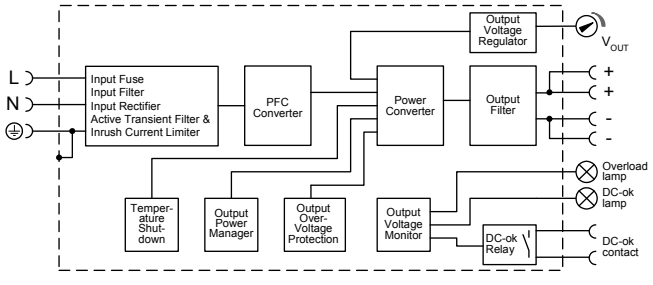
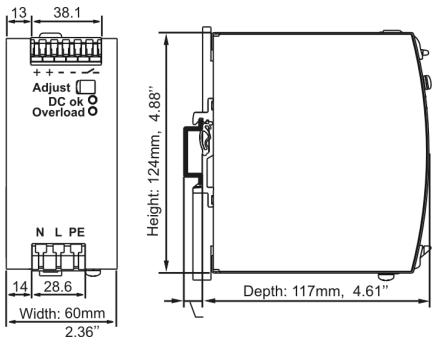


Fig. 7 / Bild 7
Dimensions / Abmessungen



Reference Manual

Allen-Bradley

Bulletin 1606 Switched Mode Power Supplies

Catalog Number: 1606-XLSRED

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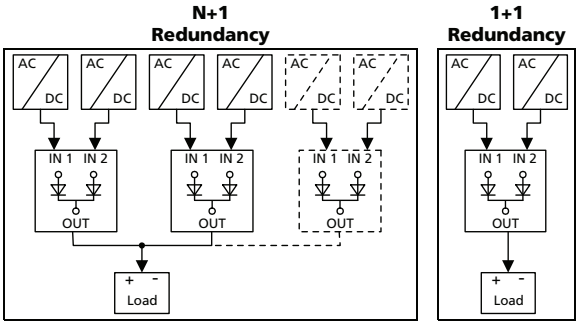
Terminology and Abbreviations

- **PE and ⏚ symbol—**PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
- **Earth, Ground—**This document uses the term "earth" which is the same as the U.S. term "ground".
- **T.b.d.—**To be defined, value or description will follow later.
- **DC 24V—**A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery whether it is full (13.7V) or flat (10V)
- **24Vdc**—A figure with the unit (Vdc) at the end is a momentary figure with no additional tolerance included.
- **may, shall, should—**Three key words indicating, respectively: flexibility of choice with no implied preference, a mandatory requirement, flexibility of choice with a strongly preferred implementation.
- **1+1 Redundancy—**Use of two identical power supplies in parallel to provide continued operation following most failures in a single power supply. The two power supply outputs should be isolated from each other by using diodes or other switching arrangements. E.g. two 10A power supplies are needed to achieve a 10A redundant system.
- **N+1 Redundancy—**Use of three or more identical power supplies in parallel to provide continued operation following most failures in a single power supply. All power supply outputs should be isolated from each other by using diodes or other switching arrangements. E.g. to achieve a 40A redundant system, five 10A power supplies are required in a N+1 redundant system.



LISTEN. THINK. SOLVE.®

Redundancy Module

- Cost Effective Solution to Build Redundant Systems
- Dual Input with Single Output
- Two Diodes (Common Cathode)
- DC12-48V (120V) ±25% Wide-range Input
- Full Power Between -40°C and +60°C
- Width only 32mm
- Rugged Metal Housing
- Quick-connect Spring-clamp Terminals
- Easy Wiring:
  Distribution Terminal for Negative Pole Included
- 3 Year Warranty

Description

The 1606-XLSRED is a redundancy module that can be used to build 1+1 and N+1 redundant systems. It is equipped with two input channels, which can be connected to power supplies with up to 10A output current and one output, able to carry nominal currents up to 20A. The module is suitable for power supplies with constant current overload behavior as well as any kind of "Hiccup" overload behavior.

The 1606-XLSRED is the perfect solution to use in a redundant system, if the power supply itself is equipped with a DC-OK signal.
In addition to the 1606-XLSRED is the 1606-XLERED which includes monitoring circuitry. LEDS and relay contacts signal when one of the two DC-input voltages is out of range due to a non-functioning power supply.

Another interesting application for the redundancy module is to separate sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.

Unique quick-connect spring-clamp terminals allow a safe and fast installation and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

Specification Quick Reference

Input voltage	DC 12-48V ±25% DC 12-120V ±25%	w/o restrictions with restrictions
Input voltage range	9-60Vdc 9-150Vdc	w/o restrictions with restrictions
Input current	2x 0-10A 2x 0-16A	continuous for 5 seconds
Output current	0-20A 20-32A 25A	continuous for 5 seconds at cont. overload/ short circuit
Input to output voltage drop	typ. 0.78V typ. 0.85V typ. 0.85V	input: 2x5A input: 1x10A input: 2x10A
Power losses	typ. 0W typ. 7.8W typ. 8.5W typ. 17W	at no load input: 2x5A input: 1x10A input: 2x10A
Temperature range Derating	-40°C to +70°C 0.5A/°C	operational, +60 to +70°C
Dimensions	32x124x102mm	WxHxD

Catalog Numbers

Redundancy Module	**1606-XLSRED**	12-48V (120V) Standard unit
Accessory	1606-XLB	Wall/panel mount bracket

Certification Marks

c UL US LISTED IND. CONT. EO. UL 508
c UL US UL 60950-1
c SA US Class I Div 2
Marine RINA
IECEx ATEX II 3G Ex nA IIC T4 Gc
GL Marine
CE EMC, LVD
GOST R
C-Tick

All parameters are specified at 24V, 20A output current, 25ºC ambient and after a 5 minutes run-in time, unless noted otherwise.

1. Intended Use

- This redundancy module is designed for installation in an enclosure and is intended for general use such as in industrial control, office, communication and instrumentation equipment.
- This redundancy module can be used with any type of power supply as long as the maximum ratings are not exceeded. It is suitable for power supplies with constant current overload behavior as well as any kind of “Hiccup” overload behavior.
- Do not use this power supply in equipment where malfunction may cause severe personal injury or threaten human life.
- This device is designed for use in hazardous, non-hazardous, ordinary or unclassified locations.

2. Installation Requirements

- This device may only be installed and put into operation by qualified personnel.
- This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.
- If damage or malfunction occurs during installation or operation, immediately turn power off and send unit to the factory for inspection.
- Mount the unit on a DIN-rail so that the input terminals are located on top and the output terminals on the bottom of the unit. For other mounting orientations, see derating requirements in the present document.
- This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!
- Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

SHOCK HAZARD: Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.

- Turn power off before working on the device. Protect against inadvertent re-powering
- Make sure that the wiring is correct by following all local and national codes
- Do not modify or repair the unit
- Do not open the unit as high voltages are present inside
- Use caution to prevent any foreign objects from entering the housing
- Do not use in wet locations or in areas where moisture or condensation can be expected
- Do not touch during power-on, and immediately after power-off. Hot surfaces may cause burns.

WARNING: EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and meets the requirements of the EN 60079-15:2010.

Notes for use in hazardous location areas:

- The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations and for use in Group II Category 3 (Zone 2) environments and is evaluated according to EN 60079-0:2009 and EN 60079-15:2010.

All parameters are specified at 24V, 2.5A, 230Vac input, 25ºC ambient and after a 5 minutes run-in time unless noted otherwise.

3. Input and Output Characteristics

Number of inputs	-	2	
Number of outputs	-	1	
Input voltage	nom.	DC 12-48V ±25%	The input circuitry must meet the SELV requirements stipulated by IEC/EN/UL 60950-1.
Input voltage range	-	9-60Vdc	
Input voltage with restrictions	nom.	DC 12-120V ±25%	See Note 3 below table.
Input voltage range with restrictions	-	9-150Vdc	Restrictions apply, see Note 3 below table.
Voltage drop, input to output	typ.	0.78V	at 2x5A, see Fig. 3-2
	typ.	0.85V	at 1x10A, see Fig. 3-3
	typ.	0.85V	at 2x10A, see Fig. 3-2
Input current	nom.	2x 0-10A	continuous
	nom.	1x 0-20A	continuous, see note 1
	nom.	2x 10-16A	for 5 seconds
Peak input current	max.	150A	for maximal 10ms per input
Output current	nom.	20A	continuous
	nom.	20-32A	for 5 seconds
	max.	25A	at continuous overload or short circuit, see note 2
Reverse current	max.	2mA	per input, -40°C to +60°C
Reverse voltage	max.	200Vdc	voltage applied to the output, continuously allowed

Note 1: Each input can be loaded up to 20A. At currents above 10A, the other input should not be loaded. It is preferable to parallel the two inputs in order to minimize the power loss in such cases.

Note 2: Ensure that the continuous output current does not exceed 25A. Check the short-circuit current of the power sources and if the power source can deliver more than 25A together, use an appropriate fuse on the output.

Note 3: The redundancy module can be used with input voltages up to 150Vdc with the constraint, that it can be used only as a single input module at voltages above 60Vdc. Both inputs need to be connected together as shown in Fig. 3-1. Ensure proper means to protect against touching this voltage.

Fig. 3-1 **Restrictions for utilizing voltages between 60 and 150Vdc (See also Note 3)**

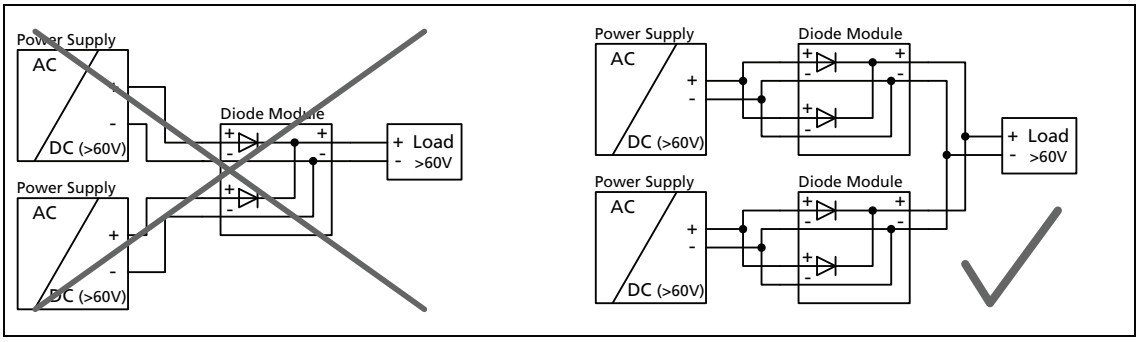


Fig. 3-2 **Input to output voltage drop when both inputs draw current**
(typical 1+1 redundant case, when the output voltages of the two units are equal or set into "parallel use" mode)

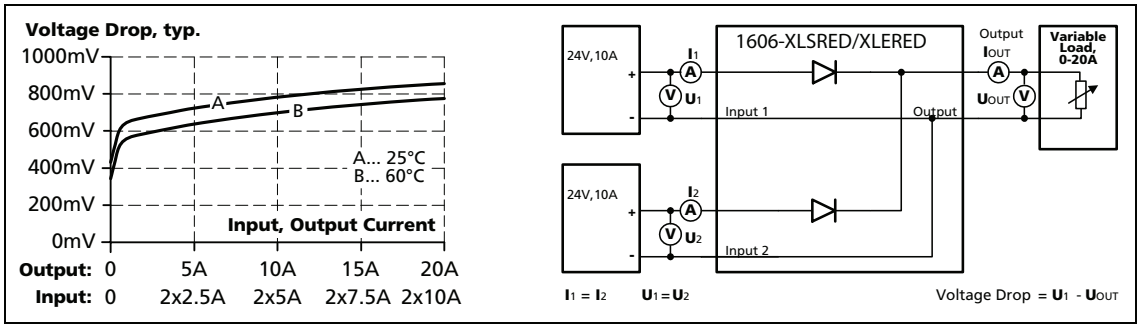
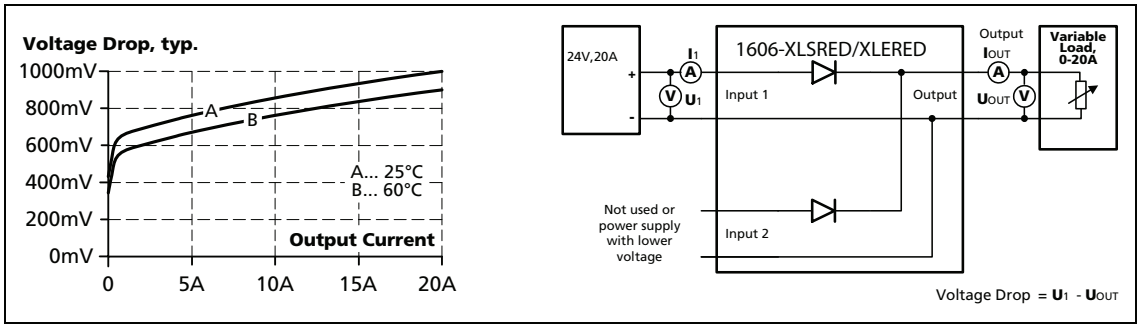


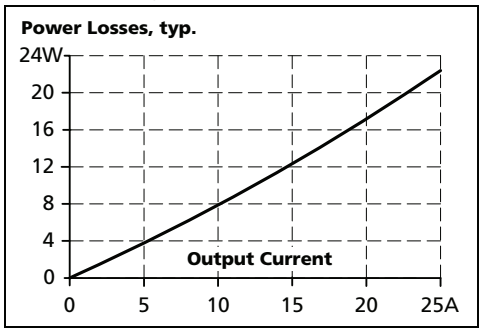
Fig. 3-3 **Input to output voltage drop when only one input draws current**



4. Power Losses

		DC 24V	
Power losses	typ.	7.8W	input: 2x5A
	typ.	8.5W	input: 1x10A
	typ.	17.0W	input: 2x10A
Standby power losses	typ.	0W	at no output current

Fig. 4-1 **Power losses**



5. Life Expectancy and MTBF

The redundancy module has two input channels which are completely independent from each other. Each control circuit, auxiliary voltage source, or other circuitry in the module are designed separately for each input. The dual input redundancy module can be considered as two single redundancy modules combined together in one housing. The only common point is the circuit trace that ties the two separate circuits together at the output.

The MTBF figures below are for the entire dual input module. If the MTBF number of only one path is needed, simply double the value from the table.

The redundancy module does not have electrolytic capacitors included. Therefore, the lifetime expectancy is extremely high.

Input / output current conditions		**Input: 2x10A Output: 20A**	**Input: 2x5A Output: 10A**	
Lifetime expectancy *)	min.	25 years	25 years	at 24V and 40°C
	min.	25 years	25 years	at 24V and 25°C
MTBF **) SN 29500, IEC 61709		46 500 000h	55 700 000h	at 24V 40°C
		70 000 000h	84 000 000h	at 24V 25°C
MTBF **) MIL HDBK 217F		36 200 000h	43 500 000h	at 24Vand 40°C (Ground Benign GB40)
		41 100 000h	49 300 000h	at 24Vand 25°C (Ground Benign GB25)

*) The **Lifetime expectancy** shown in the table indicates the minimum operating hours (service life).

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.
The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it can not be determined if the failed unit has been running for 50 000h or only for 100h.

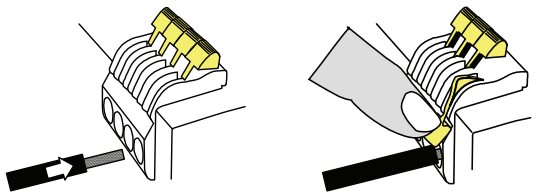
6. Terminals and Wiring

	Input and output
Type	Bi-stable, quick-connect spring clamp terminals. IP20 Finger safe construction. Suitable for field- and factory installation. Shipped in open position.
Solid wire	0.5-6mm^2
Stranded wire	0.5-4mm^2
American Wire Gauge	20-10 AWG
Max. wire diameter	2.8mm (including ferrule)
Wire stripping length	10mm / 0.4inch
Pull-out force	10AWG:80N, 12AWG:60N, 14AWG:50N, 16AWG:40N (according to UL486E)

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C and
90°C for ambient up to 70°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Ferrules are allowed.
e) Do not connect or disconnect the wires from the terminals below -25°C (-13°F).

Fig. 6-1 **Connecting a wire**

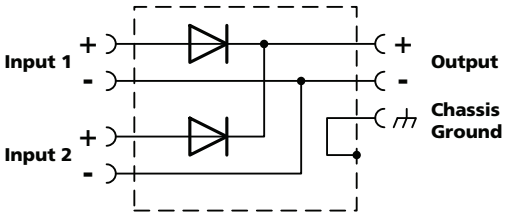


1. Insert the wire **2.** Snap the lever

To disconnect wire: reverse this procedure.

7. Functional Diagram

Fig. 7-1 **Functional diagram**



8. Front Side and User Elements

Fig. 8-1 **Front side**

A **Output terminals**

B **Chassis ground terminal**
Connection of the chassis to ground is optional and not required since the unit fulfils the requirements according to protection class III.

C **Input terminals for input 1**

D **Input terminals for input 2**

9. EMC

The redundancy module is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available upon request.

EMC Immunity	According generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	2kV 2kV	Criterion A Criterion A
Surge voltage on input lines	EN 61000-4-5	+ → - +/- → Chassis ground	200V 1kV	Criterion A Criterion A
Surge voltage on output lines	EN 61000-4-5	+ → - +/- → Chassis ground	200V 1kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Power-frequency magnetic field *)	EN 61000-4-8	50Hz	30A/m	Criterion A

Criteria:

A: Redundancy module shows normal operation behavior within the defined limits.

Notes:

***)** A test is not applicable according to EN 61000-6-2, since the device does not contain components susceptible to magnetic fields, e.g. hall elements, electrodynamic microphones, etc.

EMC Emission	According generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Class B, input lines *)
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Class B, output lines *)
Radiated emission	EN 55011, EN 55022	Class B

This device complies with FCC Part 15 rules.

Operation is subjected to following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

*) Provided, that power sources connected on the inputs fulfill the class B requirements as well.

10. Environment

Operational temperature *)	-40°C to +70°C (-40°F to 158°F)	Reduce output power above +60°C
Output de-rating	0.5A/°C	60-70°C (140°F to 158°F), see
Storage temperature	-40 to +85°C (-40°F to 185°F)	for storage and transportation
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm 17.8-500Hz: g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature, see Fig. 10-2
Altitude de-rating	1.25A/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 10-2
Over-voltage category	not applicable	The concept of the overvoltage category is used for equipment energized directly from the low voltage mains (IEC 60664-1 §4.3.3.2.1).
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 10-1 **Output current vs. ambient temp.**

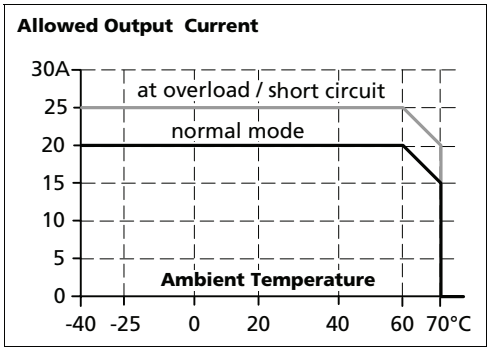
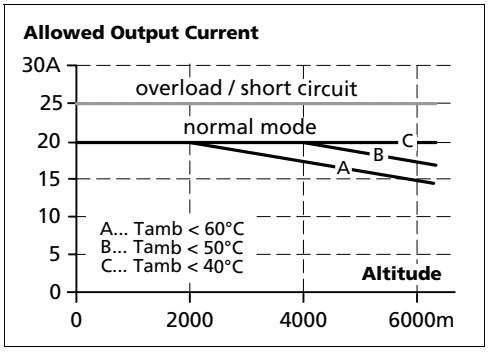


Fig. 10-2 **Output current vs. altitude**



11. Protection Features

Output over-current protection	not included	
Reverse input polarity protection	included	unit does not start when input voltage is reversed
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.6mm	e.g. screws, small parts
Over-temperature protection	not included	
Input transient protection	not included	
Output transient protection	included	see EMC section
Internal input fuse	not included	

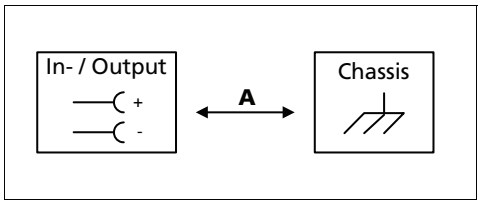
12. Safety Features

Input / output separation	no galvanic separation	200V epitaxial diode between input and output
Safety level of output voltage	The output voltage is regarded to be SELV (EN 60950-1) or PELV (EN 60204-1, EN 50178, IEC 60364-4-41) if the input voltage fulfills the requirements for a SELV source or PELV source.	
Class of protection	III	PE (Protective Earth) or chassis connection not required
PE resistance	< 0.1Ohm	between housing and chassis-ground terminal

13. Dielectric Strength

The input and output voltages have the same reference, are floating and have no ohmic connection to ground.
Type and factory tests are conducted by the manufacturer. Field tests may be conducted in the field using the appropriate test equipment which applies the voltage with a slow ramp (2s up and 2s down). Connect input/output terminals together before conducting the test.
When testing, set the cut-off current settings to the value in the table below.

Fig. 13-1 **Dielectric strength**



		A
Type test	60s	500Vac
Factory test	5s	500Vac
Field test	5s	500Vac
Cut-off current setting		> 2mA

All parameters are specified at 24V, 2.5A, 230Vac input, 25ºC ambient and after a 5 minutes run-in time unless noted otherwise.

14. Certifications

EC Declaration of Conformity	CE	Complies with - CE EMC directive, - CE Low-voltage directive
	CE	The CE mark indicates conformance with the - ATEX directive 94/9/EC (Equipment and protection systems intended for use in potentially explosive atmospheres)
UL 508	UL LISTED IND. CONT. EQ.	LISTED E56639 for use in the U.S.A. (UL 508) and Canada (C22.2 No. 14-95). Industrial Control Equipment
UL 60950-1	c UL us	RECOGNIZED E168663 for use in the U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950) Information Technology Equipment, Level 3
CSA 22.2 No 107,1-01	CSA c us	CSA Certified under File Number 2400020; CERTIFIED for use in the U.S.A. (ISA 12.12.01) and Canada (C22.2 No. 213) Hazardous Location Class I Div. 2 - Groups A, B, C, D
ISA 12.12.01, CSA C22.2 No. 213	c UL us	RECOGNIZED UNDER FILE NUMBER E244404 for use in the U.S.A. (ISA 12.12.01) and Canada (C22.2 No 213) Hazardous Location Class I Div. 2 - Groups A, B, C, D
ATEX	Ex II 3G Ex nA IIC T4 Gc	II 3G Ex nA IIC T4 Gc EPS 11 ATEX 1 312 X
Marine GL	GL	GL (Germanischer Lloyd) classified for marine and offshore applications. Environmental category: C, EMC2. See below for link to Certificate.
Marine Rina	RINA 1861	RINA (Registro Italiano Navale) certified. See below for the link to Certificate.
GOST R	PCT	GOST R certification is applicable for products intended for sale and use within Russia. See below for link to Certificate.
C-TICK	C-tick	C-tick compliance is for products intended for sale and use within the Australian market. See below for the link to the C-tick Declarations of Conformity.

Product certification information (including Certificates and Declarations of Conformity) can be found at www.ab.com/certifications.

All parameters are specified at 24V, 2.5A, 230Vac input, 25°C ambient and after a 5 minutes run-in time unless noted otherwise.

15. Physical Dimensions and Weight

Weight	290g / 0.64lb
DIN Rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN rail height must be added to the unit depth (102mm) to calculate the total required installation depth.
Installation clearances	See section 2.

Fig. 15-1 **Front view**

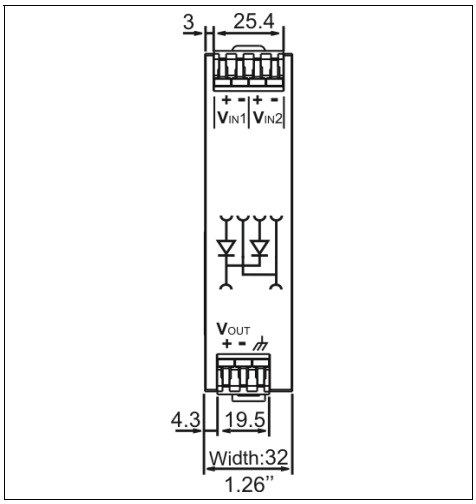
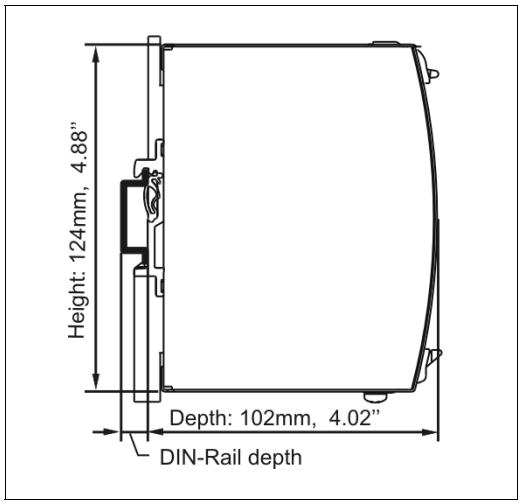


Fig. 15-2 **Side view**



16. Accessories

1606-XLB Wall mounting bracket

This standard bracket is used to mount the redundancy module onto a flat surface without a DIN rail.

Fig. 16-1 **1606-XLB Wall mounting bracket**

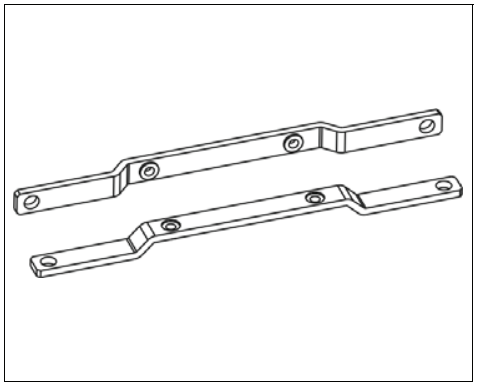
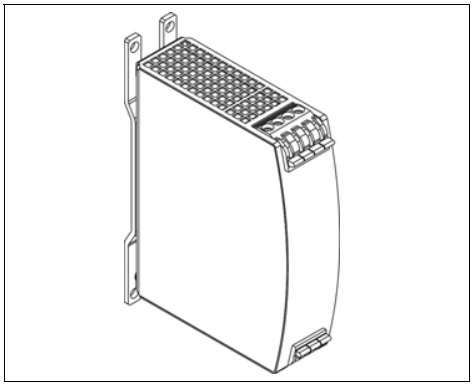


Fig. 16-2 **Assembled wall mounting bracket**



17. Application Notes

17.1. Recommendations for Redundancy

Recommendations for the configuration of redundant power systems:

- Use separate input fuses for each power supply.
- Use three-phase power supplies to gain functional safety if one phase fails.
- When single-phase power supplies are utilized connect them to different phases or mains circuits if possible.
- Set the power supply in "Parallel-Use" mode if this feature is available
- It is desirable to set the output voltages of all power supplies to the same value.

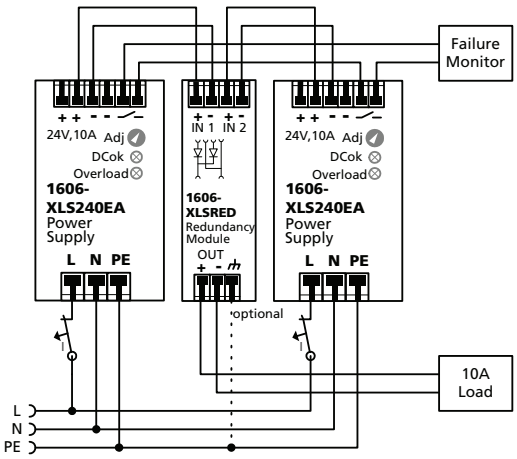
17.2. Inductive and Capacitive Loads

The unit is designed to supply any kind of loads, including unlimited capacitive and inductive loads.

17.3. Example: 1+1 Redundancy up to 10A

1+1 Redundancy up to 10A requires two 10A power supplies and one 1606-XLSRED redundancy module.

Fig. 17-1 **Wiring diagram, 1+1 Redundancy, 10A output current**

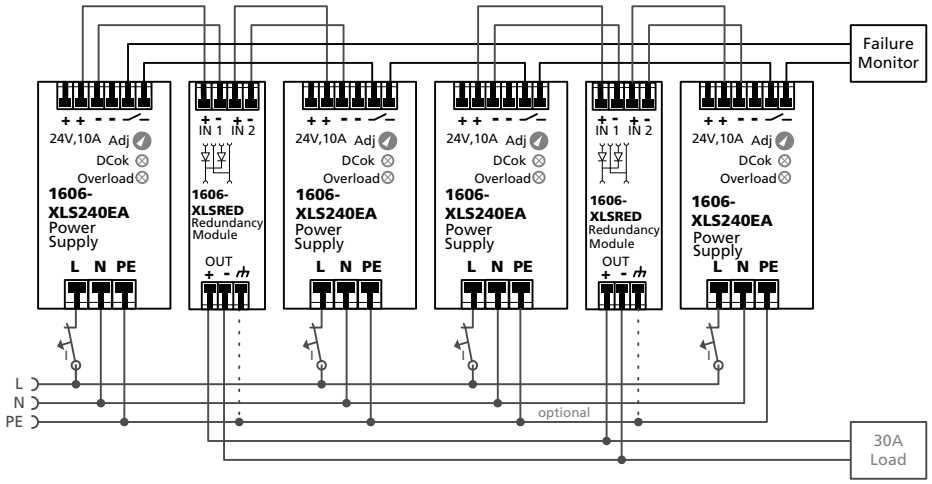


Note: Use separate mains systems for each power supply whenever possible.

17.4. Example: N+1 Redundancy up to 30A

N+1 Redundancy up to 30A requires four 10A power supplies and two 1606-XLSRED redundancy modules.

Fig. 17-2 **Wiring diagram, n+1 Redundancy, 30A output current**



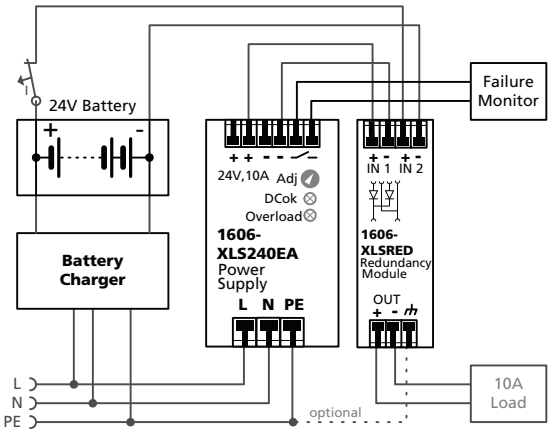
Note: Use separate mains systems for each power supply whenever possible.

17.5. Example: Battery Back-up

A battery back-up with 10A requires one 10A power supply and one 1606-XLSRED redundancy module.

Please note:
Set output voltage of power supply to 26.5Vdc minimum to ensure that the load current is delivered from the power supply and not from charger (battery). Use a fuse between battery and 1606-XLSRED.

Fig. 17-3 **Wiring diagram, 10A Battery back-up**

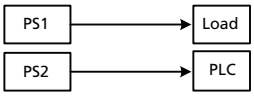


17.6. Example: Redundancy for Controls

The example shows a cost effective solution to get redundant power for a PLC or controller system.

In many cases, two power supplies are used; one for the demanding loads and another one for the controls and sensitive loads. The power supply for the demanding loads can be used as a redundant source to supply the controls.

Traditional approach:



Improved approach:

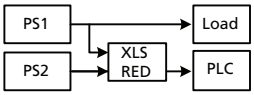
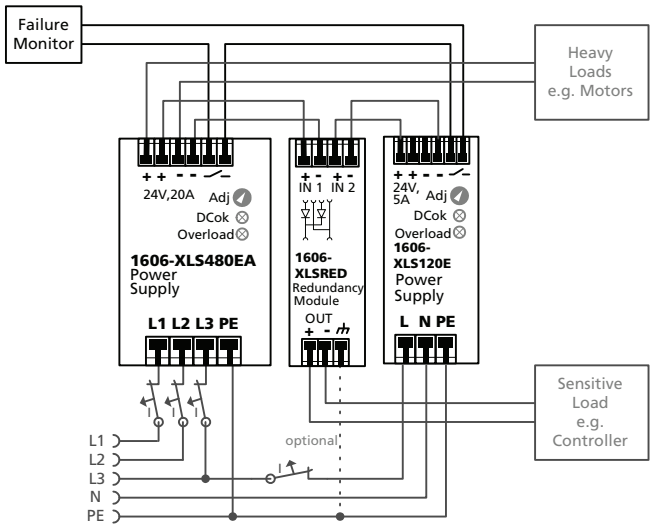


Fig. 17-4 **Wiring diagram, redundancy for sensitive loads**



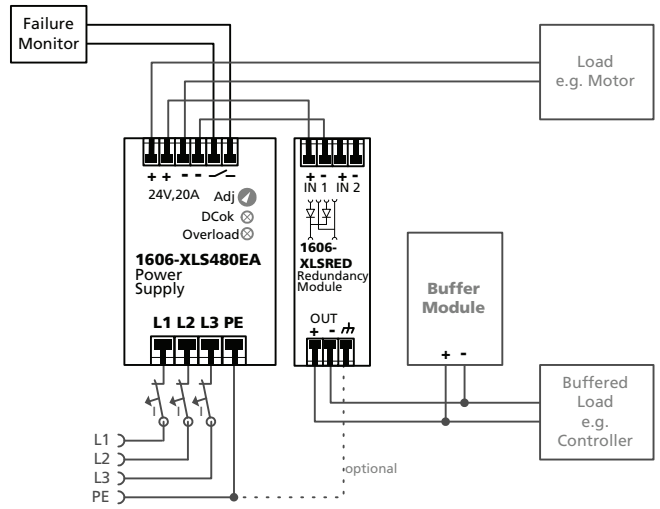
Note: Use separate mains systems for each power supply whenever possible.

17.7. Example: Decoupling of Branches

Buffer energy supplied from a DC-UPS or buffer module is not wasted in "power branches."

Please note:
Set output voltage of the power supply to a level that the buffer unit or DC-UPS will not start unexpected. Take the voltage drop of the 1606-XLSRED into account.

Fig. 17-5 **Wiring diagram, decoupling of buffered branches**



Note: Use separate mains systems for each power supply whenever it is possible

17.8. Use in a Tightly Sealed Enclosure

When the redundancy module is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. The inside temperature defines the ambient temperature for the redundancy module.

Results from such an installation:

Power supply is placed in the middle of the box, no other heat producer is inside the box.

Enclosure:	Rittal Typ IP66 Box PK 9516 100, plastic, 110x180x165mm
Load:	24V, 16A; (=80%) load is placed outside the box
Input:	24Vdc
Temperature inside enclosure:	57.8°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside enclosure:	24.6°C
Temperature rise:	33.2K

17.9. Mounting Orientations

Mounting orientations other than input terminals on the bottom and output on the top require a reduction in continuous output power or a limitation in the maximum allowed ambient temperature.

Fig. 17-6
Mounting Orientation A
(Standard orientation)

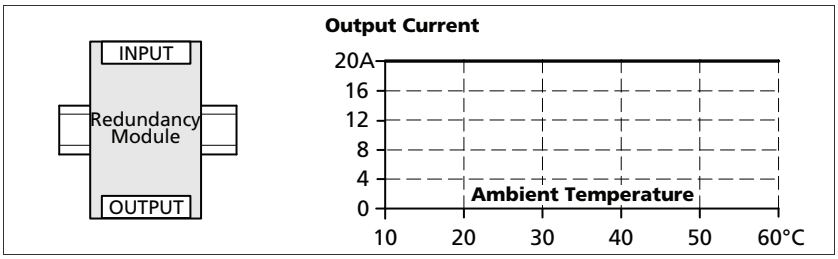


Fig. 17-7
Mounting Orientation B
(Upside down)

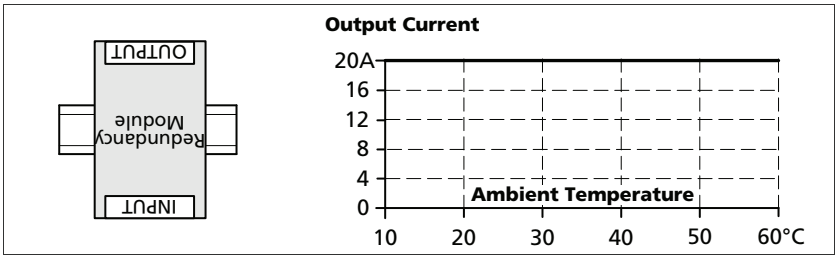


Fig. 17-8
Mounting Orientation C
(Table-top mounting)

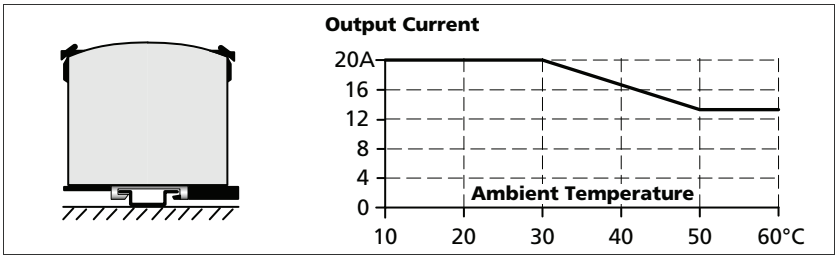


Fig. 17-9
Mounting Orientation D
(Horizontal cw)

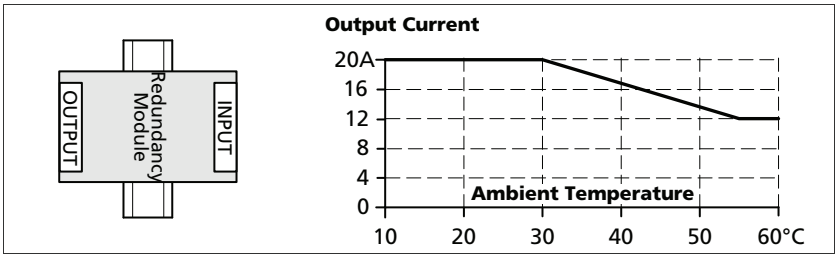
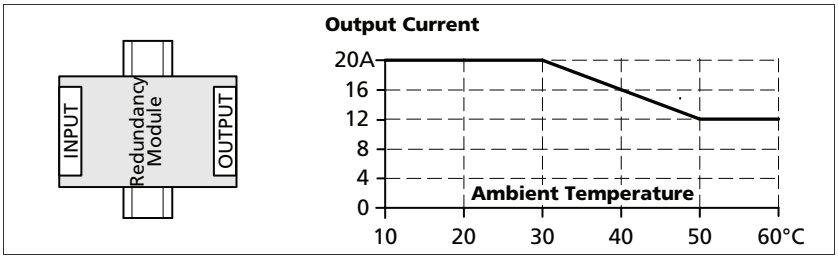


Fig. 17-10
Mounting Orientation E
(Horizontal ccw)



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Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

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NT24k®-8TX Industrial Ethernet Switch

N-Tron® Networking Series

RED LION®
a spectris company

Industrial Managed Gigabit Ethernet Switch

Red Lion's N-Tron® series NT24k®-8TX compact managed Gigabit Ethernet switch features eight 10/100/1000Base-T(X) ports providing a reliable and secure communication network to equipment in harsh environments.

The versatile NT24k-8TX managed switch features 8 ports (eight Gigabit copper ports) and is housed in a compact, hardened metal DIN-rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-8TX offers wire-speed throughput, expanded shock and vibration ratings and wide -40° to 85°C operating temperature rating. IGMP auto-configuration, IEEE 802.1x with RADIUS remote server authentication and N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in alternative energy, factory automation applications, transportation and water/wastewater.

APPLICATIONS

> Alternative Energy
> Manufacturing
> Oil & Gas
> Transportation
> Water/Wastewater

PRODUCT HIGHLIGHTS

> Copper Ports
> Smart Plug-and-Play Operation
> 10 to 49 VDC Redundant Power Inputs
> -40° to 85°C Wide Operating Temperature
> Robust Remote Monitoring
> N-Ring™ & N-Link Network Ring Technology

IEEE 1588v2 PTP OPTIONS

- Boundary Clock
- Transparent Clock

IEEE 1588v2 applications include

- Coordinated motion control
- Time-stamped data logging
- Time-stamped fault detection

PTP Models & Upgrade Kit Available

FEATURES & BENEFITS

> 8 Copper Ports
  - Eight 10/100/1000Base-T(X) copper ports
> Redundant 10 to 49 VDC Power Inputs
  - Keeps network running in the event of a power supply failure
> Extended Environmental Specifications
  - -40° to 85°C operating temperature range
  - > 2M hours MTBF
  - UL/cUL: Class I, Div. 2 Groups A, B, C and D
> Plug-and-Play Operation:
  - IGMP auto-configuration
  - MDIX auto-sensing cable
  - Simple network ring configuration
  - Backup and restore via recovery card or XML

> Fully Managed Features Include:
  - SSH/SSL/HTTPS
  - SNMP v1, v2, v3
  - Web browser management
  - Detailed ring map and fault location charting
  - RSTP - 802.1d, 802.1w, 802.1D
  - Trunking and port mirroring
  - 802.1Q tag VLAN and port VLAN
  - IEEE 802.1x with RADIUS remote server authentication
  - DHCP Server, Option 82 relay, Option 61, IP fallback
  - Port Security – MAC address based
  - 802.1p QoS, port QoS and DSCP
  - Event Log/Syslog
  - SNTP (Simple Network Time Protocol)
  - IEEE 1588v2 (PTP) models available
  - Multi-Member N-Ring™ technology with ~30ms healing
  - N-Link redundant ring technology
  - N-View™ monitoring technology
  - EtherNet/IP™ CIP™ messaging
  - 802.1AB-2005 LLDP (Link Layer Discovery Protocol)

FC
c UL us LISTED 65SN
CE
UK CA
ABS TYPE APPROVED PRODUCT
RoHS compliant
EtherNet/IP

NT24k-8TX Specifications

SWITCH PROPERTIES

Operation: Managed
Number of MAC Addresses: 16,000
IEEE Compliance: 802.3, 802.3u, 802.3ab, 802.3x, 802.1d/D/w, 802.1p, 802.1Q, 802.1x
IEEE 1588v2 Software-Based Option
Latency (Typical): 1.6 µs
Switching Method: Store-and-Forward
LED Status Indicators
Configurable Alarm Contact
Onboard Temperature Sensor
Supports Full/Half Duplex Operation
Maximum Throughput: Up to 16 Gb/s
MDIX Auto Sensing Cable
Auto Sensing Speed and Flow Control
Communications: Full Wire Speed
MTBF: >2 million hours
Jumbo Frame Support

POWER INPUT

Input Voltage: 10-49 VDC
Steady Input Current: 490 mA @ 24 VDC
Inrush: 22 A / .33 ms @ 24 VDC
BTU/HR: 40.14

CONNECTORS

10/100/1000BaseT: Eight (8) RJ-45 ports
ESD and surge protection diodes on all copper ports
Configuration Port: One (1) USB Type B

NETWORK MEDIA

10BaseT: ≥ Cat3 cable
100BaseTX: ≥ Cat5 cable
1000BaseT: ≥ Cat5e cable

RECOMMENDED WIRING CLEARANCE

Front: 2" (5.08 cm)
Top: 4" (10.16 cm)

ENVIRONMENTAL

Operating Temperature: -40°C to 85°C
Storage Temperature: -40°C to 85°C
Operating Humidity: 10% to 95% (non condensing)
Operating Altitude: 0 to 10,000 ft.
Shock: 200 g @ 10 ms (bulkhead mounted)
Vibration: 50 g @ 5-20 Hz, Triaxial (bulkhead mounted)

CERTIFICATION & COMPLIANCE

Product Safety:
ANSI/ISA 12.12.01-2013 Class I and II, Div. 2 and Class III, Div. 1 and 2, Groups A, B, C and D Hazardous Locations
UL508 Industrial Control Equipment
CAN/CSA-C22.2 No. 213-M1987 Class I Div. 2 Hazardous Locations
CAN/CSA-C22.2 No. 14-M1987 Industrial Control Equipment
Emissions:
FCC Title 47, Part 15, Radio Frequency Devices, Subpart B ANSI C63.4-2009; Industry Canada ICES-003, EN 55011; EN 61000-6-4, EN 61000-3-2, EN61000-3-3, EN 55032
Immunity:
EN 55024, EN 61000-6-2; IEC 61000-4-2 (ESD); IEC 61000-4-3 (RFAM); IEC 61000-4-4 (EFT); IEC 61000-4-5 (SURGE); IEC 61000-4-6 (RFCM); IEC 61000-4-8 (PFMF); IEC 61000-4-11 (VDI)
Rail:
EN 50155, EN 50121 and EN 61373
Designed to Comply with:
IEEE 1613 (Electric Utility Substations), NEMA TS1/TS2 (Traffic Control)
Other:
ABS Type Approval for Shipboard Applications; EMC Directive 2014/30/EU; LV Directive 2014/35/EU, RoHS Compliant

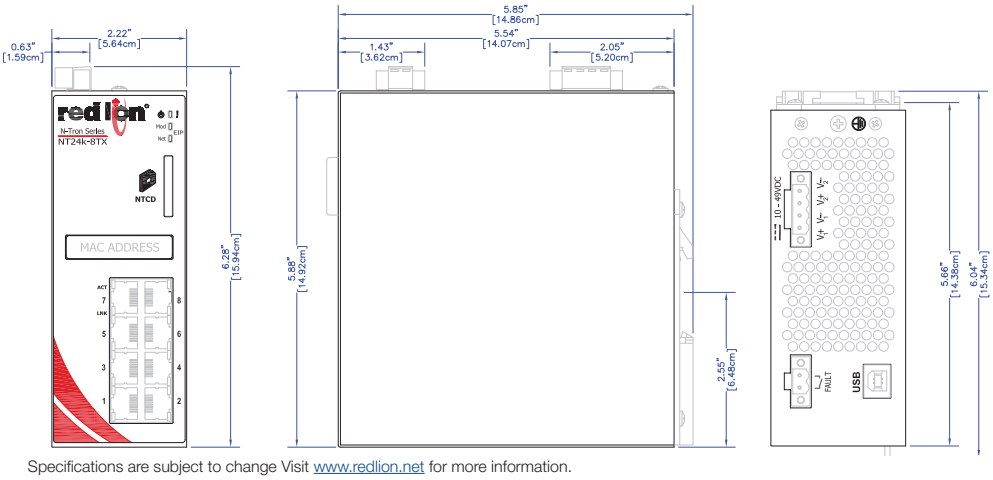
MECHANICAL

Case Dimensions:
Height: 5.88" (14.92 cm)
Width: 2.22" (5.64 cm)
Depth: 5.54" (14.07 cm)
Weight: 1.68 lbs (0.76kg)
Mount: DIN Rail 35 mm

WARRANTY

3 Years on Design and Manufacturing Defects

DIMENSIONS



ORDERING GUIDE

PART NUMBER	DESCRIPTION
NT24K-8TX	Eight Port 10/100/1000BaseT Managed Industrial Ethernet Switch
NT24K-8TX-PT	Eight Port 10/100/1000BaseT Managed Industrial Ethernet Switch, PTP Enabled
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN-Rail Power Supply 1.3 Amp @ 24 VDC
NT24K-NM-PMK	NT24k Non-Modular Panel Mount Kit
NT24K-KIT-PTP	NT24k Upgrade License to Enable IEEE 1588/PTP on Non-PT NT24k Switches

Specifications are subject to change Visit www.redlion.net for more information.

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www.redlion.net
contact us

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N-Tron® Series NT24k® Compact Series Industrial Managed Gigabit Ethernet Switches

Hardware Guide | January 2023
LP0987 | Revision F

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Preface

Disclaimer

This hardware guide provides an overview of installation, maintenance and operation of the N-Tron® Series NT24k® Compact Series Industrial Managed Gigabit Ethernet Switches equipment. It is not intended as a step-by-step guide or a complete set of all procedures necessary and sufficient to complete all operations.

While every effort has been made to ensure that this document is complete and accurate at the time of release, the information that it contains is subject to change. Red Lion Controls, Inc. is not responsible for any additions to or alterations of the original document. Industrial networks vary widely in their configurations, topologies, and traffic conditions. This document is intended as a general guide only. It has not been tested for all possible applications, and it may not be complete or accurate for some situations.

Users of this document are urged to heed warnings and cautions used throughout the document.

Compliance Information

It is recommended that the owner of this equipment determine and ensure conformance with any specific and applicable local regulations.

FCC Statement

This product complies with Part 15 of the FCC-A Rules.

Operation is subject to the following conditions:

1. This device may not cause harmful Interference
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this device in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense.

Déclaration de conformité FCC

Ce produit est conforme à la partie 15 des règles de la FCC–A

Utilisation est soumise aux conditions suivantes:

1. Ce dispositif ne doit pas causer des interférences nuisibles
2. Cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent causer un mauvais fonctionnement.

Note: Cet équipement a été testé et jugé conforme aux limites de la classe A des appareils numériques, conformément à la partie 15 des règles de la FCC . Ces limites sont conçues pour fournir une protection raisonnable contre les interférences nuisibles dans une installation résidentielle. Cet équipement génère, utilise et peut émettre de l'énergie radiofréquence et, si il n'est pas installé et utilize conformément aux instructions, peut causer des interférences nuisibles aux communications radio. L'utilisation de cet appareil dans une zone résidentielle est susceptible de provoquer des interférences nuisibles, auquel cas l'utilisateur sera tenu de corriger les interférences à ses propres frais.

Industry Canada

This Class A digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following two conditions; (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Cet appareillage numérique de la classe A répond à toutes les exigences de l'interférence canadienne causant des règlements d'équipement. L'opération est sujette aux deux conditions suivantes: (1) ce dispositif peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue, y compris l'interférence qui peut causer l'opération peu désirée.

Environmental Impact Statement

Red Lion equipment contains no hazardous materials as defined by the United States Environmental Protection Agency (USEPA). Red Lion recommends that all failed product be returned to Red Lion for failure analysis and proper disposal.

Toxic Emissions

Red Lion equipment releases no toxic emissions.

Trademark Acknowledgments

Red Lion Controls acknowledges and recognizes ownership of the following trademarked terms used in this document.

- Ethernet is a registered trademark of Xerox Corporation.
- EtherNet/IP and CIP are registered trademarks of ODVA.

All other company and product names are trademarks of their respective owners.

Document History and Related Publications

The hard copy and electronic media versions of this document are revised only at major releases and therefore, may not always contain the latest product information. Tech Notes and/or product addendums will be provided as needed between major releases to describe any new information or document changes.

The latest online version of this document can be accessed through the Red Lion website at www.redlion.net/support/documentation.

Additional Product Information

Additional product information can be obtained by contacting the local sales representative or Red Lion through the contact numbers and/or support website address listed on the inside of the front cover.

Cautions and Warnings / Mises en Garde et Avertissements

Warnings apply to situations where personal injury or death may result.

Cautions apply to where reduced function or damage to equipment may result.

General Safety Cautions and Warnings / Précautions et Avertissements de Sécurité Générale

⚠	**CAUTION:** If the equipment is used in the manner not specified by Red Lion, the protection provided by the equipment may be impaired. **ATTENTION:** Si l' équipement est utilisé d'une manière non spécifiée par Red Lion, la protection fournie par l'équipement peut être compromise.

	CAUTION: Do not remove any of the covers. There are no serviceable parts within the unit. Do not substitute unauthorized parts or make unauthorized modifications to the unit. **ATTENTION:** Ne retirez aucun des couvercles. Il n'y a pas des pieces utilisables à l'intérieur de l'appareil. Ne pas remplacer les pièces non-autorisées ou effectuer des modifications non-autorisées de l'appareil.

	CAUTION: Do not block any air vents on the unit. **ATTENTION:** N'obstruez pas les fentes d'aération de l'unité.

	CAUTION: Do not operate the equipment in a manner not specified by this manual. **ATTENTION:** Ne pas faire fonctionner l'équipement d'une manière non spécifiée par ce manuel.

	WARNING: Install only in accordance with Local and National Codes of authorities having jurisdiction. **AVERTISSEMENT:** Installer uniquement, conformément aux codes locaux et nationaux des autorités ayant compétence.

Electrical Safety Warnings / Avertissements de Sécurité Électrique

	WARNING: Never install or work on electrical equipment or cabling during periods of lightning activity. **AVERTISSEMENT:** Ne jamais installer ou travailler sur équipement électrique ou de câblage pendant les périodes d'activité de la foudre.

	CAUTION: Do not perform any services on the unit unless qualified to do so. Do not substitute unauthorized parts or make unauthorized modifications to the unit. **ATTENTION:** Ne pas effectuer de services sur l'appareil s'il n'est pas qualifié pour le faire. Ne pas substituer pièces non autorisées ou de modifications non autorisées de l'appareil.

	WARNING: Properly ground the unit before connecting anything else to the unit. Units not properly grounded may result in a safety risk and could be hazardous and may void the warranty. See the grounding technique section of this manual for proper ways to ground the unit. **AVERTISSEMENT:** L'unité doit être correctement mise à la terre avant tout raccordement à l'unité. Unités pas correctement mise à la terre peuvent causer un risque de sécurité et pourraient être dangereuses et peuvent annuler la garantie. Voir la section technique de mise à la terre dans ce mode d'emploi pour des moyens appropriés à la masse de l'appareil.

	WARNING: Device must be supplied by a Class 2 power source (except for POE DIN-Rail models and all 16M12 models). **AVERTISSEMENT:** l'appareil doit être alimenté par une source d'alimentation de classe 2 (sauf pour les modèles de rail-DIN POE et tous les modèles 16M12).

	WARNING: Do not operate the unit with the top cover removed, as this could create a shock or fire hazard. **AVERTISSEMENT:** Ne pas faire fonctionner l'unité avec le couvercle retiré, ceci pourrait créer une décharge électrique ou un incendie.

	CAUTION: Observe proper DC Voltage polarity when installing power input cables. Reversing voltage polarity can cause permanent damage to the unit and void the warranty. ATTENTION: Respectez la polarité correcte de tension DC lors de l'installation des câbles d'alimentation d'entrée. Inversion de polarité de tension peut causer des dommages permanents à l'appareil et annule la garantie.

Environmental Safety Cautions and Warnings / Sécurité Environnementale Mises en Garde et Avertissements

WARNING: Do not operate the equipment in the presence of flammable gases or fumes. Operating electrical equipment in such an environment constitutes a definite safety hazard.

AVERTISSEMENT: Ne pas utiliser le matériel en présence de gaz ou de vapeurs inflammables. L'utilisation de matériel électrique dans un tel environnement constitue un danger certain.

WARNING: Disconnect the power and allow to cool 5 minutes before touching.

AVERTISSEMENT: Déconnectez le câble d'alimentation et laisser refroidir 5 minutes avant de la toucher.

Hazardous Location Warnings / Les Avertissements d'Emplacement Dangereux

CAUTION: This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only. Combinations of equipment in your system are subject to investigation by the local authority having jurisdiction at the time of installation.

ATTENTION: Cet appareil est adapté pour utilisation en Classe I, Division 2, Groupes A, B, C, D ou endroits non-dangereux seulement. Combinaisons d'équipements de votre système sont objet d'une enquête par l'autorité locale compétente au moment de l'installation.

CAUTION: These devices are open-type devices that are to be installed in an enclosure suitable for the environment such that the equipment is only accessible with the use of a tool.

ATTENTION: Ces appareils sont de type ouvert matériels qui doivent être installés dans un boîtier adapté à l'environnement, tels que l'équipement n'est accessible qu'avec l'utilisation d'un outil.

WARNING: Explosion Hazard – Substitution of components may impair suitability for Class I, Division 2.

AVERTISSEMENT - Risque d'explosion - La substitution de tout composant peut nuire à la conformité de Classe 1, Division 2.

WARNING: Explosion Hazard – Do not connect or disconnect any connections while circuit is live unless area is known to be non-hazardous.

AVERTISSEMENT: Risque d'explosion - Ne pas brancher ou débrancher les connexions lorsque le circuit est sous tension sauf si la zone est connue pour être non dangereux.

WARNING: Exposure to some chemicals may degrade the sealing properties of materials used in the following devices: Relay U1 and DIN-Rail models.

AVERTISSEMENT: L'exposition à certains produits chimiques peut altérer l'étanchéité des propriétés des matériaux utilisés dans les appareils suivants : U1 Relais rail DIN et modèles.

WARNING: Explosion Hazard – Do not replace the device unless power has been switched off or the area is known to be non-hazardous.

AVERTISSEMENT: Risque d'explosion - Ne pas remplacer l'appareil à moins que l'alimentation a été coupée ou que la zone est connue pour être non-dangereuse.

WARNING: Never connect or disconnect power when hazardous gases are present.

AVERTISSEMENT: Ne jamais brancher ou débrancher l'alimentation lorsqu'en presence de gaz dangereux.

Surrounding Air Temperature / Temperature Ambiante

NT24k® models without PoE (Power over Ethernet) option: -40 to 85 °C

NT24k PoE models: -40 to 80 °C

Temperature Codes:

NT24k-16M12, NT24k-16M12-R: T3C

NT24k-16M12-POE, NT24k-16M12-POE-R: T4

Note: Use 110 °C or higher rated copper wire, 0.5 Nm/0.368 lb/ft tightening torque for field installed conductors.
Remarque: l'utilisation de 110 °C ou plus classé le fil de cuivre, 0,5 Nm/0,368 lb/ft couple de serrage pour conducteurs installé sur le terrain.

Laser Safety Warnings / Avertissements de Sécurité Laser

CAUTION: CLASS 1 LASER PRODUCT. Do not stare into the laser.
ATTENTION: PRODUIT LASER CLASSE 1. Ne pas regarder dans le laser.

Note: Please reference sections NT24k-10FX2, NT24k-11FX3, NT24k-12FX4, NT24k-14FX6, NT24k-12SFP-DM4, NT24k-10FX2-POE, NT24k-11FX3-POE, NT24k-12FX4-POE, NT24k-14FX6-POE, and NT24k-12SFP-DM4-POE for all models with lasers present.
Remarque: S'il vous plaît consulter la section NT24k-10FX2, NT24k-11FX3, NT24k-12FX4, NT24k-14FX6, NT24k-12SFP-DM4, NT24k-10FX2-POE, NT24k-11FX3-POE, NT24k-12FX4-POE, NT24k-14FX6-POE, et NT24k-12SFP-DM4-POE pour tous les modèles avec lasers.

Regulatory Information for DIN Rail Models

Product Safety
ANSI/ISA 12.12.01-2013 Class I and II, Div. 2 and Class III, Div. 1 and 2, Groups A, B, C and D Hazardous Locations
UL508 Industrial Control Equipment
CAN/CSA-C22.2 No. 213-M1987 Class I Div. 2 Hazardous Locations
CAN/CSA-C22.2 No. 14-M1987 Industrial Control Equipment
Emissions
FCC Title 47, Part 15, Radio Frequency Devices, Subpart B ANSI C63.4-2009
Industry Canada ICES-003, EN 55011; EN 61000-6-4, EN 61000-3-2, EN61000-3-3, EN 55032
Immunity
EN 55024, EN 61000-6-2; IEC 61000-4-2 (ESD); IEC 61000-4-3 (RFAM); IEC 61000-4-4 (EFT); IEC 61000-4-5 (SURGE); IEC 61000-4-6 (RFCM); IEC 61000-4-8 (PFMF); IEC 61000-4-11 (VDI)
Railway/Rolling Stock
EN 50155, EN 50121 and EN 61373
Marine
ABS Type Approval for Shipboard Applications

Designed to Comply With
IEEE 1613 for Electric Utility Substations
NEMA TS1/TS2 for Traffic Control
Other
EMC Directive 2014/30/EU
LV Directive 2014/35/EU GOST-R
RoHS compliant

Regulatory Information for M12 Models

Product Safety
ANSI/ISA-12.12.01-2015 - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations, Groups A, B, C and D Hazardous Locations
UL 61010-1 Edition 3 - Revision Date 2016/04/29
CAN/CSA C22.2 No. 213-16 - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations, Groups A, B, C and D Hazardous Locations
CSA C22.2 NO. 61010-1-12
Emissons
FCC 47 CFR Part 15, Radio Frequency Devices, Subpart B, ANSI C63.4-2014; ISED Canada ICES-003 Issue 6, EN 55011, EN 61000-3-2, EN61000-3-3, EN 55032
Immunity
EN 55024, IEC 61000-4-2 (ESD), IEC 61000-4-3 (RFAM), IEC 61000-4-4 (EFT), IEC 61000-4-5 (SURGE), IEC 61000-4-6 (RFCM), IEC 61000-4-11 (VDI)
Railway/Rolling Stock
EN 50155, EN 50121, EN 61373 and EN 45545-2
Designed to Comply With
IEEE 1613 for Electric Utility Substations
NEMA TS1/TS2 for Traffic Control
Other
EMC Directive 2014/30/EU
LV Directive 2014/35/EU, GOST-R
RoHS Compliant

Chapter 1 Product Overview

NT24k® Series Common Features

Red Lion's N-Tron® Series NT24k Compact Gigabit managed industrial Ethernet switches offer a wide array of port configurations, media types, and Power over Ethernet. Modular NT24k models are also available. Please see the NT24k Modular Series Hardware Manual for more information.

All NT24k switches offer plug-and-play installation with IGMP auto-configuration, media/port auto-detection and simple ring configuration, making the NT24k platform one of the easiest to deploy managed switches in the industry. Housed in rugged hardened enclosures, the NT24k switches feature extended shock and vibration specifications, wide operating temperature ratings and best-in-class ring technology.

Connectivity

The NT24k compact switches offer a wide array of port configurations, media types and Power over Ethernet models with 10/100/1000 copper, as well as Fast Ethernet and Gigabit fiber options. For maximum flexibility, the compact models are available with copper only ports or a mix of copper and fiber ports. IEEE 802.3af/at PoE models are also available.

Performance

NT24k managed switches provide uncompromising performance in harsh environments, including network features like N-Ring™, VLAN, Quality of Service (QoS), port mirroring, IGMP, SNTP, and SNMP. Additionally the NT24k offers IEEE 802.1x with RADIUS remote server authentication to ensure port security. These network management features provide best-in-class visibility, security and uptime performance.

Environmental

The ultra-reliable NT24k compact switches are DIN rail and bulkhead mountable and offer IP20 rated models and rugged IP67 dust tight, water resistant models with M12 connectors with operating temperatures up to -40 to 85 °C. With UL Class I, Division 2 listing, and CE certifications, these industrial switches are built to last in the most demanding and hazardous environments.

Monitoring

The N-View™ monitoring technology provided with the switch provides 47 different status points on switch and port conditions and displays that information in the N-View 2 Windows application.

Security

The NT24k series provides a high level of security utilizing IEEE 802.1x with RADIUS remote server authentication and SNMPv3 communication protocol to ensure the safest networks.

Available Models

PART #	TOTAL PORTS	MOUNTING	OPERATING TEMPERATURE	IP RATING	10/100/ 1000 COPPER	100 FIBER	GIG FIBER	SFPS*	10-49 VDC REDUNDANT POWER INPUT	22-49 VDC REDUNDANT POWER INPUT
NT24k-8TX	8	DIN rail	-40 to 85 °C	IP20	8	-	-	-	✓	
NT24k-16TX	16	DIN rail	-40 to 85 °C	IP20	16	-	-	-	✓	
NT24k-10FX2	10	DIN rail	-40 to 85 °C	IP20	8	2	-	-	✓	
NT24k-10GX2	10	DIN rail	-40 to 85 °C	IP20	8	-	2	-	✓	
NT24k-11FX3	11	DIN rail	-40 to 85 °C	IP20	8	3	-	-	✓	
NT24k-11GX3	11	DIN rail	-40 to 85 °C	IP20	8	-	3	-	✓	
NT24k-12FX4	12	DIN rail	-40 to 85 °C	IP20	8	4	-	-	✓	
NT24k-12GX4	12	DIN rail	-40 to 85 °C	IP20	8	-	4	-	✓	
NT24k-14FX6	14	DIN rail	-40 to 85 °C	IP20	8	6	-	-	✓	
NT24k-14GX6	14	DIN rail	-40 to 85 °C	IP20	8	-	6	-	✓	
NT24k-12SFP-DM4	12	DIN rail	-40 to 85 °C	IP20	8	-	-	Up to 4	✓	
NT24k-8TX-POE	8	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	-	-		✓
NT24k-16TX-POE	16	DIN rail	-40 to 80 °C	IP20	16 (16 PoE+)	-	-	-		✓
NT24k-10FX2-POE	10	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	2	-	-		✓
NT24k-10GX2-POE	10	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	2	-		✓
NT24k-11FX3-POE	11	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	3	-	-		✓
NT24k-11GX3-POE	11	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	3	-		✓
NT24k-12FX4-POE	12	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	4	-	-		✓
NT24k-12GX4-POE	12	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	4	-		✓
NT24k-14FX6-POE	14	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	6	-	-		✓
NT24k-14GX6-POE	14	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	6	-		✓
NT24k-12SFP-DM4-POE	12	DIN rail	-40 to 80 °C	IP20	8 (8 PoE+)	-	-	Up to 4		✓
NT24k-16M12	16	Bulkhead	-40 to 85 °C	IP67	16	-	-	-	✓	
NT24k-16M12-POE	16	Bulkhead	-40 to 80 °C	IP67	16 (16 PoE+)	-	-	-		✓
NT24k-16M12-R**	16	Bulkhead	-40 to 85 °C	IP67	16	-	-	-	✓	
NT24k-16M12-POE-R**	16	Bulkhead	-40 to 80 °C	IP67	16 (16 PoE+)	-	-	-		✓

* See NT24k-12SFP-DM4-POE on page 74 for Fast Ethernet and Gigabit SFP transceivers

** Includes Bypass Relays

NT24k-8TX

The versatile NT24k-8TX managed switch features eight all-Gigabit copper Ethernet ports housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-8TX offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication, and Multi-Member N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater and manufacturing applications.

Features and Benefits

Features and Benefits

Eight 10/100/1000Base-T(X) RJ45 Ports
- Easily transitions to Gigabit network requirements

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure.

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

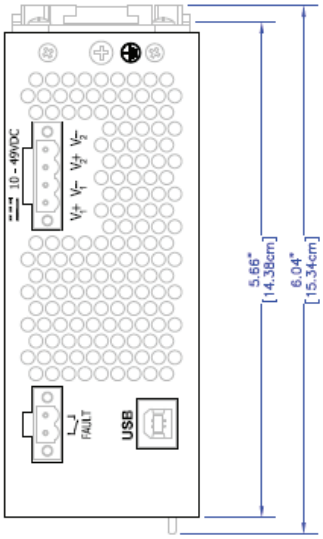
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN Tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-8TX Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	2.22" (5.64 cm)	5.54" (14.07 cm)	1.68 lbs (0.76 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	490 mA @ 24 VDC	22 A /.33 ms @ 24 VDC	40.14	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**	**Note**		
200g @ 10ms	50g, 5-200Hz, Triaxial	Unit must be bulkhead mounted to achieve these levels.		
CONNECTORS				
10/100/1000BaseT(X): Eight RJ45 copper ports				
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	2" (5.08 cm)			
Front	4" (10.16 cm)			

NT24k-8TX DIMENSIONS In inches (mm)



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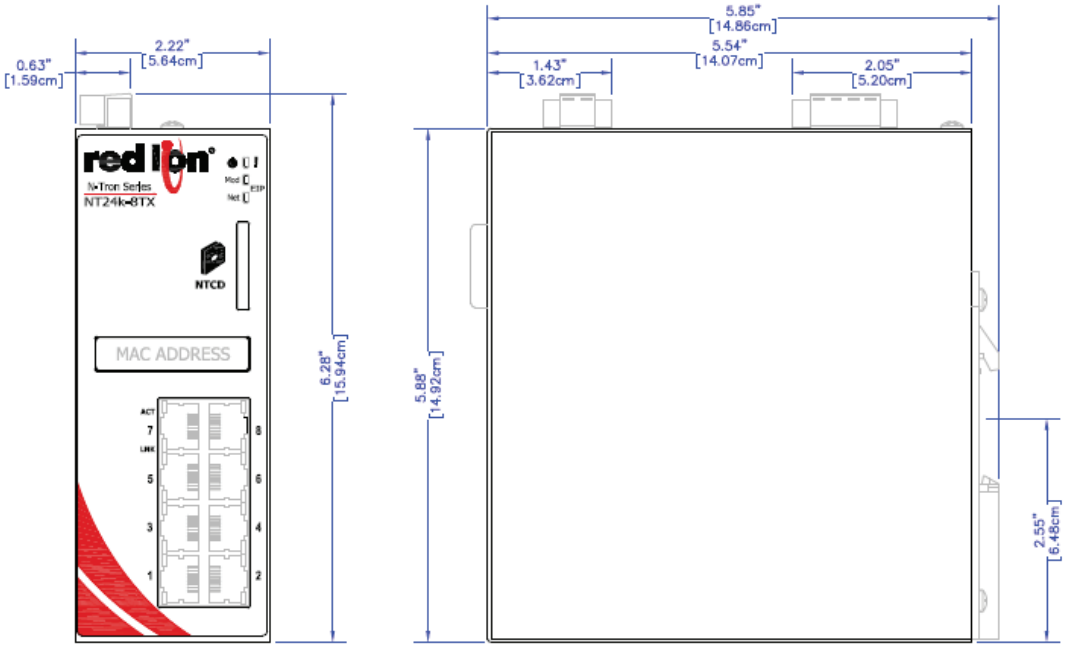


FRONT RIGHT

All specifications are subject to change. Consult the company website for more information.

NT24k-16TX

The versatile NT24k-16TX managed switch features 16 all-Gigabit copper Ethernet ports housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-16TX offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

16 10/100/1000Base-T(X) RJ45 Ports
- Easily transitions to Gigabit network requirements

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure.

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

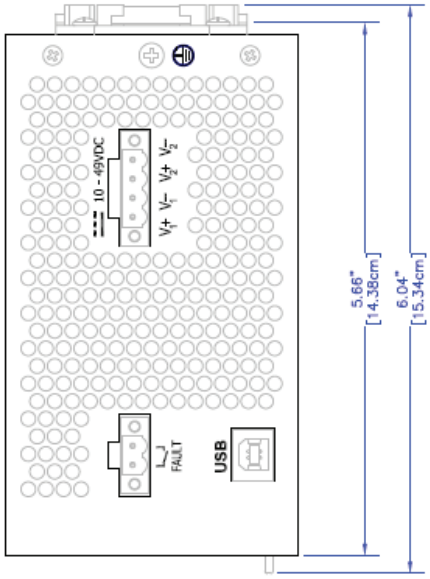
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN Tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-16TX Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.97 lbs (0.89 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	710 mA @ 24 VDC	22 A /.33 ms @ 24 VDC	58.14	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: 16 RJ45 copper ports				
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	2" (5.08 cm)			
Front	4" (10.16 cm)			

NT24k-16TX DIMENSIONS In inches (mm)



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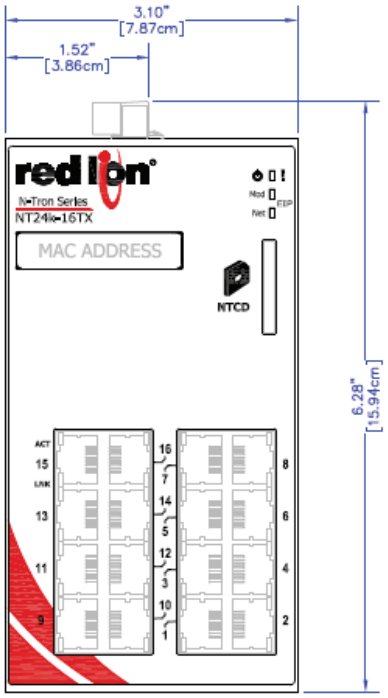

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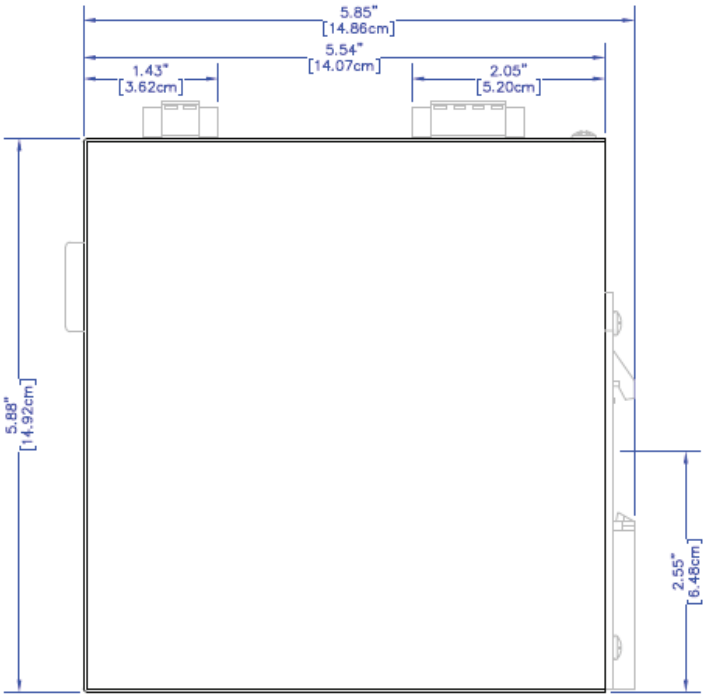

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All specifications are subject to change. Consult the company website for more information.

NT24k-10FX2

The versatile NT24k-10FX2 managed switch features 10 Ethernet ports (eight Gigabit copper ports and two 100Base fiber ports) and is housed in a compact, hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-10FX2 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature rating. IGMP autoconfiguration, IEEE 802.1x with RADIUS remote server authentication, and N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in alternative energy, factory automation applications, transportation, and water/wastewater.

Features and Benefits

Features and Benefits

10 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Two 100BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

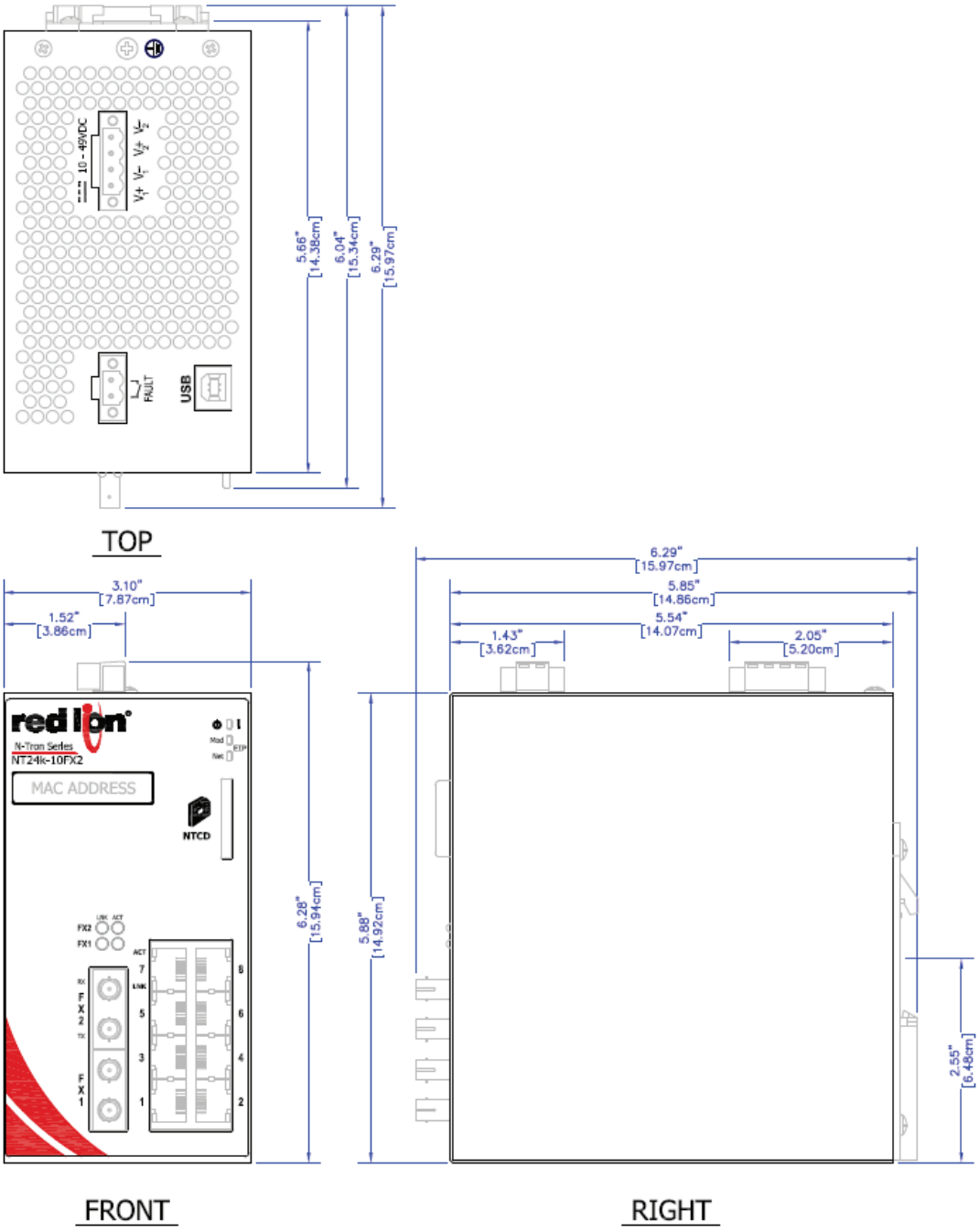
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN Tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-10FX2 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.95 lbs (0.89 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	750 mA @ 24 VDC	21 A /.30 ms @ 24 VDC	61.44	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: 16 RJ45 copper ports		100BaseFX: Two SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-10FX2 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-10GX2

The versatile NT24k-10GX2 managed switch features 10 Ethernet ports (eight Gigabit copper ports and two 1000Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-10GX2 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

10 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Two 1000BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

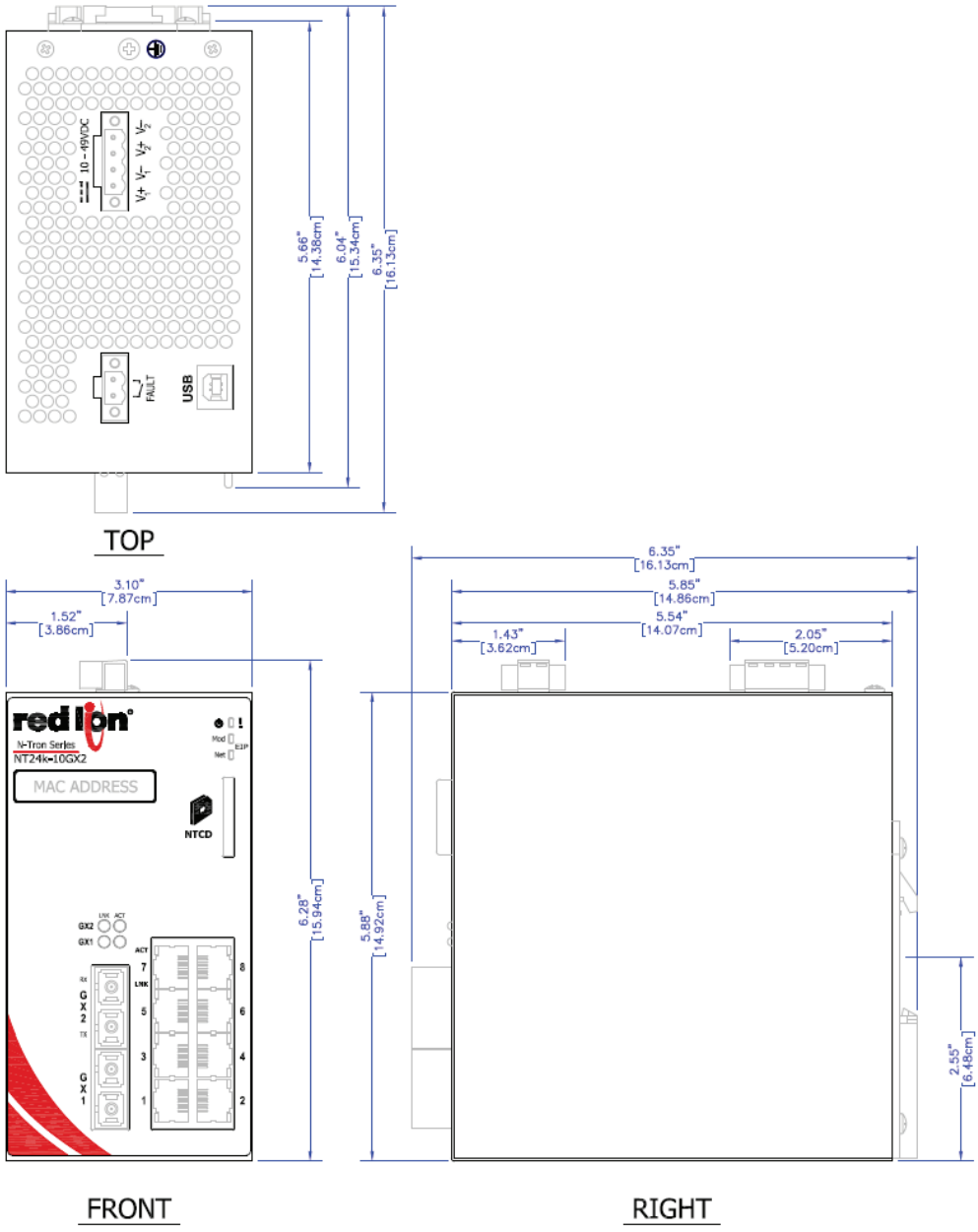
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN Tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-10GX2 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.95 lbs (0.89 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	780 mA @ 24 VDC	22.6 A /.30 ms @ 24 VDC	63.89	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseFX: Two SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-10GX2 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-11FX3

The versatile NT24k-11FX3 managed switch features 11 Ethernet ports (eight Gigabit copper ports and three 100Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-11FX3 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

11 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Three 100BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

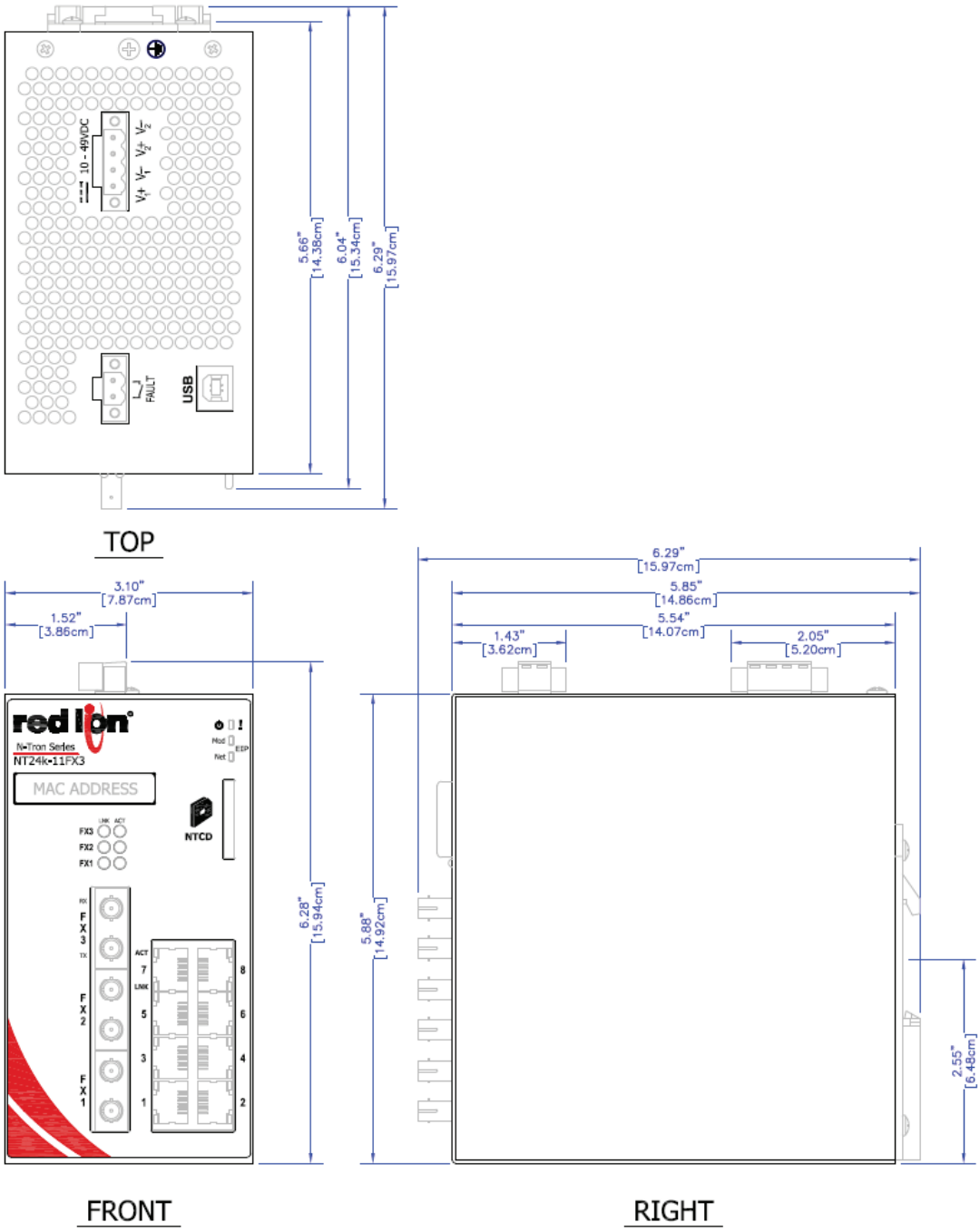
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-11FX3 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.96 lbs (0.89 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	750 mA @ 24 VDC	21 A /.30 ms @ 24 VDC	61.44	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseT: Eight RJ45 ports 100BaseFX: Three SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-11FX3 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-11GX3

The versatile NT24k-11GX3 managed switch features 11 Ethernet ports (eight Gigabit copper ports and three 1000Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-11GX3 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing

Features and Benefits

Features and Benefits

11 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Three 1000BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

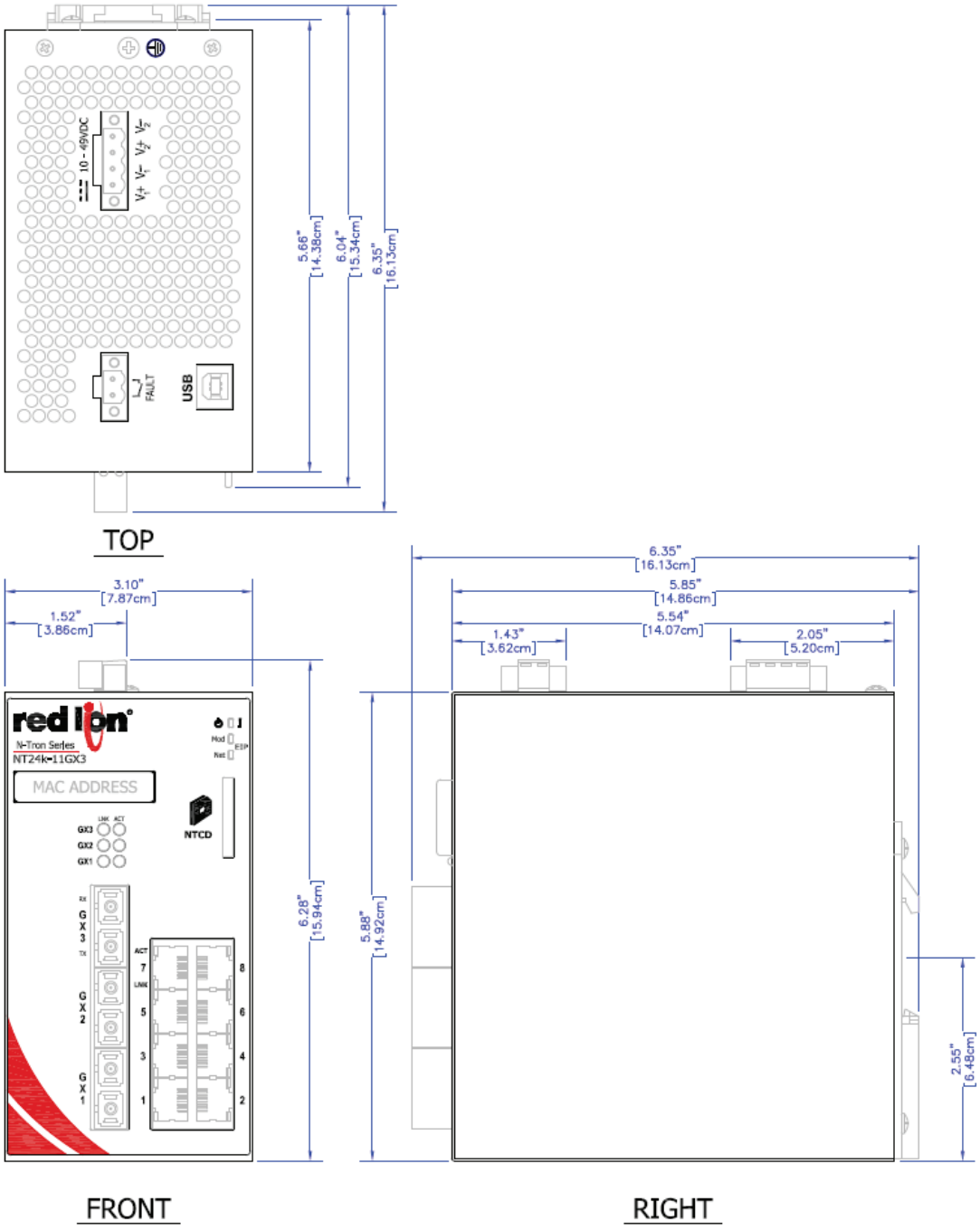
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-11GX3 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.96 lbs (0.89 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	780 mA @ 24 VDC	22.6 A /.30 ms @ 24 VDC	63.89	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseFX: Three SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-11GX3 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12FX4

The versatile NT24k-12FX4 managed switch features 12 Ethernet ports (eight Gigabit copper ports and four 100Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12FX4 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

12 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Four 100BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

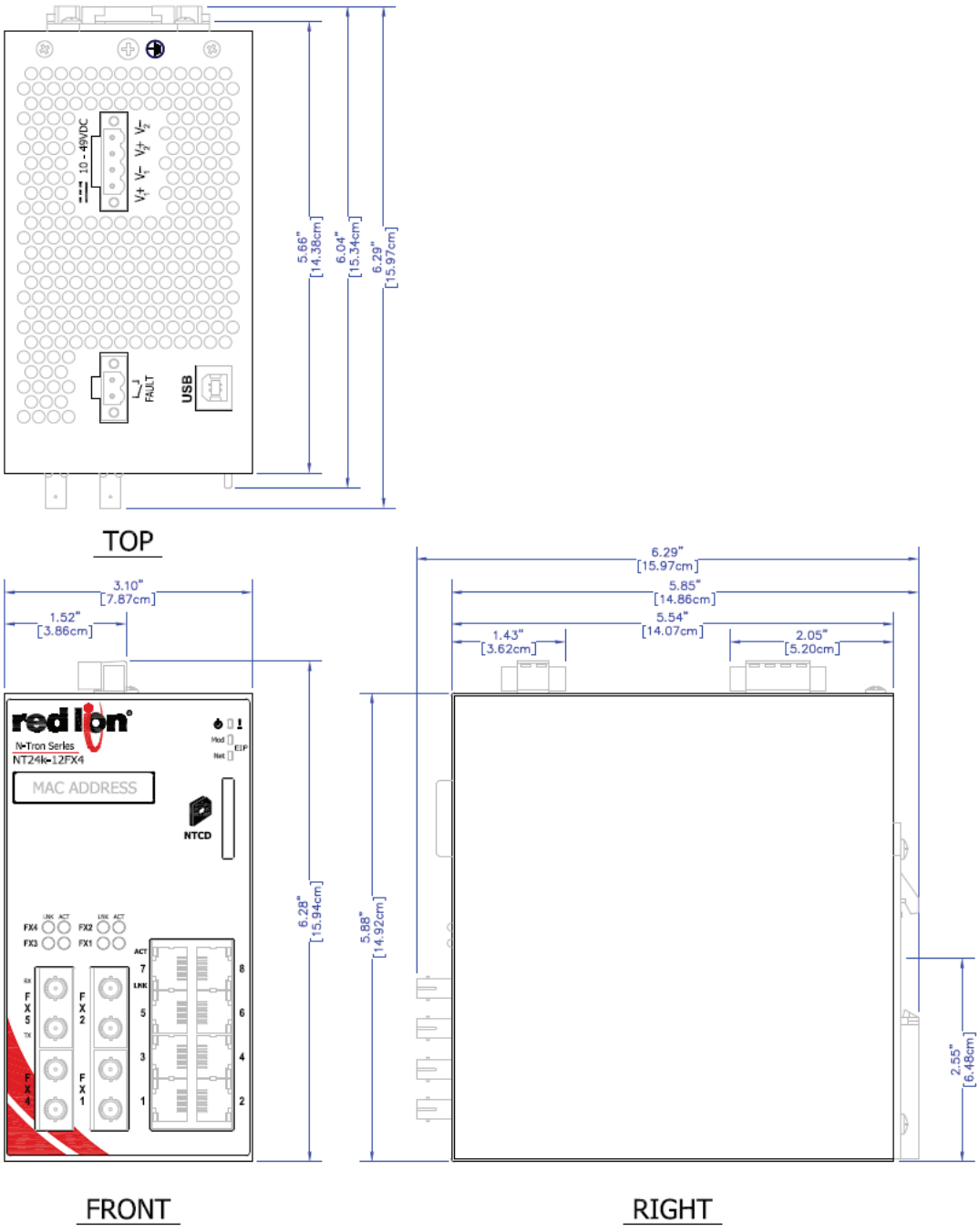
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-12FX4 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	2.05 lbs (0.93 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	750 mA @ 24 VDC	21 A /.30 ms @ 24 VDC	61.44	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 TX copper ports		100BaseFX: Four SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-12FX4 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12GX4

The versatile NT24k-12GX4 managed switch features 12 Ethernet ports (eight Gigabit copper ports and four 1000Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12GX4 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing application.

Features and Benefits

Features and Benefits

12 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Four 1000BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

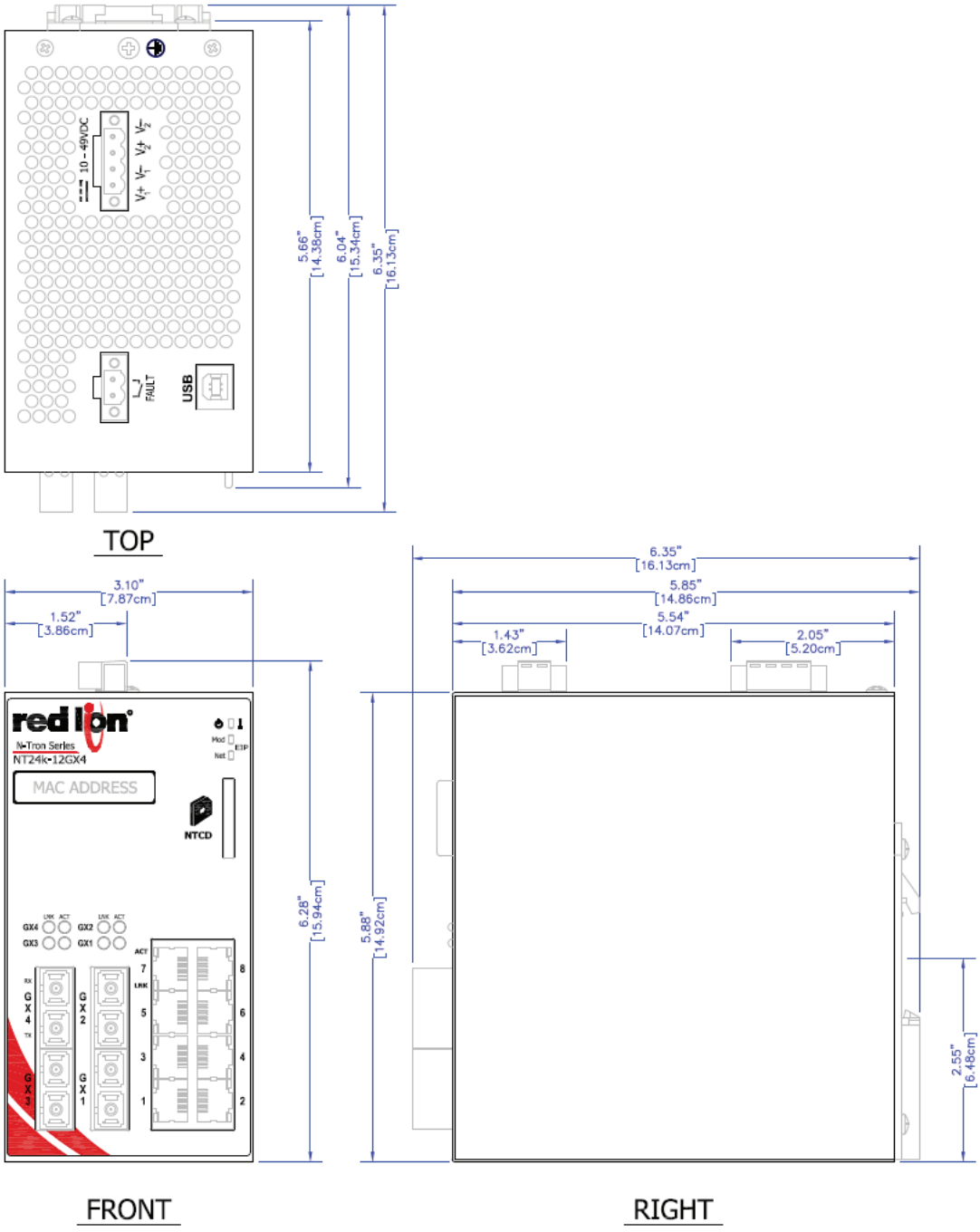
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-12GX4 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	2.05 lbs (0.93 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	780 mA @ 24 VDC	22.6 A /.30 ms @ 24 VDC	63.89	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 TX copper ports		1000BaseFX: Four SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-12GX4 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-14FX6

The versatile NT24k-14FX6 managed switch features 14 Ethernet ports (eight Gigabit copper ports and six 100Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-14FX6 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

14 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Six 100BaseFX fiber ports

Redundant 10 to 49 VDC Power Input
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

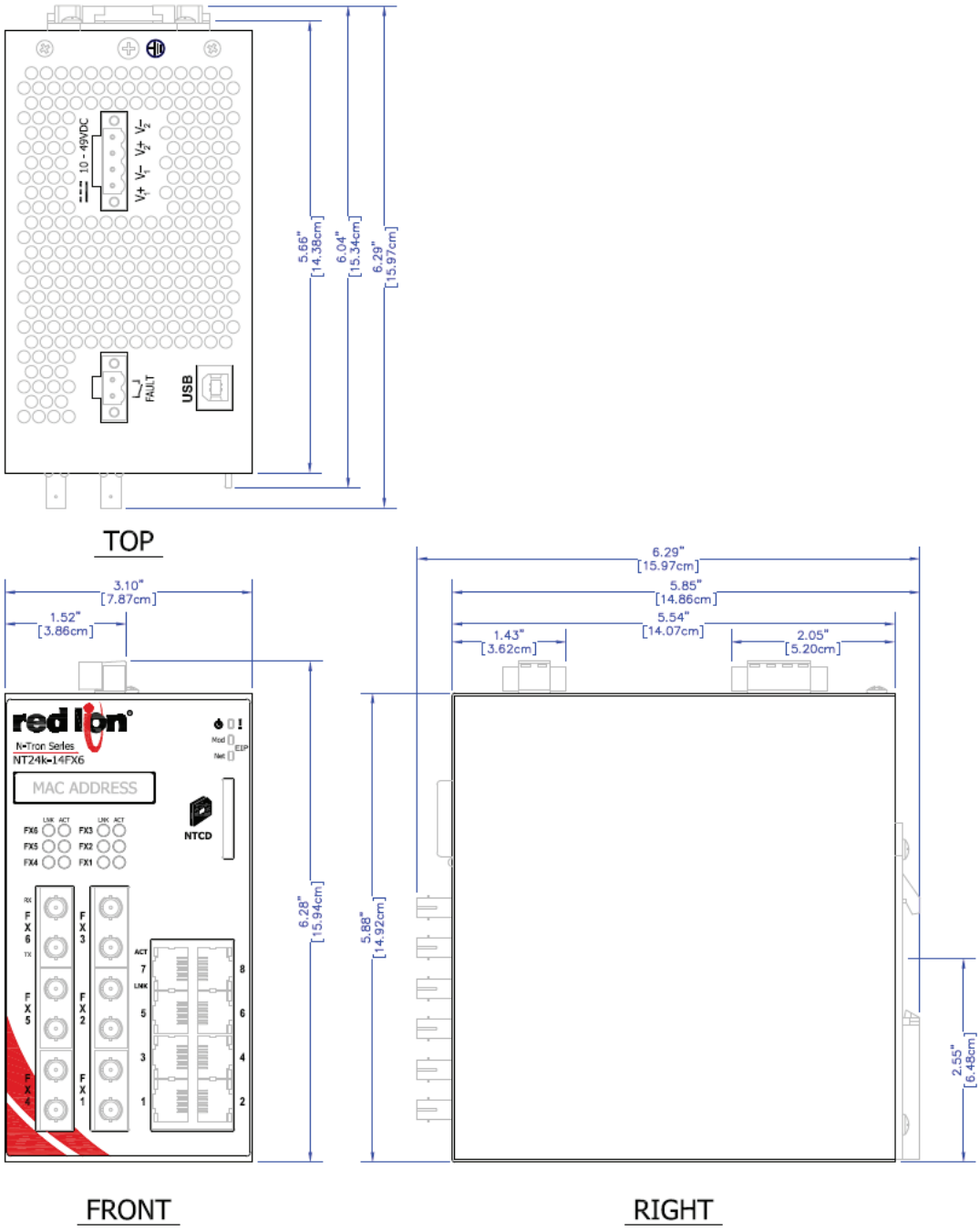
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-14FX6 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	2.06 lbs (0.94 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	750 mA @ 24 VDC	21 A /.30 ms @ 24 VDC	61.44	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Six SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-14FX6 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-14GX6

The versatile NT24k-14GX6 managed switch features 14 Ethernet ports (eight Gigabit copper ports and six 1000Base fiber ports) housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-14GX6 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

14 Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports
- Six 1000BaseFX fiber ports

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

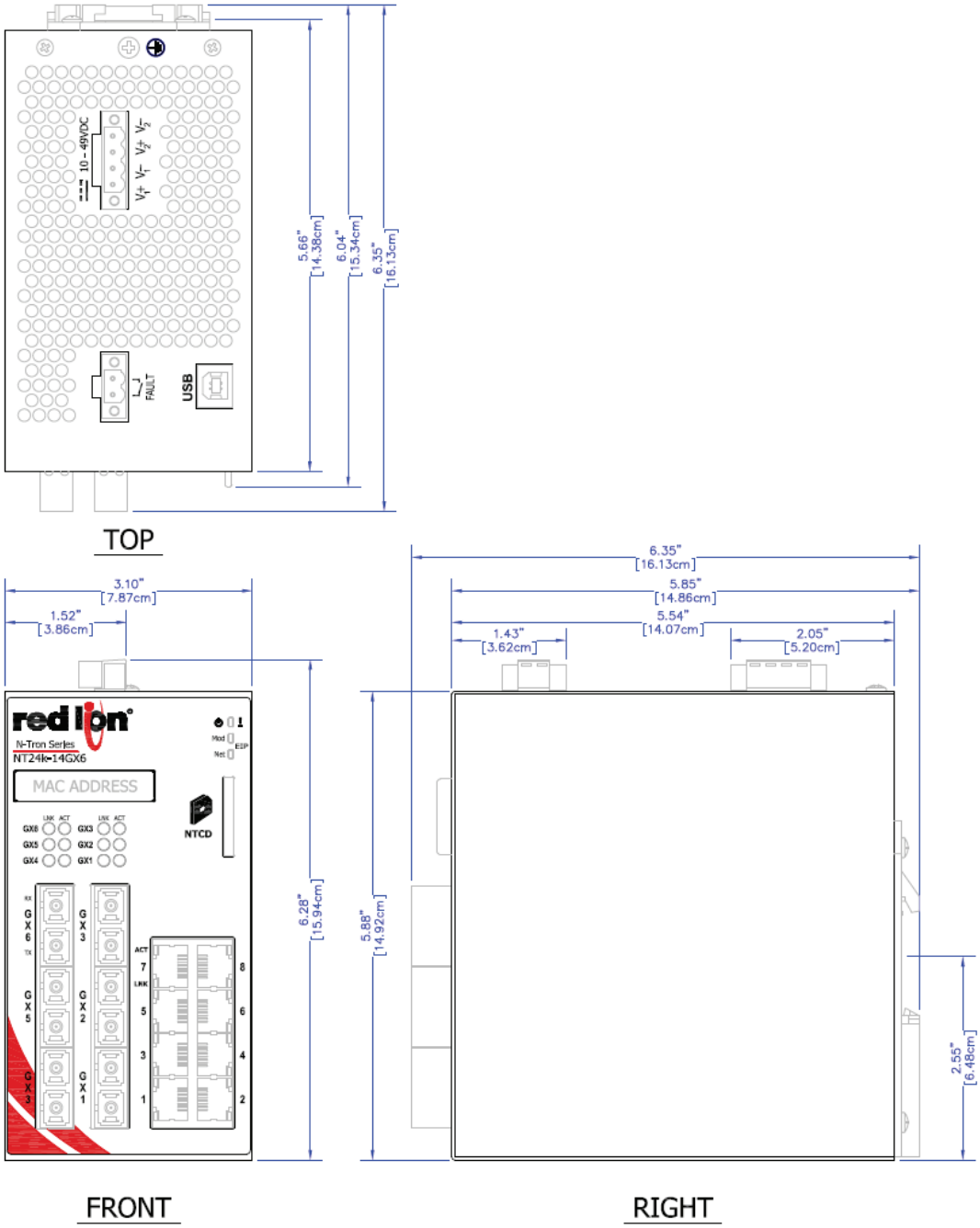
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-14GX6 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	2.06 lbs (0.94 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	780 mA @ 24 VDC	22.6 A /.30 ms @ 24 VDC	63.89	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseFX: Six SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-14GX6 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12SFP-DM4

The versatile NT24k-12SFP-DM4 managed switch features eight Gigabit copper Ethernet ports plus four SFP ports that support 100Base or 1000Base SFP transceivers, housed in a hardened metal DIN rail enclosure with redundant 10-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12SFPDM4 offers wire-speed throughput, expanded shock and vibration ratings and wide -40 to 85 °C operating temperature ratings. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

12 Mixed Copper and SFP Ports
- Eight 10/100/1000Base-T(X) copper ports
- Four SFP ports (100Base and 1000Base transceivers - sold separately)

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- -40 to 85 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

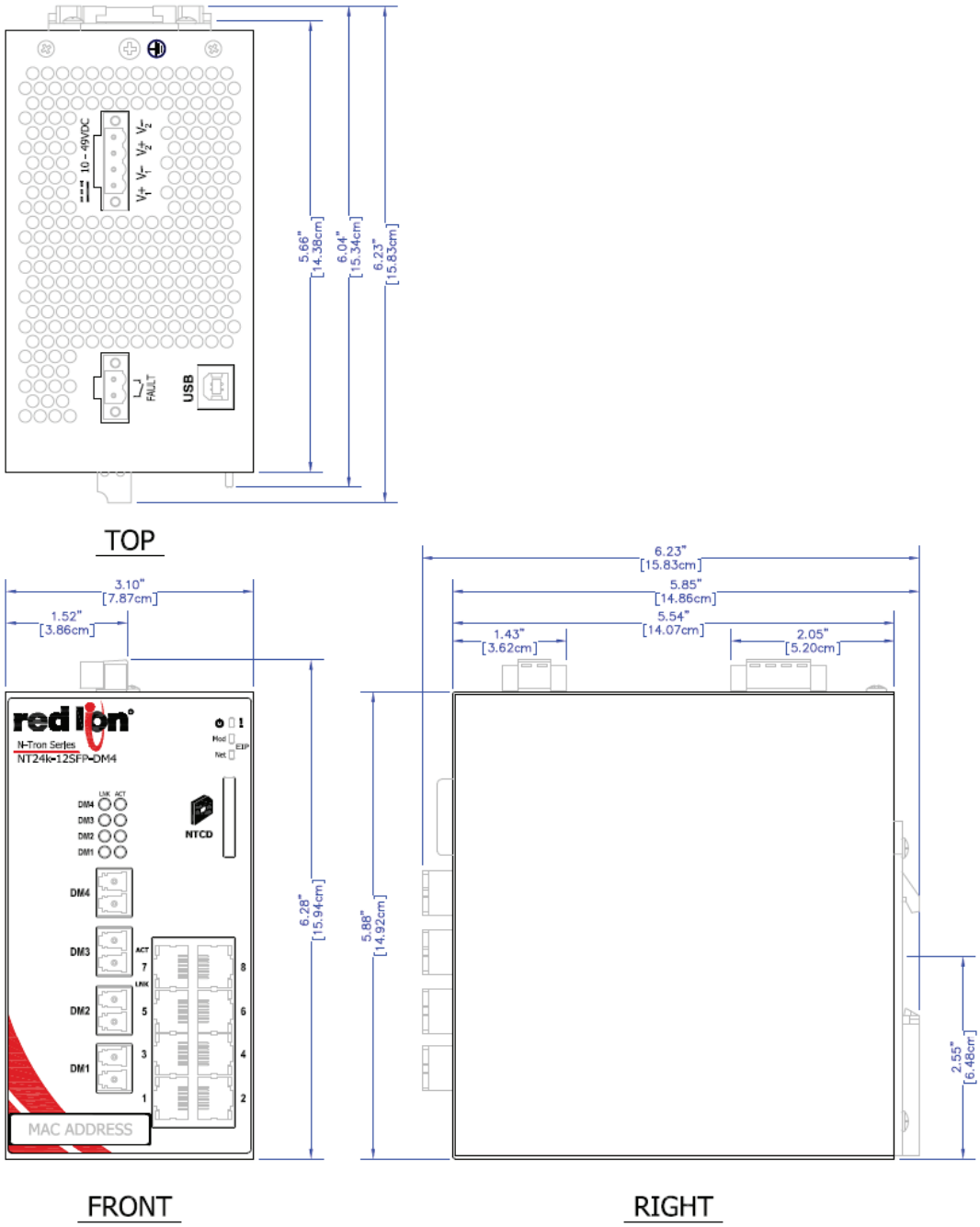
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-12SFP-DM4 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	1.91 lbs (0.87 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	760 mA @ 24 VDC	20.4 A /.30 ms @ 24 VDC	62.26	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100/1000 Base-SX/LX SFP Port: Up to four SFP port transceivers (SFP transceivers sold separately)		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4" (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-12SFP-DM4 DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-8TX-POE

The versatile NT24k-8TX-POE managed switch features eight ports (eight Gigabit IEEE 802.3af/at Power over Ethernet Plus (PoE+) ports) and is housed in a compact, hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-8TX-POE provides up to 30 Watts of power per port, high shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

Eight 10/100/1000Base-T(X) RJ45 Ports
- Easily transitions to Gigabit network requirements

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure.

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

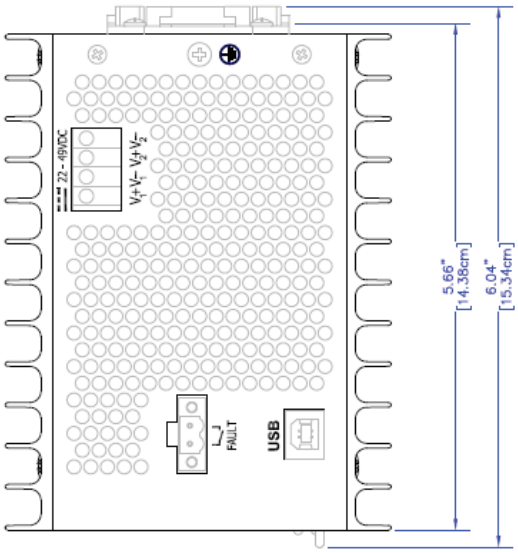
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-8TX-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	3.10" (7.87 cm)	5.54" (14.07 cm)	3.13 lbs (1.42 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	10.94 A @ 24 VDC (30W load on all PoE ports)	68 A /.09 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports				
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	2" (5.08 cm)			
Front	4" (10.16 cm)			

NT24k-8TX-POE DIMENSIONS In inches (mm)



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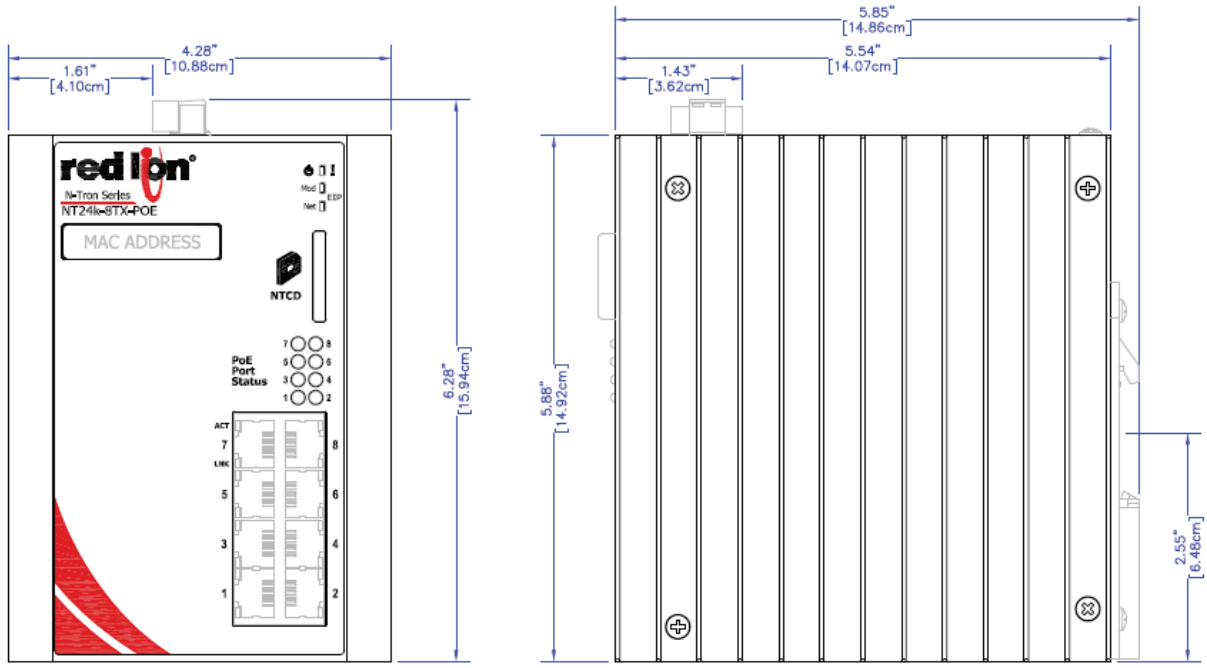

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All specifications are subject to change. Consult the company website for more information.

NT24k-16TX-POE

The versatile NT24k-16TX-POE compact managed Gigabit Ethernet switch features 16 Gigabit ports and IEEE 802.3af/at(PoE+) providing a robust solution for transmitting power and data to equipment in harsh environments. Housed in a compact, hardened DIN rail enclosure, the NT24k-16TX-POE managed switch features redundant 22-49 VDC power inputs, high shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. Rugged, reliable and easy to use, the NT24k-16TX-POE's 240 Watt Power over Ethernet budget can be allocated to any of its 16 ports, up to 30 watts per port. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

16 10/100/1000Base-T(X) RJ-45 Copper Ports
- Easily transitions to Gigabit network requirements

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure.

IEEE 802.3af/at PoE Output
- 240 Watt PoE budget configurable across all 16 ports; up to 30 Watts per port

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- MDIX auto-sensing cable
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

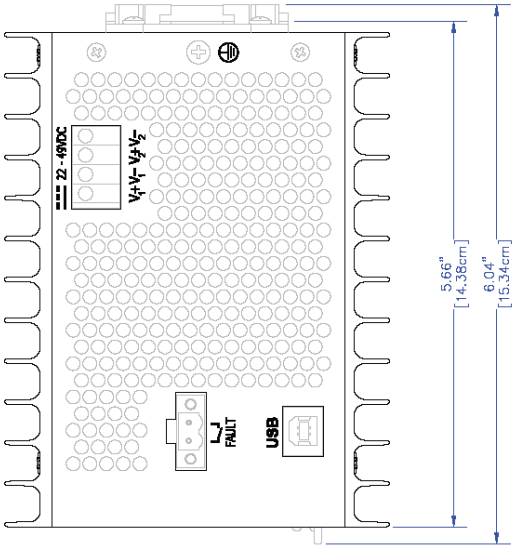
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- EtherNet/IP™ CIP™ messaging

NT24k-16TX-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28” (10.88 cm)	5.54" (14.07 cm)	3.25 lbs (1.48 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.24 A @ 24 VDC (240W combined load on all PoE ports))	67 A /.096 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: 16 RJ45 copper ports				
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	2" (5.08 cm)			
Front	4" (10.16 cm)			

NT24k-16TX-POE DIMENSIONS In inches (mm)



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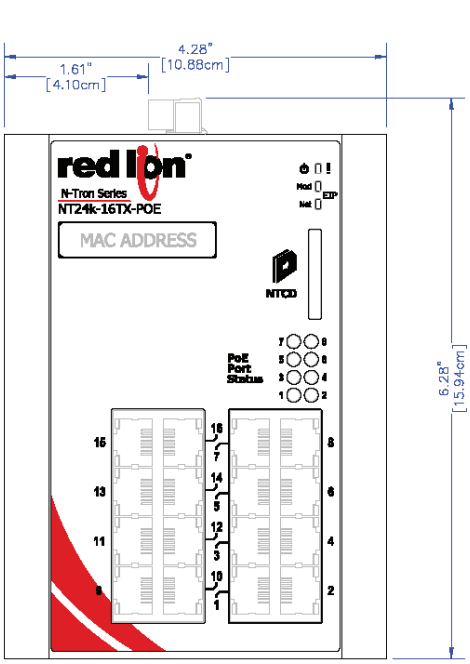

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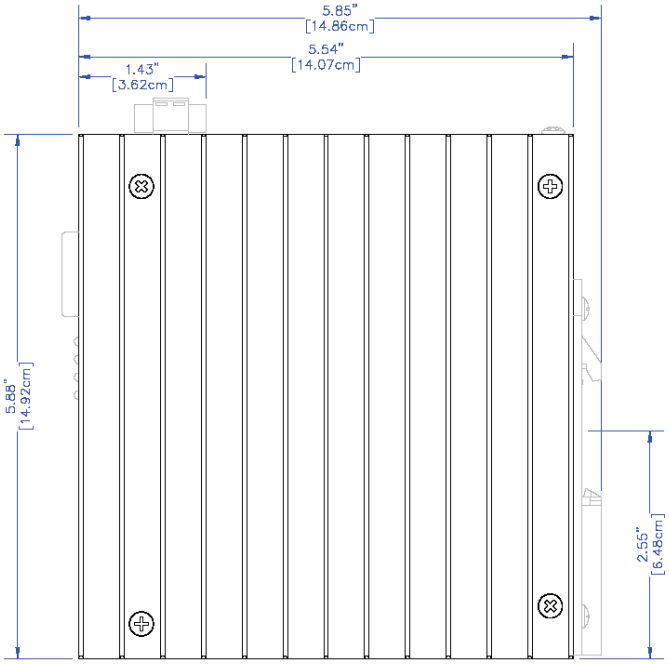

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All specifications are subject to change. Consult the company website for more information.

NT24k-10FX2-POE

The versatile NT24k-10FX2-POE managed switch features 10 ports (eight Gigabit IEEE 802.3af/at Power over Ethernet Plus (PoE+) ports and two 100Base-FX fiber ports) and is housed in a compact, hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-10FX2-POE provides up to 30 Watts of power per port, high shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

10 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Two 100BaseFX fiber ports with SC/ST connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

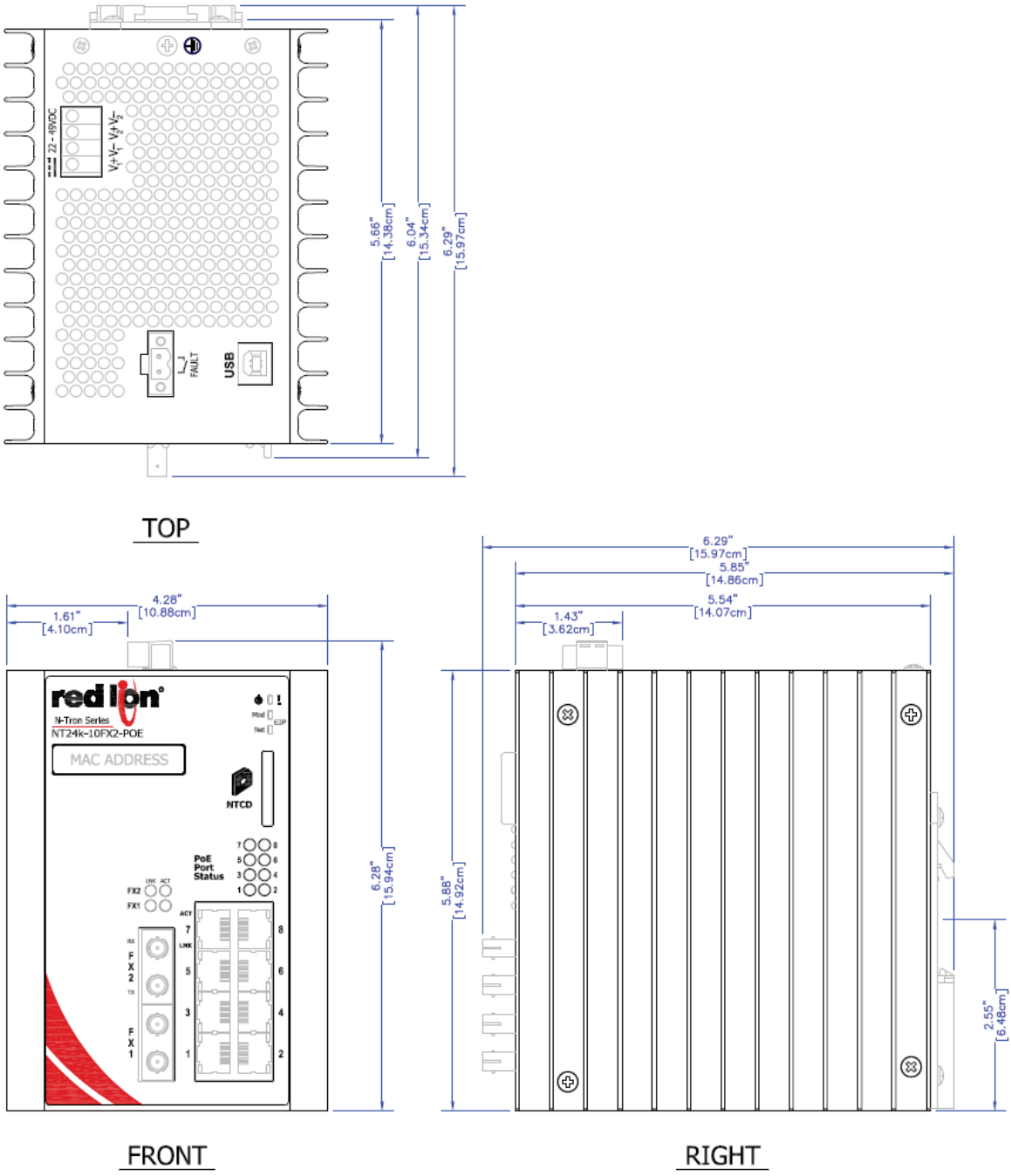
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-10FX2-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.23 lbs (1.46 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.24 A @ 24 VDC (30W load on all PoE ports)	60.8 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Two SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-10FX2-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-10GX2-POE

The versatile NT24k-10GX2-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus two 1000Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k- 10GX2-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

10 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Two 1000BaseFX fiber ports with SC connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

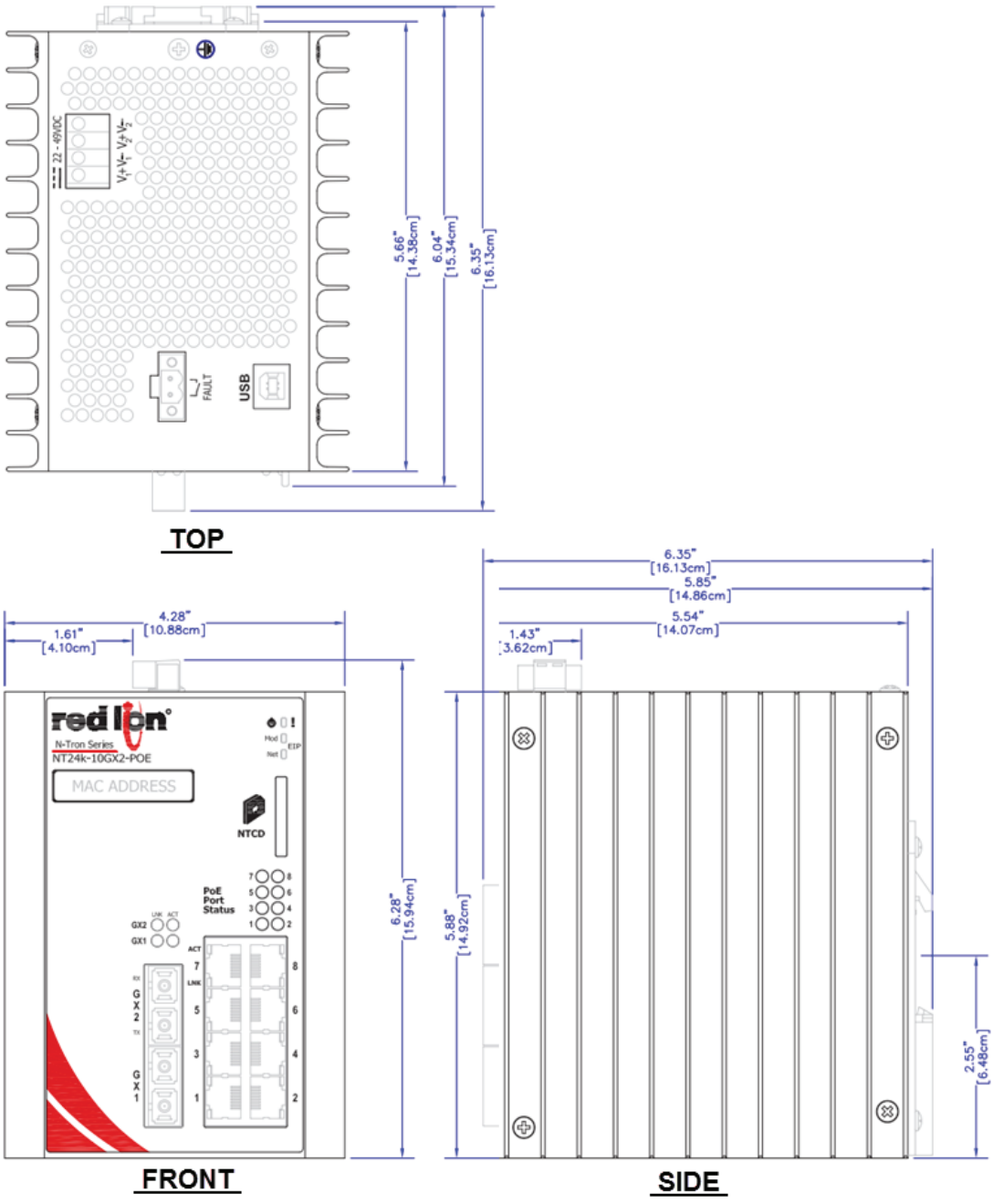
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-10GX2-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.23 lbs (1.46 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.37 A @ 24 VDC (30W load on all PoE ports)	60 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Two SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-10GX2-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-11FX3-POE

The versatile NT24k-11FX3-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus three 100Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-11FX3-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

11 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Three 100BaseFX fiber ports with SC/ST connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ outputs on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

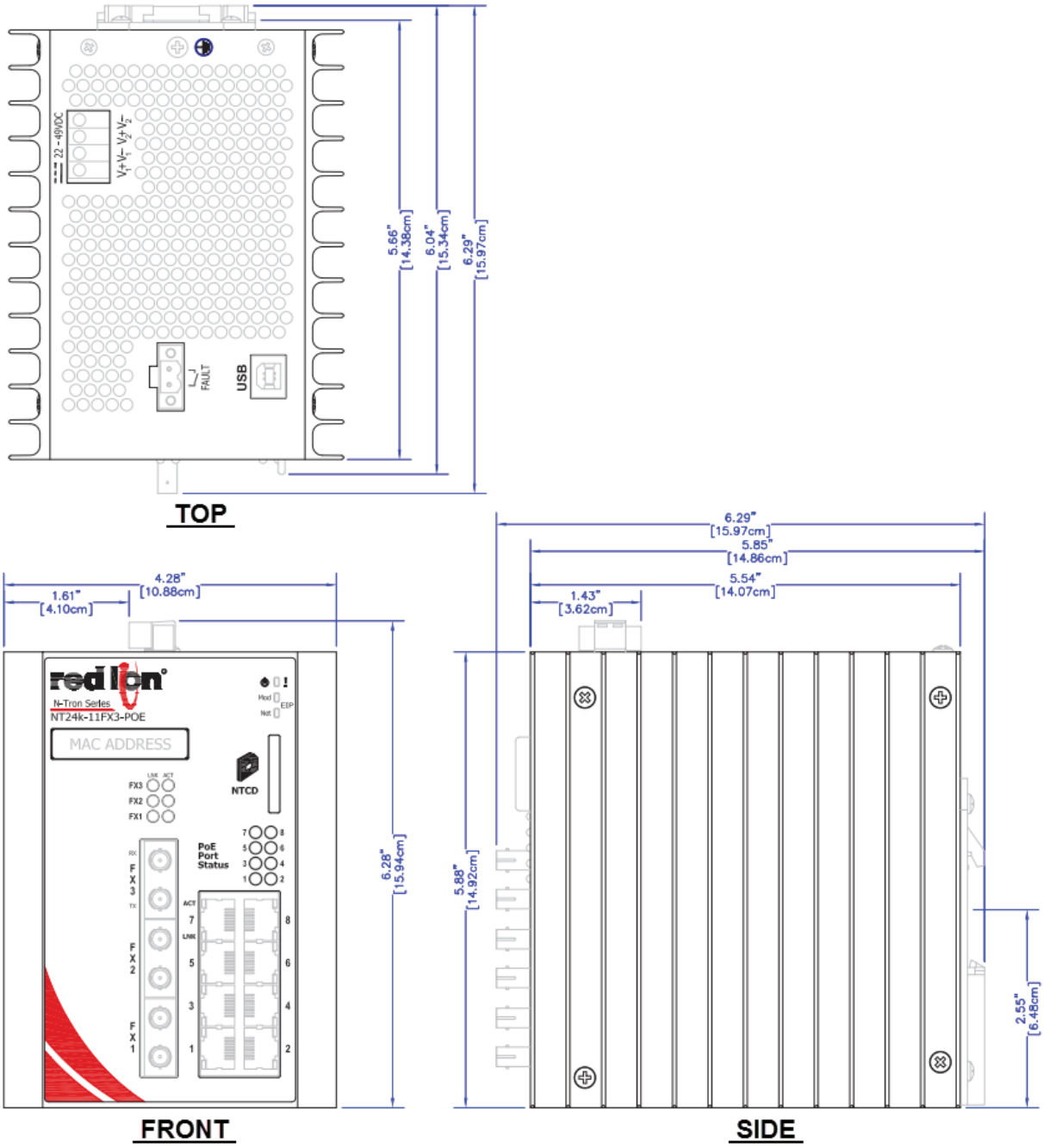
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-11FX3-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.24 lbs (1.47 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.24 A @ 24 VDC (30W load on all PoE ports)	60.8 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Three ST or SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-11FX3-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-11GX3-POE

The versatile NT24k-11GX3-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus three 1000Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-11GX3-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

11 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Three 1000BaseFX fiber ports with SC connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

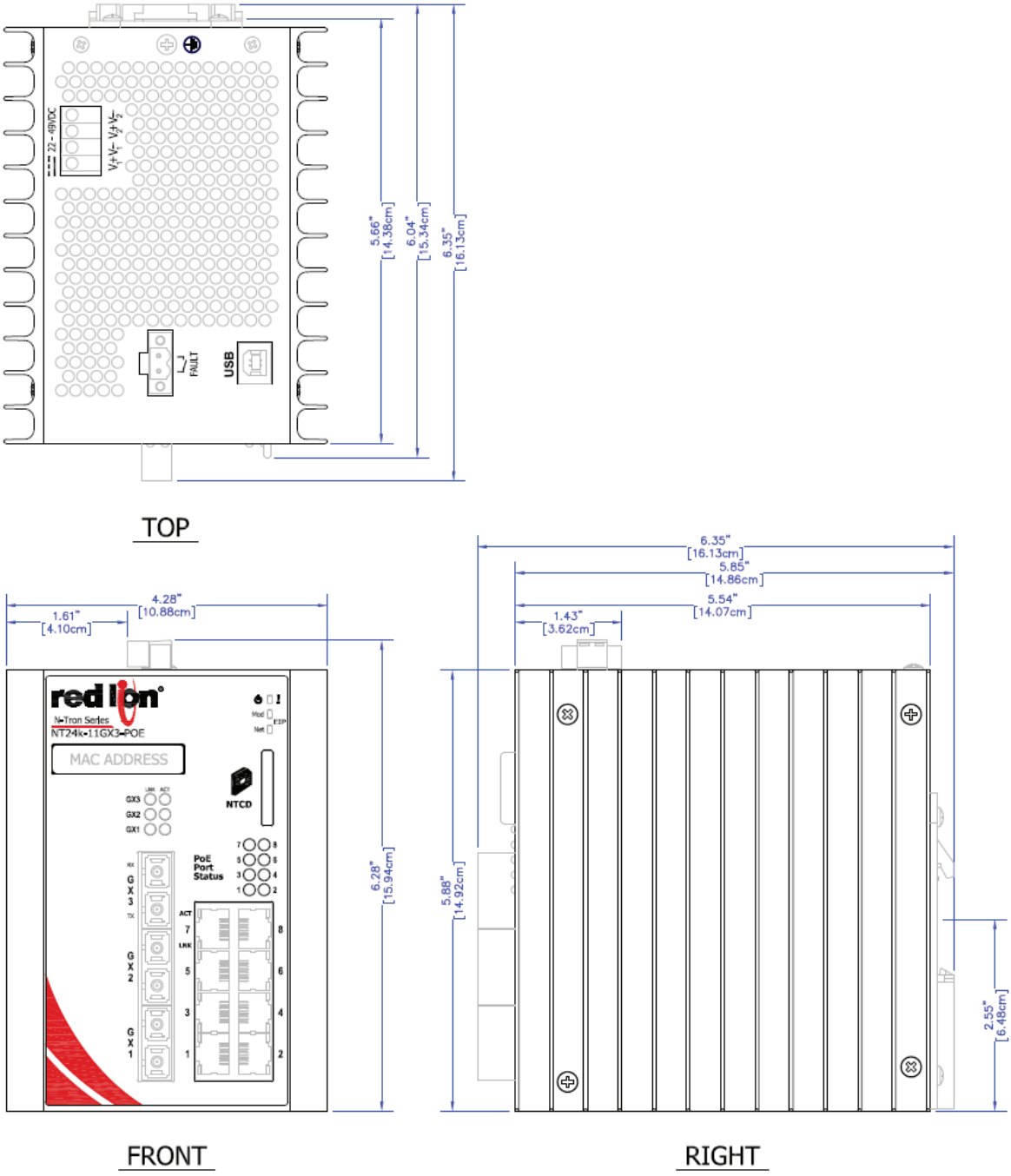
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-11GX3-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.24 lbs (1.47 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.37 A @ 24 VDC (30W load on all PoE ports)	60 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Three SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-11GX3-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12FX4-POE

The versatile NT24k-12FX4-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus four 100Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12FX4-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

12 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Four 100BaseFX fiber ports with SC/ST connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

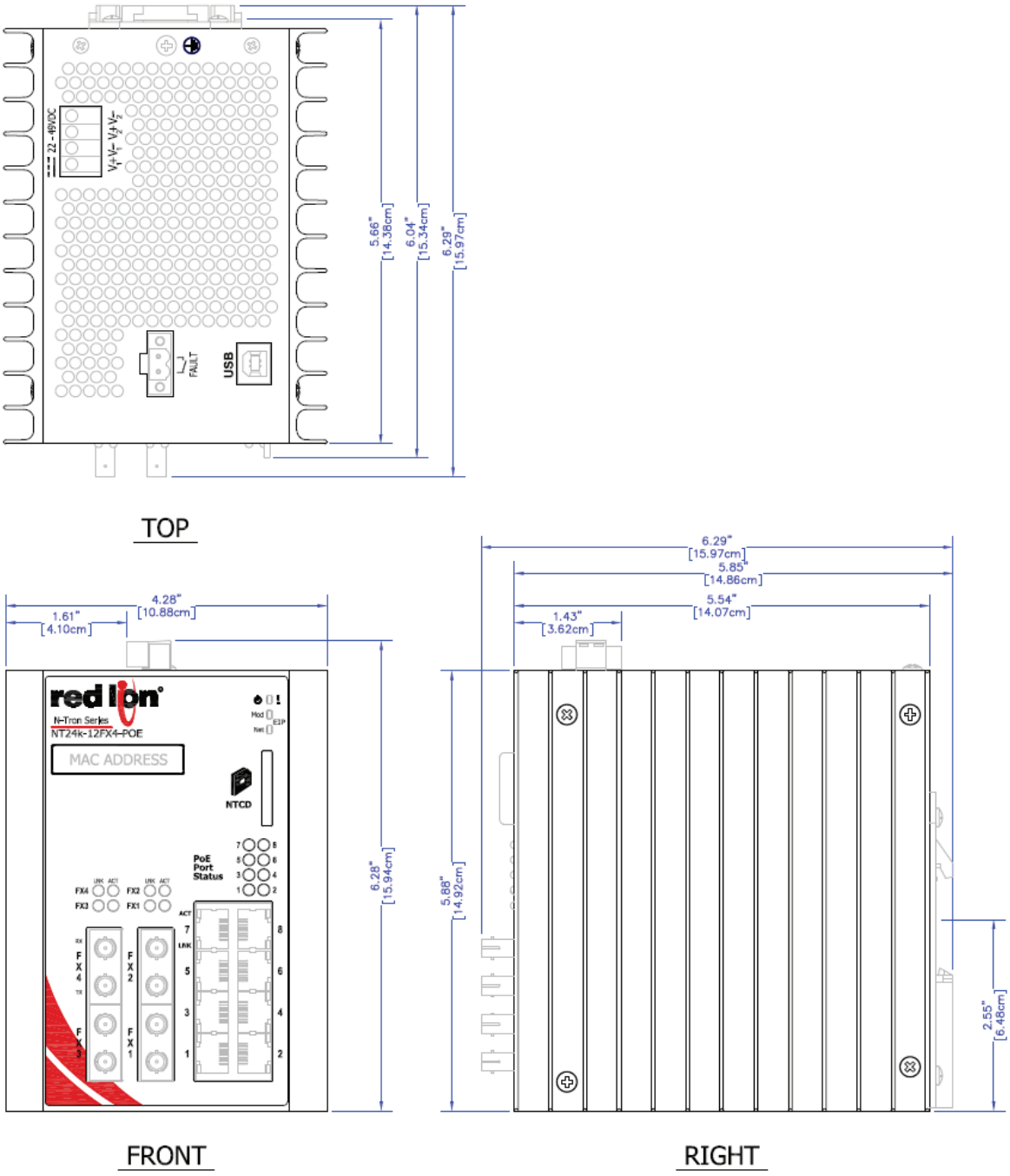
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-12FX4-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.32 lbs (1.51 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.24 A @ 24 VDC (30W load on all PoE ports)	60.8 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Four SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-12FX4-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12GX4-POE

The versatile NT24k-12GX4-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus four 1000Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12GX4-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

12 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Four 1000BaseFX fiber ports with SC connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

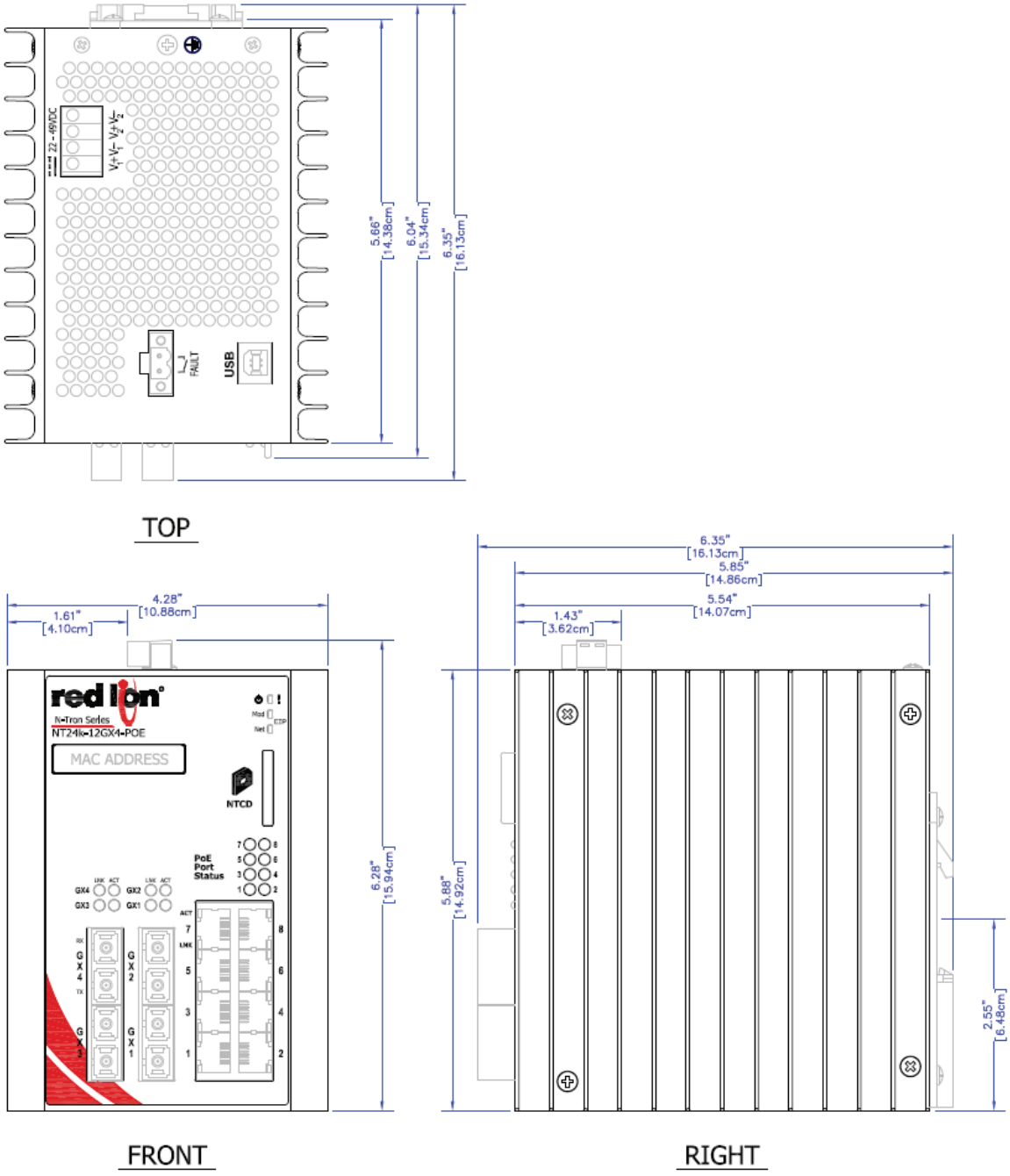
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-12GX4-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.32 lbs (1.51 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.37 A @ 24 VDC (30W load on all PoE ports)	60 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseFX: Four SC duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-12GX4-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-14FX6-POE

The versatile NT24k-14FX6-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus six 100Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-14FX6-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

14 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Six 100BaseFX fiber ports with SC/ST connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

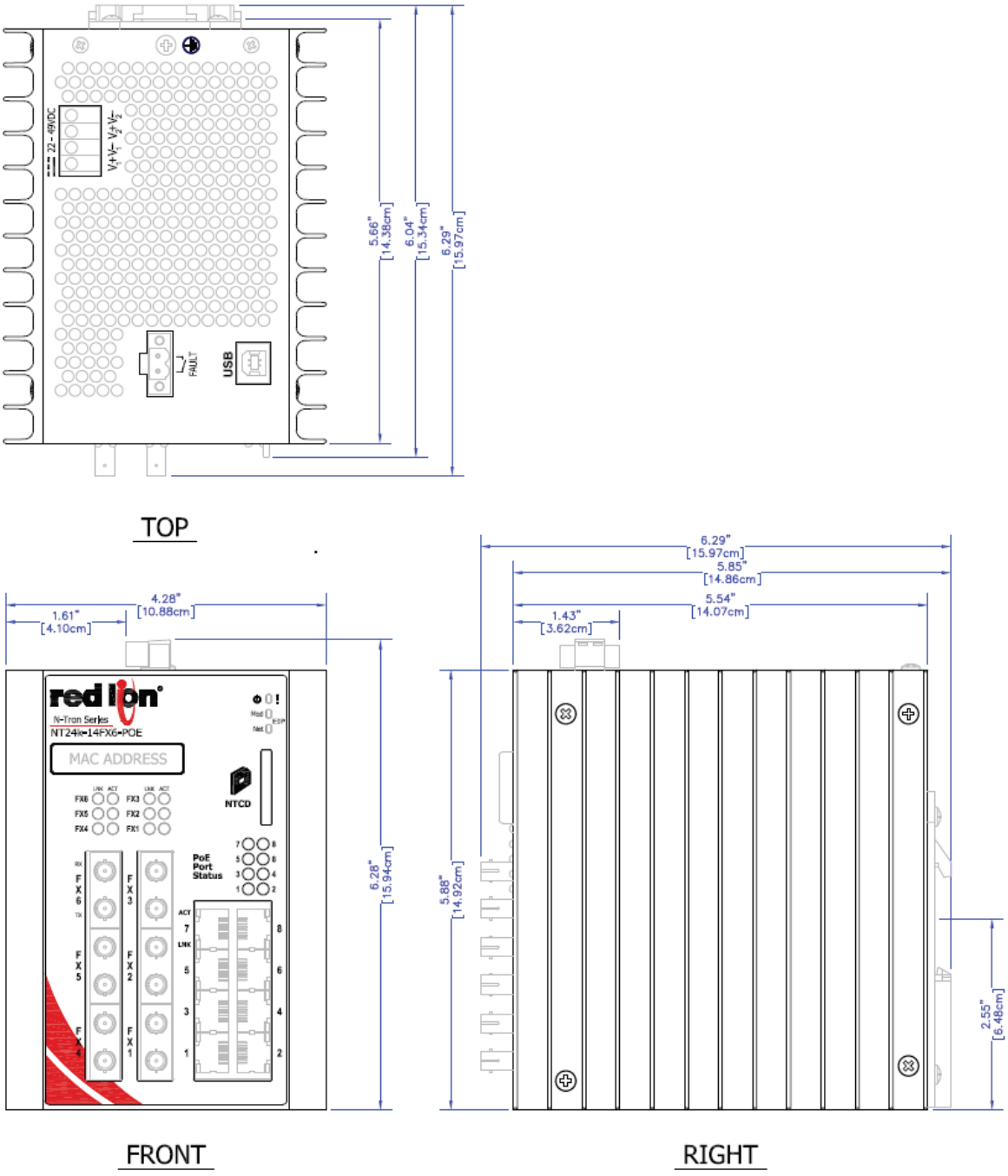
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-14FX6-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.35 lbs (1.52 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.24 A @ 24 VDC (30W load on all PoE ports)	60.8 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100BaseFX: Six SC or ST duplex fiber ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-14FX6-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-14GX6-POE

The versatile NT24k-14GX6-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus six 1000Base fiber ports, housed in a hardened metal DIN rail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-14GX6-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

14 Mixed Copper and Fiber Ports
- Eight 10/100/1000Base-T(X) copper ports, supporting PoE+ on each port
- Six 1000BaseFX fiber ports with SC connectors

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

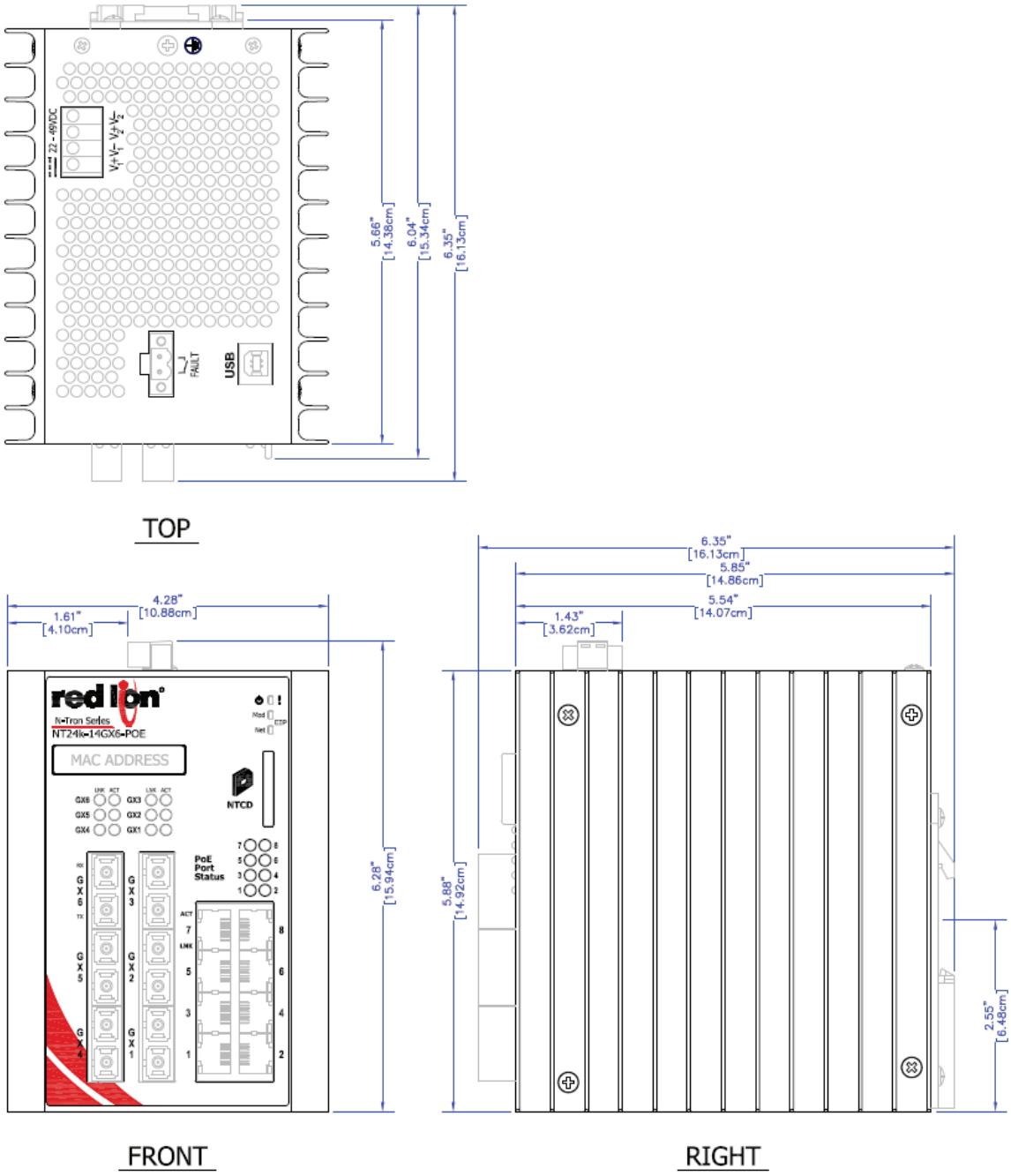
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

NT24k-14GX6-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.35 lbs (1.52 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.37 A @ 24 VDC (30W load on all PoE ports)	60 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		1000BaseFX: Six SC duplex ports		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

NT24k-14GX6-POE DIMENSIONS In inches (mm)



All specifications are subject to change. Consult the company website for more information.

NT24k-12SFP-DM4-POE

The versatile NT24k-12SFP-DM4-POE managed switch features IEEE 802.3af/at Power over Ethernet Plus (PoE+) on eight Gigabit copper Ethernet ports plus four dual mode SFP ports, housed in a hardened metal DINRail enclosure with redundant 22-49 VDC power inputs. Designed to handle the most demanding environments, the NT24k-12SFP-DM4-POE offers wire-speed throughput, expanded shock and vibration ratings and a wide -40 to 80 °C operating temperature rating. IGMP auto-configuration, IEEE 802.1x port-based network access control with RADIUS remote server authentication and Multi-Member N-Ring™ fast healing technology ensure quick deployment and robust secure network communications in alternative energy, transportation, water/wastewater, and manufacturing applications.

Features and Benefits

Features and Benefits

12 Copper and SFP Ports
- Eight 10/100/1000Base-T(X) copper ports
- Four SFP ports (100Base and 1000Base transceivers - sold separately)

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

IEEE 802.3af/at PoE Output
- Supports PoE+ output on all RJ45 ports simultaneously

Extended Environmental Specifications
- -40 to 80 °C operating temperature range
- > 2M hours MTBF
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- IGMP auto-configuration
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG configuration device or XML configuration file

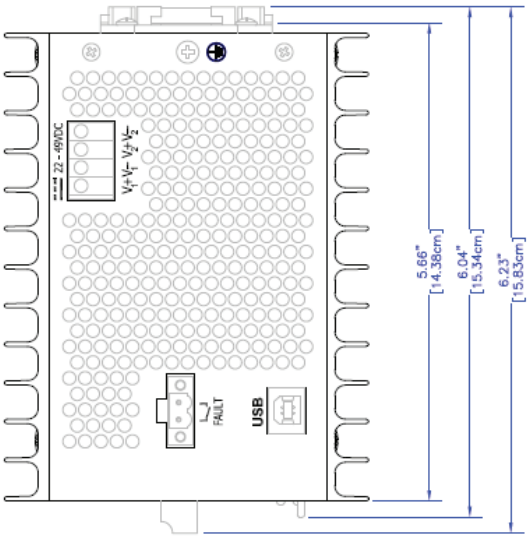
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web browser management
- Detailed ring map and fault location charting
- RSTP - 802.1d, 802.1w, 802.1D
- Trunking and port mirroring
- 802.1Q VLAN tagging and port VLAN
- IEEE 802.1x RADIUS remote server authentication
- 802.1p QoS, port QoS and DSCP
- DHCP client
- Event Log / Syslog
- SNTP (Simple Network Time Protocol)
- Multi-Member N-Ring™ technology with ~30ms healing
- N-Link redundant ring technology
- N-View™ monitoring technology
- CIP™ messaging

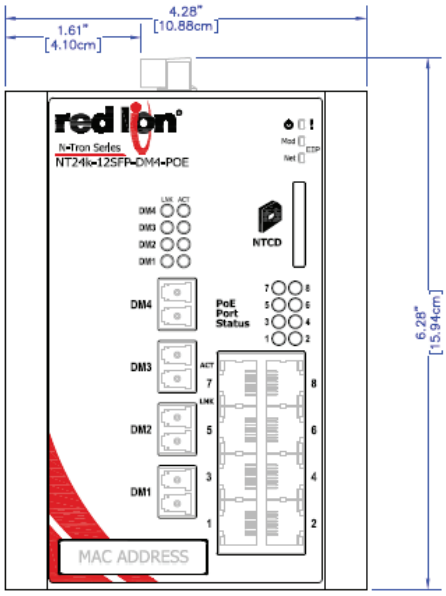
NT24k-12SFP-DM4-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.88" (14.92 cm)	4.28" (10.88 cm)	5.54" (14.07 cm)	3.19 lbs (1.45 kg)	35mm DIN rail
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
22-49 VDC	11.6 A @ 24 VDC (30W load on all PoE ports)	60.8 A /.2 ms @ 24 VDC	122	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000BaseT: Eight RJ45 copper ports		100/1000Base SX/LX SFP Port: Up to four SFP port transceivers (SFP transceivers sold separately) reference sections 1.31 for SFP specifications and available transceivers.		
RECOMMENDED MINIMUM WIRING CLEARANCE				
Top	4” (10.16 cm)			
Front	4" (10.16 cm)			

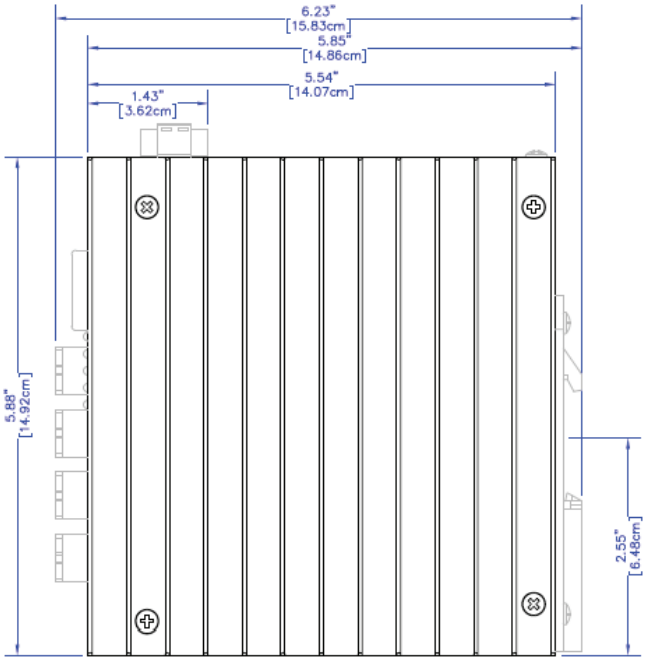
NT24k-12SFP-DM4-POE DIMENSIONS In inches (mm)



TOP



FRONT



RIGHT

All specifications are subject to change. Consult the company website for more information.

NT24k-16M12

The versatile NT24k-16M12 IP67 Managed Industrial Ethernet switches are designed for fully managed operation in extreme industrial environments. A rugged, dust proof and water resistant IP67 hardened metal enclosure and 16 Gigabit copper ports with 8-pin M12 connectors, provide secure and robust connections between the switch and Ethernet enabled devices. The NT24k-16M12 IP67 rugged design offers Gigabit performance and plug and play operation while providing the unique feature sets of N-Ring, N-Link, Auto IGMP configuration and CIP Messaging. IEEE 802.1x port-based network access control with RADIUS remote server authentication, and Multi-Member N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in ITS, Rail, alternative energy, transportation, water/wastewater and manufacturing applications.

Features and Benefits

Features and Benefits

Full IEEE 802.3 Compliance
16 10/100/1000Base-T M12 X-Code Ports
- M12 cable connections ensure continuity in applications where motion or vibration exist.

IP67 Enclosure
- Dustproof
- Protection against low/high water jets
- Protection from immersion in water up to 1 meter

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure.

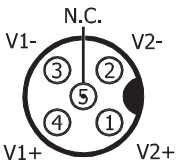
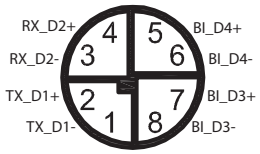
Extended Environmental Specifications
- High tolerance to shock and vibration
- -40 to 85 °C operating temperature range
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG-M12 configuration device or XML configuration file
- Auto Sensing Speed and Flow Control
- Full Wire Speed Communications
- Supports Full/Half Duplex Operation
- Up to 32.0 Gb/s Maximum Throughput
- Supports up to 16k MAC Addresses

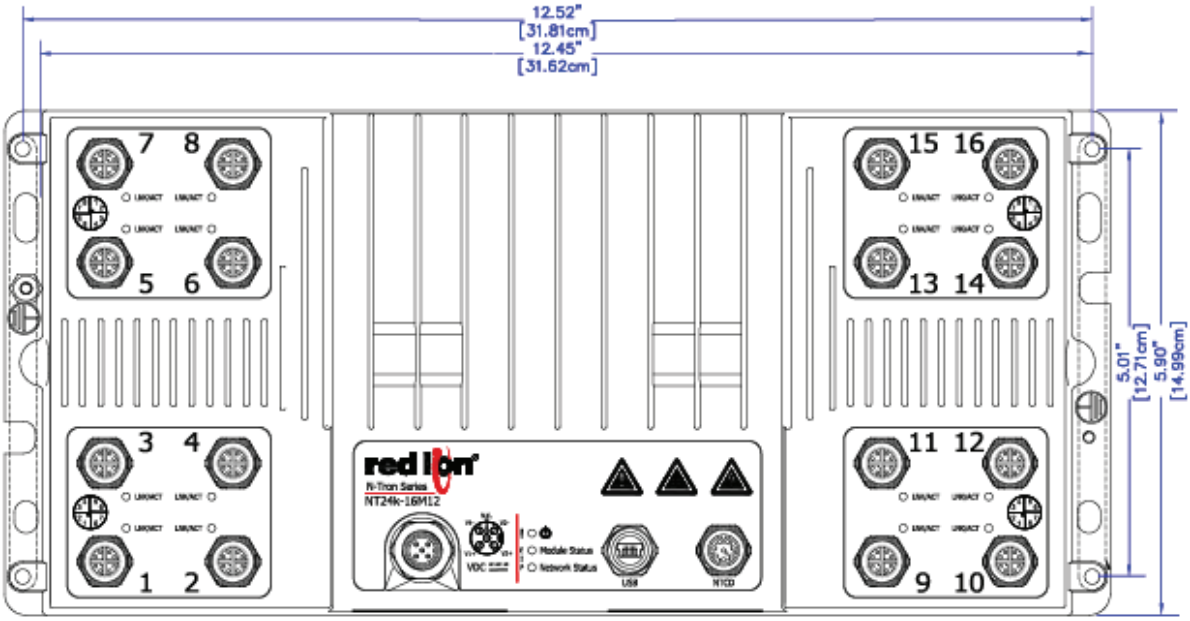
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web Browser Management
- 802.1x with RADIUS Remote Server Authentication
- Multi-Member N-Ring™ Technology with ~30ms Healing
- N-Link Redundant Ring Technology
- N-View™ (1 and 2) Monitoring and Management Technology
- EtherNet/IP™ CIP™ Messaging
- Web configuration
- 802.1Q tag VLAN and Port VLAN
- 802.1p QoS and Port QoS
- SNTP
- Event Log / Syslog
- Port Trunking
- Port Mirroring
- 802.1d, 802.1w, 802.1D RSTP
- DHCP Client

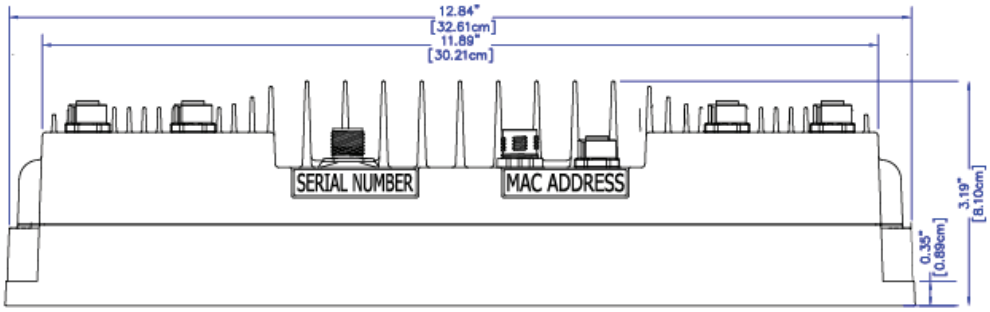
NT24k-16M12 Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.90" (14.99 cm)	12.84" (32.61 cm)	3.19" (8.10 cm) **With Handles:** 3.60" (9.14 cm)	5.00 lbs (2.27 kg)	Bulkhead
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	700 mA @ 24 VDC	37.0 A /0.022 ms @ 24 VDC	58	
POWER OVER ETHERNET (PoE)				
PoE Standard		**PoE Output Power**		**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE		57 VDC / 30 Watts output (25.5 W at PD)		Type 2
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000Base-T: 16 M12 X-Code Ports				
PIN ASSIGNMENTS				
POWER  **A-Code**			**ETHERNET**  **X-CODE M12**	
RECOMMENDED MINIMUM WIRING CLEARANCE				
Front	4" (10.16 cm)			

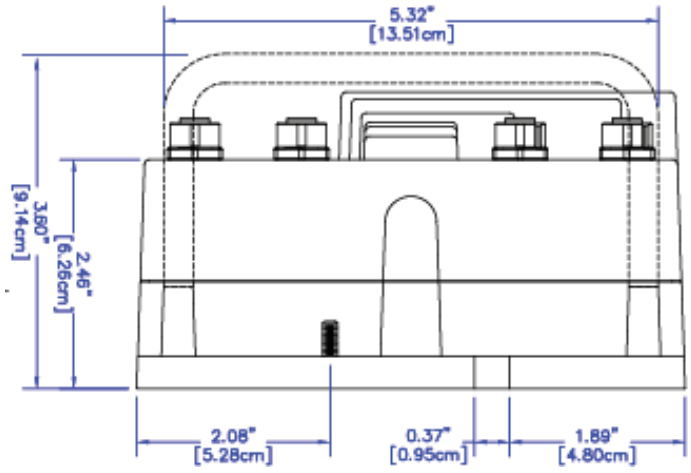
NT24k-16M12 DIMENSIONS In inches (mm)



FRONT



BOTTOM



RIGHT

All specifications are subject to change. Consult the company website for more information.

NT24k-16M12-POE

The versatile NT24k-16M12-POE IP67 Managed Industrial Ethernet switches are designed for fully managed operation in extreme industrial environments. A rugged, dust proof and water resistant IP67 enclosure features Power over Ethernet Plus (PoE+) on 16 Gigabit copper ports with 8-pin M12 connectors. The NT24k-16M12-POE supports communication to IEEE802.3af/at capable powered devices. The NT24k-16M12-POE rugged design offers Gigabit performance and plug and play operation while providing the unique feature sets of N-Ring™, N-Link, Auto IGMP configuration and CIP Messaging. IEEE 802.1x port-based network access control with RADIUS remote server authentication, and Multi-Member N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in ITS, Rail, alternative energy, transportation, water/wastewater and manufacturing applications.

Features and Benefits

Features and Benefits

Full IEEE 802.3 Compliance
16 10/100/1000Base-T M12 X-Code Ports
- M12 cable connections ensure continuity in applications where motion or vibration exist.

IP67 Enclosure
- Dustproof
- Protection against low/high water jets
- Protection from immersion in water up to 1 meter

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- High tolerance to shock and vibration
- -40 to 80 °C operating temperature range
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG-M12 configuration device or XML configuration file
- Auto Sensing Speed and Flow Control
- Full Wire Speed Communications
- Supports Full/Half Duplex Operation
- Up to 32.0 Gb/s Maximum Throughput
- Supports up to 16k MAC Addresses

Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web Browser Management
- 802.1x with RADIUS Remote Server Authentication
- Multi-Member N-Ring™ Technology with ~30ms Healing
- N-Link Redundant Ring Technology
- N-View™ (1 and 2) Monitoring and Management Technology
- EtherNet/IP™ CIP™ Messaging
- Web configuration
- 802.1Q tag VLAN and Port VLAN
- 802.1p QoS and Port QoS
- SNTP
- Event Log / Syslog
- Port Trunking
- Port Mirroring
- 802.1d, 802.1w, 802.1D RSTP
- DHCP Client

NT24k-16M12-POE Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.90" (14.99 cm)	12.84" (32.61 cm)	3.19" (8.10 cm) **With Handles:** 3.60" (9.14 cm)	5.5 lbs (2.49 kg)	Bulkhead

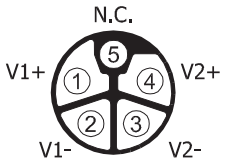
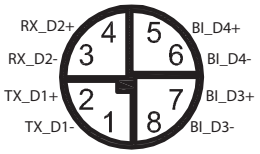
POWER INPUT			
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**
22-49 VDC	11.5 A @ 24 VDC (240W combined load on all PoE ports)	64.2 A /0.044 ms @ 24 VDC	123

POWER OVER ETHERNET (PoE)		
PoE Standard	**PoE Output Power**	**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE	57 VDC / 30 Watts output (25.5 W at PD)	Type 2

ENVIRONMENTAL			
Operating Temperature	**Storage Temperature**	**Operating Humidity**	**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)	0 to 10,000 ft.

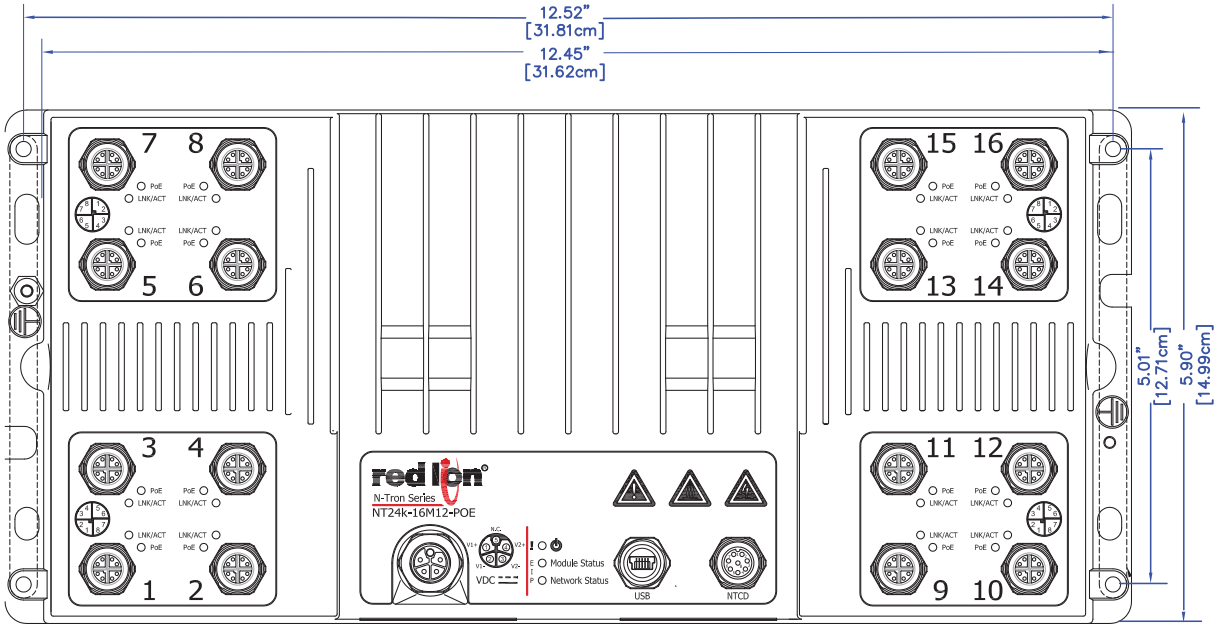
SHOCK AND VIBRATION		
Shock	**Vibration**	**Note**
200g @ 10ms	50g, 5-200Hz, Triaxial	Unit must be bulkhead mounted to achieve these levels.

CONNECTORS	
10/100/1000Base-T: 16 M12 X-Code Ports	

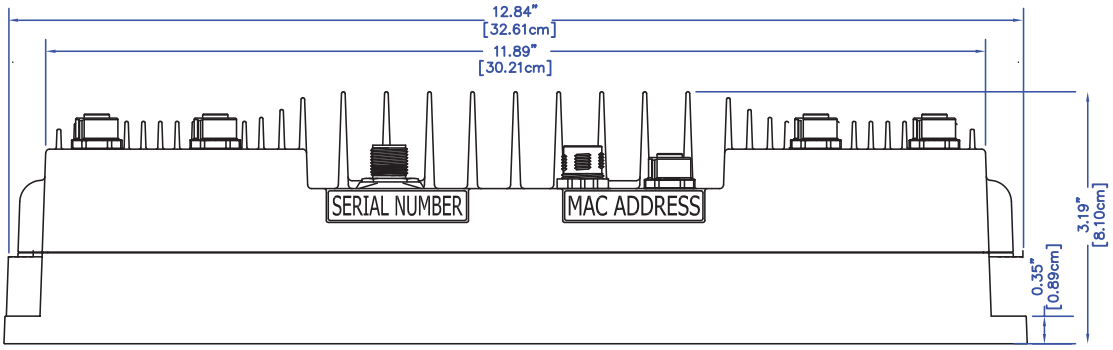
PIN ASSIGNMENTS		
POWER  **L-Code**		**ETHERNET**  **X-CODE M12**

RECOMMENDED MINIMUM WIRING CLEARANCE	
Front	4" (10.16 cm)

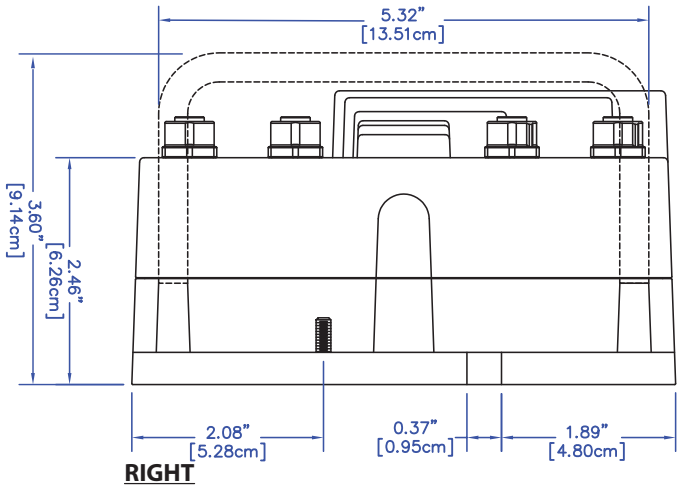
NT24k-16M12-POE DIMENSIONS In inches (mm)



FRONT



BOTTOM



RIGHT

All specifications are subject to change. Consult the company website for more information.

NT24k-16M12-R

The versatile NT24k-16M12-R IP67 Managed Industrial Ethernet switches are designed for fully managed operation in extreme industrial environments. The Bypass Relays allow network traffic to flow through the bypass ports in the event of a power outage. A rugged, dust proof and water resistant IP67 hardened metal enclosure and 16 Gigabit copper ports with 8-pin M12 connectors, provide secure and robust connections between the switch and Ethernet enabled devices. The NT24k-16M12-R IP67 offers Gigabit performance and plug and play operation while providing the unique feature sets of N-Ring™, N-Link, Auto IGMP configuration and CIP Messaging. IEEE 802.1x port-based network access control with RADIUS remote server authentication, and Multi-Member N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in ITS, Rail, alternative energy, transportation, water/wastewater and manufacturing applications.

Features and Benefits

Features and Benefits

Full IEEE 802.3 Compliance
16 10/100/1000Base-T M12 X-Code Ports
- M12 cable connections ensure continuity in applications where motion or vibration exist.
- Two pairs of Bypass Ports: 7/8 and 9/10

IP67 Enclosure
- Dustproof
- Protection against low/high water jets
- Protection from immersion in water up to 1 meter

Redundant 10 to 49 VDC Power Inputs
- Keeps network running in the event of a power supply failure.

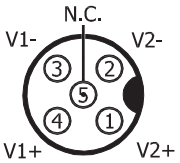
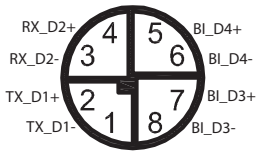
Extended Environmental Specifications
- High tolerance to shock and vibration
- -40 to 85 °C operating temperature range
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG-M12 configuration device or XML configuration file
- Auto Sensing Speed and Flow Control
- Full Wire Speed Communications
- Supports Full/Half Duplex Operation
- Up to 32.0 Gb/s Maximum Throughput
- Supports up to 16k MAC Addresses

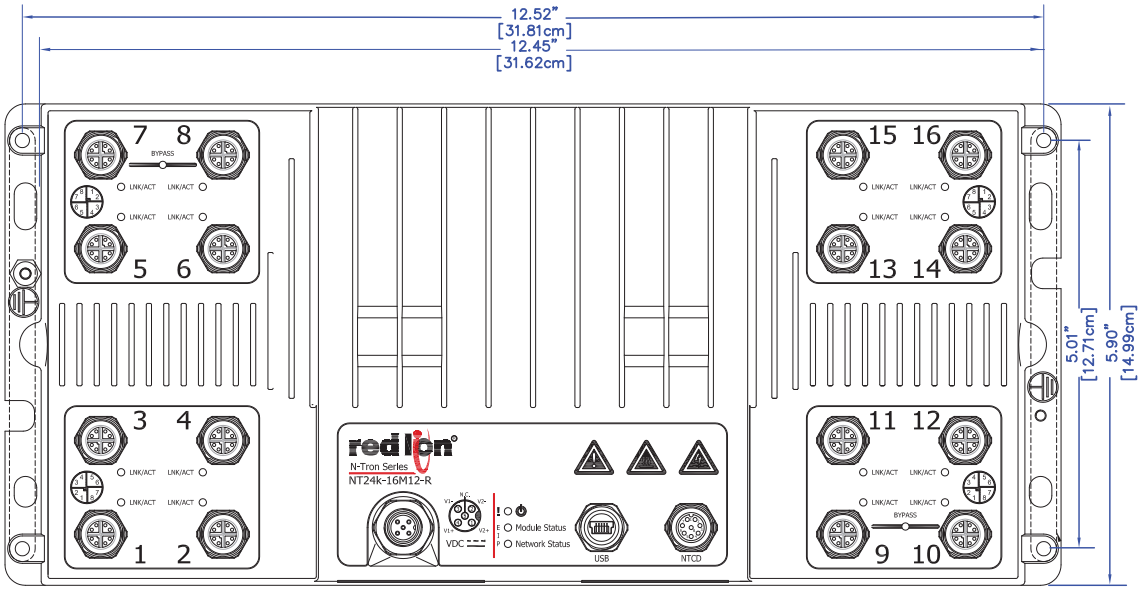
Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web Browser Management
- 802.1x with RADIUS Remote Server Authentication
- Multi-Member N-Ring™ Technology with ~30ms Healing
- N-Link Redundant Ring Technology
- N-View™ (1 and 2) Monitoring and Management Technology
- EtherNet/IP™ CIP™ Messaging
- Web configuration
- 802.1Q tag VLAN and Port VLAN
- 802.1p QoS and Port QoS
- SNTP
- Event Log / Syslog
- Port Trunking
- Port Mirroring
- 802.1d, 802.1w, 802.1D RSTP
- DHCP Client

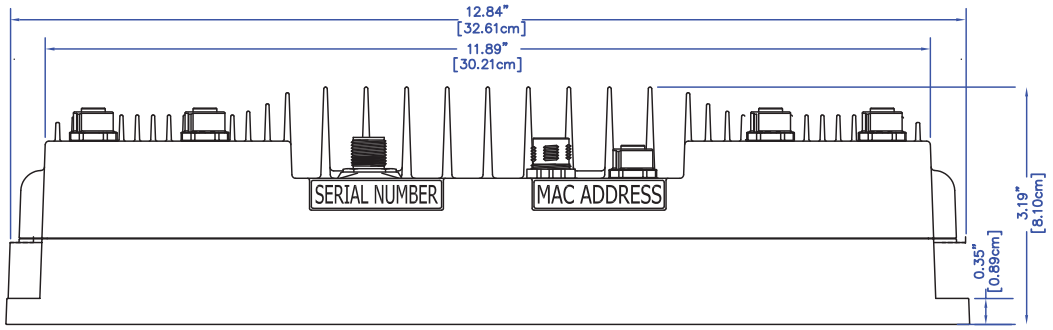
NT24k-16M12-R Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.90" (14.99 cm)	12.84" (32.61 cm)	3.19" (8.10 cm) **With Handles:** 3.60" (9.14 cm)	5.00 lbs (2.27 kg)	Bulkhead
POWER INPUT				
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**	
10-49 VDC	850 mA @ 24 VDC	37.0 A /0.022 ms @ 24 VDC	70	
ENVIRONMENTAL				
Operating Temperature	**Storage Temperature**	**Operating Humidity**		**Operating Altitude**
-40 to 85 °C	-40 to 85 °C	10% to 95% (non condensing)		0 to 10,000 ft.
SHOCK AND VIBRATION				
Shock	**Vibration**		**Note**	
200g @ 10ms	50g, 5-200Hz, Triaxial		Unit must be bulkhead mounted to achieve these levels.	
CONNECTORS				
10/100/1000Base-T: 16 M12 X-Code Ports				
PIN ASSIGNMENTS				
POWER  **A-Code**			**ETHERNET**  **X-CODE M12**	
RECOMMENDED MINIMUM WIRING CLEARANCE				
Front	4" (10.16 cm)			

NT24k-16M12-R DIMENSIONS In inches (mm)



FRONT



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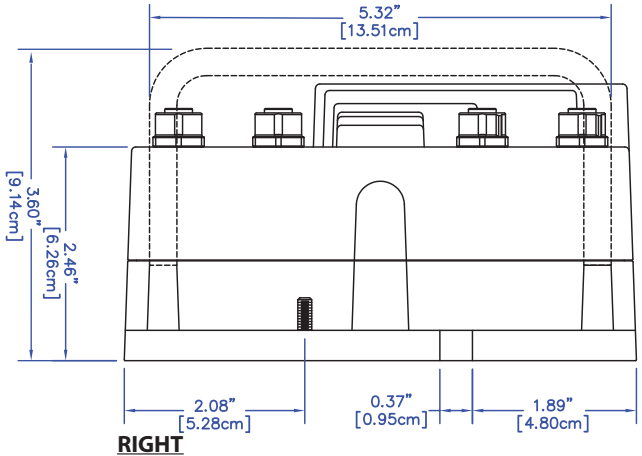


RIGHT

All specifications are subject to change. Consult the company website for more information.

NT24k-16M12-POE-R

The versatile NT24k-16M12-POE-R IP67 Managed Industrial Ethernet switches are designed for fully managed operation in extreme industrial environments. A rugged, dust proof and water resistant IP67 enclosure features Power over Ethernet Plus (PoE+) on 16 Gigabit copper ports with 8-pin M12 connectors. The Bypass Relays allow network traffic through the bypass ports in the event of a power outage. The NT24k-16M12-POE-R supports communication over a standard Ethernet cable to IEEE802.3af/at capable powered devices. The NT24k-16M12-POE-R rugged design offers Gigabit performance and plug and play operation while providing the unique feature sets of N-Ring™, N-Link, Auto IGMP configuration and CIP Messaging. IEEE 802.1x port-based network access control with RADIUS remote server authentication, and Multi-Member N-Ring™ fast healing ring technology ensure quick deployment and robust secure network communications in ITS, Rail, alternative energy, transportation, water/wastewater and manufacturing applications.

Features and Benefits

Features and Benefits

Full IEEE 802.3 Compliance
16 10/100/1000Base-T M12 X-Code Ports
- M12 cable connections ensure continuity in applications where motion or vibration exist.
- Two pairs of Bypass Ports: 7/8 and 9/10

IP67 Enclosure
- Dustproof
- Protection against low/high water jets
- Protection from immersion in water up to 1 meter

Redundant 22 to 49 VDC Power Inputs
- Boosts power to meet PoE+ output requirements
- Keeps network running in the event of a power supply failure

Extended Environmental Specifications
- High tolerance to shock and vibration
- -40 to 80 °C operating temperature range
- UL/cUL: Class I, Div 2 Groups A, B, C and D

Plug-and-Play Operation
- Automatic port detection and setup
- Simple network ring configuration
- Backup and restore via NTCD-CFG-M12 configuration device or XML configuration file
- Auto Sensing Speed and Flow Control
- Full Wire Speed Communications
- Supports Full/Half Duplex Operation
- Up to 32.0 Gb/s Maximum Throughput
- Supports up to 16k MAC Addresses

Safety
- ESD Protection: 8KV Contact, 15KV Air

Fully Managed Features Include:
- Jumbo frame support
- SNMP v1, v2, v3
- Web Browser Management
- 802.1x with RADIUS Remote Server Authentication
- Multi-Member N-Ring™ Technology with ~30ms Healing
- N-Link Redundant Ring Technology
- N-View™ (1 and 2) Monitoring and Management Technology
- EtherNet/IP™ CIP™ Messaging
- Web configuration
- 802.1Q tag VLAN and Port VLAN
- 802.1p QoS and Port QoS
- SNTP
- Event Log / Syslog
- Port Trunking
- Port Mirroring
- 802.1d, 802.1w, 802.1D RSTP
- DHCP Client

NT24k-16M12-POE-R Specifications

MECHANICAL				
Height	**Width**	**Depth**	**Weight**	**Mount**
5.90" (14.99 cm)	12.84" (32.61 cm)	3.19" (8.10 cm) **With Handles:** 3.60" (9.14 cm)	5.5 lbs (2.49 kg)	Bulkhead

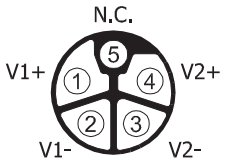
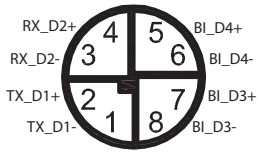
POWER INPUT			
Input Voltage	**Steady Input Current**	**Inrush Current**	**BTU/HR**
22-49 VDC	11.6 A @ 24 VDC (240W combined load on all PoE ports)	64.2 A /0.044 ms @ 24 VDC	131

POWER OVER ETHERNET (PoE)		
PoE Standard	**PoE Output Power**	**PSE Type**
IEEE 802.3af/at Gigabit Endspan PSE	57 VDC / 30 Watts output (25.5 W at PD)	Type 2

ENVIRONMENTAL			
Operating Temperature	**Storage Temperature**	**Operating Humidity**	**Operating Altitude**
-40 to 80 °C	-40 to 85 °C	10% to 95% (non condensing)	0 to 10,000 ft.

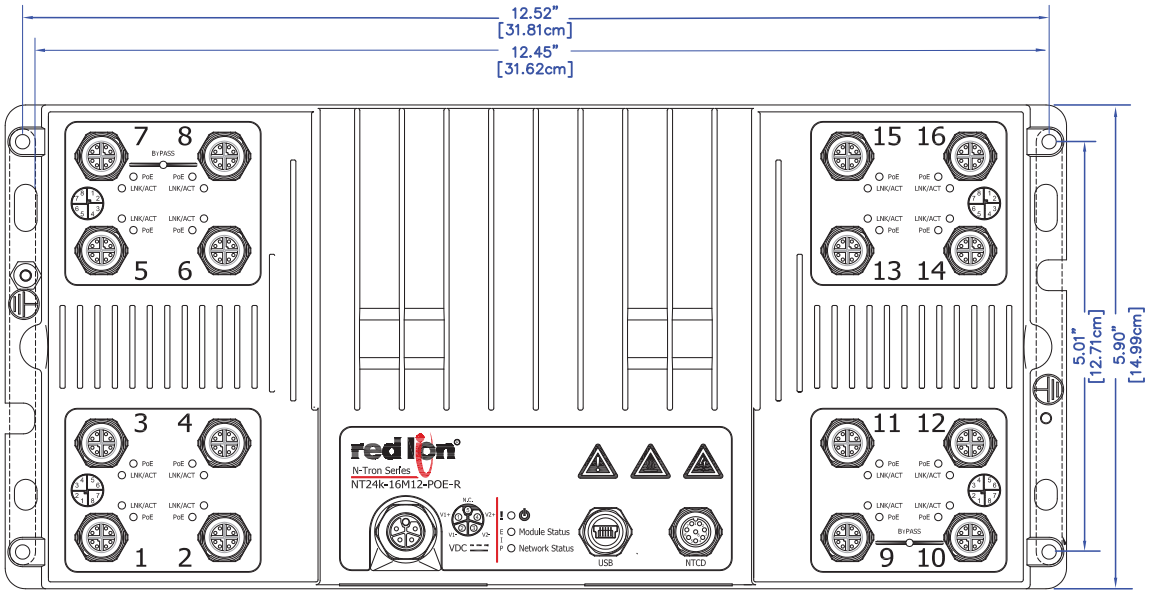
SHOCK AND VIBRATION		
Shock	**Vibration**	**Note**
200g @ 10ms	50g, 5-200Hz, Triaxial	Unit must be bulkhead mounted to achieve these levels.

CONNECTORS	
10/100/1000Base-T: 16 M12 X-Code Ports	

PIN ASSIGNMENTS		
POWER  **L-Code**		**ETHERNET**  **X-CODE M12**

RECOMMENDED MINIMUM WIRING CLEARANCE	
Front	4" (10.16 cm)

NT24k-16M12-POE-R DIMENSIONS In inches (mm)



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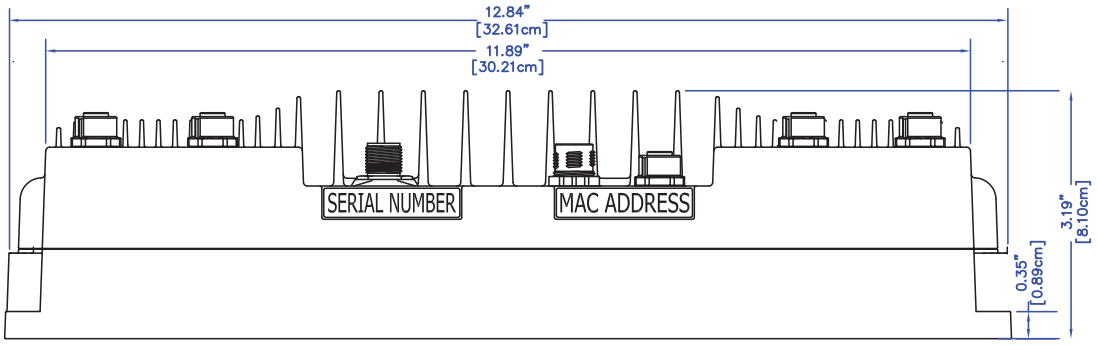
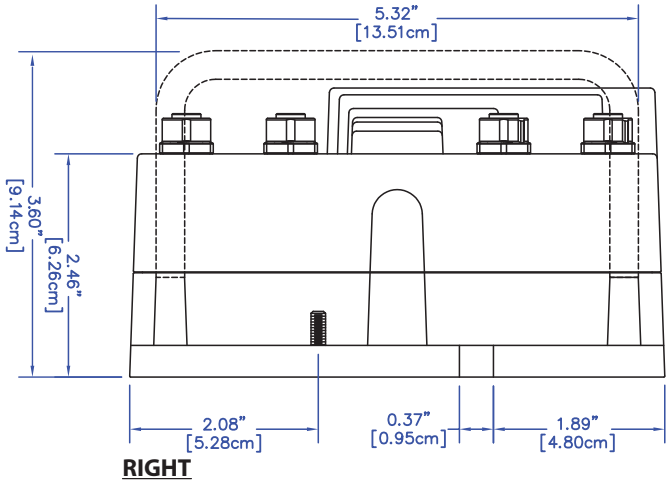


BOTTOM

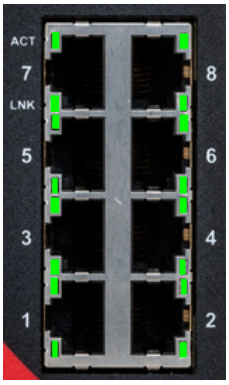


RIGHT

All specifications are subject to change. Consult the company website for more information.

LEDs

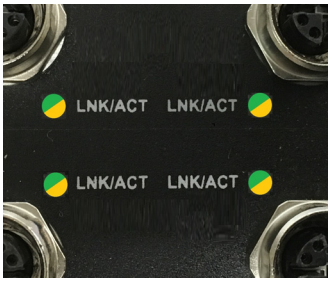
Data ports have two LEDs labeled LNK and ACT. The LNK LED indicates link status and the ACT LED indicates activity. The NT24k-16M12 models have one LED labeled LNK/ACT where solid green indicates link only and flashing or solid yellow indicates link and activity.



RJ45 ports

GX ports

FX ports



M12 ports

DM ports

The table below describes the operating modes:

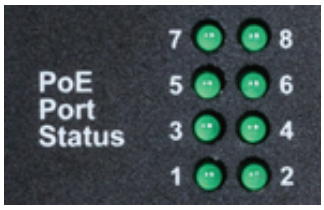
LED NAME	COLOR	DESCRIPTION
⏻	Green	Power is On
	Red	Power is On and a fault condition exists
	Off	Power is Off
LNK	Green	10/100/1000 Mb Link between ports
	Off	No link between ports
ACT	Green	Data is active between ports. Activity light blink rate indicates activity, not necessarily the volume of activity
	Off	Data is inactive between ports
LNK/ACT	Green	10/100/1000 Mb Link between ports. Data is inactive between ports
	Yellow	10/100/1000 Mb Link between ports. Data is active between ports. The blink rate indicates activity, not necessarily the volume of activity
	Off	No link or activity between ports
PoE Port Status	Green	Port is supplying PoE power normally
	Blinking	Port has not completed negotiation with the powered device or indicates a fault condition exists
	Off	No PoE power is being supplied to the device
BYPASS	Green	Ports are in forced bypass mode
	Off	When unit is powered on, ports are not in bypass mode (operate as standard ports) When unit is powered off, ports are in bypass mode

PoE Port Status Indicators (PoE Models)

The PoE Port status LED will turn green if the switch is supplying power to the PoE powered device (PD). If the PoE port status LED is blinking, the port has one or more of the following conditions:

- Improper or Failed negotiation with the PD
- Overload or over current condition
- Short circuit condition
- Under voltage condition

Compact Models



IP67 Models

EIP Indicators

The EIP Indicators are located on the front of the switch. The indicator shows the status of the switch. The Network Status indicator shows the status of the network interface.

MODULE STATUS	
INDICATOR STATE	DESCRIPTION
Steady Off	The switch is not powered up
Steady Green	The switch is operating normally
Flashing Green	The switch has not been configured
Flashing Red	A recoverable minor fault has occurred
Steady Red	A non-recoverable major fault has occurred
NETWORK STATUS	
INDICATOR STATE	DESCRIPTION
Steady Off	The switch is not powered up, or an IP address has not been configured
Flashing Green	An IP address is configured, but no connections have been established
Steady Green	A connection has been established
Flashing Red	A connection has timed out

Transceiver Characteristics

100 MB Fiber Transceiver Characteristics

Fiber Length	2 km	15 km	40 km	80 km
TX Power Min.	-19 dBm	-15 dBm	-5 dBm	-5 dBm
RX Sensitivity Max.	-31 dBm	-34 dBm	-34 dBm	-34 dBm
Wavelength	1310 nm	1310 nm	1310 nm	1550 nm

Gigabit Fiber Transceiver Characteristics

Fiber Length	550 m @ 50/125 µm 300 m @ 62.5/125 µm	10 km	40 km	80 km
TX Power Min.	-9.5 dBm	-9.5 dBm	-5 dBm	0 dBm
RX Sensitivity Max.	-17 dBm	-20 dBm	-23 dBm	-24 dBm
Wavelength	850 nm	1310 nm	1310 nm	1550 nm
Laser Type	VCSEL	FP	DFB	DFB

SFP 100Base Fiber Transceiver Characteristics

Fiber Length	2 km	10 km	40 km	80 km
TX Power Min.	-19 dBm	-15 dBm	-5 dBm	-5 dBm
RX Sensitivity Max.	-31 dBm	-34 dBm	-34 dBm	-34 dBm
Wavelength	1310 nm	1310 nm	1310 nm	1550 nm
Laser Type	FP	FP	FP	DFB

SFP Gigabit Fiber Transceiver Characteristics

Fiber Length	550 m @ 50/125 µm 275 m @ 62.5/125 µm	10 km	40 km	80 km
TX Power Min.	-9.5 dBm	-9.5 dBm	-2 dBm	0 dBm
RX Sensitivity Max.	-17 dBm	-20 dBm	-22 dBm	-24 dBm
Wavelength	850 nm	1310 nm	1310 nm	1550 nm
Laser Type	VCSEL	FP	DFB	DFB

Note: Fiber Length distances represent typical performance. Link budgets should be evaluated based on specific application conditions.

Chapter 2 Hardware Installation

Unpacking

Remove all the equipment from the packaging and store the packaging in a safe place. File any damage claims with the carrier.

Make certain the NT24k® Ethernet Switch package contains the following items:

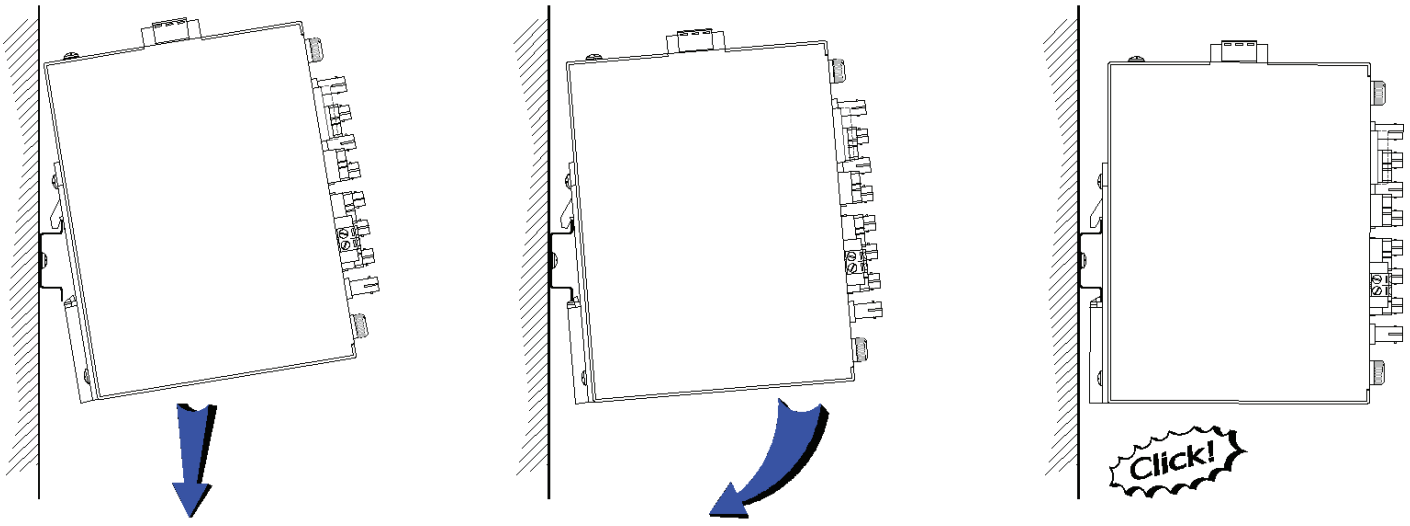
1. NT24k switch
2. Product CD

Mounting the NT24k Unit

Red Lion offers its NT24k Panel Mount Assemblies which may be used to securely mount the NT24k Compact Series products to a panel or other flat surface.

A clearance of one inch should be observed on the sides, back, top and bottom to allow proper ventilation. Also a cable bend radius of two inches should be observed for the front and top side of the unit.

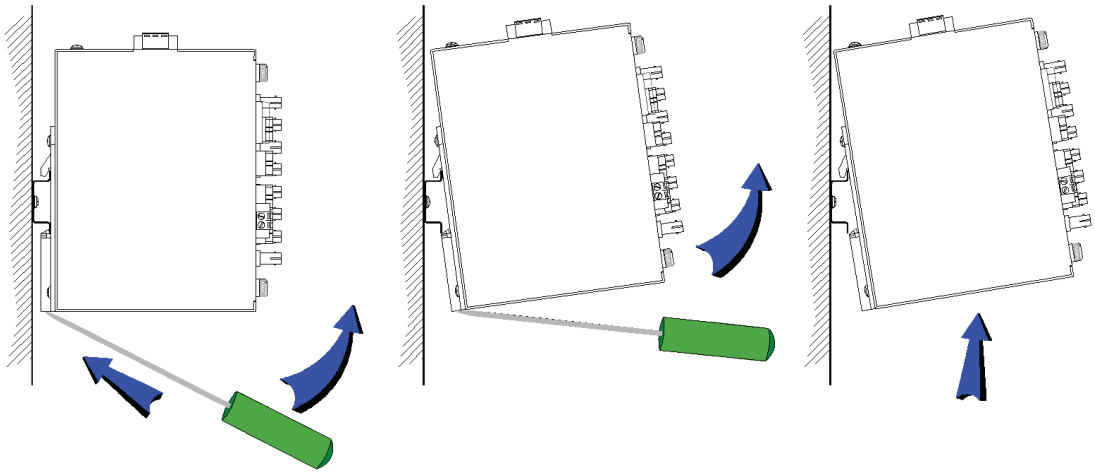
DIN Rail Mounting Instructions



Install the switch to standard 35mm DIN rail as shown in the diagram above.

1. First, hook the top of the DIN rail clip on the back of the switch to the rail.
2. Then, gently rotate the front of the switch downward, towards the panel.
3. Push the bottom of the switch towards the rail until it locks into place.
4. Apply upward force to verify the switch is securely installed.
5. Connect any communications cables to the switch.
6. Install the power and ground wires.
7. Apply power to the power supply.

DIN Rail Removal Instructions



Remove the switch from standard 35mm DIN rail as shown in the diagram above.

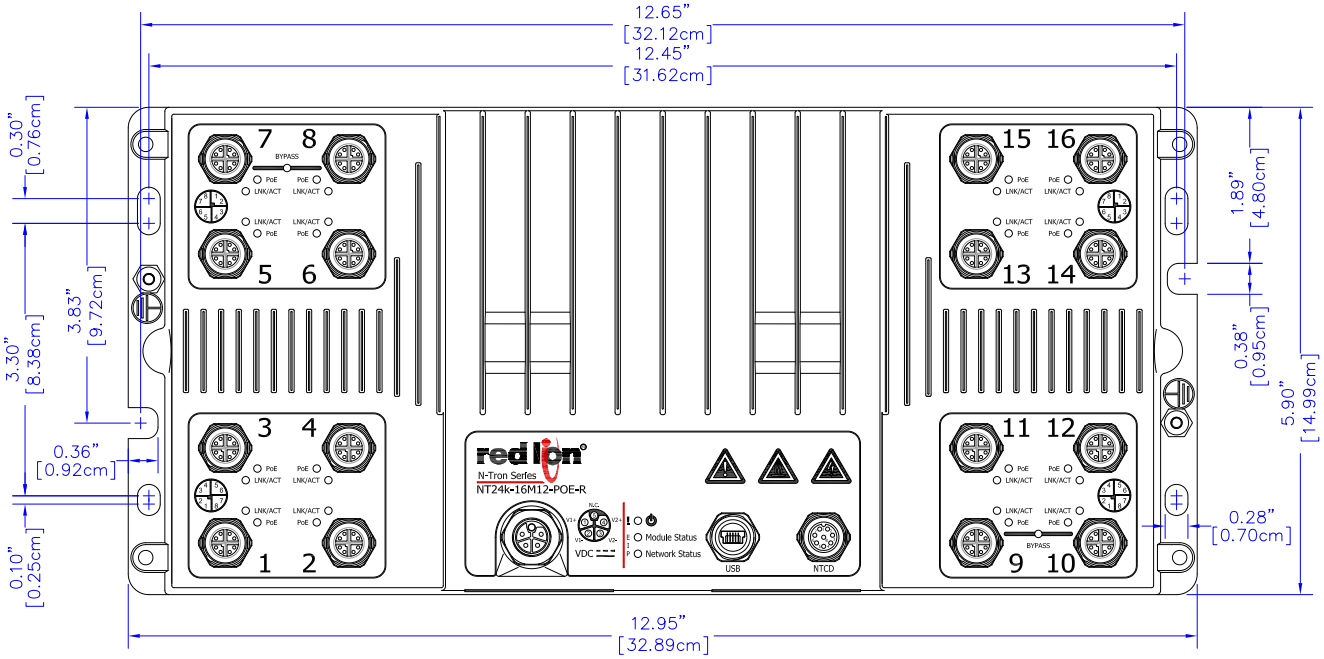
1. Ensure power from the power source is off.
2. Disconnect power and ground wires.
3. Disconnect any communications cables from the unit.
4. Insert a standard flat/slotted screwdriver into the slot provided on the DIN rail clip.
5. Using the base of the switch as a pivot point, apply upward force on the screwdriver to release the DIN rail clip.
6. With the DIN rail clip latching mechanism released, continue to rotate the switch upward and away from the panel.
7. Once the switch has been rotated upward, remove the screwdriver.

Carefully lift the switch upward and away from the DIN rail and panel.

Bulkhead Mounting NT24k-16M12 Models

The NT24k-16M12 models are designed for bulkhead mounting or within an enclosure and are IP67-rated. This section includes the mechanical dimensions and drill hole placements to consider when bulkhead mounting the unit. Allow at least 4" of horizontal clearance in the installation location for copper cable bend radius.

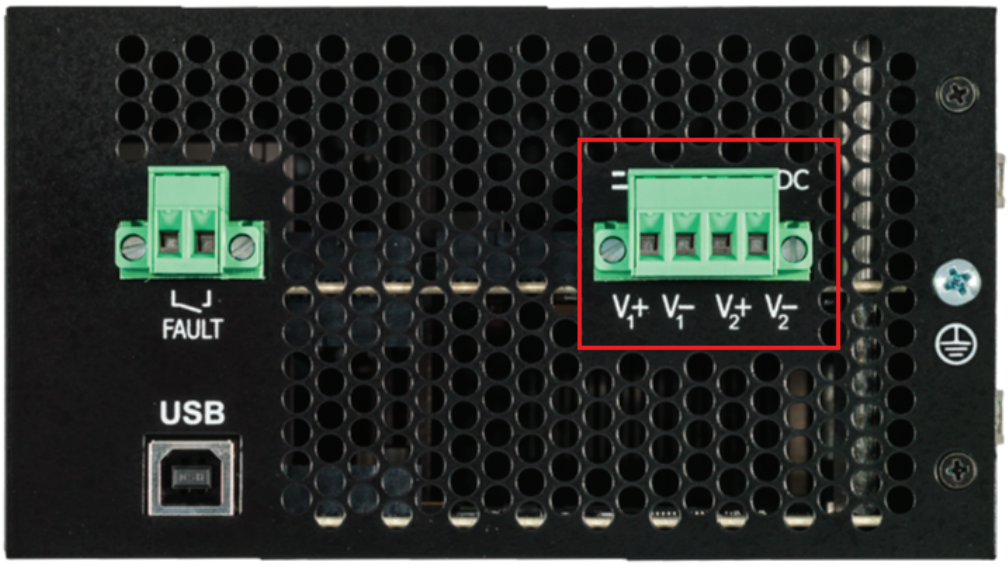
NT24k-16M12 Dimensions and Drill Hole Locations

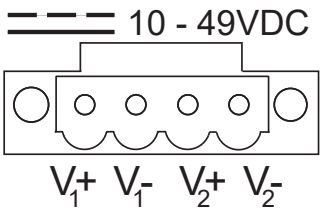


Power Source

Non-PoE Compact Models

The NT24k non-PoE (Power over Ethernet) Compact models come with a redundant 10-49 VDC power input.





- Unscrew and remove the DC voltage input plug from the power input header
- Install the DC power cables into the plug (observing polarity)
- Plug the voltage input plug back into the power input header
- Tightening torque for the terminal block power plug is 0.5 Nm/0.368 lb/ft
- Verify that the power LED is on

Note: When a DC power supply is installed, only one power supply must be connected to power for minimal operation. For redundant power operation, V1 and V2 inputs must be connected to separate DC voltage sources. This unit will draw power from the supply with higher voltage. Use 16-28 gauge wire when connecting to the power supply.

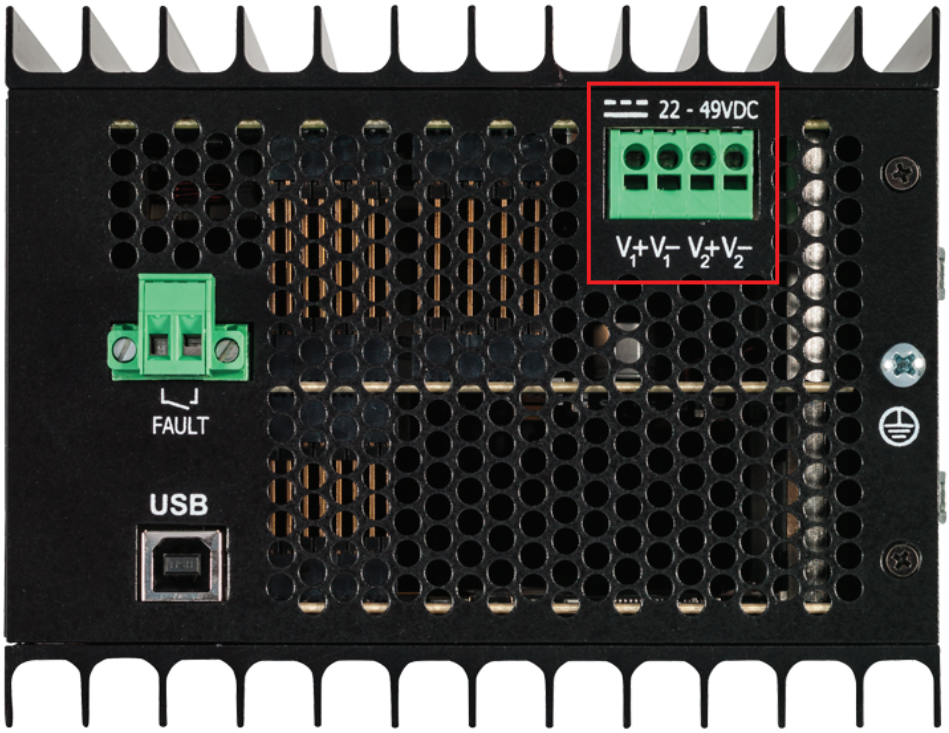
Recommended 24 VDC power supply, similar to Red Lion's P/N NTPS-24-1.3.

Verify that the proper input voltage is connected to the NT24k before powering on the unit. Applying AC power to a DC NT24k unit will damage the unit.

Note: LEDs are described in detail in the LEDs section on page 89.

PoE Compact Models

PoE Compact models come with a redundant 22-49 VDC power input.



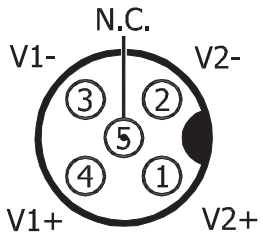
Recommended 24 VDC power supply, similar to Red Lion's P/N NTPS-24-20.

Note: LEDs are described in detail in the LEDs section on page 89.

NT24k-16M12 Models

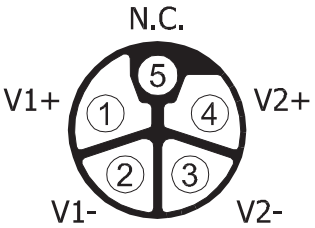
The NT24k non-PoE (Power over Ethernet) models come with a redundant 10-49 VDC power input. PoE models come with a redundant 22-49 VDC power input.

Non-POE Models



A-Code

POE Models



L-Code

PoE Ports and Input Power

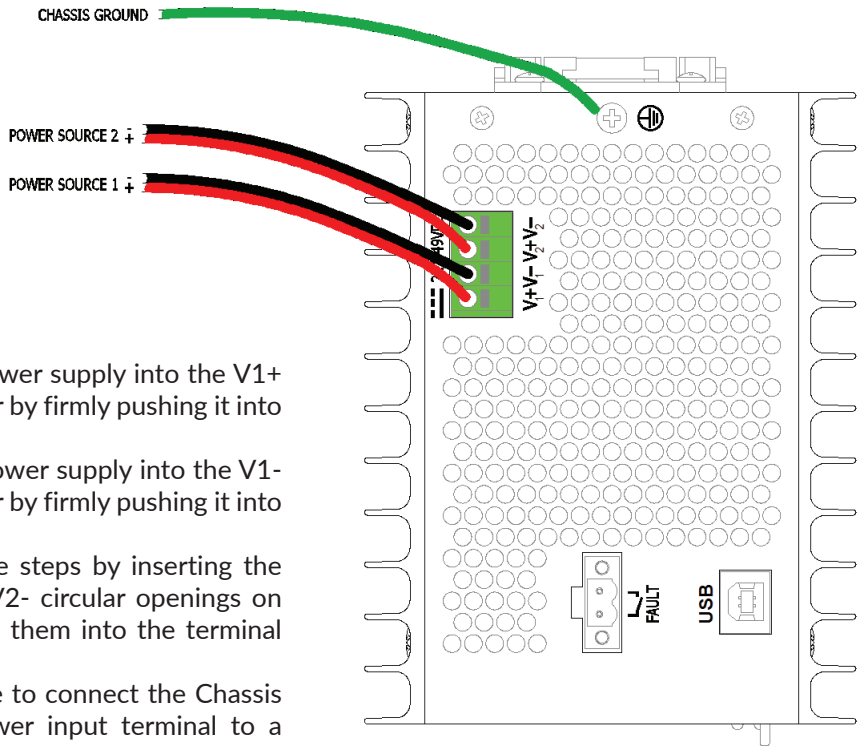
PoE capable models will attempt to power any valid PoE Powered Device (PD) that is connected to a copper port. The PoE PD must meet the requirements for IEEE 802.3af and/or IEEE 802.3at for it to negotiate properly. Devices with invalid PD signatures or non-PoE devices will not be powered ON.

PoE capable models will remove power from the Powered Device if any of the following conditions occur:

- Minimum power requirements are not satisfied. The PD must draw minimum required current set forth by 802.3af/at specifications in order to be powered on.
- Maximum power is exceeded. The PD must not exceed the power levels set by the 802.3af/at specification.
- The PoE device signature becomes corrupted.
- The maximum power budget is exceeded.

PoE Compact Models - DC Power Supply Installation

- NT24k models that support PoE functionality are designed with special terminal blocks with push-in direct plugin technology that support solid (or stranded with ferrules) wire for ease of installation.
- Use 12-14 gauge solid or stranded wire when connecting to the VDC power supply.



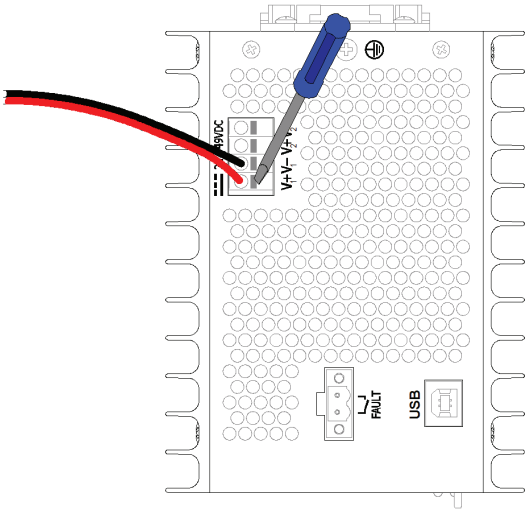
1. Strip back the ends of the wire 0.4”.
2. Insert the positive wire from the DC power supply into the V1+ circular opening on the power connector by firmly pushing it into the terminal block.
3. Insert the negative wire from the DC power supply into the V1- circular opening on the power connector by firmly pushing it into the terminal block.
4. For redundant inputs, repeat the above steps by inserting the positive/negative wires into the V2+, V2- circular openings on the power connector by firmly pushing them into the terminal block.
5. Use 12-14 gauge solid or stranded wire to connect the Chassis Grounding point located near the power input terminal to a known good ground.
6. Verify that no exposed conductors are touching each other or the unit case before powering on the unit.
7. Apply power to the unit and verify that the power LED stays on.

Note: When a DC power supply is installed, only one power supply must be connected to power for minimal operation. For redundant power operation, V1 and V2 inputs must be connected to separate DC voltage sources. This device will draw current from the higher voltage source. The NT24k can be configured to fault when either of the two supplies goes below a minimum voltage threshold.

Note: If stranded wire is not used with ferrules, the stranded wire must be tinned with solder.

To Remove Wires from Terminal Block

1. Disconnect power to the unit and verify that the power LED remains Off.
2. Remove the positive wire from the DC power supply by inserting a small screw driver or tool into the slot adjacent to the positive wire and gently pulling on the wire being removed.
3. Remove the negative wire from the DC power supply by inserting a small screw driver or tool into the slot adjacent to the negative wire and gently pulling on the wire being removed.
4. In the event redundant inputs are utilized, repeat the above steps by removing the positive/negative wires from the V2+, V2- circular openings on the power connector.



General Power Supply Notes for NT24k PoE models

- NT24k PoE models, use 12-14 gauge solid or stranded wire with ferrules.
- Voltage drop across the power wires between the source power supply and the NT24k unit should be considered during installation. (~0.5V/10ft for 12 AWG wire, ~0.65V/10ft for 14AWG).
- Failure to use proper wire may cause the following:

  Unit does not power up properly or may cycle power on/off.
  PoE ports being shut off
  Excessive heat on the wire conductors may cause permanent damage.
- Verify that the proper input voltage is connected to the NT24k before powering on the unit. **Never apply AC power to a DC NT24k unit as it will permanently damage the unit.**
- Input power supply should be rated to at least 360 Watts of continuous power. Failure to use a properly rated power supply may result in any or all of the following:

  Power Supply damage
  NT24k unit damage or sporadic operation
  PoE ports powering down due to under voltage condition.
- The NT24k can be configured to fault when either of the two supplies goes below a minimum voltage threshold.

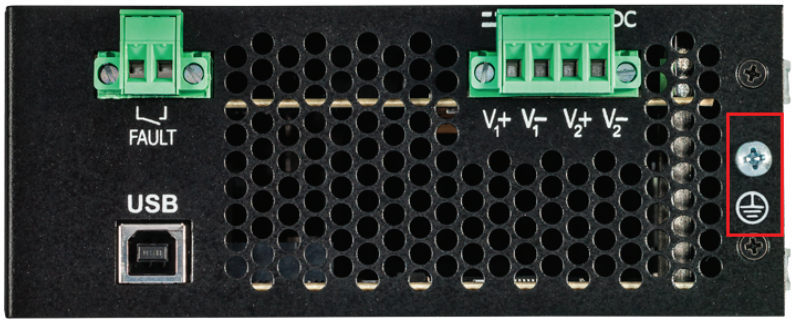
Grounding the Unit

The grounding of any control system is an integral part of the design. The optimum noise immunity and emissions are obtained when the NT24k chassis is connected to earth ground via a 12-14 gauge wire for the POE models and 14-18 gauge drain wire for all other units. The NT24k units provide a ground lug or grounding point (see illustrations) that is used to provide a safe grounding path of the device.

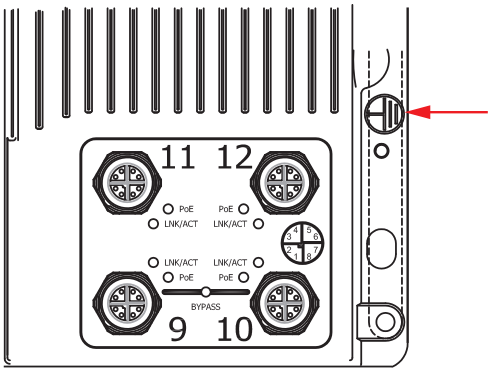
Compact Models

Note: The NT24k power input (V-) pins are isolated from chassis ground. Do not attempt to ground the switch to earth ground via the power input pins (V-).

Remarque: La NT24k puissance d'entrée (V-) broches sont isolés de la masse du châssis. Ne pas essayer pour mettre le commutateur à la terre via les broches d'entrée d'alimentation (V-).



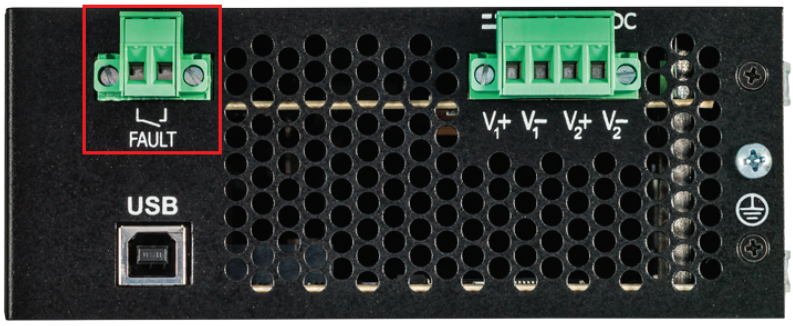
NT24k-16M12 Models



Configurable Alarm Contact

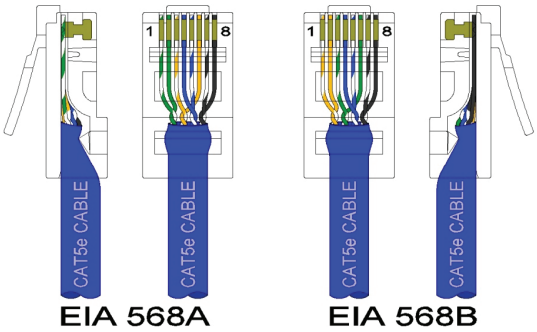
The alarm contact located on the top of the NT24k compact series, can be used to control an external warning device based on an event. The current carrying capacity is 1A at 24VDC. It is normally open and the relay closes when a fault condition occurs, though this can be reversed via configuration. These pins can be used to connect an external warning device such as a light in order to provide an external alarm. The conditions for generating a fault condition (closing the relay) can be configured through software.

Refer to the NT24k Software User's Guide for more information.



Connecting the Unit

For 10/100/1000/T(x) ports, plug a Category 5E twisted pair cable into the RJ45 connector. Connect the other end to the far end station. Verify that the LNK LEDs are ON once the connection has been completed. To connect any port to another device, use a standard CAT5E straight through or crossover cable with a minimum length of one meter and a maximum length of 100 meters.



Red Lion recommends the use of pre-manufactured CAT5E cables to ensure the best performance. If this is not an option and users must terminate their own ends on the CAT5E cables; one of the two color coded standards shown to the right should be utilized. If a user does not follow one of these standards then the performance and maximum cable distance will be reduced significantly, and may prevent the switch from establishing a link.

For FX/FXE/GX/GXE units, remove the dust cap from the fiber optic connectors and connect the fiber optic cables. The TX port on the FX/FXE/GX/GXE models should be connected to the RX port of the far end station. The RX port on the FX/FXE/ GX/GXE versions should be connected to the TX port of the far end station.

Warning / Avertissement

- Creating a network loop without employing a network path protocol such as N-Ring, N-Link, or RSTP is an illegal operation that can create a network storm which will crash the network.
- La création d'un réseau sans boucle employant un chemin réseau protocole tels que N-Ring, N-Link, ou RSTP est une opération illégale que peut créer une tempête du réseau qui va planter le réseau.

Ethernet Cable

If you are connecting to the unit via the copper port, you will need a straight or crossover cable with two 8-pin RJ45 connectors on each end.

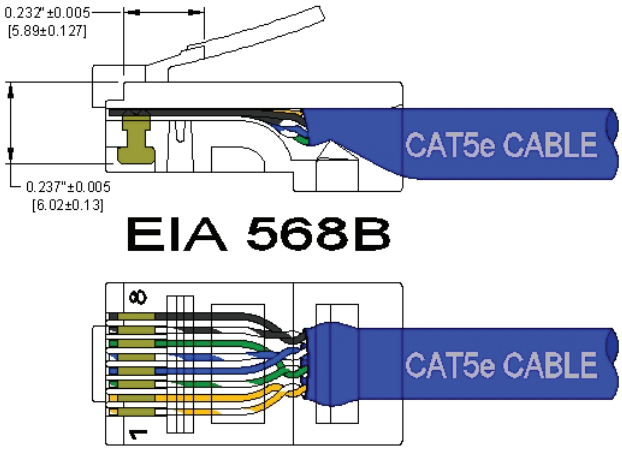
To visually confirm that Ethernet cabling was done properly, check the LED indication on the Ethernet port of the unit. The link LED should be on when the correct cable is used.

Note: A shielded cable is required to fully meet EMC standards.

When using shielded cables, it is generally recommended to only connect the shield at one end to prevent ground loops and interference with low level signals (i.e. thermocouples, RTD, etc.). CAT5e cables manufactured to EIA- 568A or 568B specifications are required for use with Red Lion series switches.

In the event all CAT5e patch cables are short (i.e. All Ethernet devices are located in the same local cabinet and/or referenced to the same earth ground), it is permissible to use fully shielded cables terminated to chassis ground at both ends in systems avoid low level analog signals.

RJ45 Connector Crimp Sepcifications



NTCD-CFG Configuration Device

NTCD-CFG-M12	NTCD-CFG	Configuration Device

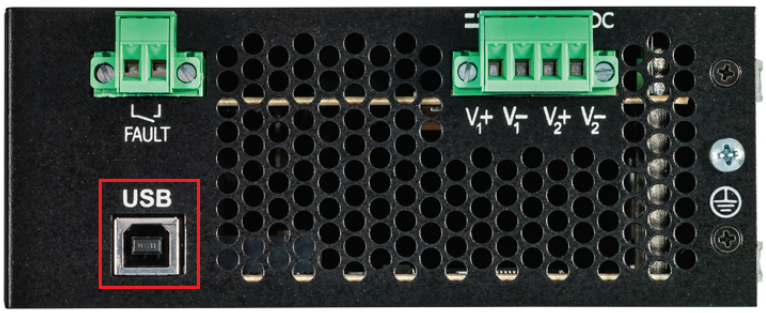
Ideal for saving or restoring switch configuration parameters quickly without the need for a computer or software. One configuration device per switch is recommended.

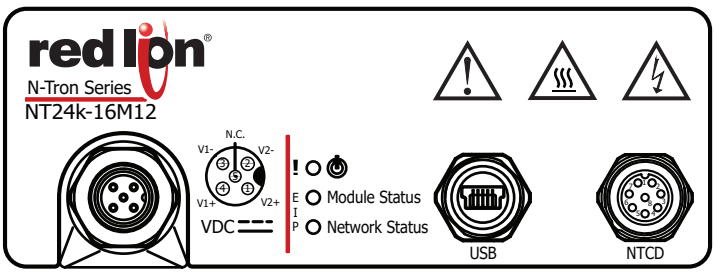
Warning/Avertissement:

- Do not use, connect, or disconnect unless the area is known to be non-hazardous. Connection or disconnection in an explosive atmosphere could result in an explosion.
- Ne pas utiliser, de connecter ou déconnecter sauf si la zone est connue pour être non dangereuse. Connexion ou la déconnexion dans une atmosphère explosive pourrait entraîner une explosion.

USB Interface

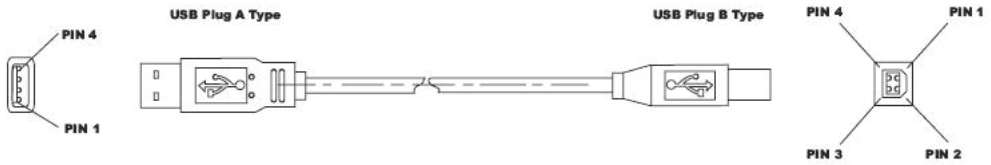
The NT24k switches provide a USB interface accessed via the USB connector labeled as “USB” on the top of the compact models. The USB connection is used to access the Command Line Interpreter (CLI) or PPP (Point-to- Point Protocol).





USB Cable

Connect the USB port of your PC and the Switch using a standard USB cable. A cable with a Type A connector for the PC end, and a Type B connector for the switch end must be used. For NT24k-16M12 models, a cable with a Type A connector for the PC end, and an M12 Mini-B USB connector for the switch end must be used.



Standard USB cables are readily available from a variety of computer stores.

Terminal

The following configuration should be used in HyperTerminal:

Port Settings: 115200
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

Warning/Avertissement:

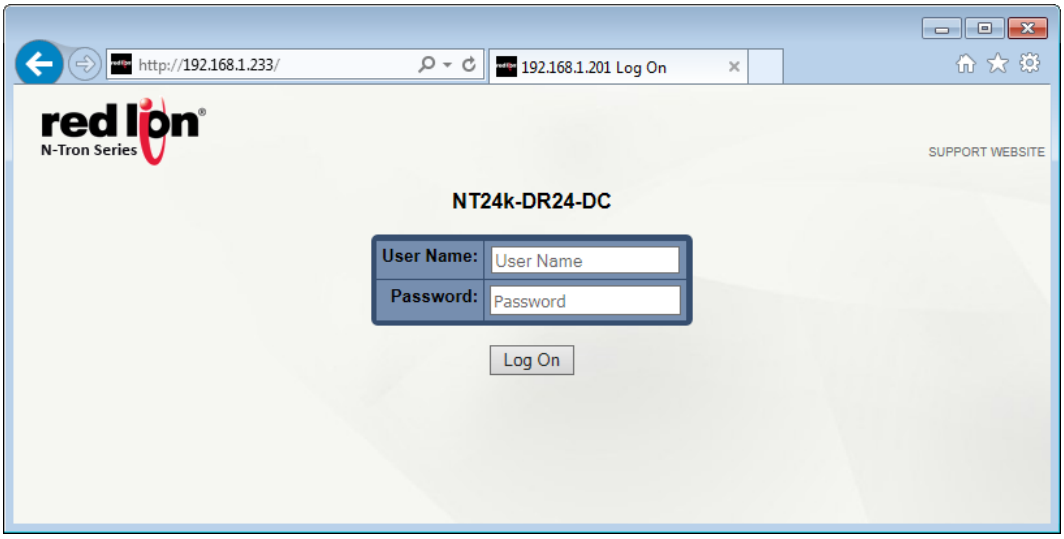
- The USB connection is for temporary connection only. Do not use, connect, or disconnect unless the area is known to be non-hazardous. Connection or disconnection in an explosive atmosphere could result in an explosion.
- La connection USB est pour la connexion temporaire seulement. Ne pas utiliser, connecter ou déconnecter sauf si la zone est connue pour être non dangereuse. Connexion ou la déconnexion dans une atmosphère explosive pourrait entraîner une explosion.

Cleaning

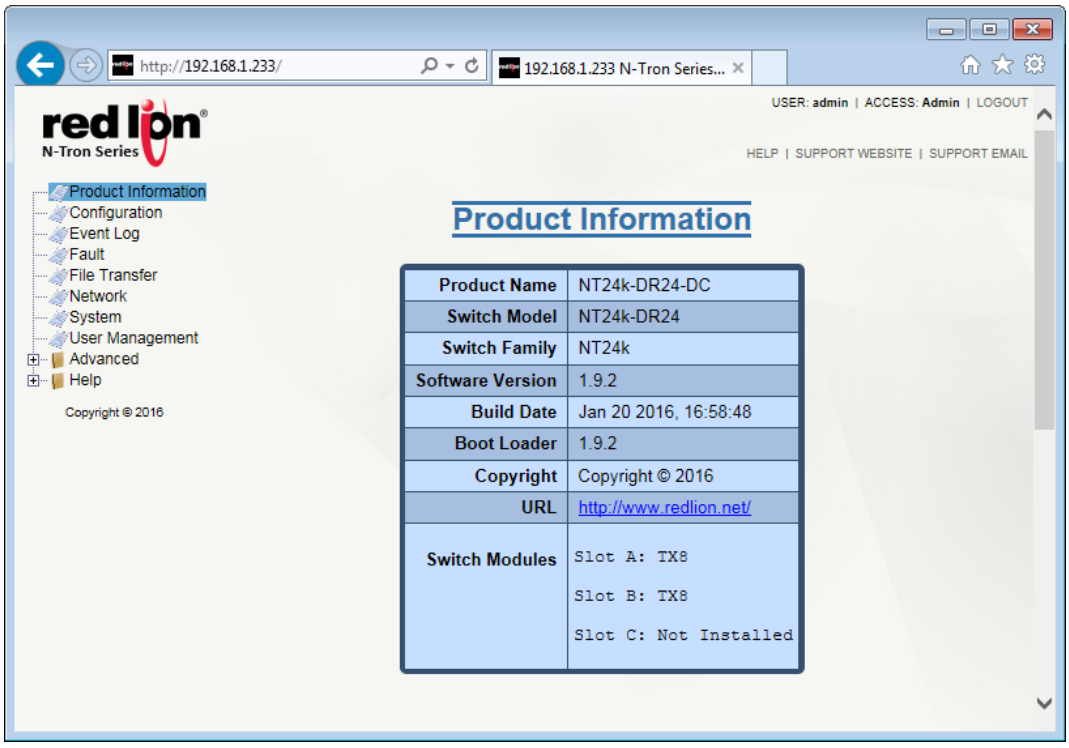
Clean only with a damp cloth. Excess moisture or harsh chemicals can cause damage to the unit.

Chapter 3 Accessing the Web Software Interface

1. Launch a web browser and enter the IP address of the device into the address bar. The DHCP Client is enabled by default by entering 192.168.1.201 as the fallback address.
2. The following login screen will appear.



3. For the User Name, enter: **admin** (all lowercase).
4. For the Password, enter: **admin** (all lowercase).
   Note: For security purposes, it is recommended that the password be changed according to your internal policies. Login credentials can be changed on the **User Management** page.
5. Upon successfully logging in, depending on the unit used, a screen similar to the one below will appear:



Please consult the NT24k Software Guide for configuration options.

Service and Support Information

Service Information

We sincerely hope that you never experience a problem with any of our products. If you do need service, call Red Lion at 1-877-432-9908 for Technical Support. A trained specialist will help you determine the source of the problem. Many problems are easily resolved with a single phone call. If it is necessary to return a unit to us, an RO (Repair Order) can be obtained on the Red Lion website.

Red Lion tracks the flow of returned material with our RO system to ensure speedy service. You must include this RO number on the outside of the box so that your return can be processed immediately.

Be sure to have your original purchase order number and date purchased available.

We suggest that you give us a repair purchase order number in case the repair is not covered under our warranty. You will not be billed if the repair is covered under warranty.

Please supply us with as many details about the problem as you can. The information you supply will be written on the RO form and supplied to the repair department before your unit arrives. This helps us to provide you with the best service, in the fastest manner. Repairs are completed as soon as possible. If you need a quicker turnaround, ship the unit to us by air freight. We give priority service to equipment that arrives by overnight delivery.

We apologize for any inconvenience that the need for repair may cause you. We hope that our rapid service meets your needs. If you have any suggestions to help us improve our service, please give us a call. We appreciate your ideas and will respond to them.

For Your Convenience:

Please fill in the following and keep this manual with your Red Lion system for future reference.

P.O. #: _____ Date Purchased: _____
Purchased From: _____
Serial Number: _____

Product Support

Technical Support:
Inside US: +1 (877) 432-9908
Outside US: +1 (717) 767-6511
Support: support.redlion.net
Hours: 8:00 am to 6:00 pm EST

Red Lion Controls
35 Willow Springs Circle
York, PA 17406
Website: www.redlion.net

Ordering Information

NT24k-8TX

PART NUMBER	DESCRIPTION
NT24k-8TX	Eight Port 10/100/1000Base-T(X) Managed Industrial Ethernet Switch
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC

NT24k-8TX-POE

PART NUMBER	DESCRIPTION
NT24k-8TX-POE	Eight Port 10/100/1000Base-T(X) Managed PoE+ Industrial Ethernet Switch
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC

NT24k-16TX

PART NUMBER	DESCRIPTION
NT24k-16TX	16 Port 10/100/1000Base-T(X) Managed Industrial Ethernet Switch
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC

NT24k-16TX-POE

PART NUMBER	DESCRIPTION
NT24k-16TX-POE	16 Port 10/100/1000Base-T(X) Managed PoE+ Industrial Ethernet Switch
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC

NT24k-10/11/12/14FX

PART NUMBER	DESCRIPTION
NT24k-10FX2-XX	10-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 2 100BaseFX, multimode 2km ports)
NT24k-10FXE2-XX-YY	10-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 2 100BaseFX, singlemode ports)
NT24k-11FX3-XX	11-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 3 100BaseFX, multimode 2km ports)
NT24k-11FXE3-XX-YY	11-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 3 100BaseFX, singlemode ports)
NT24k-12FX4-XX	12-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 4 100BaseFX, multimode 2km ports)
NT24k-12FXE4-XX-YY	12-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 4 100BaseFX, singlemode ports)
NT24k-14FX6-XX	14-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 6 100BaseFX, multimode 2km ports)
NT24k-14FXE6-XX-YY	14-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 6 100BaseFX, singlemode ports)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

NT24k-10/11/12/14GX

PART NUMBER	DESCRIPTION
NT24k-10GX2-SC	10-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 2 1000BaseSX, multimode 550m ports)
NT24k-10GXE2-SC-ZZ	10-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 2 1000BaseLX, singlemode ports)
NT24k-11GX3-SC	11-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 3 1000BaseSX, multimode 550m ports)
NT24k-11GXE3-SC-ZZ	11-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 3 1000BaseLX, singlemode ports)
NT24k-12GX4-SC	12-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 4 1000BaseSX, multimode 550m ports)
NT24k-12GXE4-SC-ZZ	12-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 4 1000BaseLX, singlemode ports)
NT24k-14GX6-SC	14-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 6 1000BaseSX, multimode 550m ports)
NT24k-14GXE6-SC-ZZ	14-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 6 1000BaseLX, singlemode ports)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

Where ZZ = 10, 40, or 80

NT24k-12SFP-DM4

PART NUMBER	DESCRIPTION
NT24k-12SFP-DM4	12-Port Gigabit Managed Industrial Ethernet Switch (8 10/100/1000BaseT, 4 Dual Mode (100/1000Base) SFP Expansion slots (SFP Transceivers sold separately)
NTSFP-FX	100BaseFX multimode fiber SFP pluggable mini-GBIC transceiver (LC style connector, 2km)
NTSFP-FXE-YY	100BaseFX singlemode fiber SFP pluggable mini-GBIC transceiver (LC style connector)
NTSFP-TX	1000BaseT copper SFP pluggable mini-GBIC transceiver
NTSFP-SX	1000BaseSX multimode fiber SFP pluggable mini-GBIC transceiver (LC style connector, 550m)
NTSFP-LX-ZZ	1000BaseLX singlemode fiber SFP pluggable mini-GBIC transceiver (LC style connector)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

Where YY = 15, 40, or 80
Where ZZ = 10, 40, or 80

NT24k-10/11/12/14FX-POE

PART NUMBER	DESCRIPTION
NT24k-10FX2-XX-POE	10-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 2 100BaseFX, multimode 2km ports)
NT24k-10FXE2-XX-YY-POE	10-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 2 100BaseFX, singlemode ports)
NT24k-11FX3-XX-POE	11-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 3 100BaseFX, multimode 2km ports)
NT24k-11FXE3-XX-YY-POE	11-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 3 100BaseFX, singlemode ports)
NT24k-12FX4-XX-POE	12-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 4 100BaseFX, multimode 2km ports)
NT24k-12FXE4-XX-YY-POE	12-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 4 100BaseFX, singlemode ports)
NT24k-14FX6-XX-POE	14-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 6 100BaseFX, multimode 2km ports)
NT24k-14FXE6-XX-YY-POE	14-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 6 100BaseFX, singlemode ports)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

Where XX = ST or SC connector
Where YY = 15, 40, or 80

NT24k-10/11/12/14GX-POE

PART NUMBER	DESCRIPTION
NT24k-10GX2-SC-POE	10-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 2 1000BaseSX, multimode 550m ports)
NT24k-10GXE2-SC-ZZ-POE	10-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 2 1000BaseLX, singlemode ports)
NT24k-11GX3-SC-POE	11-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 3 1000BaseSX, multimode 550m ports)
NT24k-11GXE3-SC-ZZ-POE	11-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 3 1000BaseLX, singlemode ports)
NT24k-12GX4-SC-POE	12-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 4 1000BaseSX, multimode 550m ports)
NT24k-12GXE4-SC-ZZ-POE	12-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 4 1000BaseLX, singlemode ports)
NT24k-14GX6-SC-POE	14-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 6 1000BaseSX, multimode 550m ports)
NT24k-14GXE6-SC-ZZ-POE	14-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 6 1000BaseLX, singlemode ports)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

Where ZZ = 10, 40, or 80

NT24k-12SFP-DM4-POE

PART NUMBER	DESCRIPTION
NT24k-12SFP-DM4-POE	12-Port Gigabit Managed PoE+ Industrial Ethernet Switch (8 10/100/1000BaseT, 4 Dual Mode (100/1000Base) SFP Expansion slots (SFP Transceivers sold separately)
NTCD-CFG	NT24k Configuration Recovery Device
NTSFP-FX	100BaseFX multimode fiber SFP pluggable mini-GBIC transceiver (LC style connector, 2km)
NTSFP-FXE-YY	100BaseFX singlemode fiber SFP pluggable mini-GBIC transceiver (LC style connector)
NTSFP-TX	1000BaseT copper SFP pluggable mini-GBIC transceiver
NTSFP-SX	1000BaseSX multimode fiber SFP pluggable mini-GBIC transceiver (LC style connector, 550m)
NTSFP-LX-ZZ	1000BaseLX singlemode fiber SFP pluggable mini-GBIC transceiver (LC style connector)
NTCD-CFG	NT24k Configuration Recovery Device
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC
NT24k-NM-PMK	NT24k Non-Modular Panel Mount Kit

Where YY = 15, 40, or 80
Where ZZ = 10, 40, or 80

NT24k-16M12

PART NUMBER	DESCRIPTION
NT24K-16M12	IP67-rated 16-Port Gigabit Managed Industrial Ethernet Switch with M12 8-pin X-coded female connectors
NTCD-CFG-M12	NT24k Configuration Recovery Device, M12
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC

NT24k-16M12-POE

PART NUMBER	DESCRIPTION
NT24K-16M12-POE	IP67-rated 16-Port Gigabit Managed PoE+ Industrial Ethernet Switch with M12 8- pin X-coded female connectors (Max 240W PoE+ Load)
NTCD-CFG-M12	NT24k Configuration Recovery Device, M12
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC

NT24k-16M12-R

PART NUMBER	DESCRIPTION
NT24K-16M12-R	IP67-rated 16-Port Gigabit Managed Industrial Ethernet Switch with M12 8-pin X-coded female connectors, with bypass relay
NTCD-CFG-M12	NT24k Configuration Recovery Device, M12
NTPS-24-1.3	DIN Rail Power Supply 1.3 Amp @ 24 VDC

NT24k-16M12-POE-R

PART NUMBER	DESCRIPTION
NT24K-16M12-POE-R	IP67-rated 16-Port Gigabit Managed PoE+ Industrial Ethernet Switch with M12 8- pin X-coded female connectors (Max 240W PoE+ Load), with bypass relay
NTCD-CFG-M12	NT24k Configuration Recovery Device, M12
NTPS-24-20	DIN Rail Power Supply 20 Amp @ 24 VDC
NTPS-48-10	DIN Rail Power Supply 10 Amp @ 48 VDC

LIMITED WARRANTY

(a) Red Lion Controls Inc. (the "Company") warrants that all Products shall be free from defects in material and workmanship under normal use for the period of time provided in "Statement of Warranty Periods" (available at www.redlion.net) current at the time of shipment of the Products (the "Warranty Period"). **EXCEPT FOR THE ABOVE-STATED WARRANTY, COMPANY MAKES NO WARRANTY WHATSOEVER WITH RESPECT TO THE PRODUCTS, INCLUDING ANY (A) WARRANTY OF MERCHANTABILITY; (B) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; OR (C) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.** Customer shall be responsible for determining that a Product is suitable for Customer's use and that such use complies with any applicable local, state or federal law.

(b) The Company shall not be liable for a breach of the warranty set forth in paragraph (a) if (i) the defect is a result of Customer's failure to store, install, commission or maintain the Product according to specifications; (ii) Customer alters or repairs such Product without the prior written consent of Company.

(c) Subject to paragraph (b), with respect to any such Product during the Warranty Period, Company shall, in its sole discretion, either (i) repair or replace the Product; or (ii) credit or refund the price of Product provided that, if Company so requests, Customer shall, at Company's expense, return such Product to Company.

(d) **THE REMEDIES SET FORTH IN PARAGRAPH (c) SHALL BE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND COMPANY'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH IN PARAGRAPH (a).**

BY INSTALLING THIS PRODUCT, YOU AGREE TO THE TERMS OF THIS WARRANTY, AS WELL AS ALL OTHER DISCLAIMERS AND WARRANTIES IN THIS DOCUMENT.

N-Tron® Series
NT24k® Gigabit Ethernet Switches

Software Guide | February 2024

LP0991 | Revision H

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Shanghai, P.R. China: +86 21-6113-3688 x767
Hours: 9 am-6 pm China Standard Time
(UTC/GMT +8 hours)

EUROPE

Netherlands: +31 33-4723-225
France: +33 (0) 1 84 88 75 25
Germany: +49 (0) 1 89 5795-9421
UK: +44 (0) 20 3868 0909
Hours: 9 am-5 pm Central European Time
(UTC/GMT +1 hour)

Website: www.redlion.net
Support: support.redlion.net

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Preface

Disclaimer

This software guide provides guidance on how to use the NT24k®. It is not intended as a step-by-step guide or a complete set of all procedures necessary and sufficient to complete all operations.

While every effort has been made to ensure that this document is complete and accurate at the time of release, the information that it contains is subject to change. Red Lion Controls is not responsible for any additions to or alterations of the original document. Industrial networks vary widely in their configurations, topologies, and traffic conditions. This document is intended as a general guide only. It has not been tested for all possible applications, and it may not be complete or accurate for some situations.

This guide is intended to be used by personnel responsible for configuring and commissioning NT24k devices for use in visualization, monitoring, and control applications. Users of this document are urged to heed warnings and cautions used throughout the document.

Trademark Acknowledgments

Red Lion Controls acknowledges and recognizes ownership of the following trademarked terms used in this document.

- EtherNet/IP™and CIP™ are trademarks of ODVA.

All other company and product names are trademarks of their respective owners.

Certifications

Red Lion Controls ensures that this device meets all the ODVA technology and standards guidelines for the Common Industrial Protocol (CIP) for industrial automation.

ODVA CONFORMANT

Document History and Related Publications

The hard copy and electronic media versions of this document are revised only at major releases and therefore, may not always contain the latest product information. Tech Notes and/or product addendums will be provided as needed between major releases to describe any new information or document changes.

The latest online version of this document can be accessed through the Red Lion website at: https://www.redlion.net/support/documentation/user-manuals.

Additional Product Information

Additional product information can be obtained by contacting your local sales representative or Red Lion through the contact numbers and/or support website address listed on the inside of the front cover.

Chapter 1 Security Best Practices

Introduction

It is more important than ever to secure network devices from unauthorized access, both within and outside of your organization. Red Lion strongly recommends installing managed layer-2 switches behind a secure network firewall in access controlled locations, and immediately changing all default user accounts and passwords, as well as disabling protocols that are not needed in your application.

Protocols and user names with their default passwords are listed in the table below.

PROTOCOLS/USERS	DEFAULT NAME	DEFAULT PASSWORD
User Login	admin	Admin
SNMPv3 User Authentication	initial	Authpass
SNMPv3 User Privacy	initial	Privpass
SNMP v1/v2	read community	Public
SNMP v1/v2	write community	Private
SNMP v1/v2	trap community	public

Some protocols and special devices are enabled by default for the best overall out of the box experience. However, if any in this group will not be used or needed in your network, then these should be disabled to prevent unexpected behavior, unauthorized access or usage. These protocols and special devices are listed in the table below:

PROTOCOLS OR SPECIAL DEVICES
CIP™
SNMP
NTCD
DHCP Client
RSTP
LLDP
N-View™

Managing Local and Remote Access Using 802.1X

Red Lion strongly recommends using 802.1X to manage local and remote access as a best practice for larger installations. 802.1X allows for the management of users, devices, profiles, certificates, and so forth from a single location which also provides a high degree of security.

Default Passwords

User Passwords

The NT24k® ships from the factory with a default ***admin*** user account. Red Lion strongly recommends creating a new user with administrative privileges and then deleting the default ***admin*** user before the unit is deployed.

At a minimum, the default password for the ***admin*** user should be changed.

SNMPv3 Users

The NT24k® ships from the factory with SNMP enabled and a default SNMPv3 user. If SNMP will be used, then Red Lion strongly recommends creating a new SNMPv3 user and then deleting the default ***initial*** SNMPv3 credentials. At a minimum, the default password for the ***default*** user should be changed.

It is strongly recommended that both authentication and privacy protocols are enabled for all v3 users. Setting the option to ***None*** for either protocol is discouraged.

See the Disabling Unused Protocols and Special Devices section if SNMP will not be used.

SNMP v1/v2 Community Names

The NT24k ships with default Community Names for SNMP v1/v2 operation. SNMP v1/v2 traffic per the standard is neither hashed nor encrypted. Therefore, it is Red Lion's recommendation that customers requiring SNMP use SNMPv3, which offers more secure SNMP communication.

If SNMP v1/v2 is required in your application, Red Lion strongly recommends changing the default SNMP credentials before deployment.

See the Disabling Unused Protocols and Special Devices section if SNMP will not be used.

Legacy Protocols

When multiple revisions of a protocol are supported, Red Lion enables the most secure version by default and disables legacy (unsecure) versions of the protocol. We strongly recommend leaving the older revisions disabled.

LEGACY PROTOCOL	SECURE PROTOCOL EQUIPMENT
HTTP	HTTPS
Telnet	SSH

Disabling Unused Protocols and Special Devices

Certain network protocols and special devices are enabled by default for the best overall out of the box experience. However, some of these protocols and devices have the capability of configuring and/or reading network settings or causing unexpected network behavior. These protocols and devices should be disabled when they are not being utilized in your network to prevent unexpected behavior, unauthorized access and/or control of your network and individual network devices.

The following protocols or special devices meet these criteria:

- CIP™
- SNMP
- NTCD (Configuration Device)
- DHCP Client
- RSTP
- LLDP
- N-View™

Chapter 2 Features and Specifications

NT24k® Series Common Features

Red Lion's N-Tron® Series NT24k all-Gigabit managed industrial Ethernet switches are available in rack or DIN-rail mountable configurations. The NT24k platform offers a wide array of port configurations, media types and Power over Ethernet Plus (PoE+) models including Fast Ethernet, Gigabit copper and fiber options. All NT24k switches are plug-and-play installable with Internet Group Management Protocol (IGMP) auto-configuration, media/port auto-detection and simple ring configuration, making the NT24k platform one of the easiest to deploy managed switches in the industry. Housed in rugged hardened enclosures, NT24k switches feature extended shock and vibration specifications, wide operating temperature ratings, and best-in-class ring technology.

Connectivity

The modular NT24k switches are available in 2 or 3 slot configurations. Port modules are hot-swappable. Available modules include 10/100/1000Base Copper, 100Base Fiber, 1000Base Fiber, Gigabit Small Form-factor Pluggable (SFP) Ports and Dual Mode (100Base/1000Base) SFP ports. Modules and SFP transceivers are sold separately. Please reference the N-Tron Series “NT24k Modular Series Hardware & Installation Manual” for available configuration options.

The compact series offers a wide variety of copper and fiber configurations, including all Gigabit copper, Gigabit fiber or SFP ports. IEEE 802.3af/at Power over Ethernet (PoE) models are also available. Please reference the N-Tron Series “NT24k Compact Industrial Managed Gigabit Ethernet Switches Hardware Manual” for more information.

Performance

NT24k-managed switches provide uncompromising performance in harsh environments, including network features like N-Ring™, Virtual Local Area Network (VLAN), Quality of Service (QoS), port mirroring, IGMP, Simple Network Time Protocol (SNTP) and Simple Network Management Protocol (SNMP). IEEE 1588v2 (Precision Time Protocol, or simply PTP) models are also available. Additionally, the NT24k offers IEEE 802.1X with RADIUS remote server authentication to ensure port security. These network management features provide best-in-class visibility, security, and uptime performance.

Environmental

The ultra-reliable NT24k switches are available in rackmount or DIN-rail mountable configurations with operating temperatures from -40 to 85°C. With UL Class I, Division 2 listing and CE certifications, these industrial switches are built to last in the most demanding and hazardous environments.

Monitoring

The N-View™ monitoring technology software provides 47 different status points on switch and port conditions and displays that information on any networked computer.

Security

The NT24k series provides a high level of security by utilizing IEEE 802.1X with RADIUS remote server authentication, MAC address based port security, Hyper Text Transfer Protocol Secure (HTTPS), Secure Shell or Secure Socket Shell (SSH), and SNMPv3 communication protocol to ensure the safest networks.

Refer to the NT24k Hardware Manuals for more information on our Modular and Compact Series.

Overview of Advanced Features

Mode of Operation

Each port on the switch can be configured to support different modes of operation as shown below:

Copper Ports:
- Half-Duplex
- Full-Duplex
- Auto-Negotiation

1000Base Copper or any Fiber Ports:
- Full-Duplex

Half-Duplex

In half-duplex mode, the CSMA/CD media access ports share a common transmission medium. To transmit, a port waits (defers) for a quiet period on the medium (that is, no other port is transmitting) and then sends the intended message in bit-serial form. If, after initiating a transmission, the message collides with that of another port, then each transmitting port intentionally transmits for an additional predefined period to ensure propagation of the collision throughout the system. The port remains silent for a random amount of time (back-off) before attempting to transmit again.

Full-Duplex

Full-duplex operation allows simultaneous communication between a pair of ports using point-to-point media (dedicated channel). Full-duplex operation does not require that transmitters defer, nor do they monitor or react to receive activity, as there is no contention for a shared medium in this mode.

However, a receiving endpoint may request that the transmitting endpoint pause transmission to prevent receive buffer overflow. When the receiving buffer capacity becomes sufficient again, the receiving endpoint will notify the transmitting endpoint that transmission may resume.

Auto-Negotiation

In Auto-Negotiation mode, the port/hardware detects the mode of operation of the port that it is connected to and sets its mode to match.

Port Mirroring

A Mirroring Port is a dedicated port that is configured to forward copies of Ethernet frames that are being sent or received from a monitored port. This is normally only used during troubleshooting and debug of the network. Under normal operation, Port Mirroring is disabled.

Port Trunking

Port Trunking is the ability to group network ports to increase the bandwidth between two machines (e.g., switch or any work station). This feature allows grouping of high-speed connectivity and provides a redundant connection between switches, so that a trunk can act as a single link between the switches.

Quality of Service (QoS)

QoS refers to resource reservation control mechanisms. QoS is the ability to provide different priorities to different applications, users, or data flows. QoS guarantees are important if the network capacity is insufficient, especially for real-time streaming multimedia applications such as Voice over IP, high resolution images, online games and IP-TV, since these often require fixed bit rate and are delay sensitive, and in networks where the capacity is a limited resource, for example in cellular data communication. In the absence of network congestion, QoS mechanisms are not required.

The QoS of an egressing frame can be set based on the three QoS mechanisms listed below:

1. IEEE 802.1p (Tagged QOS)

2. DSCP (differentiated services code points) (RFC 2474)
3. Port (Default Priority)

Virtual Local Area Network (VLAN)

The switch provides support for setting up tagged VLANs. A port may belong to any number of VLANs. The VLAN membership of an end device is determined by the VLAN(s) defined for the port to which the device is connected. If a device should move from one port to another, it loses its current VLAN membership and inherits that of its new port.

VLANs facilitate easy administration of logical groups of devices that can communicate as if they were physically on the same LAN. Traffic between VLANs is restricted unless the ports are explicitly configured as overlapping VLANs. Switches forward unicast, multicast, and broadcast traffic only on LAN segments that serve the VLAN to which the traffic belongs.

A default Virtual LAN (VID=1) exists so if a port is not a member of any other VLAN, it will default back to VLAN 1. This allows the switch to operate as a 'normal' switch when it is used in a network. A port may be automatically removed from the default VLAN when it is reconfigured to belong to another VLAN. By default, the switch will automatically remove a port from the default VLAN when it is reconfigured to another VLAN. See the VLAN configuration section in Chapter 2 for additional information.

If switch ports are configured to transmit and receive untagged frames, then their connected devices are able to communicate throughout the LAN. Using Tagged VLANs, the switch has the ability to take non-tagged packets in some ports, add a VLAN tag to the packet and send it out to tagged ports on the switch. VLANs can also be configured to accept tagged packets in tagged ports, strip the tags off the packets, and then send the packets back out to other untagged ports. This allows a network administrator to set up the switch to support devices on the network that do not support VLAN tagged packets. The administrator can also set up the ports to discard any packets that are tagged or to discard any packets that are untagged, based on a hybrid VLAN of both tagged and untagged ports and by using the VLAN Ingress Filter on the switch.

For each switch port there is one and only one PVID (port VLAN ID) setting. If an incoming frame is untagged and untagged frames are being accepted, then that frame will inherit the tag of the PVID value for that port. Subsequent switch routing and treatment will be in accordance with that VLAN switch map. By configuring PVIDs properly and configuring for all frames to exit untagged, the switch can achieve a 'port VLAN' configuration in which all frames in and out can be untagged, thus not requiring external devices to be VLAN cognizant.

To understand how a VLAN configuration will perform, first look at the port on which the frame enters the switch, then the VLAN ID (VID) (if the frame is tagged) or the PVID (if the frame is untagged). The VLAN defined by the VID or PVID defines a VLAN group with a membership of ports. This membership determines whether a port is included or excluded as to frame egress from the switch.

The NT24k® switch also has the ability to allow overlapping VLANs. Overlapping VLANs give the user the ability to have one or more ports share two or more VLAN groups. For more information and examples on how this could be implemented, refer to the 'VLAN Configuration Examples' in this document, and/or our website's technical documents.

Note: RSTP is only supported on one VLAN.

Rapid Spanning Tree Protocol (RSTP)

Rapid Spanning Tree Protocol as specified in IEEE 802.1D-2004, is supported. One Spanning Tree on one VLAN is supported. (RSTP supersedes the Spanning Tree Protocol (STP) described in IEEE 802.1D-1998.) RSTP establishes a simply connected active network topology from the arbitrarily connected bridges of a bridged network. Bridges effectively connect just the LANs to which their forwarding ports are attached. Ports that are in a blocking state do not forward frames. The bridges in the network exchange sufficient information to automatically derive a spanning tree.

RSTP provides quicker learning of network topology changes than the older STP. RSTP supports new and improved features such as the rapid transition of ports to the forwarding state. While STP transmits BPDUs (Bridge Protocol Data Units) from only the root bridge, RSTP transmits BPDUs from every bridge. RSTP inter-operates with older STP switches by falling back to STP when the older BPDUs are detected on bridge ports. The user can also manually configure bridge ports to use STP, if desired.

SNMP Traps

The NT24k® Series switch supports SNMP Trap Stations to which SNMP Traps will be sent. Four standard SNMP traps are supported: Link Status (Link Up / Link Down), Cold Start, Warm Start, and Authentication Errors. SNMP Traps are sent to all trap stations configured on a given switch when the corresponding trap is enabled.

IGMP Snooping

IGMP Snooping is enabled by default. The switch provides automatic (Plug and Play) IGMP configuration. IGMP snooping provides intelligent network support for multicast applications, reducing unneeded network traffic. IGMP Snooping is configured via the web console and if enabled, operates dynamically upon each power up. Also, there can be manual only or manual and dynamic operation. Note that “static multicast group address” can be used whether IGMP Snooping is enabled or not.

The Internet Group Management Protocol (IGMP) is a protocol that provides a way for a device to report its multicast group membership to adjacent 'routers'. In this case NT24k switches provide router-like functionality. Multicasting allows one computer to send content to multiple other computers that have identified themselves as interested in receiving the originating computer's content. Multicasting can be used to transmit only to an audience that has joined (and not left) a multicast group membership. IGMP version 2 is formally described in the Internet Engineering Task Force (IETF) Request for Comments (RFC) 2236. IGMP version 1 is formally described in the Internet Engineering Task Force (IETF) Request for Comments (RFC) 1112. The NT24k series supports v1 and v2.

IGMP Snooping will function dynamically without user intervention. If some of the devices in the LAN do not understand IGMP, then manual settings are provided to accommodate them.

N-Link

The purpose of N-Link is to provide a way to redundantly couple an N-Ring topology to another topology, typically another N-Ring topology. Each N-Link configuration requires 4 switches, two on each network. On the N-Ring network, one switch is the N-Link Master and an adjacent switch is the N-Link Slave. On the connected network, one switch is the N-Link Primary Coupler and another switch is the N-Link Standby Coupler.

N-Link monitors the link status of the Primary and Standby Coupler links. As long as the Primary Coupler link is healthy, N-Link forwards network traffic and the Standby Coupler link blocks network traffic. When a problem is detected on the Primary Coupler link, the Primary Coupler link blocks network traffic and the Standby Coupler forwards network traffic. While the N-Link Master and Slave are in communication via the Control link, only one Coupler link (Primary or Standby) forwards network traffic, while the other Coupler link blocks network traffic.

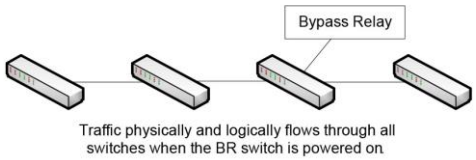
N-Ring™

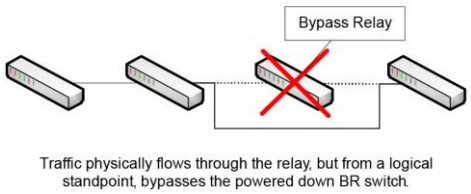
N-Ring is designed for easy setup. Switches are configured for N-Ring membership, by default. Setting a switch as the N-Ring Manager is the only required step for enabling the ring as long as preset ports are used to connect ring members. Subsequently, N-Ring operates dynamically upon each power up. N-Ring technology offers expanded ring size capacity, detailed fault diagnostics, and a standard healing time of 30ms. The N-Ring Manager periodically checks the health of the N-Ring via health check packets. If the N-Ring Manager stops receiving the health check packets, it times-out and converts the N-Ring to a

backbone within 30ms. When using all N-Ring enabled switches in the ring, a detailed ring map and fault location chart is also provided on the N-Ring Manager's web browser. N-Ring status is also sent from the N-Ring Manager to the N-View™ OLE for Process Control (OPC) Server to identify the health status of the ring. Up to 250 N-Ring enabled switches can participate in one N-Ring topology. Switches that do not have N-Ring capability may be used in an N-Ring, however the ring map and fault location chart cannot be as detailed at these locations.

Bypass Relay (BR)

BR ports have an internal hardware technology that forces paired BR ports to create a physical connection when the switch powers down. The BR switch is in bypass mode when it is powered down. This feature allows devices connected via these ports to continue communicating despite the BR switch being powered down.





Note: BR ports are only supported on select NT24k® models. BR-capable equipment is denoted by a "-R" in the model name. Likewise, BR capable ports are denoted by a "-R" in the port description.

Note: Some port protocols and port properties are not supported or may be affected by BR ports.

Affected Port Protocols

802.1X

802.1X security cannot be enabled on BR ports. Allowing this protocol on BR ports will lead to network security issues when the switch enters bypass mode. Therefore, 802.1X security is not allowed.

N-Link

N-Link Coupler and Control ports cannot be selected on BR ports. If BR ports were utilized for these links, there would be connection issues upon the switch entering bypass mode. It is also a best practice to ensure that neither the Master nor Slave Partner ports are connected to a BR port. Unlike the Coupler and Control ports, these ports are not user configured, but are auto-detected by the N-Link protocol. Use extra care when introducing BR equipment into an N-Link topology and avoid using BR ports for the N-Link connections.

N-Ring™

N-Ring Manager, Auto Member, and Multi Member cannot be enabled on BR port sets. N-Ring port sets exclude BR-capable ports.

RSTP

RSTP is disabled on BR ports to prevent unacceptable performance within an RSTP topology.

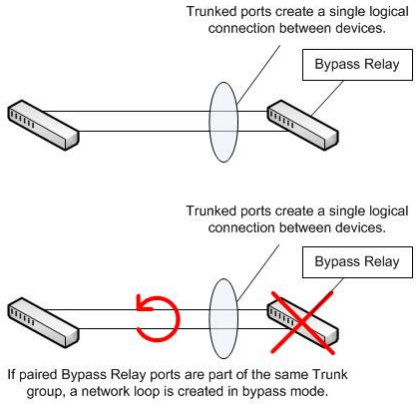
IGMP

Caution must be taken when IGMP is enabled. Devices connected to BR ports must be able to accommodate higher traffic rates. Test your network conditions with the BR switch both powered on and off if IGMP is to be enabled on a BR port.

Affected Port Properties

Port Trunking

BR port pairs cannot be members of the same trunk group to prevent a network loop being created in bypass mode.



VLAN

VLAN group membership must be identical between BR port pairs to ensure proper flow of traffic when the switch enters bypass mode. Caution must also be taken when modifying VLAN tags or filtering VLAN traffic on BR ports to ensure that all devices connected to BR ports can accommodate VLAN traffic whether the BR switch is powered on or powered off.

Note: The VLAN(s) associated with RSTP may contain BR ports, however RSTP will be disabled on the BR ports.

Port Compatibility

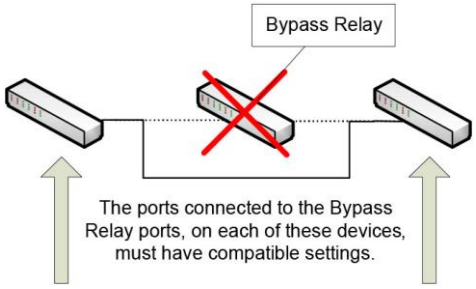
Care should be taken to ensure port characteristics of devices connected via BR ports are compatible, so that there are no interruptions in traffic when a BR switch enters bypass mode.

Ports and/or devices connected to the BR ports must be configured with compatible settings.

The following characteristics should be compatible for devices connected via BR ports:

- Auto-Negotiation
- Port Speed
- Duplex Mode
- Flow Control
- Flow Control
- PVID
- QoS
- Rate Limiting

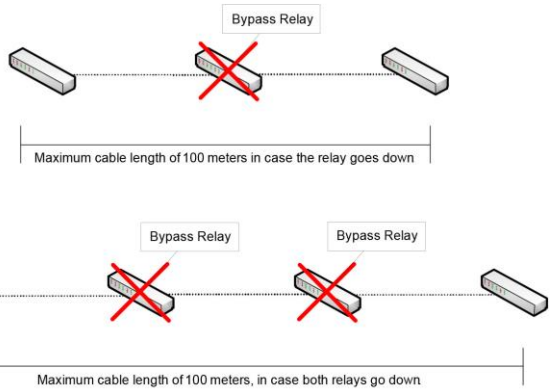
For example, if switches A and B are connected via a BR switch, the connecting port on switch A should have the same configured port speed as the connecting port on switch B. If these ports have incompatible speeds, they may have issues communicating once the switch enters bypass mode.



Note: It is still possible to customize port settings in any configuration desired, based on network requirements. Network testing must be performed to ensure correct network operation whether the switch is powered on or powered off.

Segment Length

Based on IEEE specifications, the maximum segment length for 10/100/1000BaseT(X) is 100 meters (328 ft). This requirement applies to combined segment lengths between all devices connected via BR port pairs. Staying within the IEEE specified segment length ensures proper operation.



CIP™

The CIP (Common Industrial Protocol) feature allows N-Tron® Series switches to directly provide switch information and configuration access to Programmable Logic Controller (PLC) and Human Machine Interface (HMI) applications via a standardized communication protocol. For example, a PLC may be programmed to monitor port links or N-Ring™ status and trigger a status indicator to turn red on an HMI if a port goes link down or if N-Ring has a fault. CIP is formally described in ODVA Publication Number PUB00001 (Volume 1: Common Industrial Protocol (CIP)), and Publication Number: PUB00002 (Volume 2: Ethernet/IP™ Adaptation of CIP). Red Lion created EDS and ICO files are provided with the NT24k® switch series.

Note: Information about using CIP with the NT24k can be found in the CIP User Manual & Installation Guide and the CIP Installation Kit for the NT24k switch family.

PTP

Precision Time Protocol (PTP), IEEE 1588v2, is supported on licensed NT24k models. PTP allows users to configure a network with very accurate, coordinated timing among devices. NT24k models with software implementations of PTP are capable of achieving accuracy in the low microseconds range. PTP is disabled by default and can be enabled as a Boundary or Transparent clock through the Web Browser interface. The switch must have a valid PTP license installed before PTP can be enabled.

Point-to-Point Protocol (PPP)

PPP allows a browser-like interface over the CLI port.

Dynamic Host Configuration Protocol (DHCP)

DHCP (Dynamic Host Configuration Protocol) simplifies network configuration by automatically assigning IP addresses from a DHCP server to connected DHCP capable devices (DHCP clients). NT24k® switch configuration options include:

- DHCP Server
- DHCP Relay Agent
- DHCP Client

DHCP Server

DHCP Server allows DHCP Client devices to automatically obtain an IP assignment. IP assignments can be set up as a dynamic range of IP addresses available to any client device; or specific IP addresses based on the client's Client ID (Option 61), or Relay Agent connection (Option 82). It also allows for a device on a specific port to receive a specific IP address and if the device is replaced, the replacement receives the same IP address as the original device.

DHCP Relay Agent

DHCP Relay Agent (Option 82) allows communication between the client and server to cross subnet and VLAN boundaries.

DHCP Client

The switch will automatically obtain an IP assignment from a DHCP server, or optionally Fallback to a configured IP assignment if unable to get an IP assignment from a DHCP server. Communication between the client and server can optionally go through a DHCP Relay Agent.

DHCP Client is enabled by default, with 192.168.1.201 as the factory fallback address.

Event Logging

The switch can be configured to log certain system events as they occur. Event Logging is enabled by default for critical events. Event log options are easily changed through a Web browser.

Even Logging includes:

- System startup and shutdown
- Logon and logout from the Web or Console
- Ports becoming enabled or disabled
- Port link up or link down changes
- N-Ring™ status changes

The most recent log information is visible via the web interface and the complete log file may be exported for external analysis.

Event Log Filter

The Event Log Filter enables the user to define which events are logged, based on severity level. Events that do not meet the minimum severity level for that component are not logged.

Syslog

The Syslog protocol, as specified in RFC-3164 and RFC-5424, are supported. The Syslog allows users to configure the switch so that certain system events (see Event Logging) are transmitted to a remote

logging device, known as a Syslog Collector. The Syslog is disabled by default but can be enabled/disabled through the Web Browser interface.

Local Security

The switch is configured for secure access by the SSH and HTTPS. The Telnet Server and Hypertext Transfer Protocol (HTTP) may be enabled to provide backwards compatibility with less secure clients.

Secure Shell

SSH, is a secure alternative to Telnet. A maximum of two concurrent SSH / Telnet connections are allowed.

The commands SFTP (SSH File Transfer Protocol or Secure File Transfer Protocol) and SCP (Secure Copy) are not supported.

Port Security

Port Security can be enabled on the MAC address level for additional security. The Port Security feature restricts access to the switch by only accepting dynamically learned MAC addresses and manually entered MAC addresses as authorized. Dynamically learned MAC addresses are those that the switch detects on any port while in 'Learning' mode. A manually entered MAC address must designate the ports that the address is authorized on. A non-authorized MAC address will be discarded and will be listed in the intruder log.

Port security supports RSTP provided the MAC address(es) are manually authorized on the RSTP ports.

LLDP

The Link Layer Discovery Protocol (LLDP), as specified in IEEE 802.1AB and IEEE 802.3-2012, is used by networking devices to advertise there identity and capabilities and to discover their network neighbors. LLDP can be configured in one of three modes: Enabled, Auto and Disabled. The "Auto" mode is an enhancement to the LLDP protocol.

When in Auto mode, LLDP is inactive until a switch sends a wake up packet. At this point, all switches set to Auto mode will become active until the Wake Time interval expires.

Troubleshooting

1. Make sure the Power LED is ON.
2. Make sure sufficient current is supplied to the switch (per model specifications).
   Note: The Inrush current will exceed the steady state current by ~ 2X.
3. Verify that Link LEDs are ON for connected ports.
4. Verify integrity of cabling between stations.
5. Verify that cabling is Category 5E or greater for 100Mbit and Gigabit operation.

Chapter 3 Web Software Configuration

Accessing the Web Software Interface

Launch a web browser and enter the IP address of the device into the address bar. The DHCP Client is enabled by default with 192.168.1.201 as the fallback address.

The following login screen will appear:

- For the User Name, enter: **admin** (all lowercase)
- For the password, enter: **admin** (all lowercase)

Note: For security purposes, it is recommended that the password be changed according to your internal policies. Login credentials can be changed on the **User Management** page.

Upon successfully logging in, depending on the unit used, a screen similar to the one below will appear:

Organization

After logging onto a NT24k® switch, the Product Information page will be displayed. On the left-hand side of the screen is a list of configurable settings supported by the NT24k switch. Below is a list of these settings with a description of their purpose.

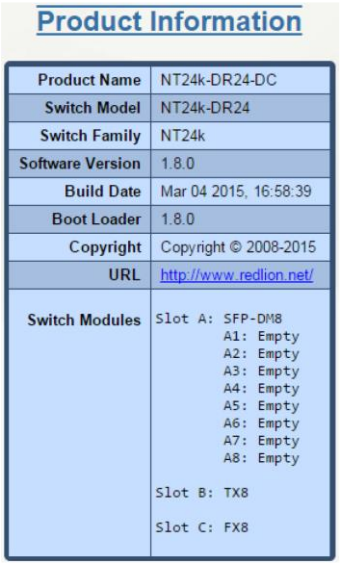
- **Product Information:** Basic information about the switch is provided in this menu.

- **Configuration:** The Configuration page is used to save or reset a running configuration.
- **Event Log:** The Event Log page is used for modifying and viewing the internal event logs.
- **Fault:** A fault is a notification of a destabilizing event. Which events are watched for and how notifications occur are configured on the Fault page.
- **File Transfer:** The File Transfer page provides the administrator the ability to upgrade the firmware or to import or export a configuration file, and export the Event Log to a file.
- **Network:** The network page is used to setup the device's IP and IP Fallback addresses, as well as Client ID and IP Configuration.
- **System:** The System page provides information pertaining to the whole system.
- **User Management:** The User Management page is used to view, add, modify and remove system user accounts, and set permissions.
- **Advanced:** The Advanced section is used to setup advanced features of the system.
- **Help:** The Help section is used to display information on configuring and monitoring the manageable parameters of the device. Specific help can be found by using the left navigation menu.

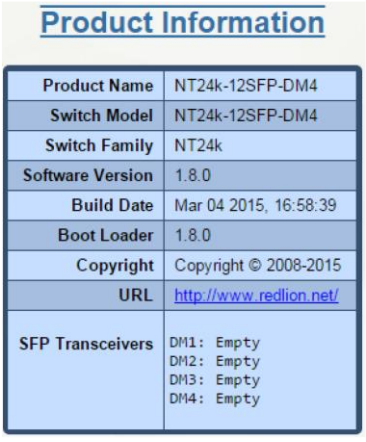
Product Information

Once a user logs onto an NT24k® switch, the Product Information page is displayed. This page shows basic information about the switch and can also be accessed by selecting the Product Information menu item on the left-hand menu.

Modular Models



Compact Series



Product Name: The full name of the switch, including any factory configured options will be displayed in this field.

For example, the product name will show NT24K-AC1 if there is one AC power unit in either location and NT24K-AC2 if there are two AC power units. If the product name ends with DC1 or DC2, this indicates that there is either one or two DC power units.

Switch Model: The base model of the switch.

Switch Family: The switch family this model and similar models belong to.

Software Version: The current firmware software version.

Build Date: The build date of the firmware.

Boot Loader: The boot loader version.

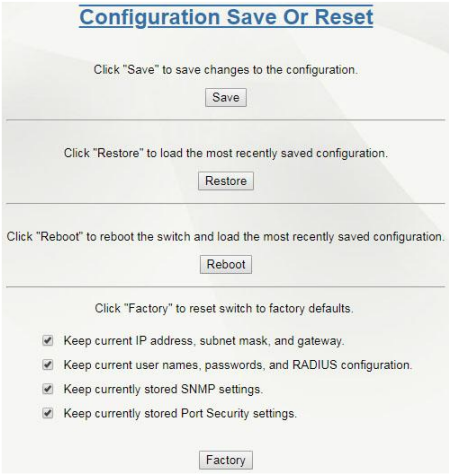
URL: This field links to Red Lion's website.

Switch Modules: The modules currently installed, including installed SFP transceivers. This option may not be present on models where modules or SFPs are not supported.

SFP Transceivers: On models where SFP transceivers are supported, the currently installed SFP transceivers will be shown in this field.

Configuration

The Configuration page allows the Administrator to save a running configuration in the switches non-volatile memory. This step is required if the switch is to remember any configuration changes after a power cycle or reboot. From this page, the Administrator can also restore a previously saved configuration, restore factory defaults or force a system reboot.



Save: Click on the *Save* button to save all current changes to the configuration stored in non-volatile memory for use after the next power cycle or reboot. If a configuration device is installed and enabled, the configuration will also be saved to the device. This option is only available when there is no misconfiguration.

Restore: Click on the *Restore* button to discard all unsaved changes and load the most recently saved configuration. If a configuration device is installed and enabled, the configuration stored on the device will be loaded and used. *See notes below*.

Reboot: Click on the *Reboot* button to reboot the switch and load the most recently saved configuration. If a configuration device is installed and enabled, the configuration stored on the device will be loaded and used. *See notes below*.

Factory: Click on the *Factory* button to reset the switch's configuration to factory defaults except for any of the selected items. Selecting the Factory option will only affect the current configuration. A *Save* must be performed in order to retain these changes after a power cycle or reboot.

- **Keep current IP address, subnet mask, and gateway:** Retains the existing IP address, subnet mask and gateway if desired.
- **Keep current user names, passwords, and RADIUS configuration:** Retain the existing user names, passwords, and RADIUS configuration if desired.

- **Keep currently stored SNMP settings:** Retains the existing SNMP settings if desired.
- **Keep currently stored Port Security settings:** Retain the existing Port Security settings if desired.
- **Keep current PoE Settings:** Retains the existing PoE settings if desired (PoE models only).

Note: When the configuration is loaded from the Configuration Device, it must be saved for it to be available if the Configuration Device is removed.

Note: When the switch is shipped, it does not have a "configuration file" since the unit is using the factory defaults. Before a configuration can be customized, click on the Save button in order to create the file.

Configuration Fault

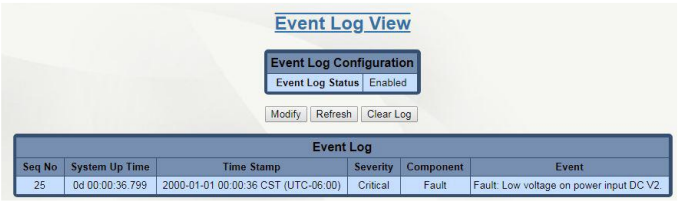
When the switch is booted and misconfigured settings are detected, a Configuration Fault will be triggered and the configuration may not be saved. This can occur when updating system firmware where settings permitted in the previous release may no longer be permitted. In this case, the *Save* button will be replaced with a *Show Errors* button (as seen below) and the misconfigured settings must be fixed before the configuration may be saved.

Show Errors: Click on the Show Errors button to view the current configuration and display any detected errors. This button is only visible when there is a settings misconfiguration.

Event Log

The Event Log View page displays the most recent 200 events that have occurred since the latest system startup or since the log was cleared. Event logging is enabled by default for critical events. Only events that occur while the Event Log was enabled will be displayed and saved with the exception of the Clear Log message which will always be displayed. Therefore, previously enabled events are still displayed when Event Logging is disabled albeit they may not be recent events.

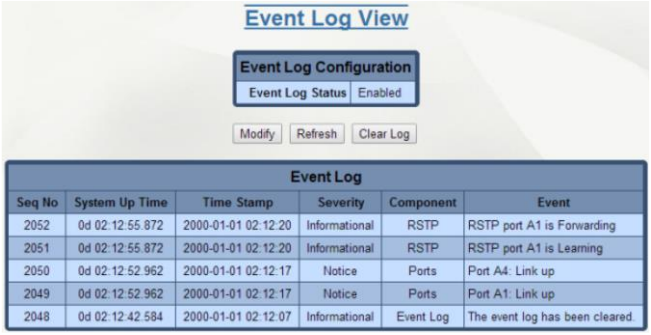
If the Event Log was disabled when the latest Startup event occurred, no events will be displayed as shown below.



When the Event Log is cleared, an informational event will be displayed.

Note: All enabled events since the last Clear Log event, including multiple Startup and Shutdown events, are stored on the system and may be exported as a CSV file from the switch for additional analysis.

Note: The event log can contain 2000 or more entries depending on individual message size. If the event log becomes full, new entries will overwrite the oldest entries.



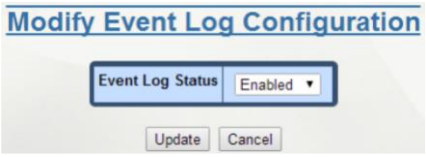
A normal startup or reboot will show startup, RSTP status, N-Ring™ and logon events. An example reboot is shown below.

Modify: Display the Modify Event Log Configuration page.

Refresh: Refresh the current Event Log display.

Clear Log: Remove all entries from the event log and then add “The event log has been cleared.” message.

The Modify Event Log Configuration page controls whether Event Logging is Enabled or Disabled.

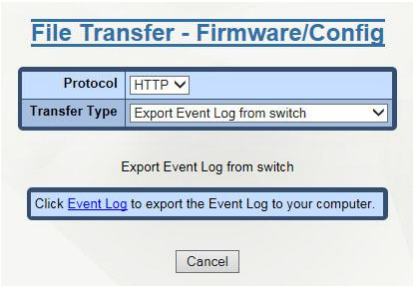


Event Log Status: Select Enabled/Disabled.

Update: Set the new Event Log Status.

Cancel: Return to Event Log View without modifying Event Log Status.

The entire Event Log may be exported to the host PC for further analysis and archiving purposes. It will contain all events that occurred while Event Log was enabled since the last Clear Log event.



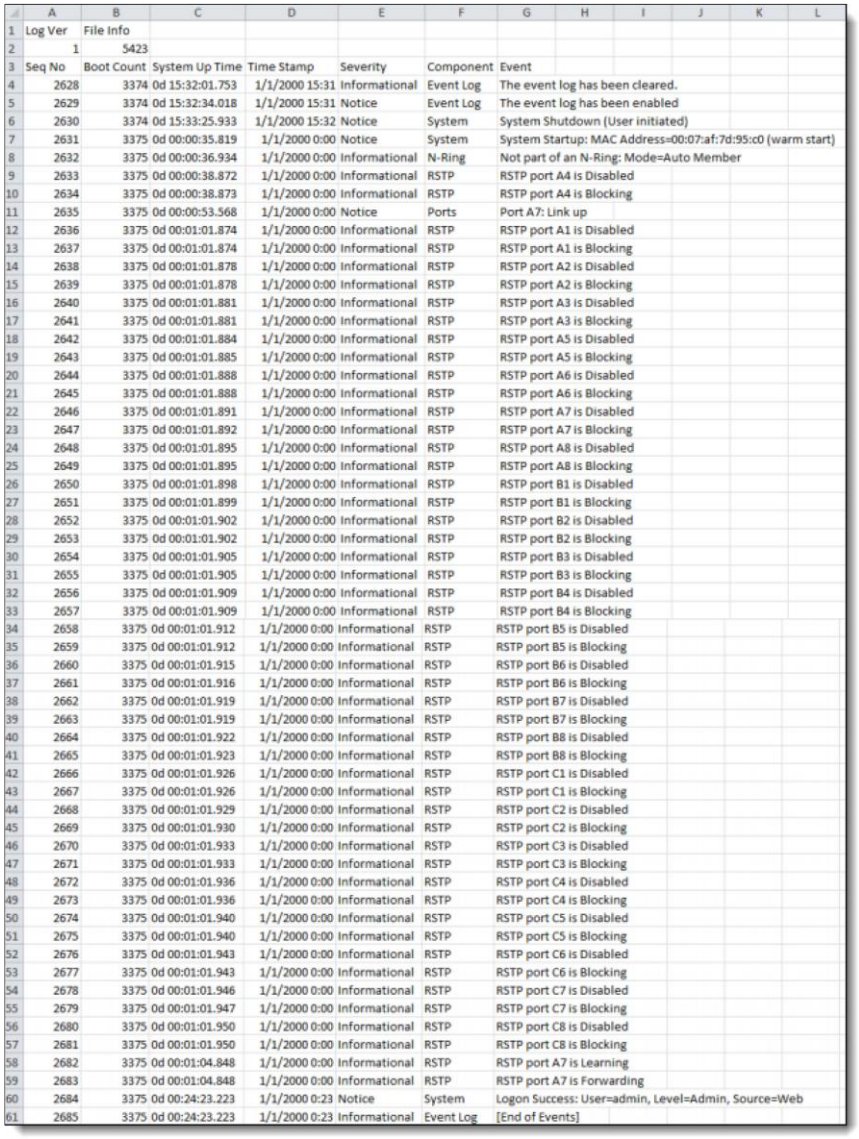
On the File Transfer - Firmware/Config page, select Transfer Type: Export Event Log from switch.

Click on Event Log in the Export Event Log from switch panel, and select the storage location for the exported file on the PC.

The default file name is “eventlog.csv”, which outputs each line in the Event Log as comma separated fields with the final text field surrounded by quotation marks. This file can be viewed with a spreadsheet application or a simple text file viewer.

The Cancel button selection will return to the Product Information page without executing any transfers.

Example Event Log CSV in Microsoft Excel:



	A	B	C	D	E	F	G
1	Log Ver	File Info					
2	1	5423					
3	Seq No	Boot Count	System Up Time	Time Stamp	Severity	Component	Event
4	2628	3374	0d 15:32:01.753	1/1/2000 15:31	Informational	Event Log	The event log has been cleared.
5	2629	3374	0d 15:32:34.018	1/1/2000 15:31	Notice	Event Log	The event log has been enabled
6	2630	3374	0d 15:33:25.933	1/1/2000 15:32	Notice	System	System Shutdown (User initiated)
7	2631	3375	0d 00:00:35.819	1/1/2000 0:00	Notice	System	System Startup: MAC Address=00:07:af:7d:95:c0 (warm start)
8	2632	3375	0d 00:00:36.934	1/1/2000 0:00	Informational	N-Ring	Not part of an N-Ring: Mode=Auto Member
9	2633	3375	0d 00:00:38.872	1/1/2000 0:00	Informational	RSTP	RSTP port A4 is Disabled
10	2634	3375	0d 00:00:38.873	1/1/2000 0:00	Informational	RSTP	RSTP port A4 is Blocking
11	2635	3375	0d 00:00:53.568	1/1/2000 0:00	Notice	Ports	Port A7: Link up
12	2636	3375	0d 00:01:01.874	1/1/2000 0:00	Informational	RSTP	RSTP port A1 is Disabled
13	2637	3375	0d 00:01:01.874	1/1/2000 0:00	Informational	RSTP	RSTP port A1 is Blocking
14	2638	3375	0d 00:01:01.878	1/1/2000 0:00	Informational	RSTP	RSTP port A2 is Disabled
15	2639	3375	0d 00:01:01.878	1/1/2000 0:00	Informational	RSTP	RSTP port A2 is Blocking
16	2640	3375	0d 00:01:01.881	1/1/2000 0:00	Informational	RSTP	RSTP port A3 is Disabled
17	2641	3375	0d 00:01:01.881	1/1/2000 0:00	Informational	RSTP	RSTP port A3 is Blocking
18	2642	3375	0d 00:01:01.884	1/1/2000 0:00	Informational	RSTP	RSTP port A5 is Disabled
19	2643	3375	0d 00:01:01.885	1/1/2000 0:00	Informational	RSTP	RSTP port A5 is Blocking
20	2644	3375	0d 00:01:01.888	1/1/2000 0:00	Informational	RSTP	RSTP port A6 is Disabled
21	2645	3375	0d 00:01:01.888	1/1/2000 0:00	Informational	RSTP	RSTP port A6 is Blocking
22	2646	3375	0d 00:01:01.891	1/1/2000 0:00	Informational	RSTP	RSTP port A7 is Disabled
23	2647	3375	0d 00:01:01.892	1/1/2000 0:00	Informational	RSTP	RSTP port A7 is Blocking
24	2648	3375	0d 00:01:01.895	1/1/2000 0:00	Informational	RSTP	RSTP port A8 is Disabled
25	2649	3375	0d 00:01:01.895	1/1/2000 0:00	Informational	RSTP	RSTP port A8 is Blocking
26	2650	3375	0d 00:01:01.898	1/1/2000 0:00	Informational	RSTP	RSTP port B1 is Disabled
27	2651	3375	0d 00:01:01.899	1/1/2000 0:00	Informational	RSTP	RSTP port B1 is Blocking
28	2652	3375	0d 00:01:01.902	1/1/2000 0:00	Informational	RSTP	RSTP port B2 is Disabled
29	2653	3375	0d 00:01:01.902	1/1/2000 0:00	Informational	RSTP	RSTP port B2 is Blocking
30	2654	3375	0d 00:01:01.905	1/1/2000 0:00	Informational	RSTP	RSTP port B3 is Disabled
31	2655	3375	0d 00:01:01.905	1/1/2000 0:00	Informational	RSTP	RSTP port B3 is Blocking
32	2656	3375	0d 00:01:01.909	1/1/2000 0:00	Informational	RSTP	RSTP port B4 is Disabled
33	2657	3375	0d 00:01:01.909	1/1/2000 0:00	Informational	RSTP	RSTP port B4 is Blocking
34	2658	3375	0d 00:01:01.912	1/1/2000 0:00	Informational	RSTP	RSTP port B5 is Disabled
35	2659	3375	0d 00:01:01.912	1/1/2000 0:00	Informational	RSTP	RSTP port B5 is Blocking
36	2660	3375	0d 00:01:01.915	1/1/2000 0:00	Informational	RSTP	RSTP port B6 is Disabled
37	2661	3375	0d 00:01:01.916	1/1/2000 0:00	Informational	RSTP	RSTP port B6 is Blocking
38	2662	3375	0d 00:01:01.919	1/1/2000 0:00	Informational	RSTP	RSTP port B7 is Disabled
39	2663	3375	0d 00:01:01.919	1/1/2000 0:00	Informational	RSTP	RSTP port B7 is Blocking
40	2664	3375	0d 00:01:01.922	1/1/2000 0:00	Informational	RSTP	RSTP port B8 is Disabled
41	2665	3375	0d 00:01:01.923	1/1/2000 0:00	Informational	RSTP	RSTP port B8 is Blocking
42	2666	3375	0d 00:01:01.926	1/1/2000 0:00	Informational	RSTP	RSTP port C1 is Disabled
43	2667	3375	0d 00:01:01.926	1/1/2000 0:00	Informational	RSTP	RSTP port C1 is Blocking
44	2668	3375	0d 00:01:01.929	1/1/2000 0:00	Informational	RSTP	RSTP port C2 is Disabled
45	2669	3375	0d 00:01:01.930	1/1/2000 0:00	Informational	RSTP	RSTP port C2 is Blocking
46	2670	3375	0d 00:01:01.933	1/1/2000 0:00	Informational	RSTP	RSTP port C3 is Disabled
47	2671	3375	0d 00:01:01.933	1/1/2000 0:00	Informational	RSTP	RSTP port C3 is Blocking
48	2672	3375	0d 00:01:01.936	1/1/2000 0:00	Informational	RSTP	RSTP port C4 is Disabled
49	2673	3375	0d 00:01:01.936	1/1/2000 0:00	Informational	RSTP	RSTP port C4 is Blocking
50	2674	3375	0d 00:01:01.940	1/1/2000 0:00	Informational	RSTP	RSTP port C5 is Disabled
51	2675	3375	0d 00:01:01.940	1/1/2000 0:00	Informational	RSTP	RSTP port C5 is Blocking
52	2676	3375	0d 00:01:01.943	1/1/2000 0:00	Informational	RSTP	RSTP port C6 is Disabled
53	2677	3375	0d 00:01:01.943	1/1/2000 0:00	Informational	RSTP	RSTP port C6 is Blocking
54	2678	3375	0d 00:01:01.946	1/1/2000 0:00	Informational	RSTP	RSTP port C7 is Disabled
55	2679	3375	0d 00:01:01.947	1/1/2000 0:00	Informational	RSTP	RSTP port C7 is Blocking
56	2680	3375	0d 00:01:01.950	1/1/2000 0:00	Informational	RSTP	RSTP port C8 is Disabled
57	2681	3375	0d 00:01:01.950	1/1/2000 0:00	Informational	RSTP	RSTP port C8 is Blocking
58	2682	3375	0d 00:01:04.848	1/1/2000 0:00	Informational	RSTP	RSTP port A7 is Learning
59	2683	3375	0d 00:01:04.848	1/1/2000 0:00	Informational	RSTP	RSTP port A7 is Forwarding
60	2684	3375	0d 00:24:23.223	1/1/2000 0:23	Notice	System	Logon Success: User=admin, Level=Admin, Source=Web
61	2685	3375	0d 00:24:23.223	1/1/2000 0:23	Informational	Event Log	[End of Events]

Where the fields are:

Sequence Number: Each entry is assigned the next sequence number – these may not always be listed in numerical order due to the priority of the internal tasks which generate the events.

Note: The "[End of Events]" message at the end of the file will contain the next sequence number, but that number will be reused for the next system event on the switch when it occurs.

Boot Count: A count of how many times the switch has been powered up or restarted.

System Up Time: The amount of time since the system was started in days, hours, minutes, seconds, milliseconds.

Time Stamp: Corresponding date, hours, minutes, seconds, based on the initial value of Current System Time as defined in the System Configuration View.

Severity: (most severe to least severe):

Emergency: Major failure, Immediate intervention required

Alert: Failure of a component, Immediate corrective steps should be taken
Critical: Partial failure of a component, Immediate corrective action should be taken
Error: Non-urgent failure
Warning: Not an error, but may lead to an error if action is not taken
Notice: Unusual event, but not an error
Informational: General Information
Debug: Information useful to a support technician for debugging the switch operation.

Component: Internal component that generated the event entry.

Event Description: Description of the event entry.

Fault

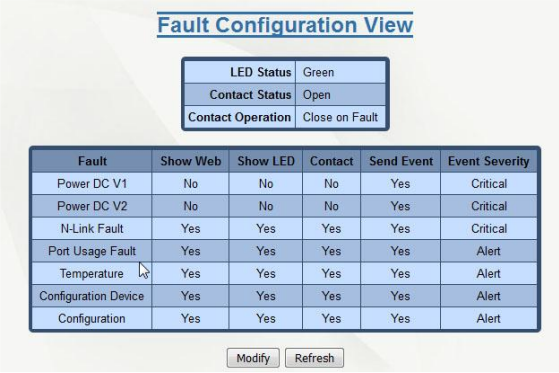
The Fault page provides configurable selections indicating the different ways to notify an administrator when a fault occurs. In each case, the notification may consist of any combination: Show Web, Show LED and/or Contact. Some fault configurations are only available under specific conditions. For example, Power AC is only available when an AC power supply is installed in the switch. N-Ring™ faults are only available when the switch is set to N-Ring Manager mode. The page below is an example of what may be seen on the Fault dialog window.

Additionally, when a fault is triggered, an event may be generated at the severity selected by the user. The event will be logged unless it is filtered by the Event Log Filter.

The event's severity can be set to any of the following values.

Note: These are based on the Event Log's Severity:

Emergency
Alert
Critical
Error
Warning
Notice
Informational
Debug



LED Status: This field shows the current color of the Power/Fault LED. Green indicates there is no fault and Red indicates a fault condition exists.

Contact Status: This field shows the current open/closed status of the fault relay.*

Contact Operation: This field determines if the fault relay is normally open (Close on Fault) or normally closed (Open on Fault).*

Show Web: If the *Show Web* option is enabled, the fault is displayed on the browser pages.

Show LED: If the *Show LED* option is enabled, the fault is indicated on the Power LED as red.

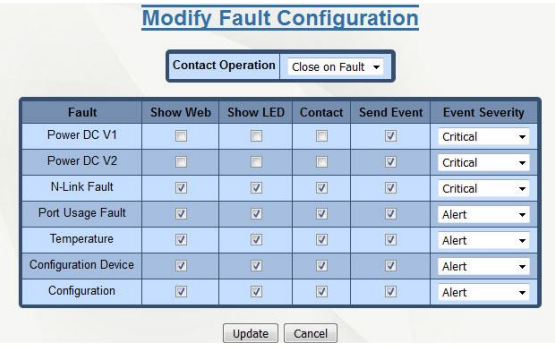
Contact: If *Contact* is enabled, the fault is indicated by opening or closing the contact switch.

Send Event: The fault is sent to the configured log(s). See the Event Log and Syslog configuration.

Event Severity: The fault will generate an event based on the configured severity level.

To make changes to the *Fault Configuration* settings, click on the *Modify* button.

* **Note:** Fault's contact is only supported on certain NT24k® switches.



Select the desired notification settings and click on the *Update* button to save any changes. Once the save is complete, the dialog window will change to Fault Configuration.

Power Fault Descriptions

The location of a power input is clearly marked on the device. Depending on the specific device configuration, some of the faults listed below may not be shown.

Note: Power Fault notifications are disabled in factory defaults on a low voltage power supply.

Power AC1: Indicates a low voltage on power input AC1.
Power AC2: Indicates a low voltage on power input AC2.
Power DC V1: Indicates a low voltage on power input DC V_1.
Power DC V2: Indicates a low voltage on power input DC V_2.
Power DC V3: Indicates a low voltage on power input DC V_3.
Power DC V4: Indicates a low voltage on power input DC V_4.

N-Ring™ Manager Fault Descriptions

The faults listed below appear when the switch is configured as an N-Ring manager.

N-Ring Broken: Indicates that an N-Ring connection is completely broken.
N-Ring Partial Break (High): Indicates that an N-Ring connection is only broken in the direction of the higher port.
N-Ring Partial Break (Low): Indicates than an N-Ring connection is only broken in the direction of the lower port.
N-Ring Multiple Managers: Indicates that more than one N-Ring Manager exists on an N-Ring.

Miscellaneous Fault Descriptions

N-Link Fault: Indicates a problem with the N-Link configuration.
Port Usage Fault: Indicates that the port usage, for one or more ports, is below the Usage Alarm Low setting, or above the Usage Alarm High setting (see Port Configuration View and Port Utilization View).
Temperature: Indicates that the temperature of the switch is outside of the configured limits.
Configuration Device: Indicates that the configuration on an installed configuration device is invalid.
Configuration: Indicates that a setting misconfiguration needs to be resolved.

File Transfer

File Transfer gives the administrator the ability to import files to the switch or export files from the switch.

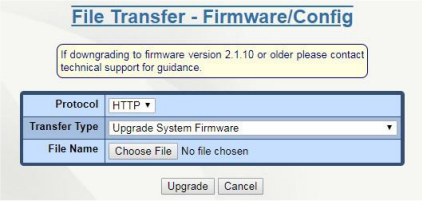
Note: Do not cycle power on the switch or interrupt the data connection between the PC and the switch while a file is being transferred.

Protocol: Select whether HTTP, HTTPS, or TFTP protocol is to be used for transfers.

Transfer Type: The different types of transfer that can be used are listed in the drop-down list. The options are: Upgrade System Firmware, Upgrade BootLoader Firmware, Import Configuration to Switch, Import Port Security Authorization List to Switch, Import License to Switch, Export Saved Configuration from Switch, Export Saved Port Security Authorization List from Switch, and Export Event Log from Switch.

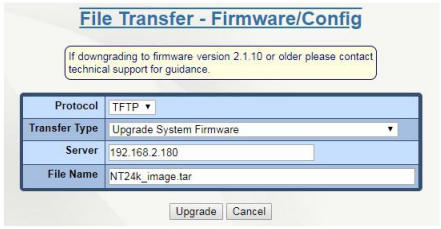
Upgrade System Firmware: Select this option to install the system firmware to the switch.

HTTP/HTTPS Protocol



File Name: Click on the *Browse* button to browse to the desired location and select an image file (typically called NT24k_image.tar). File names are limited to a maximum length of 63 characters.

TFTP Protocol



Server: This field displays the IP address of the TFTP server. It is automatically populated with the IP address of the PC which is connected to the switch.
File Name: This field displays the name of the file to be imported (typically NT24k_image.tar). File names are limited to a maximum length of 63 characters.

Click on the *Upgrade* button to upgrade the system.

Note: After successfully transferring new firmware to the switch, the switch must be rebooted.

WARNING: Due to security enhancements, downgrading the system firmware to 2.1.10 or older will reset all passwords to “password” (users and administrators). The Administrator should immediately change each user’s password and notify the user.

Upgrade BootLoader Firmware: Select this option to install the bootloader firmware.

HTTP/HTTPS Protocol

File Name: Click on the Browse button to browse to the desired location and select an image file (typically NT24k_bootloader.tar). File names are limited to a maximum length of 63 characters.

TFTP Protocol

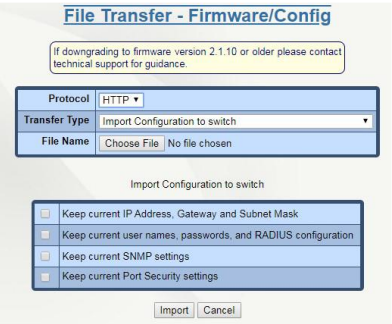
Server: This field displays the IP address of the TFTP server.
File Name: This field displays the name of the file to be imported (typically NT24k_bootloader.tar). File names are limited to a maximum length of 63 characters.

Click on the *Upgrade* button to upgrade the system.

Note: After successfully transferring new firmware to the switch, the switch must be rebooted.

Import Configuration to Switch: Select this option to change the switch configuration by importing a configuration file.

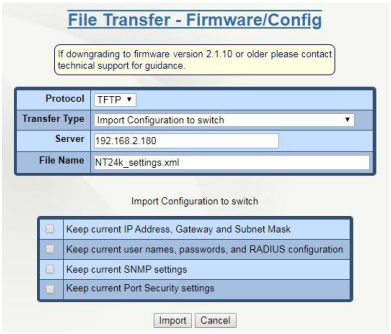
HTTP/HTTPS Protocol



File Name: Click on the Browse button to browse to the desired location and select a configuration file (typically NT24k_settings.xml). File names are limited to a maximum length of 63 characters.

Import Configuration to switch: Select which configuration settings to keep when the new configuration file is imported by checking on the relevant checkbox.

TFTP Protocol



Server: This field displays the IP address of the TFTP server.

File Name: This field displays the name of the file to be imported (typically NT24k_settings.xml). File names are limited to a maximum length of 63 characters.

Import Configuration to switch: Select which configuration settings to keep when the new configuration file is imported by checking on the relevant checkbox.

Click on the *Import* button to upgrade the system.

Note: Find out more on working with Configuration Files in **Appendix B Working with Configuration Files.**

Import Port Security Authorization List to Switch: Select this option to change the Port Security Authorization List by importing a configuration file.

HTTP/HTTPS Protocol

File Name: Click on the Choose File button to browse to the desired location and select a configuration file (typically NT24k_portsecurity.auth). File names are limited to a maximum length of 63 characters.

Import Port Security Authorization List to switch: Select which configuration settings to keep when the new configuration file is imported by checking on the relevant checkbox.

TFTP Protocol

Server: This field displays the IP address of the TFTP server.

File Name: This field displays the name of the file to be imported (typically NT24k_portsecurity.auth). File names are limited to a maximum length of 63 characters.

Import Port Security Authorization List to switch: Select which configuration settings to keep when the new configuration file is imported by checking on the relevant checkbox.

Click on the *Import* button to upgrade the system.

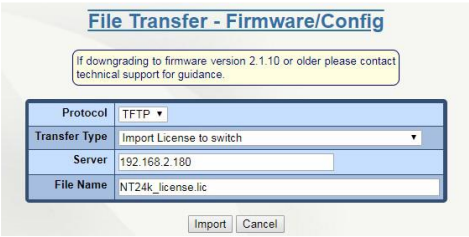
Note: Find out more on working with Configuration Files in **Appendix B Working with Configuration Files.**

Import License to Switch: Select this option to install a license to the switch by importing a license file.

HTTP/HTTPS Protocol

File Name: Click on the Browse button to browse to the desired location and select a license file (typically NT24k_license.lic). File names are limited to a maximum length of 63 characters.

TFTP Protocol



Server: This field displays the IP address of the TFTP server.

File Name: Click on the Browse button to browse to the desired location and select a license file (typically NT24k_license.lic). File names are limited to a maximum length of 63 characters.

Click on the *Import* button to import the license.

*The same file transfer dialog box is used for both HTTP and HTTPS.

Import Security Certificate to Switch:

HTTP/HTTPS Protocol

Certificate File Name: Click on the Choose File button to browse to the desired location and select a certificate file (typically cert.pem). File names are limited to a maximum length of 63 characters.

Key File Name: Click on the Choose File button to browse to the desired location and select a key file (typically key.pem). File names are limited to a maximum length of 63 characters.

TFTP Protocol

Server: This field displays the IP address of the TFTP server.

Certificate File Name: This field displays the name of the file to be imported (typically cert.pem). File names are limited to a maximum length of 63 characters.

Key File Name: This field displays the name of the file to be imported (typically key.pem). File names are limited to a maximum length of 63 characters.

Click on the *Import* button to import the Security Certificate.
*The same file transfer dialog box is used for both HTTP and HTTPS.

Note: After successfully transferring a new Security Certificate to the switch, the switch must be rebooted.

Export Saved Configuration from Switch: Select Export Saved Configuration from switch in the Transfer Type field.

HTTP/HTTPS Protocol

Click on the *Configuration Settings* link to export the settings to your computer. This option allows administrators to back up their configurations to an offsite server in case a custom configuration must be reloaded at a later time.

A download dialog pop-up will appear, prompting the user to open or save the configuration file. The file is called *NT24k_settings.xml* per default.

TFTP Protocol

Server: This field displays the IP address of the TFTP server.

File Name: This field displays the name of the file to be exported (typically NT24k_settings.xml). File names are limited to 63 characters maximum.

Click on the *Export* button to export the settings to the specified TFTP server.

Export Saved Port Security Authorization List from Switch: Select Export Saved Port Security Authorization List from switch in the Transfer Type field.

HTTP/HTTPS Protocol

Click on the *Port Security Authorization List* link to export the authorization list to your computer. This option allows administrators to back up their Port Security Authorization List.

A download dialog pop-up will appear, prompting the user to open or save the authorization file. The file is called *NT24k_portsecurity.auth* per default.

TFTP Protocol

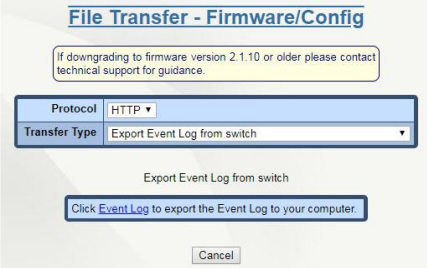
Server: This field displays the IP address of the TFTP server.

File Name: This field displays the name of the file to be exported (typically NT24k_portsecurity.auth). File names are limited to 63 characters maximum.

Click on the *Export* button to export the configuration file to the specified TFTP server.

Export Event Log from switch: The entire Event Log may be exported to the host PC for further analysis and archiving purposes. The log file lists all events that occurred while event logging was enabled and since the last Clear Log event was performed.

HTTP/HTTPS Protocol



Click on the *Event Log* link to export the log file to your computer. A download dialog pop-up will appear, prompting the user to open or save the configuration file.

TFTP Protocol

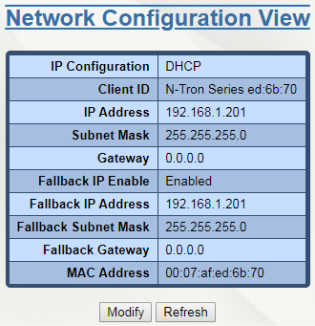
Server: This field displays the IP address of the TFTP server.

File Name: This field displays the name of the file to be imported (typically eventlog.csv). File names are limited to a maximum length of 63 characters.

Click on the *Export* button to export the log file to the specified TFTP server.

Network

Setting the IP Configuration to DHCP will use the Primary Management VLAN ports to receive an IP address from the DHCP Server. Changes to the Primary Management VLAN are made in the VLAN section. If no changes are made, the default VLAN will be used as the default Primary Management VLAN.



IP Configuration: Determines the method used to obtain an IP address, Subnet Mask, and Gateway address. When Static is selected, the statically configured values are used. When DHCP is selected, DHCP protocols are used to obtain these values.

Client ID: This option is used by DHCP clients to specify their unique identifier. DHCP servers use this value to index their database of address bindings. This value is expected to be unique for all clients in an administrative domain. The identifier may be the MAC address, switch name, or entered as a text string or hex characters. (Only shown in DHCP Mode) The DHCP option 61 client identifier will be sent with a preceding type-byte as listed below:

MAC Address = 0x01
Switch Name = 0x00 (Default)
Other String = 0x00
Other HEX = 0x00

IP Address: Contains the current IP Address of the device.

Subnet Mask: Contains the current Subnet Mask of the device.

Gateway: Contains the current Gateway of the device.

Fallback IP Enable: Enables/disables the use of the Fallback IP address.

Fallback IP Address: Contains the configured Fallback IP address of the device. This address will be used if the switch fails to obtain a DHCP address from the DHCP Server. This option is only shown in DHCP Mode and if Fallback IP is enabled.

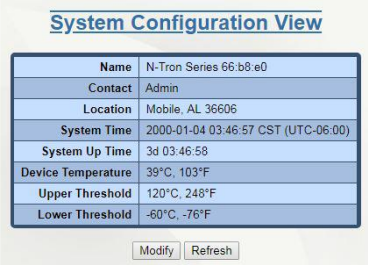
Fallback Subnet Mask: Contains the configured Fallback Subnet Mask of the device. This option is only shown in DHCP Mode and if Fallback IP is enabled.

Fallback Gateway: Contains the configured Fallback Gateway of the device. This option is only shown in DHCP Mode and if Fallback IP is enabled.

MAC Address: MAC Address of the device.

To modify any of the fields, click on Modify. Enter the desired system settings and click on the *Update* button.

System



The System page presents the user with current system information.

Name: Contains the name assigned to the device, which allows alphanumeric and special characters (,#_-:) only. When IP Configuration is DHCP, then this may be used as the Client ID (Option 61) of the DHCP Request.

Contact: The person to contact for system issues, which should be someone within your organization. Only alphanumeric and special characters (,#_-) are allowed.

Location: The physical location of the switch. Only alphanumeric and special characters (,#_-) are allowed.

System Time: Displays the date/time of the system. The system date/time defaults to 2000-01-01 00:00:00 CST (UTC-06:00) at system start.

System Up Time: Parameter represents the total time elapsed since the switch was turned on or rebooted.

Device Temperature: The device temperature reported by the on-board digital temperature sensor. This option is only shown on devices with temperature sensors.

Upper Threshold: The highest temperature for the switch without causing a fault to occur. The threshold is specified as an integer in degrees Celsius. The range is from -60 °C to 120 °C, and the default is product dependent. This option is only shown on devices with temperature sensors.

Lower Threshold: The lowest temperature for the switch without causing a fault to occur. The threshold is specified as an integer in Celsius degrees. The range is from -60 °C to 120 °C, and the default is product dependent. This option is only shown on devices with temperature sensors.

Power DC V1: The voltage measurement on power input DC V1. This option is only shown on devices with a voltage sensor.

Power DC V2: The voltage measurement on power input DC V2. This option is only shown on devices with a voltage sensor.

Total Current: The total input current measurement in Amps. This option is only shown on devices with a current sensor.

Total Power: The calculated power in Watts obtained from voltage and current measurements. This option is only shown on devices with a voltage and current sensor.

To make modifications to the fields above, click on the Modify button. Enter the desired settings and click on the *Update* button.

Bridging

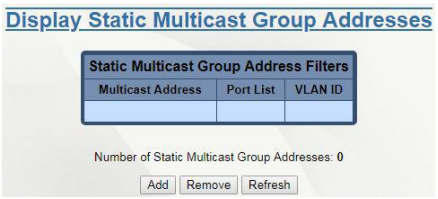
Aging Time

The Aging menu item under the Bridging category displays the currently configured Aging Time. This configurable field shows the desired aging time for dynamically learned MAC addresses. Inactive MAC addresses will be removed from the Hardware Address Entry Table after the aging time period has expired. The internal aging time period will be between 1 and 2 times the selected aging time value.

To modify the Aging Time field, click on the Modify button. Enter the desired Aging Time (value must be between 10 - 630 seconds) and click on the *Update* button. The default value for this field is 300 seconds. To save the changes made, return to the Configuration menu and click on the *Save* button.

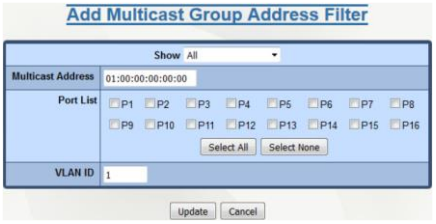
Multicast Addresses

The Multicast Addresses page displays a list of Multicast Group Addresses that are associated with respective port numbers.



Adding a Multicast Group Address

To add a Multicast Address, click on the Add button and the following dialog window will appear:



Enter a valid Multicast Group Address and VLAN ID, then select the port(s) to which matching packets will be directed.

Click on the *Update* button to return to the Display Static Multicast Group Addresses page.

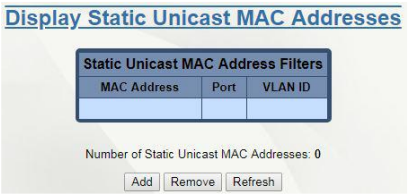
To save the changes go to the Configuration menu and click on the *Save* button.

Removing a Multicast Group Address

To remove a Multicast Address, click on the *Remove* button. A listing of available Multicast Group Addresses will appear. Click on the *Delete* button to remove an address.

Unicast Addresses

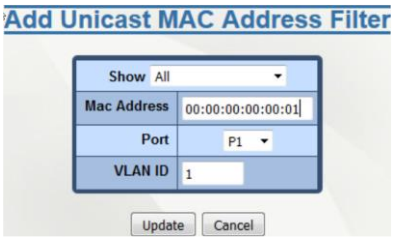
The Unicast Addresses dialog window displays a list of MAC addresses that are associated with each respective port number. This can be used to statically assign a MAC address access to a single port on the switch.



Adding a Unicast Address

To add a Unicast Address, click on the Add button and the following dialog window will appear:

Enter a valid MAC address and VLAN ID, then select the port to which matching packets will be directed.



Click on the Update button to add the unicast address and return to the Display Static Unicast MAC Addresses dialog window.

To save the changes go to the Configuration menu and click on the *Save* button.

Removing a Unicast MAC Address

To remove a Unicast Address, click on the *Remove* button and a dialog window with a listing of available Unicast MAC Addresses will appear. Click on the *Delete* button to remove the MAC Address and return to the *Display Static Unicast MAC Addresses* dialog window.

CIP™

EtherNet/IP™, better known as the Common Industrial Protocol (CIP), was designed for use in process control and industrial automation applications. CIP was designed to provide consistent device access to eliminate the need for vendor specific software for configuration and monitoring of their devices.

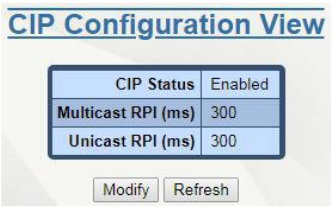
N-Tron® switches with CIP support can be used to communicate with other industrial devices.

Note: Information about using CIP with the NT24k® can be found in the CIP User Manual & Installation Guide and the CIP Installation Kit for the NT24k switch family. This manual can be found on the Red Lion website.

Configuration

The CIP Configuration View dialog window displays the CIP status as well as the Multicast and Unicast RPIs (Requested Packet Interval).

Click on the *Modify* button to make changes to the CIP Configuration:



CIP Status: This field determines whether CIP is enabled or disabled on the NT24k switch. The default setting is Enabled.

Multicast RPI: The minimum Requested Packet Interval for Class 1 (multicast) connections in milliseconds is shown in this field. Requests for less than this value will be rejected. The default value for this option is 300 ms. The available range is 300 - 300,000.

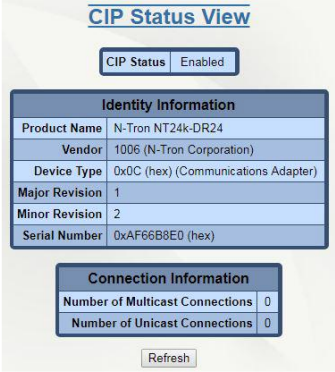
Unicast RPI: This field shows the minimum Request Packet Interval for Class 3 (unicast) connections in milliseconds. Requests for less than this value will be rejected. The default value for this field is 300ms. The available range is 300 - 300,000.

Click on the *Update* button once the desired information is entered and to return to the *CIP Configuration View* dialog window. To save the changes made, return to the Configuration menu and click on the *Save* button.

Status

The Status menu item displays the CIP status. The switch status and partner status information will be shown.

Example CIP™ Status View showing a Connection Summary table with one Multicast connection:



Identity Information

Product Name: This field displays the Switch Model Number.

Vendor: This field shows N-Tron®'s ODVA Ethernet/IP™ Vendor ID (1006).

Device Type: This field displays that the ODVA device type is Communications Adapter (0x0C hex).

Major Revision: This field displays the major revision of the CIP implementation.

Minor Revision: This field shows the minor revision of the CIP implementation.

Serial Number (hex): This field shows the CIP serial number, which is unique across all N-Tron CIP devices. The number shown is the last 4 octets of the base switch MAC address.

Connection Information

Number of Multicast Connections: This field shows the current number of CIP Ethernet/IP class 1 (multicast) connections.

Number of Unicast Connections: This field displays the current number of CIP Ethernet/IP class 3 (unicast) connections.

Connection Summary

Transport Class: This field displays the Transport class for the connection, such as class 1 (multicast) or class 3 (unicast).

Connection State: This field indicates the state of the connection (established, timed out, closing or configuring).

RPI: The field displays the Requested Packet Interval in milliseconds.

Config Assembly: This field shows the configuration assembly number.

Output Assembly: This field displays the Output assembly number (the assembly that is sent out from the switch).

Input Assembly: This field displays the input assembly number (the assembly that is received into the switch).

Peer Address: This field shows the peer IP address of the device connected to the switch.

EIP Indicators

The module status indicator shows the current status of the switch. The network status indicator shows the status of the EtherNet/IP™ network interface. These indicators are located on the back of the rack mount version of the switch or on the front of the CPU module on the DIN-Rail versions of the switch.

Module Status

INDICATOR STATE	SUMMARY	DESCRIPTION
Steady Off	No power	The switch is not powered up.
Steady Green	Device operational	The switch is operating normally.
Flashing Green	Standby	The switch has not been configured for CIP™ operations.
Flashing Red	Minor fault	A recoverable minor fault has occurred.
Steady Red	Major fault	A non-recoverable major fault has occurred.

Network Status

INDICATOR STATE	SUMMARY	DESCRIPTION
Steady Off	Not powered, no IP address	The switch is not powered up, or an IP address has not been configured.
Flashing Green	No connections	An IP address is configured, but no connections have been established.
Steady Green	Connected	A connection has been established
Flashing Red	Connection timeout	A connection has timed out.

DHCP Client Configuration

The switch will automatically obtain an IP assignment from a DHCP server, or optionally Fallback to a configured IP assignment if unable to get an IP assignment from a DHCP server. Communication between the client and server can optionally go through a DHCP Relay Agent.

DHCP Client is enabled by default, with 192.168.1.201 as the factory fallback address.

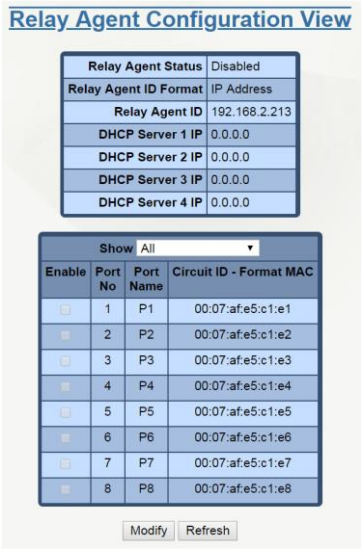
Refer to Network for enabling DHCP Client mode.

DHCP Relay Agent Configuration

A relay agent, configured via the Relay Agent Configuration View, provides a way for DHCP client requests to reach DHCP servers, including those that reside on a different subnet and/or VLAN.

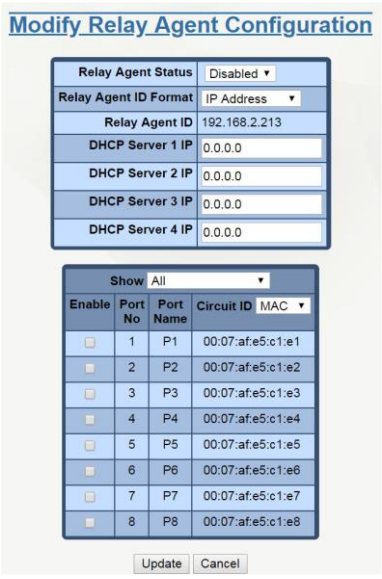
Note: DHCP traffic is sent and received only on Management VLANs.

View Page



Click on the *Modify* button to open the DHCP Server Configuration Modification page.

Modify Page



Click on the *Update* button to apply the changes.

Relay Agent Status: Indicates whether the DHCP relay agent is active. The default is Disabled.

Relay Agent ID Format: The format selector with options for IP address, MAC address, Client ID, Other String, or Other Hex characters.

Relay Agent ID: A unique identifier that designates this relay agent switch.

DHCP Server 1-4 IP: The configured IP address of the DHCP servers.

Enable: Indicates whether relay agent functionality is enabled for the port.

Port No: The number of the port. This field is read-only.

Port Name: The descriptive name of the port. This field is read-only.

Circuit ID: When enabled, the Circuit ID for the port can be specified. By default, the Circuit ID is set to the MAC Address of the port. Circuit IDs must be unique for each port.

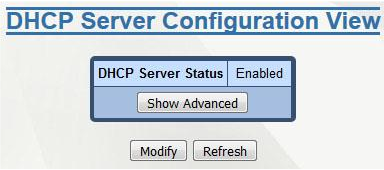
Circuit ID Format: The format selector with options for MAC, Hex, and String.

DHCP Server Configuration

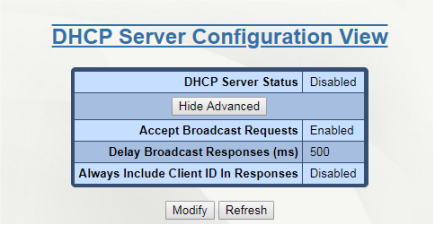
The DHCP Server provides IP addresses to DHCP clients on the same subnet or VLAN. DHCP traffic is sent and received only on Management LANs.

Note: A DHCP Relay Agent is required, to provide an IP address to clients on a different subnet or VLAN.

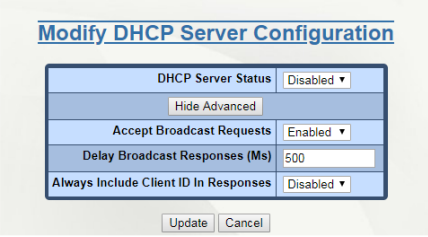
The following screen shows the Advanced configuration hidden:



The following screen shows the Advanced configuration unhidden:



Click on the *Modify* button to open the DHCP Server Configuration Modification page.
Click on the *Update* button to apply the changes.



DHCP Server Status: Indicates whether the DHCP server is active. The default is Disabled.

Show/Hide Advanced: Button used to toggle whether or not to show advanced settings.

Accept Broadcast Requests: Indicates whether the DHCP server will process broadcast messages. Typically, client requests are broadcast and relay agent requests are unicast. When enabled, the server will respond to broadcast requests. When disabled, the server will ignore broadcast requests. The default is Enabled.

Delay Broadcast Responses (Ms): The amount of time (in milliseconds) that the DHCP server will delay the processing of a broadcast message. This setting is used when clients and relay agents are on the same subnet and/or VLAN. A delay provides the opportunity for relay agent requests to be honored before client requests. This setting only applies when Allow Broadcast is Enabled. The range is 0-2500 and the default is 500.

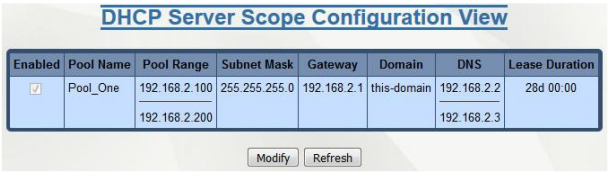
Always Include Client ID In Responses: Indicates whether the DHCP Server will always respond to the client with the Client ID in the frame. This should be disabled for a network that is non-compliant to the RFC- 6842(2013). The default is Disabled.

DHCP Server Scope Configuration

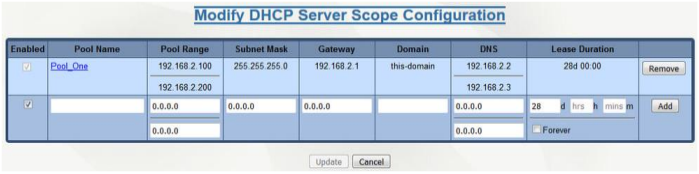
Scope Configuration Pools

The DHCP Server Scope Configuration contains vital network configuration options, called scope configuration pools, for potential clients. At least one scope configuration pool is necessary to create static assignments.

View Page



Modify Page



On the Modify page, the last column contains various buttons. The *Remove* button removes the corresponding scope configuration pool along with all static assignment and bindings associated with the pool. The *Add* button is used to add a new scope configuration pool.

Click on the *Add* button to add the new scope.
Click on the *Remove* button to remove an existing or new scope.
Click on the *Update* button to apply the changes.

Enabled: Indicates whether the pool is enabled or disabled.

Pool Name: Descriptive name of the scope configuration pool. This field is required and must be unique.

Pool Range: Starting and ending IP addresses for the pool of addresses.

Subnet Mask: The subnet mask for the IP address pool.

Gateway: The gateway IP address offered to the client. This field is optional.

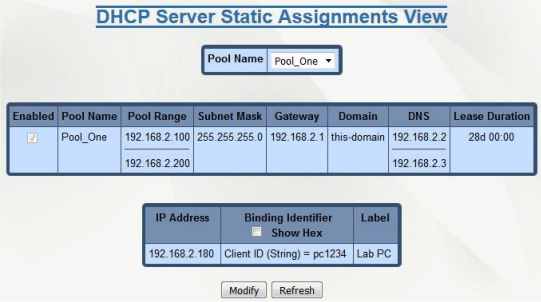
Domain: The domain name offered to the client. This field is optional.

DNS: The DNS server IP addresses offered to the client. These fields are optional.

Lease Duration: The lease time (in days, hours and minutes) offered to the client. The range is 1 minute to 1000 days. The default is 28 days. If the Forever checkbox is checked, the lease does not expire.

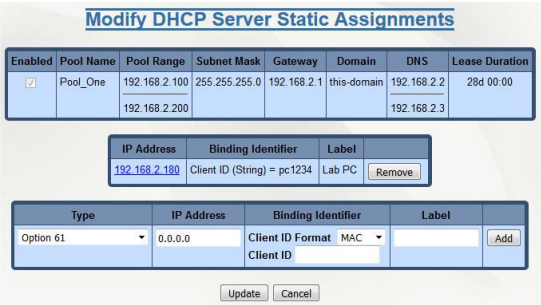
DHCP Server Static Assignments

View Page



Select the Pool Name drop-down list to filter on a specified pool.
Click on the *Modify* button to open the Modify DHCP Server Static Assignments page.

Modify Page



Click on the IP address hyperlink to modify the corresponding static assignment.
Click on the *Add* button to add the new static assignment.
Click on the *Remove* button to remove an existing or new static assignment.
Click on the *Update* button to apply the changes.

Enabled: Indicates whether the pool is enabled or disabled. This field is read-only.

Pool Name: Descriptive name of the scope configuration pool. This field is read-only.

Pool Range: Starting and ending IP addresses of a pool of addresses. This field is read-only.

Subnet Mask: The subnet mask offered to the client. This field is read-only.

Gateway: The gateway IP address offered to the client. This field is read-only.

Domain: The domain name offered to the client. This field is read-only.

DNS: The DNS server IP addresses offered to the client. This field is read-only.

Lease Duration: The lease time (in days, hours and minutes) that will be offered to a client. This field is read-only.

Type: The type of binding identifier for the static assignment. The options are Option 61 and Relay Agent (Option 82).

IP Address: The static IP address offered to the DHCP client.

Binding Identifier: The binding identifier of the static IP address assignment. For Option 61, the binding identifier requires a Client ID, the identifier of the desired client. The identifier formats are MAC, HEX, and String. A type-byte is assumed to precede the identifier and does not have to be entered here. The type-byte value is assumed to be as follows:

MAC = 0x01
String = 0x00
HEX = 0x00

For Option 82, the binding identifier requires a Remote Agent ID and Circuit ID. These identifiers must match the relay agent's Remote ID and Circuit ID. The identifier formats are IP (for a Remote ID), MAC, Hex, and String.

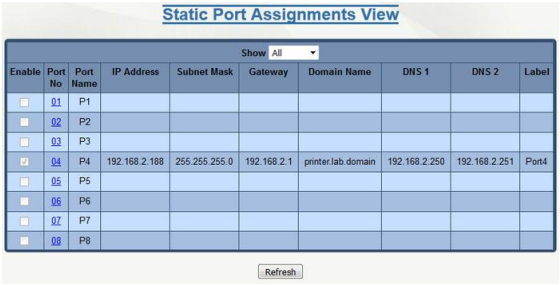
Label: The descriptive name of the static assignment. The field is optional.

DHCP Static Port Assignments

When a static port assignment is enabled on the port, the port will act as a DHCP server and provide a static IP address to the client connected to the port.

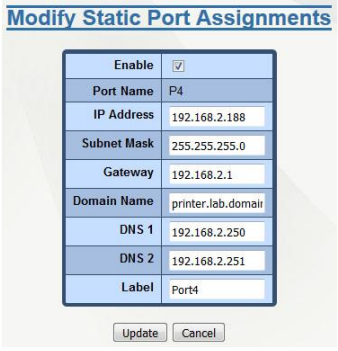
Note: Only one DHCP client can be connected per port.

View Page



Select the Show drop-down list to show only enabled ports or all ports. Click on the port number hyperlink to modify the port's static port assignment.

Modify Page



Click on the *Update* button to apply the changes.

Enable: Indicates whether Static Port Assignment is enabled on the port.

Port No: The number of the port.

Port Name: The descriptive name of the port. This field is read-only.

IP Address: The IP address offer to the DHCP client connected to the port.

Subnet Mask: The subnet mask offer to the DHCP client connected to the port.

Gateway: The gateway offer to the DHCP client connected to the port.

Domain Name: The domain name offer to the DHCP client connected to the port. The field is optional.

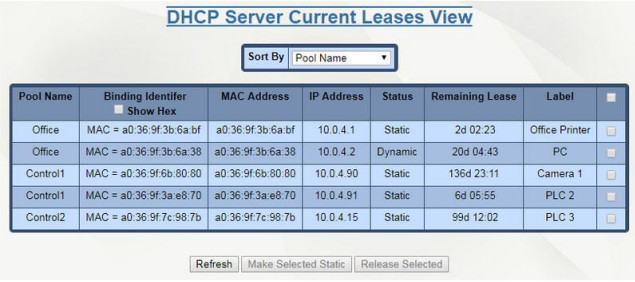
DNS 1: The primary DNS offer to the DHCP client connected to the port. The field is optional.

DNS 2: The secondary DNS offer to the DHCP client connected to the port. The field is optional.

Label: The descriptive name of the DHCP client connected to the port. The field is optional.

DHCP Server Current Leases

The Current Leases table shows the IP addresses that have been leased, or offered, to devices.



Sort By: Sort the current leases by Pool Name, Binding Identifier, MAC Address, IP Address, Status, Remaining Lease, or Label.

Pool Name: The pool from which the lease was obtained.

Binding Identifier: The client associated with the lease entry. If Show Hex checkbox is checked, then detailed hex data about the Binding Identifier is displayed.

MAC Address: Indicates the MAC address of the client associated with the lease.

IP Address: Indicates the IP address assigned to the lease entry.

Status: Indicates the current status of the lease entry.

- Dynamic = Assigned dynamic IP.
- Static = Assigned static IP.

Remaining Lease: The client's remaining lease time.

Label: The descriptive name of the client.

Check Box: Click the individual checkbox to either make the clients static or release its lease.

Note: Only clients with a dynamic lease can be made static.

Make Selected Static: Make the selected client dynamic IP address static.

Release Selected: Release selected client lease.

Event Notification

Event Notification is a combination of features that deal with filtering and routing system and fault events to different destinations.

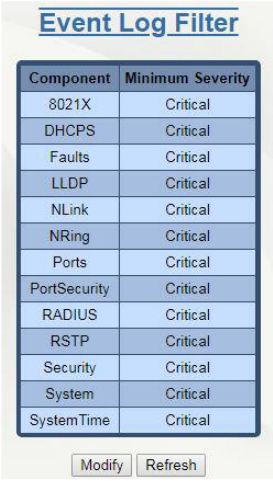
Event Log Filter

The Event Log Filter allows the user to define which events will be logged based on the severity level of the event.

Note: The event log is enabled by default for critical events.

Event Log Filter View

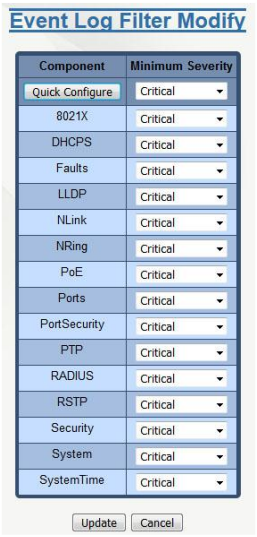
The Event Log Filter page displays the current minimum severity settings for each component. Events below the minimum severity level will not be logged.



Click on the Modify button to make changes to the Event Log Filter.

Event Log Filter Modify

The Event Log Filter configuration can be changed by clicking on the Modify button.



Quick Configure: Use Quick Configure to change all components to the same severity level.

Component: The feature, protocol, or system service of the switch that generates events. The component list is model dependent.

Minimum Severity: Events below the minimum severity level will not be logged. A severity of None will disable events for that component. For more information, see Severity under the section Event Log.

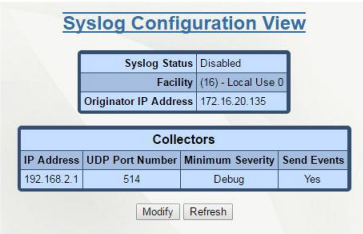
Syslog

The Syslog feature allows certain system events (see Event Log) to be sent as messages to remote hosts for monitoring and analysis.

The messages can be sent to up to 5 different remote hosts, known as Syslog Collectors. A minimum severity level is associated with each Syslog Collector. Events below the minimum severity level will not be sent out from the switch. Syslog is disabled by default and can be enabled through the Web Browser interface.

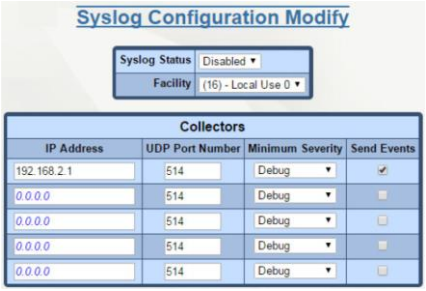
Syslog Configuration View

The Syslog Configuration View is accessible under Event Notification within the Advanced section. Below is an example of the current configuration status of Syslog, the configuration of each Syslog Collector, and a list of the Syslog Collectors.



Syslog Configuration Modify

The Syslog configuration may be changed by an admin level user by clicking on the Modify button. In this section the settings of each Syslog Collector can be updated and the Syslog Distributor itself can be disabled or enabled.



Syslog Status: This field indicates whether the Syslog Distributor (client) has been enabled or disabled. To enable Syslog at least one Syslog Collector (server) must be specified.

Facility: This is used to identify which process is logging the message. This is a global setting for the switch and will be used for all messages. Available Facility values as defined per RFC-5424 are 1 (user level) and 16 - 23 (local use).

Originator IP Address: The field displays the configured IP address of the switch.

Collector: The Syslog server to which the messages are sent.

IP Address: The IP address of the Collector (server) to receive a log message.

UDP Port Number: The UDP port on the Collector (server) to receive the message. The default port number is 514, per RFC-5424, but can be changed to meet installation requirements. Allowed port numbers are 1 - 65535.

Minimum Severity: The minimum Severity level of the messages that will be sent to the specified Collector (server). Values range from Debug (7) to Emergency (0). For example, a Collector configured with a value of Warning (4) will receive all messages from 4 to 0. The importance of a message increases with a lower severity level setting value. These are the same Severity level setting values as the Event Log and Event Log Filter. For more information, see Severity under the section Event Log.

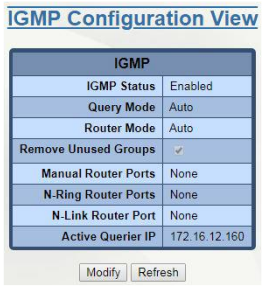
Send Events: This setting can be enabled or disabled, per Collector, to control the distribution of Event Log messages.

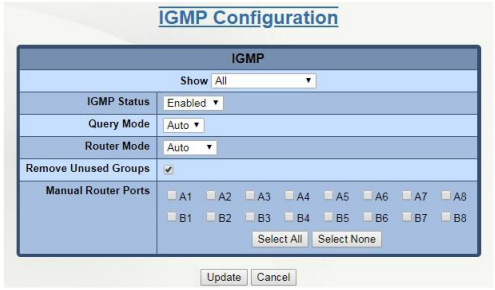
IGMP

Configuration

The Configuration dialog window displays the IGMP basic configuration settings. If an active N-Ring™ participant, the ring ports are informatively shown as N-Ring router ports. On an N-Link Master, Slave or Coupler switch, the coupler port is shown as an N-Link router port.

Note: Bypass Relay models affect the implementation of this protocol. For more information, see the section Bypass Relay (BR).





IGMP Status: This field indicates whether the IGMP is enabled or disabled. The default value for this field is *Enabled*.

Query Mode: The default value for this option is Auto. Available options are:

Auto: Multiple switches will ensure that only one switch is the active querier.
On: This switch is always an active querier.
Off: This switch never queries.

Router Mode: The available options for this field are:

Auto: This option allows for dynamically detected and manually set router ports. This is the default value.
None: This option allows for no router ports.
Manual: This option allows for manually set router ports.

Remove Unused Groups: If this option is checked, unused IGMP Groups will be removed and traffic with those multicast addresses will be treated as normal multicast. If this option is unchecked, unused IGMP Groups will remain and traffic with those multicast addresses will be limited. The default value for this field is checked.

Note: IGMP Groups are not retained through a power cycle.

Manual Router Ports: Manually specify the used ports.

N-Ring™ Router Ports: This field displays the N-Ring ports designated as active IGMP Router ports.

N-Link Router Port: This field indicates the N-Link ports that have been designated as active IGMP Router ports.

Active Querier IP: This field shows the IP address of the Active Querier.

Click on the *Modify* button to make changes to the IGMP Status, Query Mode, Router Mode and Manual Router Ports.

Groups

The Groups dialog window displays a list of IGMP groups based on the Group IP and the port that it is associated with.

Total Number of Active IP Group Memberships: The total number of active group IP memberships based on the dotted quad view (aaa.bbb.ccc.ddd) counting each joined port are displayed here.

Group IP: This field shows the dynamically created multicast group IP address.

Port Name: The descriptive name of the port is shown here.

VLAN ID: This field indicates the VLAN in which the Group IP is assigned. The available range is 1-4094.

RFilter Ports

From the RFilter (Router Multicast Data Filter) option, the user can choose whether or not data frames with known group multicast addresses are sent to the router ports. Control packets will be sent to the router(s) regardless of this setting.

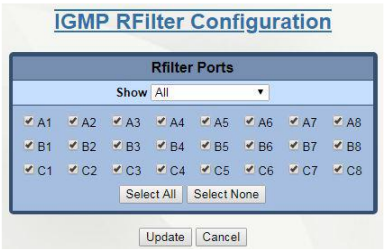
Known group multicast addresses are learned from dynamic IGMP Snooping operations. If IGMP is enabled and a port is a router port, then having RFilter enabled will stop IGMP group data from egressing on the port unless a join to that specific IGMP group has come into the port. IGMP controls (Join, Leave, Query) are still sent.

The Router Multicast Data Filter is enabled for all ports by default. Router ports do not get data frames with known multicast destination addresses unless a join for that specific multicast address has been received on that port. Join overrides an RFilter.

If RFilter is disabled, the router ports get data frames with known multicast destination addresses.

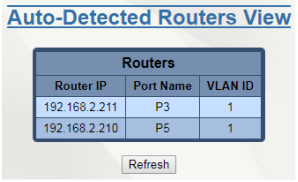
RFilter can be set for individual ports: any, all or none. For each port, RFilter will have an impact only if that port is manually or dynamically chosen as a router port.

Click on the *Modify* button to make changes to the IGMP RFilter Configuration. The following dialog window will appear:



From this dialog window, the administrator selects which ports to identify as RFilter ports and can view all possible ports (Modules), currently installed ports or currently linked up ports. Click on the *Update* button when done with required changes. To save the changes made, return to the Configuration menu and click on the *Save* button.

Routers



The Routers dialog window displays a list of the following:

Router IP: Auto-detected router IP address.

Port Name: The descriptive name of the port.

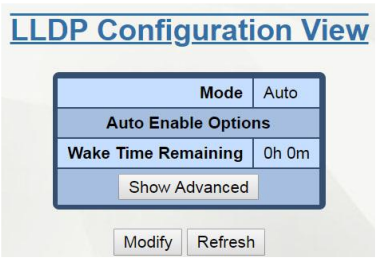
VLAN ID: VLAN in which the Router IP is assigned. The range is 1 - 4094.

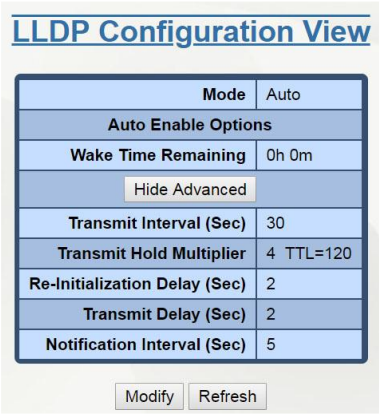
LLDP

LLDP Configuration

The LLDP Configuration Page can be used to view or configure LLDP operation on the switch. The default mode for LLDP is Auto. Other configurable options are revealed by clicking on the "Show Advanced" button.

To enable LLDP on all switches that are in Auto mode, set the mode to Auto, set the Wake Time to a non-zero time, and click the "Send" button.





Mode: The LLDP mode can be Enabled, Disabled, or Auto. In Auto mode, LLDP is inactive until a switch sends a wake-up packet. The default is Auto.

Wake Time: The length of time LLDP will be active on switches that are in Auto mode. A value of 0 hours and 0 minutes will deactivate LLDP. Modify this value and click the "Send" button to set the wake time on all switches that are in Auto mode. The default is 0 hours and 0 minutes.

Show/Hide Advanced: Button used to toggle whether or not to show advanced settings.

Transmit Interval (Sec): The interval at which periodic LLDP frames are transmitted. The default is 30 seconds.

Transmit Hold Multiplier: A multiplier on the Transmit Interval when calculating a Time-to-Live value. The default is 4.

Re-Initialization Delay (Sec): The minimum time an LLDP port will wait before re-initializing after its setting has changed from disabled to Tx-Only or Tx/Rx. This prevents excessive notifications when LLDP Port settings are changed. The default is 2 seconds.

Transmit Delay (Sec): When LLDP information is changing on the switch, the time to wait before sending an LLDP frame with the updated information. The default is 2 seconds.

Notification Interval (Sec): The interval between notifications sent by the switch. If a port sends out a notification and another port tries to send out a notification, then the subsequent notification will not be sent until the interval expires. The default is 5 seconds.

LLDP Ports Configuration

The LLDP Ports Configuration Page displays and configures LLDP options for each port.

Show: View the ports that are available to install (Modules) currently installed or currently linked up.

Port No: The number of the port.

Mode: The port mode can be Tx Only, Rx Only, Tx/Rx, or Disabled. This configures whether or not LLDP frames are transmitted or received. The default is Tx/Rx.

Allow Management Data: Allows the transmission of management type information. Example: IP address of the switch. The default is checked.

Allow Notification: Allows an SNMP notification to be transmitted when local or remote data changes. The default is unchecked. Note: SNMP Notification Traps must be enabled under SNMP.

Port Description: Indicates whether or not to send the descriptive name of the port in the transmitted LLDP frame. The default is unchecked.

System Name: Indicates whether or not to send the name assigned to the device on the System page in the transmitted LLDP frame. The default is unchecked.

System Description: Indicates whether or not to send the switch model and current firmware version in the transmitted LLDP frame. The default is unchecked.

System Capabilities: Indicates whether or not to send the primary function(s) of the system in the transmitted LLDP frame. The default is unchecked.

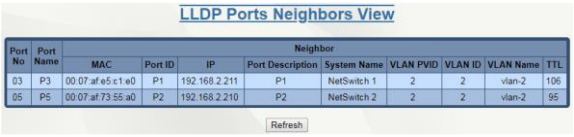
VLAN PVID: Indicates whether or not to send the Port VLAN identifier (PVID) associated with the port in the transmitted LLDP frame. The default is unchecked.

VLAN Name: Indicates whether or not to send the VLAN IDs and Names associated with the port in the trans-mitted LLDP frame. The default is unchecked.

LLDP Ports Neighbors

The LLDP Ports Neighbors shows the results of LLDP discovery. The LLDP Ethernet frames received from neighboring ports are composed of collections of data units called Type Length Value (TLV). Each TLV contains a defined type of information such as the Chassis ID described below, which contains the

MAC address of the device sending the frame. The maximum number of six neighbors can be displayed per each port.



Port No: The port the neighbor information was received from.

MAC: MAC address of neighbor device. Corresponds to the LLDP Chassis ID TLV.

Port ID: Identifier of the neighbor port from which the LLDP frame was sent.

IP: IP address of neighbor device. Corresponds to the LLDP Management Address TLV.

Port Description: Description of the neighbor port from which the LLDP frame was sent.

System Name: The system's administratively assigned name on the neighbor device.

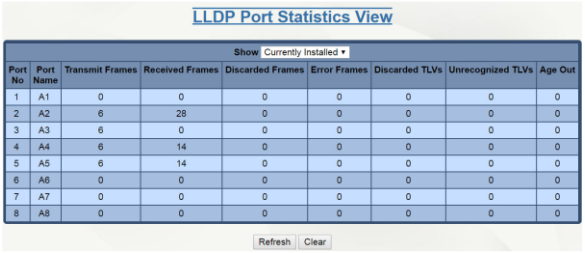
VLAN PVID: The Port VLAN identifier (PVID) associated with the neighbor port.

VLAN ID: A list of all VLAN IDs associated with the neighbor port.

VLAN Name: A list of all VLAN Names associated with the neighbor port.

TTL: Indicates the number of seconds that the information associated with this neighbor will be valid. Time to Live (TTL)

LLDP Port Statistics



Port No: The number of the port.

Port Name: The descriptive name of the port.

Transmit Frames: The total number of LLDP frames transmitted by the local switch.

Received Frames: Total number of LLDP frames received by the local switch.

Discarded Frames: The total number of frames discarded due to incorrect Type Length Values (TLVs) in the frames.

Errors Frames: Total count of all LLDP frames received with one or more errors.

Discarded TLVs: The count of all TLVs discarded for any reason.

Unrecognized TLVs: The count of all TLVs received on the port that are not recognized by LLDP.

Age Out: The count of times that a neighbor's information has been deleted because its Time To Live (TTL) has expired.

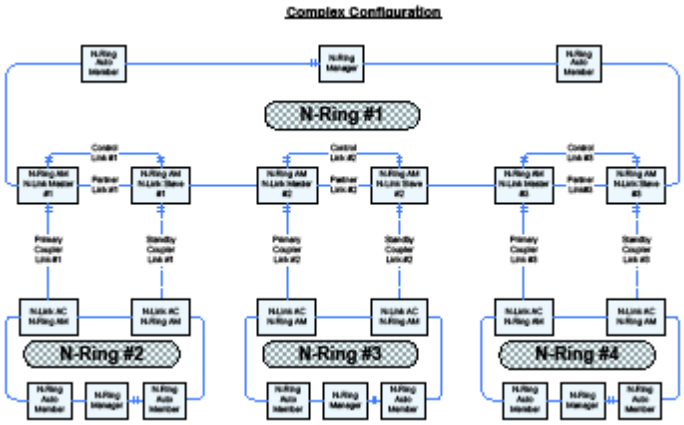
N-Link

N-Link provides a way to couple an N-Ring topology to one or more other topologies, usually other N-Ring topologies. Each N-Link configuration requires 4 switches: N-Link Master, N-Link Slave, N-Link Primary Coupler and N-Link Standby Coupler.

Note: Bypass Relay models affect the implementation of this protocol. For more information, see the section Bypass Relay (BR).

Example of a standard N-Link configuration

Example of a complex N-Link configuration



Configuration steps to redundantly couple 2 N-Ring™ networks:

1. Ensure the Coupler and Control cables are disconnected at this point.
2. Get Both N-Rings working with a status of OK.
3. Configure N-Link Slave: Ensure that the N-Link Slave is set to Auto Configure and select a Default Coupler Port. Save Configuration.
4. Configure N-Link Master: Select the Control and Coupler ports. Save the Configuration.
5. Connect the Control Link cable. Ensure that the Slave switch status now shows a state of “Slave”.
6. Connect the Coupler Link cables.
7. Check N-Link status on the Master by selecting the N-Link Status View page.

Configuration Requirements:

- The Master and Slave must be part of the N-Ring topology.

- If using default configuration choices, the administrator only needs to configure the N-Link Master. The N-Link Slave and both Coupler switches will auto-detect any needed configuration.
- If not using default configuration choices, the administrator may also need to configure the Default Coupler port on the N-Link Slave.
- There must be a direct link between the Master and Slave Control ports. Use of media converters or other switches is not supported.
- There must be a direct link between the Master and Slave Partner ports. Use of media converters or other switches is not supported.
- There must be an N-Link aware switch on each side of the Master.
- N-Link will only support a single point of failure. Multiple points of failure and misconfiguration are not supported and may cause a network storm under some circumstances.
- Control and Partner connections should be either fiber or 10/100Base-TX copper.

  The use of copper SFP transceivers for N-Link control and partner connections is not recommended due to the variances of link performance between SFP manufacturers.

  Per the IEEE 802.3 standard (Clause 40), a 1000Base-T PHY is required to wait 350-750 milliseconds before reporting a link down condition; and is therefore unsuitable for use as an N-Link control or partner connection.
- For optimal performance:

  The speed of the Partner segment must match the speed of the other N-Ring™ segments. Therefore, the Partner connection must be 1 gigabit fiber when the other N-Ring segments have a 1 gigabit speed.

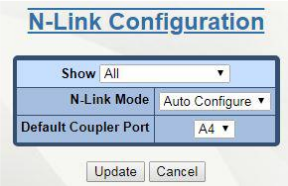
  When using a 700/7000 Series N-Link Slave, the control port should use a fiber connection.

Configuration/Basic

The Basic tab under the N-Link Configuration category will display the basic configuration settings. By default, N-Link is in Auto-Configuration mode and will use A4 as the Default Coupler port.

The port configured as the Default Coupler Port will be used as the Standby Coupler port if the switch detects an N-Link Master and becomes an N-Link Slave.

Click on the *Modify* button to make changes. Click on the *Update* button to retain the changes. To save the changes made, return to the Configuration menu and click on the *Save* button.



Show: View the ports that are available to install (Modules) currently installed or currently linked up.

N-Link Mode: Select the required N-Link mode from the drop-down list. The available options are:

Disabled: N-Link is disabled and will not operate as an N-Link capable switch.
Auto Configure: In this mode, the switch will automatically detect whether it is a slave or a coupler.
Master: If this option is selected, then the administrator must configure the Control Port (default: A3) and the Primary Coupler Port (default: A4).

Default Coupler Port: The Coupler Port is used to establish a redundant path for Ethernet data. If the role of the switch is Slave the port will be a Standby Coupler. The default is A4.

Click on the *Update* button to retain the changes. To save the changes made, return to the Configuration menu and click on the *Save* button.

Configuration/Advanced

The Advanced dialog window displays the advanced configuration settings. If N-Link is set to *Auto Configure*, the following configuration data will be used. The selected Auto Configure detection timeout value range is 2-180 seconds. The default Auto Configure detection time is 4 seconds.

Click on the *Modify* button to change the detection timeout. Click on the *Update* button once the field has been updated with the required information. To save the changes made, return to the *Configuration* menu and click on the *Save* button.

Status

The Status dialog window displays the N-Link status. If the switch is an N-Link Master or Slave, the following switch status and partner status information will be shown. Fields with a red background designate a fault condition.

N-Link Master or Slave

The following switch status and partner status information are shown.

State: This field displays the current N-Link mode of the switch.

Partner Port: This field shows the port being used for normal communication between the N-Link Master and N-Link Slave switches. There must be a direct link between the Master and Slave Partner ports. Use of media converters or other switches is not supported. This port will be detected automatically.

Coupler Port: The port being used to establish a redundant path for Ethernet data transmission is displayed in this field.

Coupler Port State: Blocking, Forwarding.

Status: If there are no errors, the status shows OK. Otherwise, a description of the faults detected is shown.

N-Link Partner Information

The following switch statuses are shown.

State: Current N-Link mode of switch.

MAC: The MAC address of the N-Link Partner switch.

Coupler Port State: Blocking or Forwarding.

Status: If there are no errors, the status will show OK. Otherwise, a description of the faults detected will be shown.

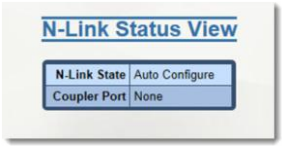
N-Link Auto Configure

N-Link State: Current N-Link mode of switch.

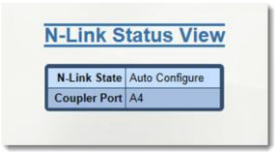
Coupler State: The port used to establish a redundant path for Ethernet data transmission. This port will be detected automatically.

Status Examples

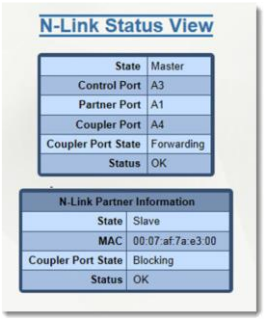
N-Link Auto Configure that is not an N-Link Master and has not become an N-Link Slave or an N-Link Coupler:



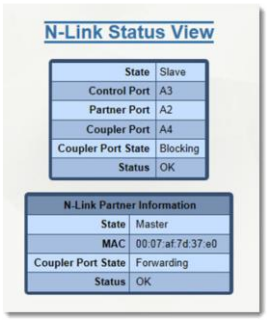
N-Link Coupler Switch:



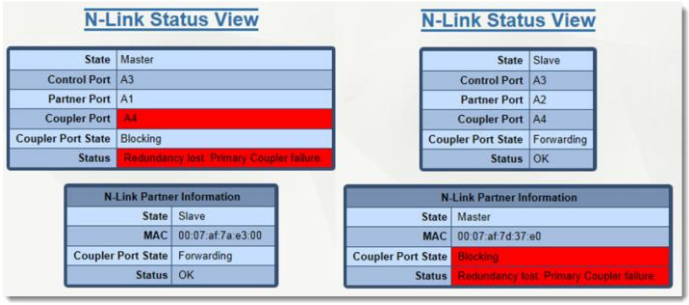
N-Link Master Switch:



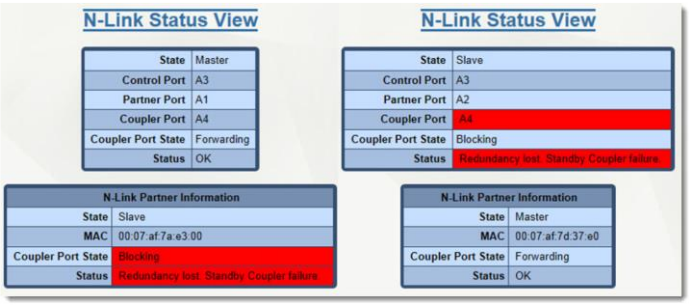
N-Link Slave Switch:



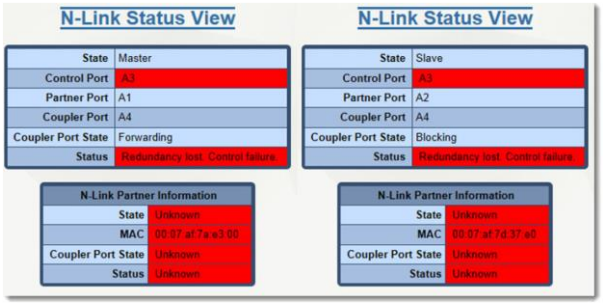
N-Link Status Master and Slave where the Primary Coupler is broken:



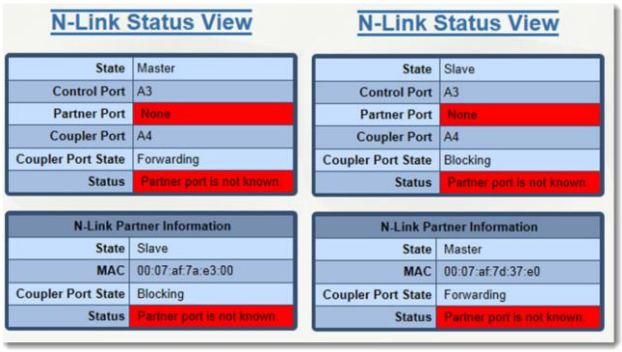
N-Link Master and Slave where the Standby Coupler link is broken:



N-Link Master and Slave where the Control link is broken:



N-Link Master and Slave where the Partner link is broken:



N-Ring™

Configuration/Basic

The Basic dialog window displays the N-Ring basic configuration settings. By default, N-Ring is in Auto Member mode.

Note: Bypass Relay models affect the implementation of this protocol. For more information, see the section Bypass Relay (BR).

Click on the *Modify* button to make changes to the N-Ring Basic Configuration:

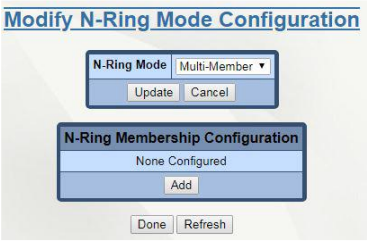
Disabled: If selected, this option disables the N-Ring capabilities on the switch.

Auto Member: When set to auto member, the switch automatically detects when it is a part of an N-Ring for participation in the ring.

Manager: When in Manager mode, the administrator may select different Port Sets as N-Ring ports. (See the Port Set Configuration section for information on adding and deleting port sets.)

N-Ring Ports: Defines the two ports that are used to connect to the N-Ring.
N-Ring™ Number: The N-Ring number can be selected from a range of 1 - 16 or a custom N-Ring number can also be chosen. The selected N-Ring number determines the VLAN ID. See table below for N-Ring numbers and corresponding VLAN IDs.
VLAN ID: This field is auto-generated based on the selected N-Ring number. See table for N-Ring numbers and corresponding VLAN IDs.
Tagging: The type of VLAN tagging used. Currently, tagged mode is the only supported mode.

Multi-Member: When in Multi-Member mode, a switch can be a member of multiple rings. If selected, then N-Ring Membership Configurations can be added for each N-Ring to which the switch will be connected. The image below shows one configured N-Ring.



To delete an existing N-Ring Membership, click on the *Delete* button.

To add a new N-Ring Membership, click on the *Add* button. The screen below will appear.

Select the N-Ring Ports and N-Ring Number to be used for the N-Ring. The VLAN ID for each N-Ring Membership must match that of the N-Ring Manager on each specific N-Ring to which the N-Ring Multi- Member will be connected.

Click on the *Update* button once the required selection has been made. To save the changes made, return to the *Configuration* menu and click on the *Save* button.

List of available N-Ring Numbers and their corresponding VLAN ID:

N-RING NUMBER	VLAN ID	N-RING NUMER	VLAN ID
1	3333	9	3341
2	3334	10	3342

3	3335	11	3343
4	3336	12	3344
5	3337	13	3345
6	3338	14	3346
7	3339	15	3347
8	3340	16	3348

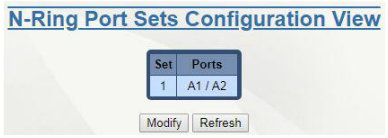
Configuration Requirements:

1. N-Ring requires tagged frames to optimize frame prioritization.
2. Do not create redundant links unless either RSTP or N-Ring is enabled.
3. The Default VLAN and any active N-Ring VLAN cannot be deleted.
4. RSTP and N-Ring™ are different modes and cannot share links or segments. If a port is both an RSTP port and an active N-Ring port, then RSTP will be disabled for that port. Other ports may have RSTP enabled.
5. Do not connect the N-Ring to actively Trunking ports on an Auto Member or Multi-Member configured switch.
6. An NT24k® switch can only participate in one N-Ring unless in Multi-Member mode.
7. Since VLANs are implemented for security reasons as well as traffic flow, N-Ring only makes minimal VLAN changes. It is up to the administrator to ensure that VLANs are configured correctly on the N-Ring manager and all N-Ring members.
8. For optimal performance, all N-Ring segments must be configured for the same speed.

> **WARNING:** To prevent a network storm, multiple segments between N-Ring members on one or more N-Rings must not occur. N-Ring members should only be connected to each other by the N-Ring ports.

Configuration/Port Sets

A port set is a group of two ports that may be used for an N-Ring. The default N-Ring Port Set is A1/A2. Click on the *Modify* button to make changes to the Port Sets.



Set: This field displays the Port set table index.

Ports: This field indicates the designated pair of N-Ring ports. To reassign different pairs, the Port sets containing those ports, if any, must be deleted before the ports can be reassigned (a port can only belong to one port set).

Delete: To delete a port set, check the box next to the line item to be deleted and click on the *Delete* button.

Click on the *Add* button below the Set column.

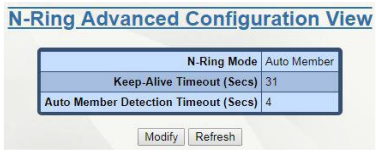
N-Ring Ports: A new port set can be added by selecting the N-Ring ports from the N-Ring Ports pull-down lists and clicking on the *Add* button.

Port Sets: Port Sets can be removed by selecting the port set from the Port Sets pull-down and pressing the *Remove* button.

Click on the *Update* button when port set configuration is complete. The N-Ring Port Sets Entry dialog window will appear. Click on the *Done* button. To save the changes made, return to the *Configuration* menu and click on the *Save* button.

Configuration/Advanced

Auto Member Mode



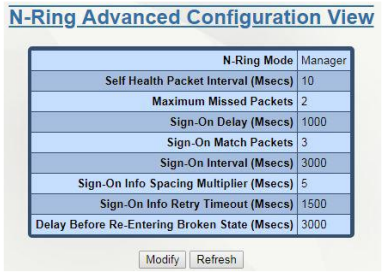
N-Ring™ Mode: This field is defined in the N-Ring/Configuration/Basic dialog window.

Keep-Alive Timeout (Sec): This field displays the amount of time to wait (in seconds) to receive a keep-alive request before switching from active member back to auto member. The default value is 31 seconds and the available range is 15 to 300 seconds. A entry of 0 will disable the feature.

Auto Member Detection Timeout (Sec): This field shows the amount of time to wait in seconds to receive N-Ring frames on any auto member port (at boot up) before assuming the switch is not part of an N-Ring. The default value is 4 seconds and the available range is 2 to 180 seconds.

Click on the *Modify* button and enter the required changes. When entries are complete, click on the *Update* button. To save the changes, return to the *Configuration* menu and click on the *Save* button.

Manager Mode



When in Manager mode, the following advanced configuration data are displayed in their respective fields:

Self Health Packet Interval (Msecs): The amount of time to wait in milliseconds before sending Self-Health packets. The default value for this field is 10.

Maximum Missed Packets: The number of consecutive missed Self-Health packets that constitute a fault. The default value for this field is 2 packets.

Sign-On Delay (Msecs): The amount of time to wait in milliseconds before requesting initial sign-on information from ring members. The default value is 1000 Msecs.

Sign-On Match Packets: The number of times the switch count must match before starting the sign-on process. The default value is 3.

Sign-On Interval (Msecs): The interval of time to wait in milliseconds before requesting subsequent sign-on information from ring members when the ring is broken. The default value for this field is 3000 Msecs.

Sign-On Info Spacing Multiplier (Msecs): The amount of time to wait in milliseconds, scaled by switch number, before sending information to the ring manager. The default value is 5 Msecs.

Sign-On Info Retry Timeout (Msecs): The amount of time the ring member will wait in milliseconds for the ring manager to acknowledge receipt of the member's information before the member tries to resend the information. The default value for this field is 1500 Msecs.

Delay Before Re-entering Broken State (Msecs): The amount of time, in milliseconds, that must elapse before the ring is allowed to go back into the broken state. The default is 3000 Msecs.

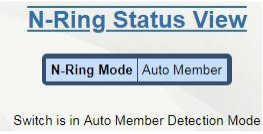
Click on the *Modify* button and make the required changes. Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

Multi-Member mode

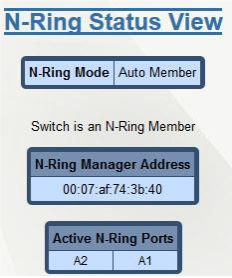
There are no advanced options when operating in Multi-Member mode.

Configuration Status

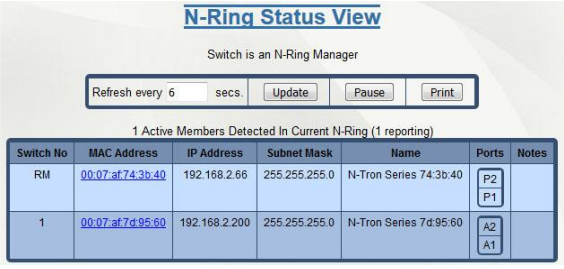
When an N-Ring™ Auto Member is not participating in an N-Ring, the following information is shown:



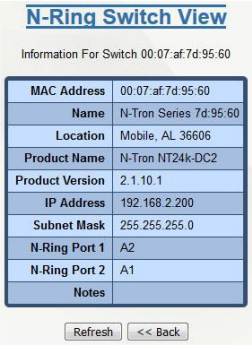
When an N-Ring Auto Member is participating in an N-Ring, the following information is shown:



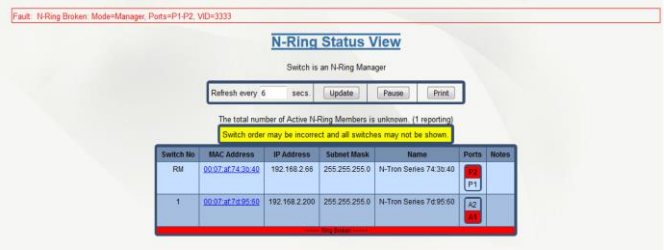
When N-Ring is in Manager Mode, the following data will be as shown below.



If the MAC is selected, more data is retrieved and shown about the N-Ring Member switch.



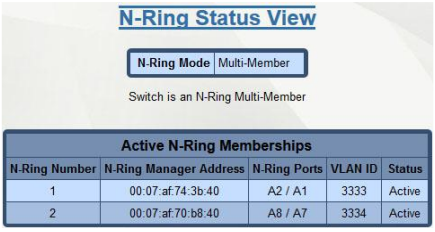
N-Ring™ Manager View for a faulted N-Ring:



A fault warning *Fault: N-Ring Fault* in red will show at the top of the dialog window.

The break is identified in red. In this case, N-Ring manager A2 to N-Ring active member Switch Number 1 TX2 is broken. A warning *Switch order may be incorrect and all switches may not be shown* is displayed in yellow. This indicates that the Sign On frames cannot get around the N-Ring and the data may not have been updated since the last successful update.

N-Ring Multi-Member Status View



N-Ring Number: N-Ring number to which the N-Ring Membership is associated.

N-Ring Manager Address: Show the MAC address of the switch acting as the N-Ring Manager.

N-Ring Ports: The port set linked to this N-Ring.

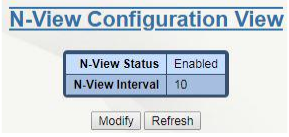
VLAN ID: The VLAN ID tag to be used with this N-Ring. The VLAN ID is associated with the N-Ring, and can be changed by switching the N-Ring number.

Status: Current status of the N-Ring Membership. The values are:

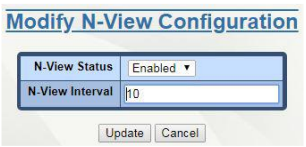
Active: The N-Ring Membership is connected and operating normally.
Inactive: The N-Ring Membership is not responding and not functioning correctly.

N-View™

The N-View Configuration dialog window displays the basic configuration for N-View. The status (enabled or disabled) and the interval between packets.



Click on the *Modify* button to make changes to the N-View Configuration.



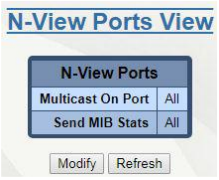
N-View™ Status: This field determines whether the N-Ring™ is enabled or disabled.

N-View Interval: This field determines the frequency in which N-View reports its information. Increasing the interval slows the update rate and decreasing it allows N-View to report more frequently. The available range is 10-500 seconds. Interval values are converted to increments of 10 seconds. The default value is 10 seconds.

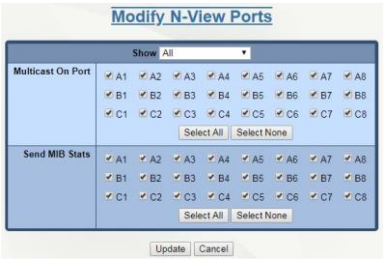
Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

Ports

The Ports dialog window displays a list of the configured ports on the NT24k® unit, along with the ports transmitting N-View related multicast packets and MIB stats respectively.



Click on the *Modify* button to make changes to the N-View Ports.



The user can modify these two variables to enable or disable N-View related multicast out of the port and if MIB stats are sent out for those ports. The ports that can be installed (Modules), currently installed or currently linked up can also be viewed.

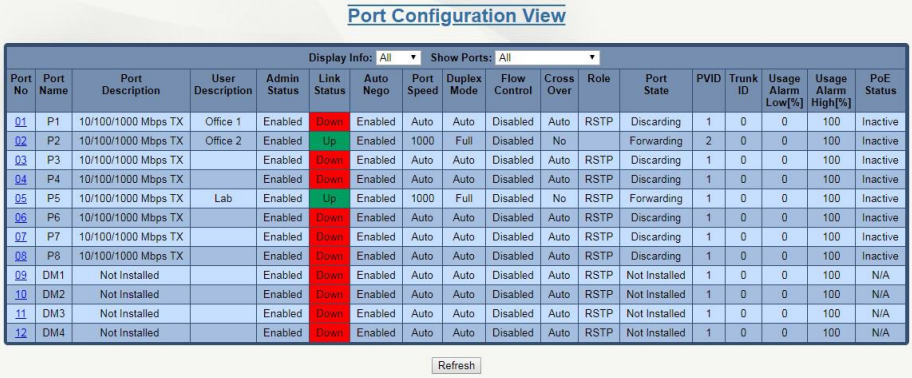
Click on the *Update* button after required changes have been made. To save the settings, navigate to the *Configuration* menu and click on the *Save* button.

Ports

Configuration

The Ports Configuration dialog window shows a detailed overview of all the ports on the switch. The administrator can view the ports that are available to install (Modules), currently installed or currently linked up.

The information displayed on the page can be changed by changing the *Display Info* from *Basic* to *All*. *Basic* shows the most commonly used information while *All* shows all of the available information.



Port Configuration View

Display Info: All Show Ports: All

Port No	Port Name	Port Description	User Description	Admin Status	Link Status	Auto Nego	Port Speed	Duplex Mode	Flow Control	Cross Over	Role	Port State	PVID	Trunk ID	Usage Alarm Low[%]	Usage Alarm High[%]	PoE Status
01	P1	10/100/1000 Mbps TX	Office 1	Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
02	P2	10/100/1000 Mbps TX	Office 2	Enabled	Up	Enabled	1000	Full	Disabled	No		Forwarding	2	0	0	100	Inactive
03	P3	10/100/1000 Mbps TX		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
04	P4	10/100/1000 Mbps TX		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
05	P5	10/100/1000 Mbps TX	Lab	Enabled	Up	Enabled	1000	Full	Disabled	No	RSTP	Forwarding	1	0	0	100	Inactive
06	P6	10/100/1000 Mbps TX		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
07	P7	10/100/1000 Mbps TX		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
08	P8	10/100/1000 Mbps TX		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Discarding	1	0	0	100	Inactive
09	DM1	Not Installed		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Not Installed	1	0	0	100	N/A
10	DM2	Not Installed		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Not Installed	1	0	0	100	N/A
11	DM3	Not Installed		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Not Installed	1	0	0	100	N/A
12	DM4	Not Installed		Enabled	Down	Enabled	Auto	Auto	Disabled	Auto	RSTP	Not Installed	1	0	0	100	N/A

Refresh

The screen above represents the Port Configuration View for a PoE model. If not using a PoE model, the page will be similar except the PoE Status column will not be present.

Port No: This field indicates the port number.

Port Name: This field displays the descriptive name of the port.

Port Description: This column provides a brief description of the port. Ports with "-R" in their description are Bypass Relay capable ports. Refer to the section Bypass Relay (BR) for more information on Bypass Relay devices and ports.

User Description: Description of the port set by a user.

Admin Status: This configurable field displays the existing status of the port. The two options are *Enabled* or *Disabled*.

Link Status: Shows the current state of the port. The two options are *Up* or *Down*.

Auto Nego: This configurable field displays the current auto-negotiation state whether it is *Enabled* or *Disabled*. Auto-negotiation cannot be disabled on a port connected to a gigabit device.

Port Speed: This configurable field displays the speed of each port. The available values are 10/100/1000 Mbps.

Duplex Mode: The existing mode of the port, whether it is *Full Duplex* or *Half Duplex*, is shown in this configurable field.

Flow Control: This configurable field displays the existing flow control status of each port.

Cross Over: This configurable field displays the existing crossover mode of the port. This can be indicated with a *Yes*, *No* or *Auto*. The default value for this field is Auto.

Role: A comma separated list of all the active roles for the port, which are based on the switch configuration. The possible roles are RSTP, N-Ring™, N-Link Control, N-Link Partner, and N-Link Coupler. For example, if a port is actively participating in an N-Ring and as an N-Link Partner, the role would be: N-Ring, N-Link Partner.

Port State: This column displays the current RSTP status of a port. It may contain *Disable*, *Discarding*, *Learning* or *Forwarding*.

PVID: This configurable field displays the existing port VLAN ID setting. The allowable range is 1-4094.

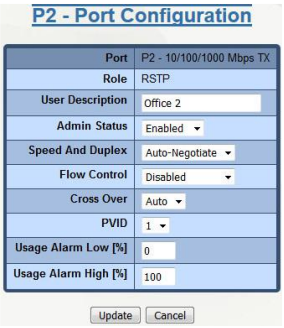
Trunk ID: When the port is an active member of a trunk group, the trunk's ID value is shown. A zero value indicates that the port is not an active trunk member.

Usage Alarm Low [%]: This field indicates the bandwidth utilization percentage below which a fault is triggered if enabled. For the half-duplex option, the bandwidth utilization percentage is the sum of both RX and TX bandwidth utilization. For the full-duplex option, this is the higher of TX or RX bandwidth utilization.

Usage Alarm High [%]: This field displays the bandwidth utilization percentage above which a fault is triggered if enabled. For half duplex the bandwidth utilization percentage is the sum of both RX and TX band-width utilization, and for full duplex this is the lower of TX or RX bandwidth utilization.

PoE Status: The current status of the PoE will be displayed in this column. It may show *Inactive*, *Active*, *Disabled* or *N/A*.

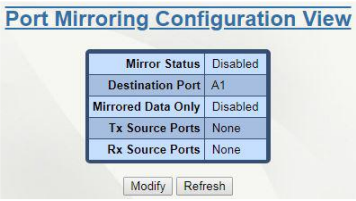
Click on the *Port Number* to configure each port individually. This will allow the user to change the port's settings.



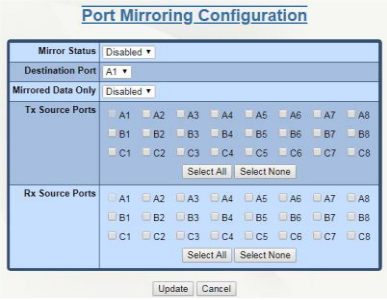
Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

Mirroring

A Mirroring Port is a dedicated port that is configured to receive copies of Ethernet frames that are sent or received from a monitored port. The Mirroring dialog window displays the status including the list of Source Ports and the Destination Port that the Sources are being mirrored to.



Click on the *Modify* button to make changes to the *Port Mirroring Configuration*.



Mirror Status: Enable or Disable the Mirroring functionality by selecting the option in the drop-down menu.

Destination Port: Select the destination ports that the source ports will be mirrored to.

Mirrored Data Only: Select the mirrored data to be transmitted to the destination port.

Tx Source Ports: Select the transmitting ports to be mirrored by checking on the desired ports or the *Select All* button.

Rx Source Ports: Select the receiving ports to be mirrored by checking on the desired ports or the *Select All* button.

Configuration Notes:

1. Non-mirrored frames take priority over mirrored frames. Mirrored frames may be discarded under rare instances when resource contention occurs.
2. The mirroring destination port is not allowed to overlap with the following features. Care should be taken to avoid configuration conflicts: N-Ring™, N-Link, Trunking.

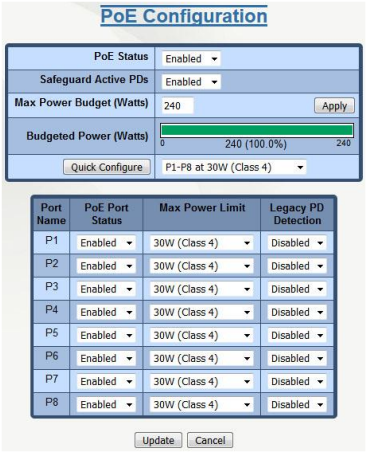
Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

PoE

PoE (Power Over Ethernet) is an internal hardware capability that outputs power and data on Ethernet cabling to Powered Devices (PDs) such as VoIP phones, IP camera, and industrial devices. PoE eliminates the need to run separate data and power cables between the PSE (PoE Source Equipment) and the PoE powered device.

PoE Management on the NT24k® provides the ability to set the PoE power budget, enable/disable PoE on specific ports, and set power limits per port.

Note: PoE is only supported on certain NT24k switches.



PoE Configuration: Table 1

PoE Status: This configurable field indicates whether the global PoE is enabled or disabled. PoE ports must also be individually enabled on the PoE configuration page. The default value for this field is Enabled.

Safeguard Active PDs: This configurable field indicates whether an active PD is safeguarded from losing power because of a configuration change. If enabled, the Max Power Limit cannot be changed if it can cause a power loss to the active PD. Similarly, Legacy PD Detection cannot be disabled on an active legacy powered device. The default value for this field is Enabled.

Max Power Budget (Watts): The maximum amount of power available for PoE. The value can range from 4 to the max power supply support for the switch.

Quick Configure: The quick configure selection menu updates the PoE port table with the desired settings based on the quick configuration option selected.The following values for 8 PoE Ports are:

- P1-P8 at 30W (Class 4) (default)
- P1-P8 at 15.4W (Class 3/0)
- P1-P8 at 7W (Class 2)
- P1-P8 at 4W (Class 1)
- All ports disabled.

For 16 PoE Ports the values are:

- P1-P8 at 30W (Class 4) (default)
- P9-P16 at 30W (Class 4)
- P1-P16 at 15.4W (Class 3/0)
- P1-P16 at 7W (Class 2)
- P1-P16 at 4W (Class 1)
- All ports disabled.

PoE Configuration: Table 2

PoE Port Status: This configurable field indicates whether PoE is enabled or disabled on the port.The default value is enabled on the first 8 PoE ports.

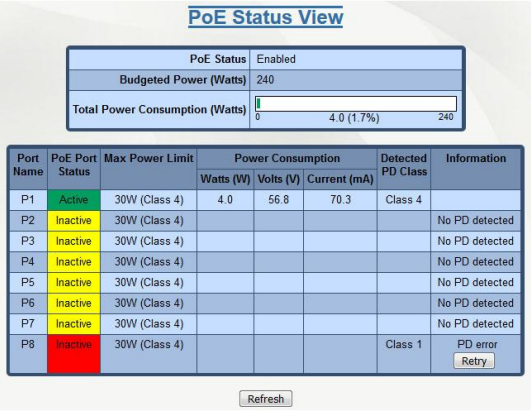
Max Power Limit: This configurable field indicates the maximum budgeted power for the port. The values are:

- 4W (Class 1)
- 7W (Class 2)
- 15.4W (Class 3/0)
- 30W (Class 4)

Legacy PD Detection: This field indicates whether legacy PD detection is enabled or disabled on the port. If enabled, legacy powered devices will be recognized. The default value is disabled.

Note: The sum of the Port Max Power Limit should not exceed the MaxBudgeted Power.

PoE Status: Table 3



Port Name: This field displays the descriptive name of the port.

PoE Port Status: Current status of the PoE port. The values are:

- Active: PoE power is outputted on the specific port
- Inactive: PoE power is not outputted on the specific port
- Disabled: PoE functionality is disabled on the specific port

Max Power Limit: The maximum budgeted power for the port.

Power Consumption: The actual power consumption of the port.

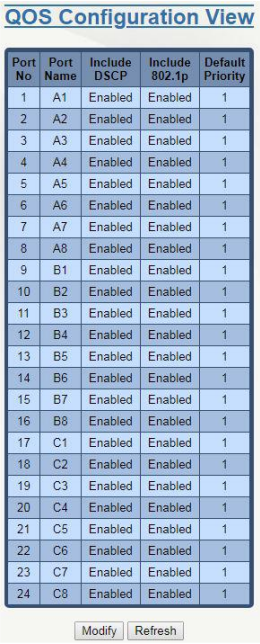
Detected PD Class: The classification of the connected device, which can range from Class 0-4.

Information: Details about the port's current state. If a Powered Device attempts to negotiate more power than the allocated maximum, PoE will be turned off on the port and a re-negotiation period will start. If re-negotiation is unsuccessful, a Retry button will be displayed below the PD error message. Select the retry button to restart negotiation after the cause of the overload is resolved.

QOS (Quality of Service)

The QOS decision tree chooses a frame's output port priority and the egress frame's IEEE 802.1p User Priority value (if needed) based on the QOS settings and the User Priority value (if any) in the ingress frame. Both the internal port priority setting and the egress frame User Priority value are always assigned the same value. The available values are 0 through 7 where 7 is the highest priority. If the ingress frame is an IP packet, the RFC 2474 DSCP field in the packet will be passed unchanged to the egress frame.

Click on the *Modify* button to make changes to the QOS Configuration.



Include DSCP: This configurable field displays the status of whether or not to include the ingress frame's RFC 2474 DSCP value in determining the transmit priority and egress frame's IEEE 802.1p User Priority value. If the ingress frame type is IP (IPv4 or IPv6) and Include DSCP is enabled, DSCP processing will override all other settings. (see QOS SELECTION CHART below). The default value is enabled.

Include 802.1p: This configurable field displays the status of whether or not to include the ingress frame's IEEE 802.1p User Priority value in determining the transmit priority and egress frame's IEEE 802.1p User Priority value. This setting is used only if the frame type is not IP (IPv4 or IPv6) or the Include DSCP setting is disabled. (see QOS SELECTION CHART below). The default value is enabled.

Default Priority: This configurable field displays the default QOS priority for the transmit priority value and the egress frame's IEEE 802.1p User Priority value if not otherwise assigned by DSCP or IEEE 802.1p processing. The range is 0-7, highest priority=7. The default value is 1.

QOS Selection Chart:

INCLUDE DSCP SETTING	INCLUDE 802.1p SETTING	INGRESS FRAME TYPE	INGRESS FRAME HAS VLAN	OUTPUT PORT PRIORITY AND EGRESS IEEE 802.1p USER PRIORITY
Enabled	N.A.	IP	N.A.	Ingress DSCP Value
N.A.	Enabled	Not IP	Yes	Ingress IEEE 802.1p UP
N.A.	Enabled	Not IP	No	Default Priority Setting
N.A.	Disabled	Not IP	N.A.	Default Priority Setting
Disabled	Enabled	N.A.	Yes	Ingress IEEE 802.1p UP
Disabled	Enabled	N.A.	No	Default Priority Setting
Disabled	Disabled	N.A.	N.A.	Default Priority Setting
Legend				
IP	Ingress packet type is IPv4 or IPv6.			
Ingress DSCP Value	Use the high order three bits of the ingress frame’s IP DSCP value.			

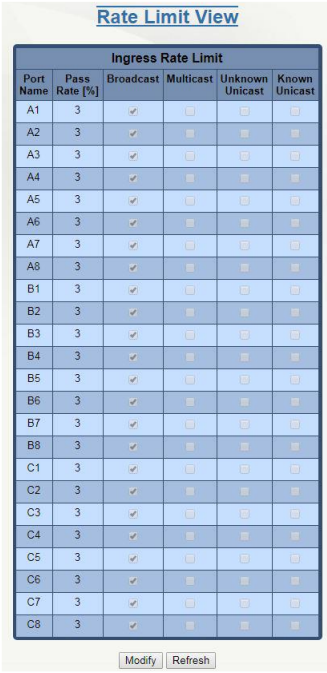
INCLUDE DSCP SETTING	INCLUDE 802.1p SETTING	INGRESS FRAME TYPE	INGRESS FRAME HAS VLAN	OUTPUT PORT PRIORITY AND EGRESS IEEE 802.1p USER PRIORITY
Ingress IEEE 802.1p UP	Use the ingress packet's IEEE 802.1p User Priority value.			
N.A.	Not applicable			

Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

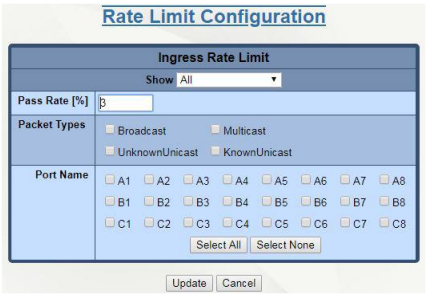
Rate Limiting

The Rate Limiting dialog window shows the NT24k® installed ports and the Pass Rate Percentage per port for each of the following: Broadcast, Multicast, Unknown Unicast and Known Unicast.

A packet type will be affected by the rate limit setting if the check box is selected and it exceeds the total number of packets established by the ingress rate limit within an assigned time period. The time periods are: 1 Gbps = 10 ms, 100 Mbps = 100 ms and 10 Mbps = 1 sec.



Click on the *Modify* button to make changes to the Rate Limiting settings.



Show: View the ports that are available to install (Modules), currently installed or currently linked up.

Pass Rate [%]: Modify the pass rate percentage for each and every port by entering the desired value.

Packet Types: Select what Packet Types are to be passed: Broadcast, Multicast, Unknown Unicast and Known Unicast.

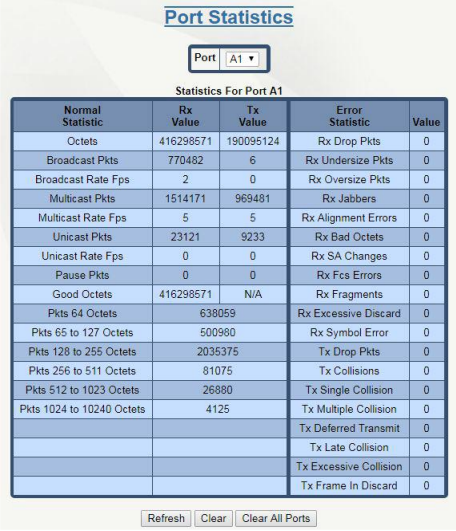
Port Name: Select which ports are affected by the changes made.

Note: Unicast packets with destinations not in the ARL table can be rate limited rather than all being flooded. This is known as “Unknown Unicast”.

Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

Status/Statistics

This dialog window displays the MIB counters for the selected port, specified by the Port pull-down menu.

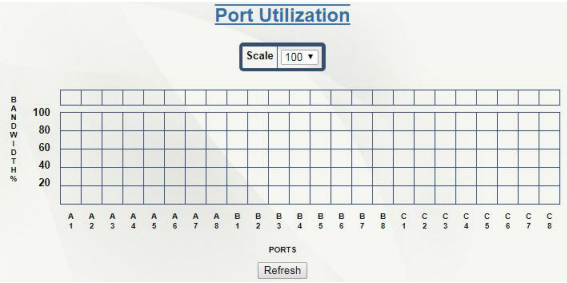


Normal Statistic	Rx Value	Tx Value	Error Statistic	Value
Octets	416298571	190095124	Rx Drop Pkts	0
Broadcast Pkts	770482	6	Rx Undersize Pkts	0
Broadcast Rate Fps	2	0	Rx Oversize Pkts	0
Multicast Pkts	1514171	969481	Rx Jabbers	0
Multicast Rate Fps	5	5	Rx Alignment Errors	0
Unicast Pkts	23121	9233	Rx Bad Octets	0
Unicast Rate Fps	0	0	Rx SA Changes	0
Pause Pkts	0	0	Rx Fcs Errors	0
Good Octets	416298571	N/A	Rx Fragments	0
Pkts 64 Octets	638059		Rx Excessive Discard	0
Pkts 65 to 127 Octets	500980		Rx Symbol Error	0
Pkts 128 to 255 Octets	2035375		Tx Drop Pkts	0
Pkts 256 to 511 Octets	81075		Tx Collisions	0
Pkts 512 to 1023 Octets	26880		Tx Single Collision	0
Pkts 1024 to 10240 Octets	4125		Tx Multiple Collision	0
			Tx Deferred Transmit	0
			Tx Late Collision	0
			Tx Excessive Collision	0
			Tx Frame In Discard	0

Pressing the *Clear* button resets all counters for the selected port. The *Clear All Ports* button resets all counters for all ports, including the selected port. The *Refresh* button reloads the dialog window.

Status/Utilization

This dialog window displays the bandwidth percentage graph of all the ports. The graph is scaled based on the “*Scale*” drop-down list.



Trunking

The Trunking dialog window displays trunking information.

Note: Bypass Relay models affect this feature. For more information, see the section Bypass Relay (BR).

Trunk ID: This column displays the trunk identifier number. The valid range is 1-127.

Trunk Name: This column shows the descriptive name of the trunk. The name can consist of alphanumeric characters and the following special characters (including the period): **# _ - .**

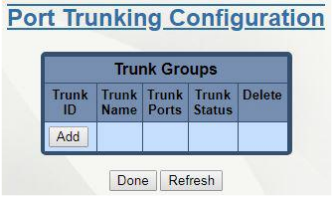
Trunk Ports: This column displays the ports associated with the trunk.

Trunk Status: The existing status of the trunk is shown in this column. Available trunk status options are *Enabled* or *Disabled*.

Configuration Note:

Note: The trunk ports are not allowed to overlap with the following features. Care should be taken to avoid configuration conflicts: N-Ring™, N-Link, 802.1X, Mirroring.

Click on the *Modify* button to add, modify or delete ports.



Click on the Add button and the following dialog window will appear:

Show: View the ports that are available to install (Modules) currently installed or currently linked up.

ID: Enter the desired Trunk ID. Valid range is 1- 127. There can be no duplicate Trunk IDs.

Name: Enter the descriptive name of the trunk. The name can consist of alphanumeric characters and the following special characters (including the period): **# _ - .**

Ports: Select the required ports from the Ports list. The list of ports shown will vary depending on the selection in the *Show* field.

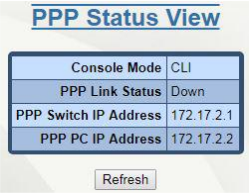
Status: Select the status of the port that is being added. Options are *Enabled* or *Disabled*.

Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

To modify an existing Trunk Group, click on the *Trunk ID* and make the required changes. To Delete an existing Trunk Group, click on the *Delete* button associated with the Trunk ID to be deleted.

PPP

The console can be either in CLI mode or PPP mode. The PPP mode provides a TCP/IP connection over the serial port. A browser may then be used to view switch information or make configuration changes. PPP mode is entered by using the PPP command on the console. To change from PPP to CLI mode, you must reboot the switch.



Console Mode: When CLI is shown, the console is in the command mode, which is the default mode. When PPP is shown, the console is in PPP mode.

PPP Link Status: This field indicates the current PPP link state.

PPP Switch IP Address: This field displays the IP address for the switch side of the PPP link.

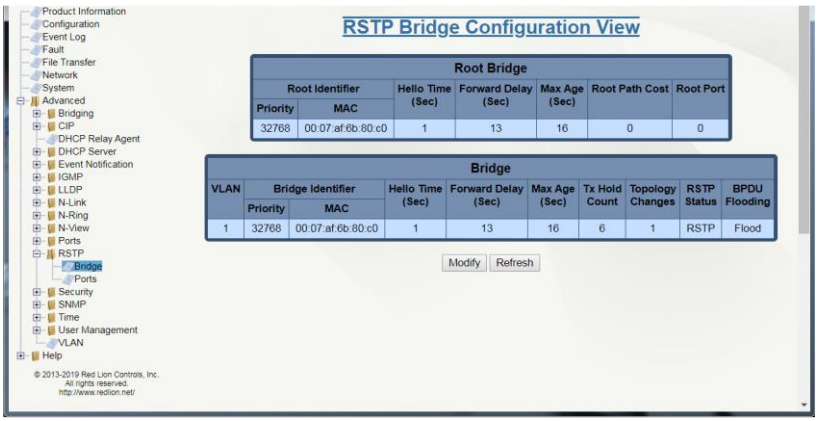
PPP PC IP Address: This field indicates the IP address for the PC side of the PPP link.

RSTP

Bridge

The Bridge dialog window displays the RSTP information for the RSTP Root Bridge and for the RSTP Bridge on this switch.

Note: Bypass Relay models affect the implementation of this protocol. For more information, see the section Bypass Relay (BR).



Root Bridge: This is the identity and parameters of the RSTP Root Bridge.

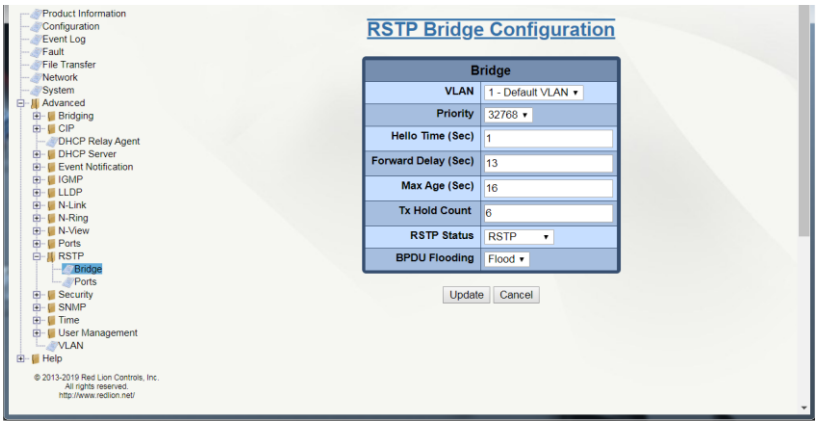
Root Identifier - Priority: This field indicates the priority of the Root Bridge.
Root Identifier - MAC: The unique MAC address of the Root Bridge is shown here.
Hello Time (Sec): This field indicates the time interval, in seconds, between the transmission of configuration BPDUs by designated ports.
Forward Delay (Sec): This field shows the time spent, in seconds, by legacy STP Bridges in transitioning Root and designated ports to forwarding. This delays port transitions until other bridges have received spanning tree information.

Max Age (Sec): For RSTP, this is the maximum time, in seconds, that a bridge will wait for configuration BPDUs before deciding it is no longer connected to the root bridge.
Root Path Cost: The cost of the path to the Root Bridge via the Root Port of this bridge.
Root Port: The Root Port of this Bridge. The Root Port provides the lowest cost path from this bridge to the Root Bridge.

Bridge: This is the configuration of the RSTP bridge on this switch.

VLAN: RSTP will operate on all ports of this VLAN. BPDUs will be transmitted with or without VLAN tags depending on the settings for this VLAN. This should be a valid VLAN ID. The default value for this field is VLAN 1.
Bridge Identifier Priority: This field indicates the Bridge priority. The range is 0 - 61440. The default value is 32768.
Bridge Identifier MAC: The unique MAC address of the Bridge is displayed in this field. This is possibly a different network device.
Hello Time (Sec): This field indicates the Hello time, when this bridge is the Root Bridge or is attempting to become the Root Bridge. This is the time interval, in seconds, between the transmission of Configuration BPDUs by Designated Ports. The range is 1 - 10. The default value is 1.
Forward Delay (Sec): This field displays the Forward Delay, when this bridge is the Root Bridge or is attempting to become the Root Bridge. This is the time spent, in seconds, by legacy STP Bridges in transitioning Root and Designated Ports to Forwarding. This delays Port transitions until other bridges have received spanning tree information. The range is 4 - 30. The default value is 13 seconds.
Max Age (Sec): This field displays the Max Age when this bridge is the Root Bridge or is attempting to become the Root Bridge. For RSTP, this is the maximum hops allowed for any protocol message before it is discarded and no longer retransmitted. For STP, this is the maximum time, in seconds, that a bridge will wait for Configuration BPDUs before deciding it is no longer connected to the root bridge. The range is 6 - 40. The default value is 16 seconds.
Tx Hold Count: This is the maximum number of configuration BPDUs that can be transmitted in one second from a port on this Bridge before transmission is throttled. The range is 1 to 10. The default value for this field is 6.
Topology Changes: This is the number of RSTP topology changes since the switch has been powered on or rebooted.
RSTP Status: This is the current status of the RSTP protocol on this bridge. The available options for this field are RSTP, Force STP or Disabled.
Note: RSTP & N-Ring™ are different network topology protocols and cannot share links or segments. If a port is both an RSTP port and an active N-Ring port, then the port will be disabled for RSTP.
Note: Do not create redundant network paths unless either RSTP or N-Ring is enabled.
Note: If a port is both an RSTP port and an enabled trunk group member, then the port will be disabled for RSTP. The RSTP port status can be seen under advanced RSTP ports.
Note: It is recommended that an RSTP network consist of RSTP capable switches.
Note: RSTP is supported on only one VLAN.
Note: When operating in a VLAN with legacy STP devices, use these values for the Bridge: Hello Time (Sec) = 2, Forward Delay (Sec) = 15 and Max Age (Sec) = 20.
BPDU Flooding: This value allows for flooding or blocking of BPDUs to other ports when the global spanning tree is disabled or when spanning tree is disabled on a specific port. If Flood is selected, BPDUs are flooded to all other ports based on the VLAN assignment. The options are Flood or Block. The default is Flood.

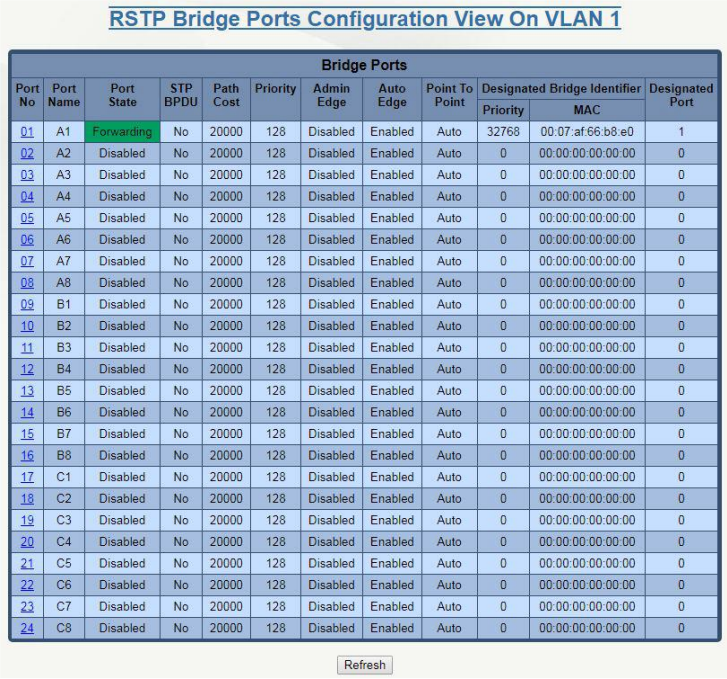
Click on the *Modify* button and the following dialog window will appear:



Make the required modifications, and click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

The RSTP Ports dialog window displays information such as the path cost and the port state. If the switch sees a redundant network path, it will put the port with the highest path cost into the Blocking port state where it will discard packets coming in on that port.

In the example shown below, A2 is a redundant port with port A1, therefore A1 is forwarding and A2 is discarding.



Port No	Port Name	Port State	STP BPDU	Path Cost	Priority	Admin Edge	Auto Edge	Point To Point	Designated Bridge Identifier		Designated Port
									Priority	MAC	
01	A1	Forwarding	No	20000	128	Disabled	Enabled	Auto	32768	00:07:af:66:b8:e0	1
02	A2	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
03	A3	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
04	A4	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
05	A5	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
06	A6	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
07	A7	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
08	A8	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
09	B1	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
10	B2	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
11	B3	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
12	B4	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
13	B5	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
14	B6	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
15	B7	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
16	B8	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
17	C1	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
18	C2	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
19	C3	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
20	C4	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
21	C5	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
22	C6	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
23	C7	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0
24	C8	Disabled	No	20000	128	Disabled	Enabled	Auto	0	00:00:00:00:00:00	0

Port No: Indicates the number of the port.

Port Name: Displays the descriptive name of the port.

Port State: The current RSTP state of the port is shown here. This state may be seen as "Forwarding, No STP, Disabled, Listening, Learning, and Discarding.

STP BPDU: Shows whether or not a legacy STP BPDU has been received or not.

Path Cost: Displays the current path cost of the port. The range is 0 - 200,000,000. If configured to 0 or Auto, the path cost will be calculated automatically using the actual speed of the port; otherwise the configured value will be used. The default value for this field is Auto.

Priority: The priority of the port is displayed in this column. The available range is 0 - 255. The default value for this field is 128.

Admin Edge: Indicates whether or not this port is treated as an Edge Port and can immediately enter the forwarding state. If set to Enabled, no BPDUs are expected to be received at the port. Set this option to Enable only when an end device is linked to this port. The default value is Disabled.

Auto Edge: Indicates whether or not to use a short timeout when waiting for BPDUs before determining that this is an Edge Port (if no BPDUs are received). It may have to be disabled for a very large network. The default value is Enabled.

Point to Point: Displays whether at most one other network port is attached to the port's LAN segment. The port may transition to Forwarding very quickly on a point-to-point MAC link. Values may be Auto (full-duplex links are assumed to be point-to-point, half duplex are not), and Force True or Force False (if the automatic determination would be wrong). The default value is Auto.

Designated Bridge Identifier Priority: The priority of the designated bridge associated with the port's LAN segment is shown in this field. The designated bridge provides the lowest cost path from this bridge port's LAN segment, through the designated bridge, to the root bridge.

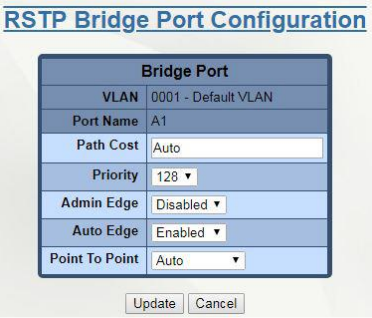
Designated Bridge Identifier MAC: Indicates the unique MAC of the designated bridge associated with the port's LAN segment.

Designated Port: The designated port of the designated bridge is shown here.

Note: When event logging is enabled, all RSTP controlled ports will log events about their status whether or not the modular based port is currently installed.

Note: When operating in a VLAN with legacy STP devices, set the Auto Edge field to Disabled for Bridge Ports.

To make changes to a Bridge port, click on the *Port No hyperlink* and the following window will appear:



Make the required modifications to the following parameters: Path Cost, Priority, Admin Edge, Auto Edge and Point to Point fields, then click on the *Update* button.

Security

Local Security

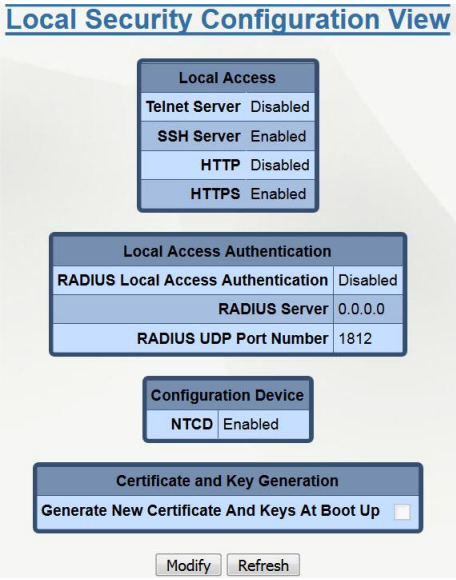
The Local Security feature allows an administrator to control local access (logins) to the switch.

Local Security Configuration View

The Local Security Configuration page displays the status of the Telnet server, SSH Server, HTTP protocol, and HTTPS protocol. The administrator can disable or enable these protocols, as desired. A RADIUS server can be configured to authenticate the user name and password entered for local access.

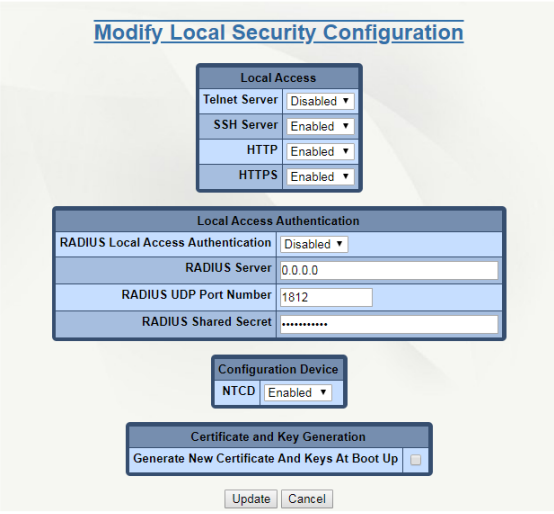
The N-Tron® Configuration Device (NTCD) SD card slot can be enabled or disabled, allowing an administrator to block and unblock reading and writing settings from the SD card as desired. A new certificate and keys can also be generated at boot up by selecting the *Generate New Certificate and Keys At Boot Up* option.

WARNING: If the NTCD device slot is disabled and the switch password is forgotten, access to the switch can only be recovered by sending it back to the factory to be unlocked.



Modify Local Security Configuration

Click on the *Modify* button and the page below will appear. Make the desired changes, and then click on the *Update* button. To save changes, navigate to the Configuration menu and click on the *Save* button.



These settings address local access to the switch. For better security, keep the Telnet Server and HTTP disabled.

Telnet Server: This field indicates whether the Telnet Server is enabled or disabled. Disabling the Telnet Server does not impact SSH. The default is disabled.

SSH Server: This field indicates whether the SSH Server is enabled or disabled. Disabling the SSH Server does not impact Telnet. The default is disabled.

HTTP: This field indicates whether HTTP is enabled or disabled. Disabling HTTP does not affect HTTPS secure connections. The default is disabled. HTTP users are not authenticated by the RADUIS server. If Radius authentication is exclusively required, then HTTP should be disabled.

HTTPS: This field indicates whether HTTPS is enabled or disabled. Disabling HTTPS requires HTTP to be enabled. The default is enabled.

A RADIUS server may be used to manage user accounts that have access to the switches.

RADIUS Local Access Authentication: This field indicates whether RADIUS Local Access Authentication is enabled or disabled. RADIUS authentication is not supported on HTTP connections. The default is disabled.

RADIUS Server: This field is the IP address of the RADIUS server used when RADIUS Local Access Authentication is enabled.

RADIUS UDP Port Number: The UDP port number of the RADIUS Server. The default port number is 1812, per RFC-2865. Allowed port numbers are 1 - 65535.

RADIUS Shared Secret: The shared secret for the local access authentication server. The shared secret authenticates the switch to the RADIUS server and must match the shared secret value on the RADIUS server.

NTCD: This field indicates whether the Configuration Device is enabled or disabled. The default is enabled. Disabling the NTCD SD card slot allows an administrator to block and unblock reading and writing settings to and from the SD card.

Generate New Certificate and Keys at Boot Up: This field indicates whether certificate and keys will be generated when the switch boots up. *A change to this setting requires that settings be saved and that the switch be rebooted before changes take effect*. The value will reset to be unchecked when the switch boots up. The default is no.

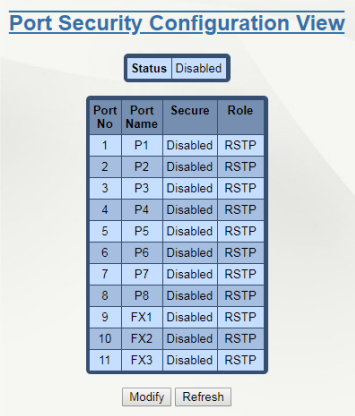
Port Security

Port Security can be enabled on the MAC address level for additional security. The Port Security feature restricts access to the switch by only accepting dynamically learned MAC addresses and manually entered MAC addresses as authorized. Dynamically learned MAC addresses are those that the switch detects on any port while in 'Learning' mode. A manually entered MAC address must designate the port(s) that the address is authorized on. A non-authorized MAC address will be discarded and will be shown on the intruder log.

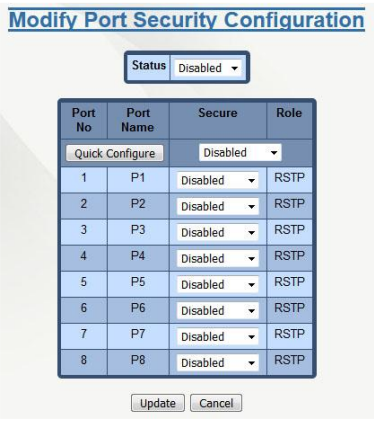
Port security allows secured ports to run with RSTP enabled on the port. Port security also allows the same MAC address to be authorized on multiple ports. When setting up authorization lists for RSTP ports, any MAC address that could migrate to other secured ports should also be placed, by the user, in the authorization list for those ports.

Port Security – Configuration

The Port Security Configuration View displays the status of Port Security and all the ports with their current settings. When Status is 'Locked' it is in secure mode. When Status is 'Learning' it builds an internal list of authorized MAC addresses and no ports are secured during this time.



The Modify button allows the administrator to change the Status of Port Security and Secure mode for all ports.



Status: The current status of Port Security. It can be Disabled, Learning, or Locked. Transitioning from Locked to Learning clears the Authorization List table on all ports. Transitioning from Locked to Disabled retains the current Authorization List. When transitioning from Learning to Locked, the Authorization List represents the authorized MAC addresses. The default value is Disabled.

Port No: The number of the port.

Port Name: The descriptive name of the port.

Secure: Displays Secure mode for the associated port. It can be Disabled, Enabled, or Single Mac.

- **Disabled:** Port Security is not active on the port regardless of the current Port Security Status.
- **Enabled:** Port Security is active when the current Port Security Status is Learning or Locked.
- **Single MAC:** Port Security will take the first learned MAC address and lock the port when current Port Security Status is Learning or Locked.

The default value is Disabled.

Role: A comma separated list of all the active roles for the port, which are based on the switch configuration. The possible roles are RSTP, N-Ring™, N-Link Control, N-Link Partner, N-Link Coupler, 802.1X, and Trunk.

Make the required modifications, and click on the Update button. To save the changes made, navigate to the Configuration menu and click on the Save button.

Note: Security is not configurable on N-Ring or N-Link interconnecting ports. These ports must be linked to adjacent switches that have the protocol enabled. This link is considered to be a

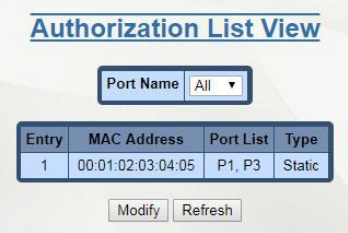
closed proprietary connection/segment that is not directly accessible. If both switches are otherwise properly secured then the proprietary connection/segment requires no additional security.

Note: It is recommended that the Bridging Aging Time be 300 seconds (the default) or longer while Port Security is Learning.

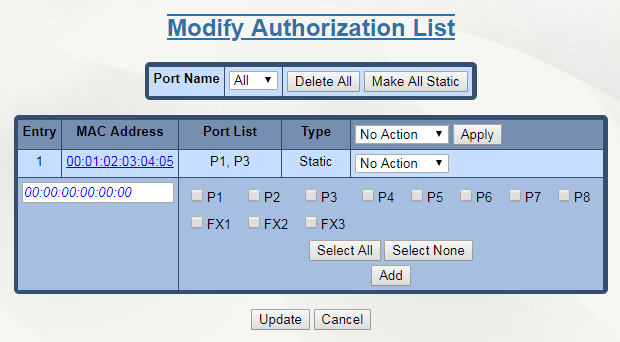
Ports Security – Authorization List

The Authorization List View displays a drop-down list of the available ports that is used to filter the authorization list. Below the drop-down list is the table of authorized Static and Learned MAC addresses and ports.

Note: Multicast Source Addresses will not show up in the Authorization List.



The Modify button allows the administrator to add new MAC addresses, and to modify and remove existing MAC addresses. The last row is used to add new MAC addresses and to change the ports of an existing MAC address.



Port Name: The descriptive name of the port.

MAC Address: The authorized host MAC address.

Port List: The port(s) that are authorized for the associated MAC address.

Type: The type of the authorized MAC Address. It can be either Learned, Static, or Single MAC.

Action: Action for the authorized MAC address. It can be No Action, Make Static from Learning mode, or Delete from the Authorization List. The maximum number of actions that may be performed on the Authorization List in a single update is 100.

Make the required modifications, and click on the Update button. To save the changes made, navigate to the Configuration menu and click on the Save button.

Delete All Authorization List

To delete the complete authorization list associated with the selected port(s), click on *Delete All* button. A confirmation dialog pop-up will appear, prompting the user to confirm the action.

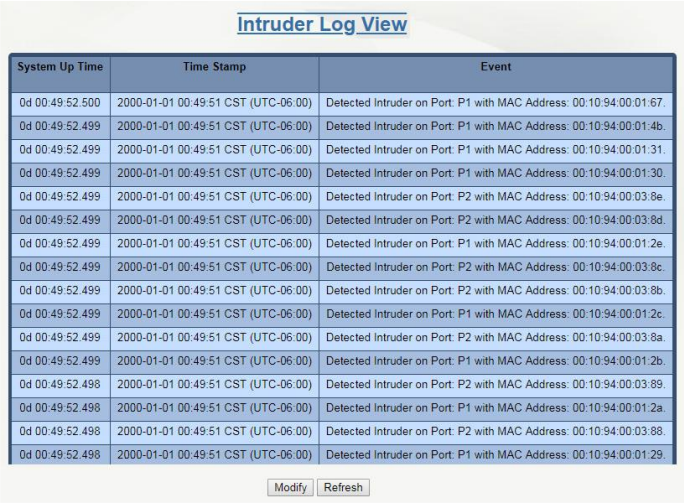
Make All Learned Authorization Entries Static

To make all learned authorization entries associated with the selected port(s) as Static, click on *Make All Static* button. A confirmation dialog pop-up will appear, prompting the user to confirm the action.

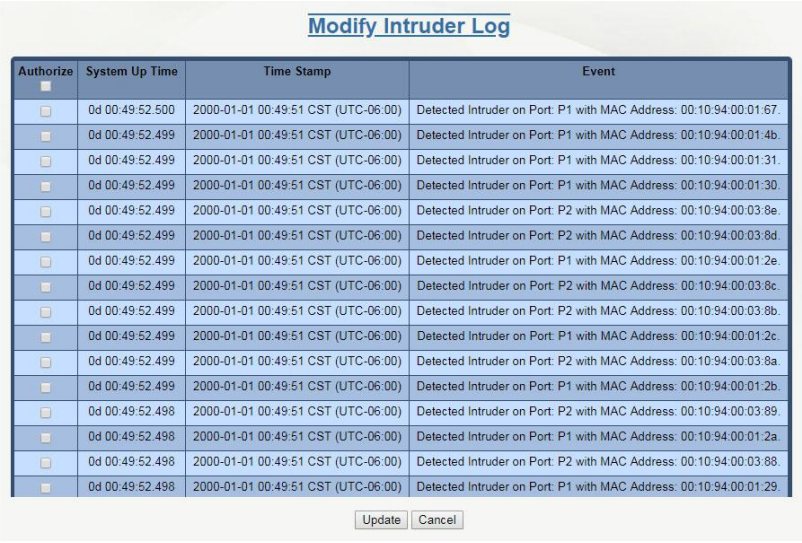
Note: Ports that are set to Single MAC cannot be included in static entries in the Authorization List.

Ports Security – Intruder Log

The Intruder Log page displays a list of unauthorized MAC addresses that attempted to access the secured device. Each intruder entry in the log is based on MAC address and Port. Multicast source MAC addresses will not be displayed in the Intruder Log table. The log is ordered by most recent first, based on the system up time and time stamp. The maximum number of entries is 100. If more than 100 intruders are detected, the oldest entries are deleted. The log is not saved through a power cycle.



To authorize a particular MAC Address from the Intruder Log, click on the Modify button and an "Authorize" field will be added as a checkbox as shown below:



Displays the most recent 100 intruders since the latest system startup. To review a complete list, please see the Event Log page.

FIELD	DESCRIPTION
Authorize	This is the selection to Authorize MAC Address(es) from the Intruder Log.
System Up Time	The elapsed time since the switch was powered on or rebooted.
Time Stamp	The date/time when the event was logged.
Event	The description of the intrusion.

Make the required modifications and click on the Update button. To save the changes made, navigate to the Configuration menu and click on the Save button.

An authorized entry will be displayed as green text color for that particular row in the Intruder Log table. The corresponding checkbox in the Authorize column will be checked and cannot be modified.

Port Security – Single MAC

Single MAC is a port security mode that allows a port to lock on a dynamically learned MAC address. The first MAC address to be learned and processed by the port will be locked in and any further traffic will be blocked as an intruder. The locking of the address is not dependent on switching the port security status to Locked. This feature helps in providing security for ports that may only have a single device plugged into the switch. The Single MAC address is not persistent following a reboot. The Single MAC will remain locked until a reboot upon which time a new MAC address will be learned and assigned as the new Single MAC entry.

Single MAC can be configured per port from the Port Security Configuration page. Manually added MAC addresses are not allowed to be assigned to a port designated as Single MAC. If a port is enabled under port security and then changed to Single MAC all learned addresses will be cleared and the next MAC address that comes in will be the new Single MAC address.

Single MAC addresses reset anytime the port security status is changed to Learning. Single MAC addresses are persistent when port security status is changed from Learning or Locked to Disabled and then back to Locked.

Single MAC limitations include: intruders on the Single MAC port cannot be manually authorized, and new addresses cannot be manually added to a Single MAC port.

Radius Server Configuration Information

The NT24k® takes advantage of Vendor Specific Attributes (VSA) as defined in section 5.26 of RFC 2865 so that multiple user levels can be authenticated using a Radius server. The VSA is defined as follows:

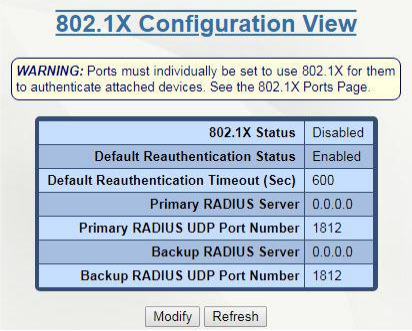
VENDOR ID	28381
Vendor ID	28381
Attribute Number	1
Attribute Format	string
Attribute Value	"AccessLevel:admin" or "AccessLevel:user"

The server and access list will need to be configured accordingly.

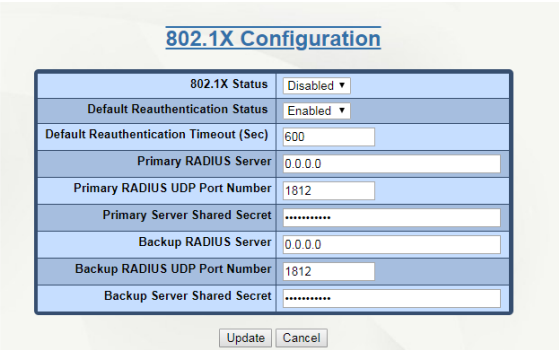
802.1X/Configuration

The Configuration dialog window displays the 802.1X status, reauthentication information, and RADIUS server information.

Note: Bypass Relay models affect the implementation of this protocol. For more information, see the section Bypass Relay (BR).



To make changes to the Security settings, click on the *Modify* button and the fields shown below will become editable:



802.1X Status: This field indicates whether the 802.1X feature is enabled or disabled. At least one RADIUS server must be specified for 802.1X to be enabled. Ports must also be individually enabled on the ports configuration page.

Default Reauthentication Status: Select whether the 802.1X Reauthentication option is enabled or disabled. With reauthentication enabled, a device will be required to reauthenticate itself based on the time period specified by the reauthentication timeout field. 802.1X must be disabled to change this value.

Default Reauthentication Timeout (Sec): Enter the time period, in seconds, between 802.1X reauthentication. This value cannot be zero (0). 802.1X must be disabled in order to change this value.

Primary RADIUS Server: This field indicates the IP address of the primary RADIUS server. If contact with this server is lost, then contact with the backup server will be attempted.

Primary RADIUS UDP Port Number: The UDP port number of the Primary RADIUS Server. The default port number is 1812, per RFC-2865. Allowed port numbers are 1 - 65535.

Primary Server Shared Secret: This field displays the shared secret for the primary server. The shared secret authenticates the switch to the RADIUS server and must match the shared secret value on the RADIUS server.

Backup RADIUS Server: This field indicates the IP address of the backup RADIUS server. If contact with the primary server is lost, contact with the backup server will then be attempted.

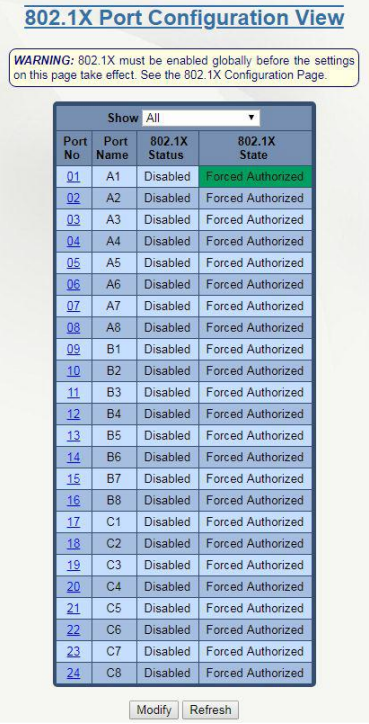
Backup RADIUS UDP Port Number: The UDP port number of the Backup RADIUS Server. The default port number is 1812, per RFC-2865. Allowed port numbers are 1 - 65535.

Backup Server Shared Secret: This field displays the shared secret for the backup server. The shared secret authenticates the switch to the RADIUS server and must match the shared secret value on the RADIUS server.

Make the required modifications and click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

802.1X/Ports

The 802.1X Port Configuration View dialog window displays all the ports and their current settings. To modify this information, click on the *Modify* button.



Port No: This column shows the number of the port.

Port Name: This column displays the port's descriptive name.

802.1X Status: This column indicates whether the existing 802.1X port is enabled or disabled. Ports only require 802.1X authentication if they are enabled and 802.1X is globally enabled on the configuration page.

802.1X State: This column shows the current state of the port. This option is only valid when the port is enabled and 802.1X is globally enabled.

Link Down: There is no link detected on the port.
Initialize: The port is being setup for 802.1X authentication.
Disconnected: A valid 802.1X client has not been detected.
Connecting: A valid 802.1X client has been detected, but authentication has not begun.
Authenticating: The 802.1X client is being authenticated.
Authenticated: The 802.1X client has been authenticated.

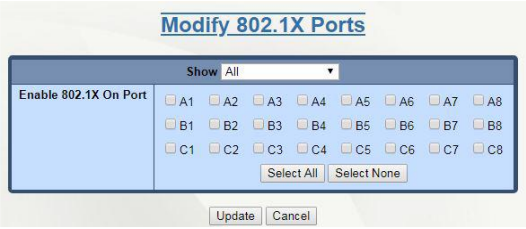
Aborting: The port is no longer authorized and is preparing to move back to the Disconnected state.

Held: The 802.1X client failed authentication and the switch is preventing new authentication attempts for a defined period of time. Default: 60 seconds.

Forced Authorized: Occurs when a port has had 802.1X disabled. The result is all traffic is allowed to pass through that port.

Forced Unauthorized: Occurs when a port is administratively disabled through the port configuration. The result is no traffic is allowed to pass through that port.

Click on the *Modify* button and the page below will appear. Select the required ports, and then click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.



IEEE 802.1X MIB

The IEEE 802.1X MIB, IEEE 8021-PAE-MIB, is supported by the NT24k®. Since the NT24k does not support the supplicant features of 802.1X, the MIB tables pertaining to the supplicant behavior will not be populated and will be blank when queried.

With this release, the IEEE 802.1X MIB support is limited. Ports are only tracked when an 802.1X aware supplicant is attached. This means that not all 802.1X enabled ports will be visible, only those with valid supplicants. The statistics available through the MIB only pertain to the device since it either passed or failed authentication. Once the link goes down on the port, the statistics will be reset. Furthermore, any configuration items accessed through the IEEE 802.1X MIB can be set to modify the behavior of the port, but these changes will not persist across link events or power cycles.

Configuration changes that occur through the NT24k MIB will be persisted across link events and power cycles. Support for persisted statistics and configuration settings in the IEEE 802.1X MIB will be added to the NT24k in a future release.

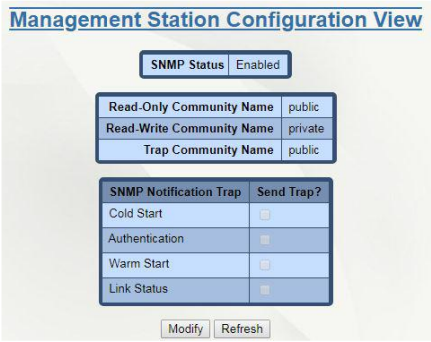
The IEEE 802.1X MIB allows for the writing to dot1xPaeSystemAuthControl. This is not supported in the current release of the NT24k firmware. dot1xPaeSystemAuthControl is considered a read-only attribute. The functionality for this is located in the NT24k MIB as ntronSecurityDot1xConfigStatus.

The IEEE 802.1X MIB allows for the writing to dot1xAuthAdminControlledDirections. Controlling the direction of the port traffic is not currently supported in the NT24k firmware and writing to dot1xAuthAdminControlledDirections will not have an effect on the system.

SNMP

Configuration

The SNMP Configuration displays the SNMP status and allows the administrator to disable or enable the protocol. The Read-Only, Read-Write and Trap Community Names are also displayed in this dialog window.



SNMP Status: This field indicates whether SNMP is enabled or disabled.

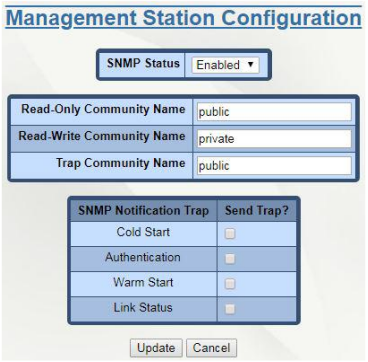
Read-Only Community Name: This configurable field represents the Authorized Community Name for SNMP Get requests. Only alphanumeric characters are allowed. The default value for this field is public.

Read-Write Community Name: This configurable field represents the Authorized Community Name for SNMP Set requests. Only alphanumeric characters are allowed. The default is for this field is private. Only administrators can view or modify this field.

Trap Community Name: This configurable field represents the Authorized Community Name for SNMP Traps. Only alphanumeric characters are allowed. The default is for this field is public.

SNMP Notification Traps: This section allows for control of which SNMP traps will be sent by this switch. Each of the four available traps can be enabled or disabled individually. The traps are: Cold Start, Authentication, Warm Start and Link Status.

Click on the *Modify* button to make changes to the SNMP Configuration. This will enable all configurable fields. Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.



Trap Stations

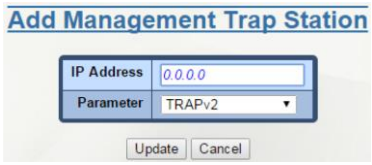
The Trap Stations dialog window displays the SNMP Trap Stations.

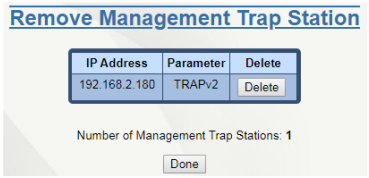
IP Address: This field represents the IP address of the Management Station to be sent SNMP Traps.

Parameter: This field displays the Target Parameters entry (TRAPv1, TRAPv2, etc) to be used for sending traps to the Management Station.

Adding Management Trap Stations

To add trap stations, click on the *Add* button and the following will appear:





Enter the required IP address and select the parameter to be used. Click on the *Update* button and the Display Management Trap Stations screen will appear.

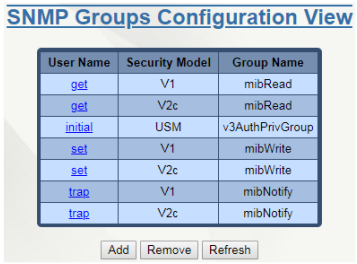
***SNMP V3 Default Security Parameters*:** The SNMP V3 default user parameters are shown here for reference only, as they are necessary for connecting to the switch securely using an SNMP V3 client when in defaults.The default user and other users can be added, deleted or modified by an administrator via either an SNMP V3 client or web browser, and the values below may be invalid if they are changed by an SNMP administrator.

Username: initial
Authentication Password: authpass
Authentication Protocol: MD5
Privacy Password: privpass
Privacy Protocol: DES

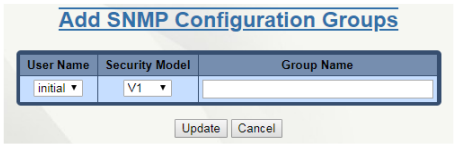
To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

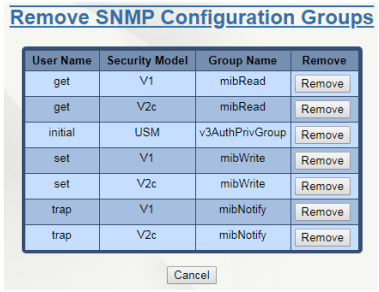
Groups

The SNMP Groups page allows the customer to configure SNMP group settings for specific SNMP users.



Click on the *Add* button to create a new SNMP group, or click the hyperlink under User Name to modify existing group settings for a user. Click the *Remove* button to display a list of current configured group and user settings, with an option to remove specific ones.





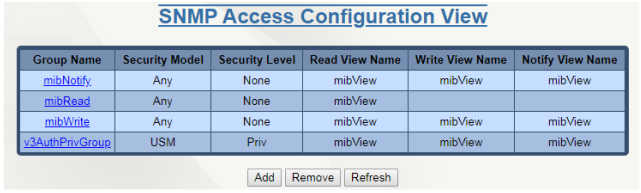
User Name: This field represents the SNMP User Name. It is a drop down list with an option for every SNMP user defined on the **Users** page.

Security Model: This field represents the security model the SNMP protocol will use for the defined group. The default is Any, while V1, V2c and USM (User-based Security) are the other available options.

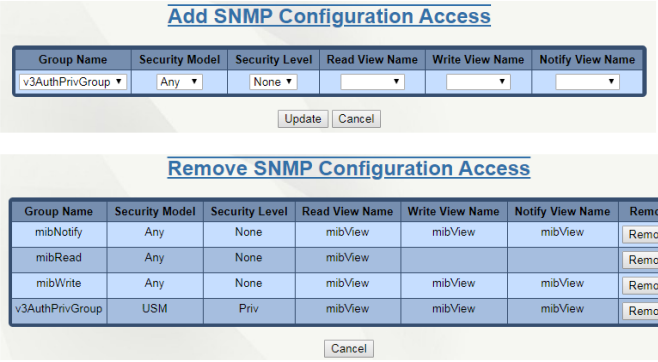
Group Name: This field represents the SNMP Group to which the SNMP user belongs.

Access

The SNMP Access page allows the customer to define various types of MIB access based on the defined view settings for each SNMP group.



Click on the *Add* button to define new access settings for a group, or click the hyperlink under Group Name to modify existing access for a group. Click the *Remove* button to display a list of current configured group and access settings, with an option to remove specific ones.



Group Name: This field represents the name of the group the user defines access settings for. It is a drop down list with an option for every SNMP group defined on the **Groups** page.

Security Model: This field represents the security model used to validate group access to views. The options are V1, V2c and USM (User-based Security).

Security Level: This field represents the security level of SNMP communications for the defined group. The options are None, Auth, and Priv.

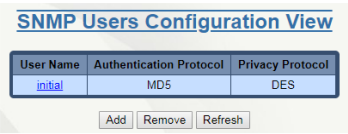
Read View Name: The name of the view that the defined group has read access to. It is a drop down list with an option for every SNMP view defined on the **View** page.

Write View Name: The name of the view that the defined group has write access to. It is a drop down list with an option for every SNMP view defined on the **View** page.

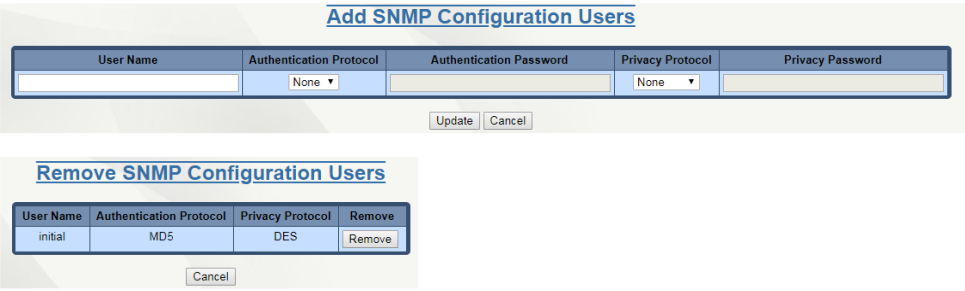
Notify View Name: The name of the view that the defined group has notify access to. It is a drop down list with an option for every SNMP view defined on the **View** page.

Users

The SNMP Users page allows a customer to create custom user names for group access and set the authentication and privacy protocols for that user. It is important to note that authorization and privacy passwords, when created, are hashed internally for security and will not be able to be retrieved.



Click on the *Add* button to create a new SNMP user, or click on a hyperlink in the *User Name* column to edit the information for that user. Click the *Remove* button to display a list of current configured users, with an option to remove specific ones.



User Name: This field represents the SNMP User Name.

Authentication Protocol: This field represents the authentication protocol utilized by the SNMP user. The options are None, MD5, and SHA1.

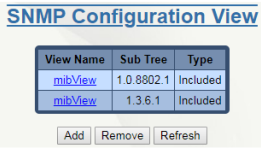
Authentication Password: The defined authentication password for the SNMP user. The password can be between 1 and 32 characters in length, but it is recommended that it is at least 8 characters in length. Alphanumeric and special characters are accepted.

Privacy Protocol: This field represents the privacy protocol utilized by the SNMP user. The options are None, DES, and AES-128.

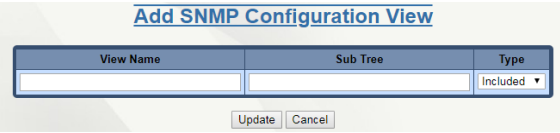
Privacy Password: The defined privacy password for the SNMP user. The password can be between 1 and 32 characters in length, but it is recommended that it is at least 8 characters in length. Alphanumeric and special characters are accepted.

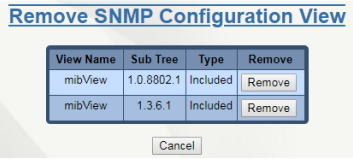
View

The SNMP View page allows a customer to define different view groups, which either include or exclude specific sub trees from the MIB tree based on the configuration.



Click on the *Add* button to create a new SNMP view, or click on a hyperlink in the *View Name* column to edit the information for that view. Click the *Remove* button to display a list of current configured views, with an option to remove specific ones.





View Name: This field represents the name of the SNMP view.

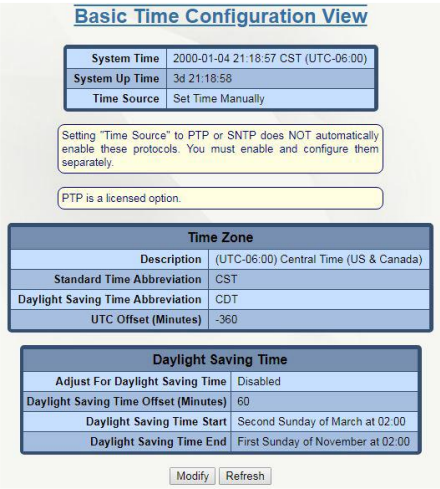
Sub Tree: This field allows the user to enter an OID string representing the sub tree being included or excluded from the view, based on the **Type** setting.

Type: This field allows the user to configure what the SNMP view does with the sub tree defined in the *Sub Tree* field. The options are Included and Excluded.

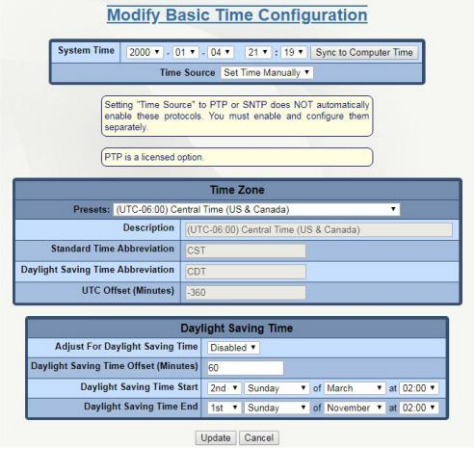
Time

Basic

From the Basic Time Configuration View dialog, the administrator can define the system time, time zone, daylight savings time and time source settings for the unit.



Click on the *Modify* button to make modifications to the unit's time settings.



System Time: This field displays the date/time of the system. The system date/time defaults to 2000-01-01 00:00:00 CST (UTC-06:00) at system start. The system date/time can be set manually but in the event of a power cycle or reboot it will revert to the default value.

Time Source: This field controls how the switch will automatically set its clock. The default value of "Set Time Manually" means that the time the switch uses can only be set manually. Setting this field to either "SNTP" or "PTP" causes the protocol to continuously update the system clock. Note that these must be enabled and configured separately from the basic time configuration. PTP is a licensed option and is unavailable otherwise.

Time Zone

Presets: This field provides a list of global time zones and cities within the time zones. Selecting from this list provides easy local time configuration and automatically populates the fields below. Choosing the "Custom..." option allows for editing of the below fields to satisfy specific requirements that are not met by one of the preset time zones.

Description: This field provides a description of the time zone selected. It contains the city and the offset from UTC for the selected location. If a custom preset is selected the description may be edited.

Standard Time Abbreviation: The common abbreviation for the selected time zone during standard daylight time is shown in this field. If a custom preset is selected the abbreviation may be edited.

Daylight Saving Time Abbreviation: This field represents the common abbreviation for the selected time zone during daylight saving time or summertime. If a custom preset is selected the abbreviation may be edited.

UTC Offset (Minutes): This field displays the offset, in minutes, from UTC. This is used to determine the local time. If a custom preset is selected the offset may be edited. Any change to the offset will affect the time calculation.

Daylight Saving Time

Adjust For Daylight Saving Time: This field indicates whether automatic adjustment for daylight saving time is made. The settings for this adjustment are defined below.

Daylight Saving Time Offset (Minutes): This field defines how much, in minutes, to adjust the time when daylight saving time starts and ends.

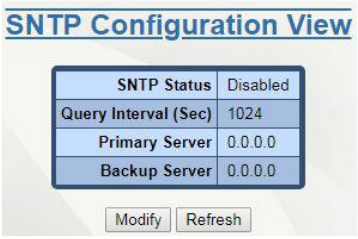
Daylight Saving Time Start: The week, the day of the week, the month, and the time at which daylight saving time should start.

Daylight Saving Time End: The week, the day of the week, the month, and the time at which daylight saving time should end.

Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

SNTP

From the SNTP Configuration View, the SNTP status can be changed, and the primary and back-up servers can be defined. Click on the *Modify* button to enable or modify the current settings.



SNTP Status: Indicates whether the SNTP client has been enabled. In order to enable SNTP, at least one SNTP or NTP server must be specified.

Query Interval (Sec): The periodic query interval used to request the time from the server(s). The valid range is between 4 and 129600. The default value is 1024.

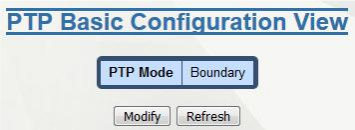
Primary Server: The address of the server to query first and most often. If contact with this server is lost, then contact with the backup server will be attempted. Either an SNTP or an NTP server may be specified.

Backup Server: The address of the backup server to query in the event that access is lost to the primary server. Either an SNTP or an NTP server may be specified. Click on the *Update* button. To save the changes made, navigate to the *Configuration* menu and click on the *Save* button.

Precision Time Protocol (PTP)

PTP Basic Configuration

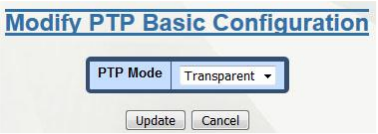
The PTP Basic Configuration View displays the PTP Mode and allows the administrator to disable the protocol, or enable one of two clock modes, Boundary or Transparent.



PTP Mode: This field indicates whether PTP is disabled, operating as a Boundary clock, or operating as a Transparent clock. When PTP is disabled, PTP traffic will route through the switch like any other multicast traffic.

Transparent Clock mode generally provides the most accurate time to a PTP client when the network is lightly loaded and there are only a few PTP clients connected to the switch. Boundary Clock mode is a better choice for a congested network. Boundary Clock mode also becomes a better choice as more PTP clients are connected to the switch.

Click on the *Modify* button to change the PTP Mode. When the desired mode has been selected, click *Update*.

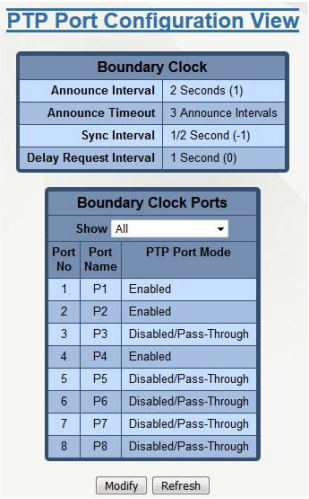


Note: When switching between PTP modes, it will be necessary to save the configuration and reboot the switch for the change to take effect.

PTP Port Configuration

The PTP Port Configuration View displays global and per port settings that relate to PTP.

The settings in the **Boundary Clock** table are applied to every port of a switch in Boundary Clock mode. The **Boundary Clock Ports** or **Transparent Clock Ports** table displays the PTP Port Mode for every port on the switch.



Global Boundary Clock Settings

Announce Interval: This is the log2 value that sets the interval for how often to announce the switch as an eligible PTP Master. The default value of "1" is every 2 seconds. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Announce Timeout: This value determines the number of announce intervals that must elapse without receipt of an announce message before a non-communicating Master is marked as unavailable. The default value is 3 intervals. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Sync Interval: This log2 value determines how often a sync message will be sent. The default value of "- 1" is twice per second. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Delay Request Interval: This log2 value determines how often the switch will request a path delay measurement from its Master. The default value of "0" is once per second. The current value is dynamically updated by the PTP protocol and may differ from the setting.

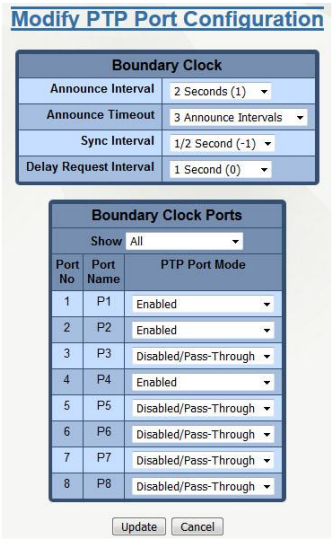
Boundary Clock Ports or Transparent Clock Ports Settings

Port No: Indicates the number of the port.

Port Name: The descriptive name of the port.

PTP Port Mode: The operation mode of the PTP port. Values are "Enabled", "Disabled/Pass-Through" (default), or "Disabled/Blocked". When Enabled, PTP packets will be processed by the switch PTP software. When Disabled/Blocked, PTP packets will be discarded as they enter the port. When Disabled/Pass- Through, PTP packets will be forwarded to other pass-through ports (within VLAN restrictions) with no PTP processing.

Click the *Modify* button to change any of the global settings or to change the PTP Port Mode of specific ports.

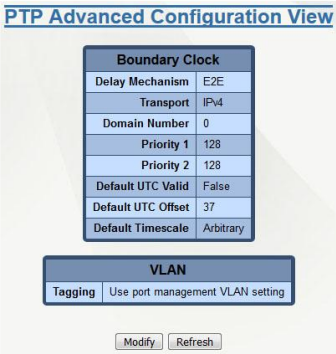


Once modifications to Announce Interval, Announce Timeout, Sync Interval, Delay Request Interval or PTP Port Mode have been made, click on the *Update* button.

Note: The settings on the PTP Port Configuration View page are associated with the mode set on the PTP Basic Configuration View page.

PTP Advanced Configuration

The PTP Advanced Configuration View displays common advanced PTP settings and advanced settings that relate specifically to the Boundary Clock mode of operation. The Common values are read-only and only some values can be modified.



Boundary Clock

Delay Mechanism: The Delay Mechanism specifies the method used by PTP to handle delay correction values. E2E is the only delay mechanism currently supported.

Transport: IPv4/UDP is the only network transport method currently supported.

Domain Number: The Domain Number selects a PTP Domain. Only PTP packets in the same domain will be received and processed, and all sent PTP packets will be tagged with the same Domain Number. The range is 0-127. The default is 0.

Priority1: This value sets the priority of this switch as a Master clock. It is the most important value used by the Best Master Clock (BMC) algorithm of other PTP devices when selecting a Master clock. The range is 0-255, with 0 being most important. The default is 128.

Priority2: This value is used to break ties in the BMC algorithm. The range is 0-255, with 0 being most important. The default is 128.

Default UTC Valid: Current UTC Valid is a field in PTP packets that tells other devices whether the UTC Offset field that is also being sent in the packet should be considered valid. The Current UTC Valid value is set to this default at boot time, until it is updated by making a connection to a PTP Master. The default is "False" because the switch does not boot with a valid calendar time. It can be changed for interoperability reasons.

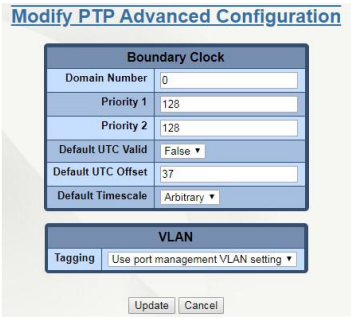
Default UTC Offset: The Current UTC Offset value is set to this default at boot time. The range is 0-127. The default is 36.

Default Timescale: The Current Timescale value is set to this default at boot time. All times exchanged in the PTP protocol are either "Arbitrary" or "PTP". Times that are "Arbitrary" cannot be converted to calendar time correctly and may have no connection to external accurate time. Times that are "PTP" can be converted to accurate calendar time using the UTC offset. The default is "Arbitrary" because the switch does not boot with a valid calendar time. It can be changed for interoperability reasons.

VLAN Tagging: PTP frames that egress a PTP port may have a VLAN tag or may be untagged. When "Use port Management VLAN setting" is selected, the PTP frame is untagged if the Management VLAN is set to 'Untag on Egress'. Otherwise, the frame is tagged with the Management VLAN ID. This is the default setting. When "Use port PVID setting" is selected, the PTP frame is untagged if the VLAN used as the PVID is set to 'Untag on Egress'. Otherwise, the frame is tagged with the port's PVID.

Note: When PTP Mode is "Transparent Clock", PTP frames will obey VLAN restrictions and will not cross VLAN boundaries.

To make changes, click on the *Modify* button. Once the desired changes have been made, click on the *Update* button to apply changes to settings.

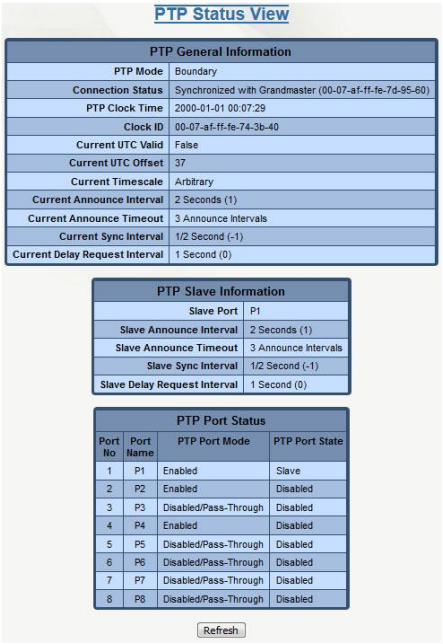


Note: The settings on the PTP Advanced Configuration View page are associated with the mode set on the PTP Basic Configuration View page.

Note: The Current UTC Valid, Current UTC Offset and Current Timescale values are not displayed on the View or Modify pages when PTP is currently disabled or in Transparent Clock mode because they do not apply.

Status

The PTP Status and Information page displays read only information about a device's PTP configuration. General and per port information is displayed on this page.



Note: When PTP is disabled, the only information displayed on this page is PTP Mode and Clock ID, because nothing else applies when PTP is disabled.

PTP General Information

PTP Mode: The PTP mode of the switch. Options include "Disabled", "Boundary Clock", and "Transparent Clock". The default is "Disabled". If the PTP protocol is disabled on the switch, all ports behave as Disabled/Pass-Through. Changes to this setting require a reboot of the switch.

Connection Status: This only applies to Boundary Clock mode. This is the current PTP Master clock of the switch. If this switch is the Master clock, then the connection status indicates that PTP is not synchronized with a Grandmaster.

PTP Clock Time: This only applies to Boundary Clock mode. This displays the date/time of the PTP Clock. The PTP Clock defaults to the system clock when not synchronized to a PTP Master clock.

Clock ID: The unique Clock ID of this PTP device. It is constructed automatically based on the switch MAC address.

Current UTC Valid: A field in exchanged PTP packets that says whether the UTC Offset field that is also being sent in the packet should be considered valid. This is a run-time value that is dynamically updated based on the most recently connected PTP Master.

Current UTC Offset: A field in exchanged PTP packets that provides the current offset to UTC. This is a run-time value that is dynamically updated based on the most recently connected PTP Master.

Current Timescale: A field in exchanged PTP packets that provides the most recently received Timescale value from the Master. This is a run-time value that is dynamically updated based on the most recently connected PTP Master. If this value is "PTP", the internal PTP time can be converted to a calendar time using the Current UTC offset.

Current Announce Interval: This only applies to Boundary Clock mode. This is the $\log_2$ value that sets the interval for how often to announce the switch as an eligible PTP Master. The default value of "1" is every 2 seconds. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Current Announce Timeout: This only applies to Boundary Clock mode. This value determines the number of announce intervals that must elapse without receipt of an announce message before a non-communicating Master is marked as unavailable. The default value is 3 intervals. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Current Sync Interval: This only applies to Boundary Clock mode. This $\log_2$ value determines how often a sync message will be sent. The default value of "-1" is twice per second. The current value is dynamically updated by the PTP protocol and may differ from the setting.

Current Delay Request Interval: This only applies to Boundary Clock mode. This $\log_2$ value determines how often the switch will request a path delay measurement from its Master. The default value of "0" is once per second. The current value is dynamically updated by the PTP protocol and may differ from the setting.

PTP Slave Information

Slave Port: This only applies to Boundary Clock mode. This is the port that is connected to and inheriting configuration values from a PTP Master. If no port is acting as a PTP Slave this field will have a value of “N/A”.

Slave Announce Interval: This only applies to Boundary Clock mode. This is the $\log_2$ value that sets the interval for how often to announce the switch as an eligible PTP Master. The default value of "1" is every 2 seconds. The slave value is dynamically updated by the PTP protocol and may differ from the setting.

Slave Announce Timeout: This only applies to Boundary Clock mode. This value determines the number of announce intervals that must elapse without receipt of an announce message before a non-communicating Master is marked as unavailable. The default value is 3 intervals. The slave value is dynamically updated by the PTP protocol and may differ from the setting.

Slave Sync Interval: This only applies to Boundary Clock mode. This $\log_2$ value determines how often a sync message will be sent. The default value of "-1" is twice per second. The slave value is dynamically updated by the PTP protocol and may differ from the setting.

Slave Delay Request Interval: This only applies to Boundary Clock mode. This $\log_2$ value determines how often the switch will request a path delay measurement from its Master. The default value of "0" is once per second. The slave value is dynamically updated by the PTP protocol and may differ from the setting.

PTP Port Status

Port No: The number of the port.

Port Name: The descriptive name of the port.

PTP Port Mode: The operation mode of the PTP port. Values are "Enabled", "Disabled/Pass-Through" (default), or "Disabled/Blocked".

PTP Port State: The current PTP state of a port. It should be noted that when PTP is in Transparent Clock mode the port state is not applicable and will not be displayed.

User Management

Authorized Users

The User Management screen allows users to view, add, modify and remove system user accounts. The display includes a list of all the users who have access to the management features of the switch and their access permissions.

Note: Up to 5 web users may be logged into the Web Management tool at once.

Adding Users

The system administrator can add users, change passwords and define access permissions for each user. Click on the *Add* button and the following dialog window will appear:

User Name: User names may include all alphanumerical characters, as well as the following 2 characters: _ - , and must be 3 to 15 characters long.

Password: Passwords can include all printable characters, except for the colon (:) and spaces, and the password length must be in the range specified by the "Password Length Min" and "Password Length

Max" fields. These fields are configurable under the User Management Configuration screen. The background print in the Password entry field will specify the currently configured range.

Access Permission: This field determines whether a user has standard *User* rights or *Admin* access.

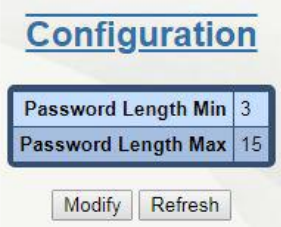
- *User* permission gives the right to view switch configurations and to view current port settings.
- *Admin* permission gives the right to change and view any switch configuration and to change and view any current port settings.

Removing Users

Users can be removed by a user with Admin access. Click on the *Remove* button, enter the User Name to be deleted and click on the *Remove* button.

Configuration

The User Management Configuration screen allows for the switch to be configured with a user password length minimum and user password length maximum.



Password Length Min: The minimum number of characters allowed in a user password. The default is 3 characters.

Password Length Max: The maximum number of characters allowed in a user password. The default is 15 characters.

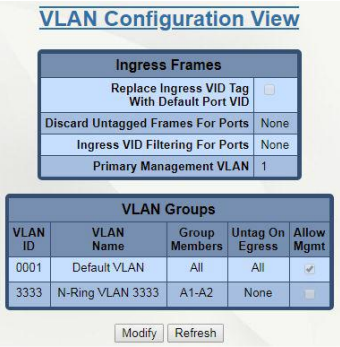
The Configuration screen allows modification of the minimum user password length and the maximum user password length. Both fields, 'Password Length Min' and 'Password Length Max' must be within the overall range of 3 to 15 characters, inclusive.

A configuration change, min or max, will not be allowed if an existing user password will fall out of the desired range (or become non-compliant). Each of the users preventing the change will be listed in the error message. In this case, each of the users that would become non-compliant would need to have their password lengths changed to fall into the new desired range before the configuration change can be applied.

VLAN

The VLAN Configuration View dialog window shows information about the existing VLANs.

Note: Bypass Relay models affect this feature. For more information, see the section Bypass Relay (BR).



Ingress Frames

Replaces Ingress VID Tag With Default Port VID: Specifies whether or not to replace the VID tag of ingress frames with the port's default VID (PVID).

Discard Untagged Frames For Ports: Specifies whether or not untagged ingress frames are dropped by the selected ports.

Ingress VID Filtering for Ports: Specifies whether or not to filter out ingress frames when a VID violation is detected on the selected ports.

Primary Management VLAN: The default egress VLAN used for communications initiated by the switch i.e. DHCP requests.

VLAN Groups

VLAN ID: Displays the VLAN identification for the group members. The range should be 1 - 4094.

VLAN Name: This field displays the VLAN name, which accepts alphanumeric and only the following special characters (including the period)**: # _ - .**

Group Members: This field specifies which ports are members of the VLAN group.

Untag on Egress: Specifies whether or not egress frames are tagged by the port.

Allow Mgmt: Specifies whether or not all ports in this VLAN are management ports.

VLAN Group Members

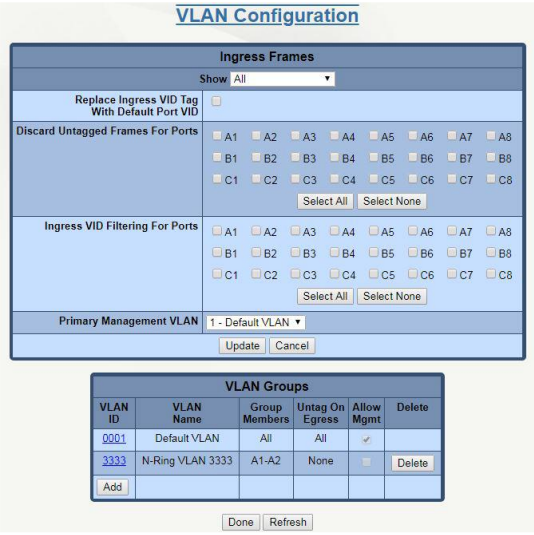
Port No.: The number of the port.

Port Name: The descriptive name of the port.

Group Member: Specifies whether or not the port is a member of the VLAN group.

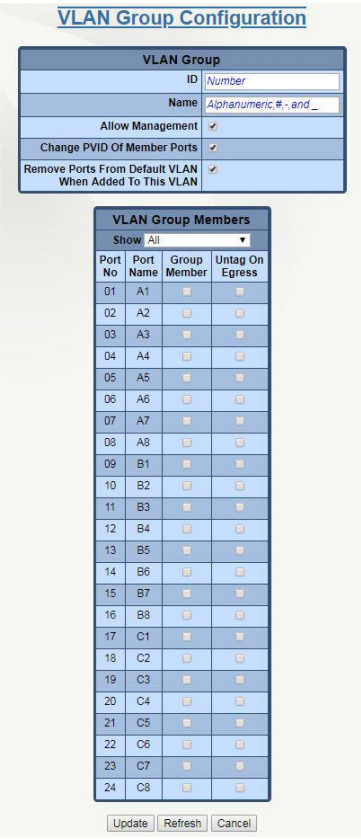
Untag on Egress: Specifies whether or not egress frames are tagged by the port.

Click on the *Modify* button and the following VLAN Configuration page will appear:



The top table is used for general VLAN changes. Once the required changes have been made, click on the *Update* button and then go to the Configuration menu and click on the *Save* button to ensure all changes are saved.

The bottom table is where new VLANs are added and existing ones are modified or deleted.Click on the *Add* button in the bottom table and the following dialog window will appear:



Note: The system is limited to a maximum of 60 configured VLAN groups.

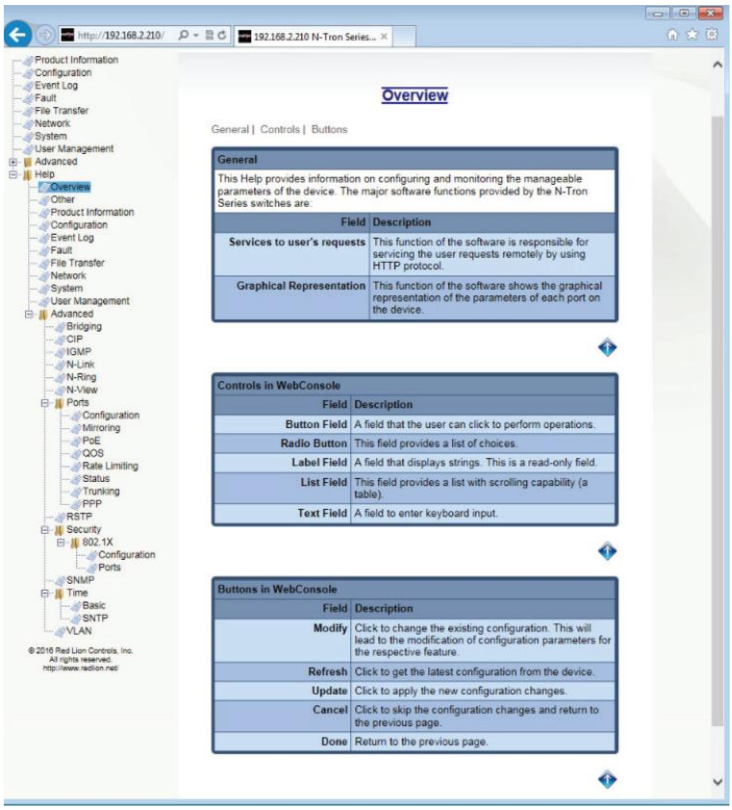
Note: The total number of configured VLAN groups is constrained by system resource usage which varies depending upon network configuration, with VLAN port membership count being the most significant factor.

Note: A port is automatically moved to the Default VLAN if no other VLAN contains that port.

Once the required changes have been made, click on the *Update* button and then go to the *Configuration* menu and click on the *Save* button to ensure all changes are saved.

Help

The Help menu provides information on monitoring and configuring the manageable parameters of the device. Specific help can be found by using the left-hand navigation menu or clicking on the Help link in the top menu.



Appendix A

Command Line Interface

The Command Line Interface (CLI) can be accessed by connecting a host device to the USB connector on the switch. Once connected, the switch will appear as a serial connection. A standard terminal application may be used to communicate to the switch through the serial connection. For serial port settings, see the “USB INTERFACE” section of the NT24k® Series Hardware Manual.

There are two additional methods for connecting to the CLI, Telnet and SSH. Using any standard Telnet client, sim-ply enter the IP address of the switch to start a connection to the CLI. SSH, the secure alternative to Telnet, can also be used with any standard SSH client by simply entering the IP address of the switch to start a secure connection to the CLI.

The CLI contains some status and configuration capability. To interact with the CLI, a login is required. The default username and password is 'admin'. Once logged in, a listing of available commands can be obtained through the help interface. This is accessible by typing either “?” or “help?”. The following commands are available:

NT24k CLI Commands

COMMAND	ARGUMENTS	DESCRIPTION
?		Show system commands. This command is the same as 'help commands' which is shown below.
admin		Administration settings, including IP settings and DHCP mode.
admin system set		Set general system settings.
admin system set contact	<contactname>	The person to contact for system issues, which should be someone within your organization. Only alphanumeric and special characters '#', '_', and '-' are allowed.
admin system set location	<locationname>	The physical location of the switch. Only alphanumeric and special characters '#', '_', and '-' are allowed.
admin system set name	<switchname>	Contains the name assigned to the device, which allows alphanumeric and special characters '#', '_', '-', and ':' only. When IP Configuration is DHCP, this may be used as the Client ID (Option 61) of the DHCP Request.
admin system set upper Threshold	<upperThreshold> - An integer from -60 to 120.	The highest temperature for the switch without causing a fault to occur. The threshold is specified as an integer in C degrees. The range is from -60 C to 120 C, and the default is product dependent (shown only on switches with temperature sensors).
admin system set lower Threshold	<lowerThreshold> - An integer from -60 to 120.	The lowest temperature for the switch without causing a fault to occur. The threshold is specified as an integer in C degrees. The range is from -60 C to 120 C, and the default is product dependent (shown only on switches with temperature sensors).
admin system show		Show general system information.
admin ip set		Set Internet protocol settings.
admin ip set clientid	<type> - A client ID type: [0-switch name, 1-switch MAC, 2-other text, 3-other hex] <value>	This option is used by DHCP clients to specify their unique identifier. DHCP servers use this value to index their database of address bindings. This value is expected to be unique for all clients in an administrative domain. The identifier may be the MAC address, switch name, or entered as a text string or hex characters.

COMMAND	ARGUMENTS	DESCRIPTION
	- A string when the type is 2 or a hex string when the type is 3.	• Usage: admin ip set clientid 0 • Usage: admin ip set clientid 2 "Switch53"
admin ip set dhcp admin ip set no dhcp		Determines the method used to obtain an IP address, Subnet Mask, and Gateway. When DHCP is enabled, DHCP protocols are used to obtain these values. When DHCP is disabled, Static is selected, and the statically configured values are used. • Usage: "admin ip set dhcp" to enable DHCP mode. • Usage: "admin ip set no dhcp" to disable DHCP and return back to Static.
admin ip set ip	[address <ipaddress>] - The IP address of the device. [mask <subnetmask>] - The Subnet mask of the device. [gateway <gateway>] - The Gateway address of the device.	Set the Static IP address, subnet mask, and/or gateway. • Usage: admin ip set ip [address (IP address)] [mask (Subnet mask)] [gateway (Gateway address)] **Example:** CLI> admin ip set ip address 192.168.2.212 mask 255.255.255.0 gateway 192.168.2.1
admin ip show		Show Internet protocol settings. **Example:** CLI> admin ip show
arl		Show ARL Configuration.
arl show		Show ARL Configuration. Example: CLI> arl show Arl Settings Src MAC Address Vlan Sta Drop Blk Loc Destination Ports Applies only to Ports ================== ==== === ==== === === ========== 00:07:af:7d:37:e0 1 Y N N FDB CPU All 01:00:5e:00:00:fb 1 Y N N FDB C7 All 01:00:5e:00:00:fc 1 Y N N FDB C7 All 01:00:5e:7f:ff:fa 1 Y N N FDB C7 All 01:07:af:00:de:d1 ANY Y N N POL CPU A1-A2 01:07:af:00:de:d2 ANY Y N N POL Drop All 01:07:af:00:de:f0 ANY Y N N POL Drop All 01:07:af:00:de:f1 ANY Y N N POL Drop All 01:07:af:00:de:f2 ANY Y N N POL Drop All 01:07:af:00:df:48 ANY Y N N POL Drop All 01:07:af:01:3d:1b ANY Y N N POL CPU All 01:07:af:7d:37:e0 ANY Y N N POL Drop All 01:80:c2:00:00:00 1 Y N Y POL CPU All a0:36:9f:3b:6c:b2 1 N N N FDB C7

COMMAND	ARGUMENTS	DESCRIPTION
		All ff:ff:ff:ff:ff:ff ANY Y N N POL CPU All
arp		Address Resolution display and control.
arp	[<arguments>]	Use arp without arguments to get help. Example: CLI> arp <arp>arguments> - Use arp without arguments to get help. Surround multiple arguments with double quotes. EX: arp "-r 192.168.2.117" CLI> arp NAME arp - address resolution display and control SYNOPSIS arp [-silent] [-V <routetab>] [-i <ifname>] –a arp [-silent] [-V <routetab>] [-i <ifname>] –A arp [-silent] [-V <routetab>] [-i <ifname>] -d <hostaddress> arp [-silent] [-V <routetab>] [-i <ifname>] [-p] [-t] -s <hostaddress> <ether_addr> arp [-silent] [-V <routetab>] [-i <ifname>] -r <hostaddress> DESCRIPTION The arp program displays and modifies the Internet-to-Ethernet address translation tables used by the address resolution protocol. Options: -silent Suppress output. MUST be the first argument. -i <ifname> Specify interface. First one if not specified. -t Temporary ARP entry. -p Public ARP entry (i.e. proxy ARP entry). -r Send an ARP request to the host address. -V <routetab> Specify route table. 0 if not specified. Commands: -a Display the currently existing ARP entries. -A Delete all the ARP entries. -d Delete specified ARP entry. -s Register a ARP entry for a node.
clear		Clear the screen.
config		Save changes to the configuration or reset the configuration to factory defaults.
config reset		Reset configuration settings to factory defaults.
config save		Save current running configuration settings.
dhcpServer		DHCP Server.
dhcpServer status set	<statusValue>	Set DHCP Server status (disabled or enabled).
dhcpServer status show		Show DHCP Server status.
exit		Exit immediate mode. **Example:** CLI> admin ip CLI(admin-ip)> exit CLI>
fileTransfer	tftp server <ip address> transferType	Transfer files to or from the switch.

COMMAND	ARGUMENTS	DESCRIPTION
	<UpgradeSystem, UpgradeBootLoader, ImportConfig, ExportSavedConfig, ExportEventLog> [file <string>]	
help		Show command help.
help commands		Show system commands. Example: CLI> help commands admin - Administration settings, including IP settings and DHCP mode. arl - Arl Settings arp - Address Resolution Protocol (ARP) clear - Clear the screen config - Save changes to the configuration, or reset switch to factory defaults. dhcpServer - DHCP Server exit - Exit immediate mode fileTransfer - Transfer files help - Show command help history - Show command history lldp - Link Layer Discovery Protocol logout - Log off this system ping - Ping a host. port - Port settings portSecurity - Port Security ppp - Start PPP server (use from serial console only). reboot - Reboot the switch and load the most recently saved configuration. who - Display users currently logged in whoami - Show current user info
help edit		Show editing keys. **Example:** CLI> help edit Available editing keystrokes: Delete current character.....Ctrl-d Delete text up to cursor.....Ctrl-u Delete from cursor to end of line.....Ctrl-k Move to beginning of line..... Ctrl-a Move to end of line.....Ctrl-e Get prior command from history.....Ctrl-p Get next command from history.....Ctrl-n Move cursor left..... Ctrl-b

COMMAND	ARGUMENTS	DESCRIPTION
		Move cursor right.....Ctrl-f Move back one word.....Esc-b Move forward one word.....Esc-f Convert rest of word to uppercase.....Esc-c Convert rest of word to lowercase.....Esc-l Delete remainder of word.....Esc-d Delete word up to cursor.....Ctrl-w Transpose current and previous character..... Ctrl-t Enter command and return to root prompt..... Ctrl-z Refresh input line..... Ctrl-l
help help		Show command help. **Example:** CLI> help help help - Show command help commands - show system commands edit - Show editing keys
history		Show command history. **Example:** CLI> history 1 admin ip set no dhcp 2 admin ip set ip 192.168.2.212 3 history
history clear		Reset all history.
history enable		Turn history capture on.
history filter		Do not capture repeated input into history.
history info		Information **Example:** CLI> history info 1 admin ip set no dhcp 2 admin ip set ip 192.168.2.212 3 history 3 history info History filter: off History modal : off History ring : on
lldp		Link Layer Discovery Protocol.
lldp mode show		Show LLDP mode.
lldp mode set	disable, enabled, auto	Set LLDP mode.
lldp wakeTime show		Show remaining wake time in auto LLDP mode.
lldp wakeTime send	hours <hours> minutes <minutes>	Send wake time in auto LLDP mode to all switches.
logout		Log off this system.
ping		Ping a host.
ping	[<arguments>]	Use ping without arguments to get help. Surround multiple arguments with double quotes. **Example:** ping "-c 3 192.168.2.121"
port		Port Mirroring configuration display and control.

COMMAND	ARGUMENTS	DESCRIPTION
port config show	<portlist>	Show all port configuration information for the specified ports.
port config show all		Show all port configuration information for all ports on the switch.
port config show basic	[<portlist>]	Show basic port configuration information for the specified ports.
port mirror set		Set Port Mirroring configuration.
port mirror set enable port mirror set no enable		Enable or disable Port Mirroring. Use "no enable" to disable.
port mirror set destination	<port>	Set the destination port for Port Mirroring. For example, "A4".
port mirror set txsource	<portlist>	Set the transmit source ports that are mirrored to the destination port. For example, "A1,A2".
port mirror set rxsource	<portlist>	Set the receive source ports that are mirrored to the destination port. For example, "A1-A3,A6".
port mirror set dataonly port mirror set no dataonly		Set mirrored data only. Use "no dataonly" to disable.
port mirror show		Show Port Mirroring configuration. **Example:** CLI> port mirror show Port Mirroring Settings Mirror Status : Enabled Destination Port : A1 Mirrored Data Only : Enabled Tx Source Ports : None Rx Source Ports : A4
portSecurity		Port Security
portSecurity status set	disabled, learning, locked	Set port security status
portSecurity status show		Show port security status.
portSecurity intruderLog show		Show the contents of the intruder log
portSecurity authList show	[<portlist>]	Show the contents of the authorization list
ppp		Start PPP server (available from the serial console only).
reboot		Reboot the switch and load the most recently saved configuration.
who		Display users currently logged in. **Example:** CLI> who Line User Host(s) Idle Location 00:00:00 admin Console
whoami		Show current user information. **Example:** CLI> whoami

COMMAND	ARGUMENTS	DESCRIPTION
		User name: admin

System Information

Command: admin system show
Description: Show general system information

```
CLI>    admin system show

System Settings

Name                              : NT24k-DR16-DC

Model Name                        : NT24k-DR16

Family Name                       : NT24k

Software Version                  : 2.2.3

Build Date                        : Oct 25 2019. 16:36:28

Boot Loader                       : 2.0.7

Copyright                         : Copyright <c> 2013-2019

URL                          : http://www.redlion.net/

Ram Size                     : 128 MB

Flash Size                   : 64 MB

Internet Protocol (IP) Settings

IP Configuration             : DHCP

DHCP Client ID Type          : Switch Name

DHCP Client ID Data          : N-Tron Series 77:fd:00

Fallback IP Enable           : Enabled

Fallback IP Address          : 192.168.1.201

Fallback IP Subnet           : 255.255.255.0

Fallback IP Gateway          : 0.0.0.0

Current IP Address           : 0.0.0.0

Current Subnet Mask          : 0.0.0.0

Current Gateway Address      : 0.0.0.0

MAC Address                  : 00:07:af:77:fd:00

--------

System Up Time               : 0d 04:05:42

System Time                  : 2000-01-01 04:05:41 CST (UTC-06:00)

Switch Name                  : N-Tron Series 77:fd:00

Switch Contact               : Admin
```

```
Switch Location            : Mobile, AL 36606

--------

Device Temperature         : 50 C, 122 F

Upper Temperature Limit    : 120

Lower Temperature Limit    : -60

CLI>
```

Displaying Port Information

Command: port config show <all|basic> <port-list>

Description: Show general port configuration, similar to what is displayed in the Web Software. The first parameter ("all" or "basic") specifies how much information to show and the port-list parameter can be used to filter the displayed ports. This can be a single port, a range of ports (ex. 1-3) or multiple ranges of ports, separated by a comma. Ports can also be selected by name or by number.

Note: If you want all information for a specific port, or set of ports, simply call **port config show <port-list>**. If you want only basic information, you will need to include "basic" before **<port-list>**.

```
CLI> port config show basic

Port Configuration View

Port Port Port                 Admin    Link   Port  Role Port          PVID
No   Name Description          Status   Status Speed      State
---- ---- ---------------------- -------- ------ -----  ---- ------------ ----
1    P1   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
2    P2   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
3    P3   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
4    P4   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
5    P5   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
6    P6   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
7    P7   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
8    P8   10/100/1000 Mbps TX Enabled  Up     1000  RSTP Forwarding    1
9    DM1  Not Installed        Enabled  Down   1000  RSTP Not Installed 1
10   DM2  Not Installed        Enabled  Down   1000  RSTP Not Installed 1
11   DM3  Not Installed        Enabled  Down   1000  RSTP Not Installed 1
12   DM4  Not Installed        Enabled  Down   1000  RSTP Not Installed 1

CLI> port config show P1

Port Configuration View

Port Number:            1
Port Name:              P1
Port Description:       10/100/1000 Mbps TX
Admin Status:           Enabled
Link Status:            Down
Auto Nego:              Enabled
Port Speed:             Auto
Duplex Mode:            Auto
Flow Control:           Disabled
Cross Over:             Auto
Role:                   RSTP
Port State:             Discarding
PVID:                   1
Trunk ID:               0
Usage Alarm Low:        0
Usage Alarm High:       100

CLI> port config show basic P1-P2,P5

Port Configuration View

Port Port Port                 Admin    Link   Port  Role Port          PVID
No   Name Description          Status   Status Speed      State
---- ---- ---------------------- -------- ------ -----  ---- ------------ ----
1    P1   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
2    P2   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1
5    P5   10/100/1000 Mbps TX Enabled  Down   Auto  RSTP Discarding    1

CLI>
```

Setting a Static IP Address

By default, the switch will use the DHCP protocol for IP address assignment. The switch may also be configured to use a static IP address.

Command: admin ip set

Description: Moves the CLI to the IP address settings immediate mode. Typing "?" will provide the command options available here.

Once in the IP immediate mode, it is easy to change the address configuration. Once set, the new configuration must be saved for this change to be retained after a reboot.

```
CLI(admin-ip-set)> ip address 192.168.2.209 mask 255.255.255.0 gateway 0.0.0.0
CLI(admin-ip-set)> no dhcp

        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        +       Static Settings
        +               IP Address:     192.168.2.209
        +               Subnet Mask:    255.255.255.0
        +               Gateway:        0.0.0.0
        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
CLI(admin-ip-set)> exit
CLI>
```

Performing a File Transfer

File transfers can be initiated through the CLI by using TFTP Protocol.

Command: fileTransfer tftp server <ip address> transferType <UpgradeSystem, UpgradeBootLoader, ImportConfig, ExportSavedConfig, ExportEventLog> [file <string>]

Description: Initiates the file transfer from the CLI.

```
CLI>

CLI> fileTransfer tftp server 192.168.2.1 transferType Upgrade System

CLI> File Transfer: Starting in the background

File Transfer: Please do not turn off power until it's completed

Processing '/ram0/xfr/NT24k_image.tar' will take about 1 minute.

Contents from /ram0/xfr/NT24k_image.tar

file NT24k.image, size 10299280 bytes, 20116 blocks

file NT24k_image.xml, size 1287 bytes, 3 blocks

end of tape encountered, read until eof…

done reading contents


Extracting from /ram0.xfr/NT24k_image.tar

file NT24k.image, size 10299280 bytes, 20116 blocks

extracting file NT24k_image.xml, size 1287 bytes, 3 blocks

end of tape encountered, read until eof…

done extracting tar.

file NT24k_image.xml, size 1287 bytes, 3 blocks

moving file /sffs0/temp/NT24k.image → /sffs0/image/NT24k.image


Stored /sffs0/image/NT24k.image (10299280 bytes) in 1:19.247 (130370
bytes/second)

Done Processing '/ram0/xfr/NT24k_image.tar'. Elapsed time: 1:25.996

File Transfer: Completed

CLI>

CLI> fileTransfer tftp server 192.168.2.1 transferType UpgradeSystem file
NT24k_Image.tar

CLI> File Transfer: Starting in the background

File Transfer: Please do not turn off power until it's completed
```

```
Processing '/ram0/xfr/NT24k_Image.tar' will take about 1 minute.

Contents from /ram0/xfr/NT24k_Image.tar
file NT24k.image, size 10299280 bytes, 20116 blocks
file NT24k_image.xml, size 1287 bytes, 3 blocks
end of tape encountered, read until eof…
done reading contents.

Extracting from/ram0/xfr/NT24k_Image.tar
file NT24k.image, size 10299280 bytes, 20116 blocks
file NT24k_image.xml, size 1287 bytes, 3 blocks
end of tape encountered, read until eof…
done extracting tar.
file NT24k_image.xml, size 1287 bytes, 3 blocks
moving file /sffs0/temp/NT24k.image → /sffs0/image/NT24k.image

Stored /sffs0/image/NT24k.image (10299280 bytes) in 1:19.595 (130370
bytes/second)
Done Processing '/ram0/xfr/NT24k_Image.tar'. Elapsed time: 1:26.333
File Transfer: Completed
```

Saving the Configuration

When configuration changes are made, they are not automatically saved to NVRAM and will be discarded at the next power cycle. Configuration changes must be saved to be retained across power cycles.

Command: config save

Description: Save all current changes to the configuration for use after the next power cycle. If a Configuration Device is installed, the configuration will also be saved to the device.

```
CLI>
CLI> config save
CLI>
```

Appendix B

Working with Configuration Files

Importing a Subset of an XML Configuration File

The XML configuration file may be used to set all of the configurable parameters on a NT24k® switch or to configure a subset of parameters. Setting common parameters across multiple switches can be easily accomplished by creating and importing an abridged configuration file for this purpose.

Appendix C contains an example XML Configuration file. A simple way to start an XML configuration file is to export the existing saved configuration file from the switch and modifying it to meet your new configuration needs.

When creating a configuration file for a subset of available parameters, setting the system configuration mode to *Keep* will maintain the current settings for all parameters other than those explicitly set by the new file being imported. If the system configuration mode is not set to *Keep*, all parameters other than those being set by the configuration file, will be reset to their default setting.

In the example below, the mode is set to Keep so that other switch settings are not reset to defaults. Additional information about the content of the configuration file can be found at the top of any exported configuration file.

```
<SystemConfiguration Mode="Keep"?
  <SystemGroup>
    <SystemConfig>
      <SwitchContact>IT Department Manager</SwitchContact>
      <SwitchLocation>Factory Floor B</SwitchLocation>
    </SystemConfig>
  </SystemGroup>
</SystemConfiguration>
```

Using Port Numbers instead of Port Names

In a configuration file, it is valid to use port numbers instead of names to simplify the sharing of configuration settings. Ports are numbered starting at 1.

Port names may differ between switch models. For example, the NT24k-DR24 uses A1-A8, B1-B8, and C1-C8 and the NT24k-14FX6 uses P1-P8 and FX1-FX6. However the configuration files can reference ports 1-24 for an NT24k and ports 1-14 for an NT24k-14FX6.

In the following example, VLAN 1 is configured for ports 1 through 8 and VLAN 2 is configured for ports 9 through 16. This settings file can be imported into any NT24k switch that supports 16 or more ports. Note that the configuration file must also set the appropriate port PVIDs.

```
<SystemConfiguration Mode="Keep">
  "VlanGroup>
    <IngressDiscardUntagged>None</IngressDisgardUntagged>
    <IngressReplaceVID>Disabled</IngressReplaceVID>
    <IngressVidFilter>None</IngressVidFilter>
    <PrimaryMgmtVlanId>1</PrimaryMgmtVlanId>
    <RemoveportsFromDefaultVlan>Enabled</RemovePortsFromDefaultVlan>
    <TaggedVlans>
      <Vlan>
            <AllowManagement>Enabled</AllowManagement?
            <MemberPorts>1-8</MemberPorts>
            <Name>Default VLAN</Name>
            <UntagEgressPorts>1-8</UntagEgressPorts>
```

```
            <VlanId>1</VlanId>
        </Vlan>
        <Vlan>
            <AllowManagement>Enabled</AllowManagement>
            <MemberPorts>1-8</MemberPorts>
            <Name>Default VLAN</Name>
            <UntagEgressPorts>1-8</UntagEgressPorts>
            <VlanId>1</VlanId>
        </Vlan>
    </TaggedVlans>
    <Type>Tagged</Type>
```

Importing an Incompatible XML Configuration File

Errors related to invalid port names or numbers may occur when importing a configuration file from one model of an NT24k® switch into a different model of an NT24k switch.

Field	Description
Destination	XML line:(216) - Could not set '/SystemConfiguration/MirrorGroup/MirrorConfig/Destination' to value 'P1'
Error Cause	0x80010008 - Invalid Port (ERR_InvalidPort)
ControlPort	XML line:(226) - Could not set '/SystemConfiguration/NLinkGroup/NLinkConfig/ControlPort' to value 'P3'
Error Cause	0x80010008 - Invalid Port (ERR_InvalidPort)
CouplerPort	XML line:(227) - Could not set '/SystemConfiguration/NLinkGroup/NLinkConfig/CouplerPort' to value 'P4'
Error Cause	0x80010008 - Invalid Port (ERR_InvalidPort)
Portx	XML line:(244) - Could not set '/SystemConfiguration/NringGroup/NringConfig/NringPortSets/PortSet/Portx' to value 'P1'
Error Cause	0x80010008 - Invalid Port (ERR_InvalidPort)
Porty	XML line:(245) - Could not set '/SystemConfiguration/NringGroup/NringConfig/NringPortSets/PortSet/Porty' to value 'P2'

Resolving Invalid Port Mappings

If the number of ports in the XML configuration file is greater than on the target model, then the following sections should be removed for each of the extra ports.

- SystemConfiguration/LldpGroup/LldpConfig/LldpPorts/Port
- SystemConfiguration/PoeMgmtGroup/PoeMgmtConfig/PoePorts/Port (PoE models only)
- SystemConfiguration/PortGroup/PortConfig/Ports/Port
- SystemConfiguration/PortSecGroup/PortSecConfig/PortSecList/PortSecEntry
- SystemConfiguration/PtpGroup/PtpConfig/BoundaryClock/PtpPorts/Port (when PTP is licensed)
- SystemConfiguration/PtpGroup/PtpConfig/TransparentClock/PtpPorts/Port (when PTP is licensed)
- SystemConfiguration/RateLimitGroup/RateLimitConfig/RateLimits/Limit
- SystemConfiguration/RstpGroup/RstpConfig/RstpPorts/Port

Notice that if the target switch has additional ports whose settings are not specified in the imported configuration file, then these additional ports will have their settings set to default values if the mode has not been set to “Keep”.

Ports on the target switch that do not exist in the configuration file will be added to Default VLAN 1. If the configuration file has extra VLANs with ports that do not exist, an error will be generated for each non-existent port.

Resolving Invalid Port Names

If the port names in the XML configuration file are different than on the target model, then rename the ports for the following sections so that the new names correspond to the intended ports on the target model.

- SystemConfiguration/LldpGroup/LldpConfig/LldpPorts/Port/PortNumber
- SystemConfiguration/MirrorGroup/MirrorConfig/Destination

- SystemConfiguration/NLinkGroup/NLinkConfig/ControlPort
- SystemConfiguration/NLinkGroup/NLinkConfig/CouplerPort
- SystemConfiguration/NringGroup/NringConfig/NringPortSets/Portx
- SystemConfiguration/NringGroup/NringConfig/NringPortSets/Porty
- SystemConfiguration/PoeMgmtGroup/PoeMgmtConfig/PoePorts/PortNumber (PoE models only)
- SystemConfiguration/PortGroup/PortConfig/Ports/Port/PortNumber
- SystemConfiguration/PortSecGroup/PortSecConfig/PortSecList/PortSecEntry/PortNumber
- SystemConfiguration/PtpGroup/PtpConfig/BoundaryClock/PtpPorts/Port/PortNumber (when PTP is licensed)
- SystemConfiguration/PtpGroup/PtpConfig/TransparentClock/PtpPorts/Port/PortNumber (when PTP is licensed)
- SystemConfiguration/RateLimitGroup/RateLimitConfig/RateLimits/Limit/PortNumber
- SystemConfiguration/RstpGroup/RstpConfig/RstpPorts/Port/PortNumber

Depending on the exported values, some of the following sections in the XML configuration file may also need to have their ports renamed.

- SystemConfiguration/BridgingGroup/BridgingConfig/MulticastFilters/PortList
- SystemConfiguration/BridgingGroup/BridgingConfig/UnicastFilters/PortNumber
- SystemConfiguration/IgmpGroup/IgmpConfig/ManualRouterPorts
- SystemConfiguration/IgmpGroup/IgmpConfig/RFilterPorts
- SystemConfiguration/MirrorGroup/MirrorConfig/RxSourcePorts
- SystemConfiguration/MirrorGroup/MirrorConfig/TxSourcePorts
- SystemConfiguration/NViewGroup/NViewConfig/SendAutocastPorts
- SystemConfiguration/NViewGroup/NViewConfig/SendMibStatsPorts
- SystemConfiguration/SecurityDot1xGroup/SecurityDot1xConfig/EnabledPorts
- SystemConfiguration/TrunkGroup/TrunkConfig/Trunks
- SystemConfiguration/VlanGroup/VlanConfig/IngressDiscardUntagged
- SystemConfiguration/VlanGroup/VlanConfig/IngressVidFilterf
- SystemConfiguration/VlanGroup/VlanConfig/TaggedVlans/Vlan/MemberPorts
- SystemConfiguration/VlanGroup/VlanConfig/TaggedVlans/Vlan/UntagEgressPorts

Example Scenarios

MODEL OF EXPORTED CONFIGURATION FILE	TARGET MODEL	EXPECTED RESULTS OF IMPORTING XML CONFIGURATION FILE
NT24k-DR16	NT24k-DR24	Import successful; Last 8 ports on target model will reset to default values if the mode has not been set to “Keep”.
NT24k-DR24	NT24k-DR16	Invalid port mappings
NT24k-DR16	NT24k-16TX	Invalid port names
NT24k-DR16	NT24k-8TX	Invalid port mappings and names

Appendix C

XML Configuration File

Factory Defaults

The following is a shortened example of an XML configuration file:

```
<!-- ************************************************************************
    Overview of XML settings for the N-Tron NT24k series switches
    XML settings can be downloaded to a switch to configure the switch.
    There are several top level configuration sections. Each section is optional.
    Common Attributes:
    ******************
    The following attributes are common to all sections. If omitted from a section,
      then the value from the parent section is used. If completely omitted, a
      system default value is used.

     Crc            Optional. This is not used in this release, but may be
                    used in a future release.
     CurSwVer       Optional. String representation of switch version that the
                    settings were exported from.
     Version        Optional. If present, represents the version of the
                    section. If not present, the default value is used instead
                    of being inherited from the parent section.
                    Default = "1".
     MinSwVer       Optional. String representation of switch version. If
                    present, ignore settings for the section if switch
                    software version does not meet minimum requirement.
                    Default = "1.0".
     Mode           Optional. If present, determines the type of action to
                    take on existing data in the section. In the event of a
                    conflict, precedence goes to the deepest level that is
                    explicitly expressed.
                    Possible values:
                    Delete   (Default) Delete all existing data for the
                    section and replace it with the values in this section.
                    Any missing data gets set to factory default values.
                    Keep   Keep existing data, unless new values are specified
                    in this section. A factory default value is used if there
                    is no previously existing data.
     Convert        Optional. If present, determines whether data conversion
                    is performed when necessary.
                    Possible values:
                    Auto   (Default) When a data conversion is determined to
                    be necessary it will be done automatically, without any
                    user intervention.
                    No   Data conversion is not performed, but settings are
                    validated.
     ValidatePorts  Optional. If present, determines if port names or numbers,
                    within lists, that are not valid on this device should be
                    ignored or generate an error.
```

```
                    Possible values:
                    Yes   (Default) Ports are validated.
                    No   Invalid ports are ignored.
      Model         Optional. If present, represents the switch model that the
                    settings were exported from.

  Notes:
  ******
  Comments added to this file will not be preserved.
  ************************************************************************ -->
  <!-- ************************************************************************
  SystemConfiguration ******************************************************
************************************************************************** -->
  <SystemConfiguration Model="NT24k-DR16" ValidatePorts="Yes" Convert="Auto"
Mode="Delete" MinSwVer="1.0" Version="2" CurSwVer="1.9.2">
  <BridgingGroup>
       <BridgingConfig>
             <AgingTime>300</AgingTime>
             <EnableIpProbe>Disabled</EnableIpProbe>
             <MulticastFilters></MulticastFilters>
             <UnicastFilters></UnicastFilters>
       </BridgingConfig> </BridgingGroup>
  [ content intentionally omitted ]
  </SystemConfiguration>
```

For a complete example of an XML configuration file, click on the following link: http://www.redlion.net/resources/software/n-tron-software and refer to section NT24k® Industrial Ethernet Switches.

FAZ-NA and FAZ-NA-L Circuit Breakers

Optimum and Efficient Protection for Every Application

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FAZ-NA and FAZ-NA-L Circuit Breakers

Product Overview

Optimum product quality, tested reliability and safety stand for best protection of personnel, installations and plant. Eaton's FAZ-NA and FAZ-NA-L DIN rail mountable circuit breakers are designed for use in branch service applications.

Powerful Offering for Machine and System Builders

FAZ-NA and FAZ-NA-L are available with B, C and D characteristics in accordance with UL® 489, CSA® C22.2 No.5; UL 1077, CSA C22.2 No.235 and IEC 60947-2. These devices are CE marked.

Application Description

Feeder and branch circuit protection for:

- Convenience receptacle circuits (internal/external)
- Motor control circuits
- Load circuits leaving the equipment (external)
- HACR internal/external equipment (heating, air conditioning, refrigeration)
- PLC I/O points
- Computers
- Power supplies
- Control instrumentation
- Relays
- UPS
- Power conditioners

Features

- Complete range of UL 489 listed DIN rail mounted miniature circuit breakers up to 63A current rating
- Two distinct UL 489 FAZ-NA offerings available to provide the best solution for the application—FAZ-NA at 277/480 Vac and FAZ-NA-L at 240 Vac
- Standard ratings of 10 kAIC available at both 240 Vac and 277/480 Vac
- Select amperages available at 14 kAIC for both the 240 Vac and 277/480 Vac offerings and 10 kAIC up to 125 Vdc per pole
- Current limiting design provides fast short-circuit interruption that reduces the let-through energy, which can damage the circuit
- Suitable for branch circuit device protection
- Thermal-magnetic overcurrent protection
  - Three levels of short-circuit protection, categorized by B, C and D curves
- Trip-free design—breaker can not be defeated by holding the handle in the ON position
- Captive screws cannot be lost
- SWD (switching duty)—suitable for switching fluorescent lighting loads ($I_n \leq 20A$)
- Fulfill UL 489, CSA C22.2 No.5 and also IEC 60947-2 Standard
- For use in applications for which UL 1077 or CSA C22.2 No.235 are also allowed
- Field-installable shunt trip and auxiliary switch subsequent mounting
- Separate version for ring-tongue connection (Type FAZ-RT), terminal screws can be removed (on both sides)
- Module width of only 17.7 mm (per pole)
- Contact Position Indicator (red/green)
- Easy installation on DIN rail
- Possibility for sealing the toggle in ON or OFF position
- Single-, two-, three- and four-pole configurations

Device Printing on Front and Side

Installation options

These branch circuit breakers are available in two terminal configurations: standard box terminals that accept multiple conductors and ring-tongue terminals, ideally suited to demanding requirements of the semi-conductor industry. All breakers mount on standard 35 mm DIN rail. Bus connectors and feeder terminal facilitate mounting and wiring of multiple miniature circuit breaker arrays in control panel assemblies. These circuit breakers can also be reverse feed.

1

Standards and Certifications

FAZ-NA

FAZ-NA complies with the latest national and international standards.

- UL 489
  - Standard for molded case circuit breakers (MCCB) for feeder and branch circuit protection
  - Products meet the requirements of the National Electrical Code® (NEC®)
- CSA C22.2 No.5
  - Standard for molded case circuit breakers (MCCB) for feeder and branch circuit protection (corresponds closely to UL 489 Standard)
  - Products meet the requirements of the Canadian Electrical Code (CEC)
- RoHS compliant
- VDE compliant
- ABS compliant

FAZ-NA-L

FAZ-NA-L 0.5–63A at 240 Vac comply with the following standards.

- UL 489 listed
- CSA C22.2 No. 5-02
- IEC rated
- RoHS compliant
- CCC compliant
- OVE compliant
- EAC compliant
- ABS compliant
- VDE compliant

Catalog Number Selection

FAZ - C 6 / 1 - NA - SP

Breaker Family

FAZ = FAZ UL circuit breaker

Trip Characteristics ①

B = 3–5X I_n
C = 5–10X I_n
D = 10–20X I_n

Ampere Rating ②

0.5 = 0.5A	**13** = 13A
1 = 1A	**15** = 15A
1.5 = 1.5A	**16** = 16A
2 = 2A	**20** = 20A
3 = 3A	**25** = 25A
4 = 4A	**30** = 30A
5 = 5A	**32** = 32A
6 = 6A	**35** = 32A
7 = 7A	**40** = 40A
8 = 8A	**50** = 50A
10 = 10A	**63** = 63A

Number of Poles

1 = Single-pole
2 = Two-pole
3 = Three-pole
4 = Four-pole

Terminal

NA = UL 489 branch circuit at 277/480 Vac with screw terminals
RT = UL 489 branch circuit at 277/480 Vac with ring-tongue terminals
DC = UL 489 branch circuit at 125 Vdc per pole
NA-L = UL 489 branch circuit at 240 Vac with screw terminals
RT-L = UL 489 branch circuit at 240 Vac with ring-tongue terminals

Single Package ③

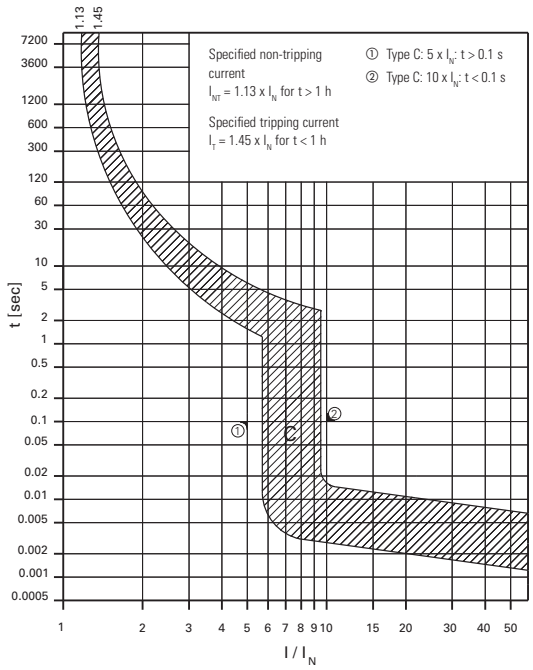
SP = Single package for C and D curve single-pole at 277 Vac only
Blank = Standard packaging

Notes

① I_n = Rated current for instantaneous trip characteristics.
② B curve starts at 1 ampere.
③ Single package only available for 277 Vac offering—not an option for 240 Vac line.

FAZ-NA C Curve 277/480 Vac Rated Offering

- UL approved (UL 489) and CSA Certified (CSA C22.2 No.5-02) as branch circuit breakers
- Interrupting capacity: 10 kA UL/CSA; 15 kA IEC 60947-2
- Current limiting device
- UL file number E235139



Single-Pole

Two-Pole

Three-Pole

Four-Pole

FAZ-NA UL 489 Circuit Breakers at 277/480 Vac—10 kAIC, 14 kAIC C Curve (15–25A)

Amps	Single-Pole ① Catalog Number	Two-Pole Catalog Number	Three-Pole Catalog Number	Four-Pole Catalog Number
C Curve (5–10X I_n Current Rating)				
0.5	FAZ-C0.5/1-NA-SP	FAZ-C0.5/2-NA	FAZ-C0.5/3-NA	FAZ-C0.5/4-NA
1	FAZ-C1/1-NA-SP	FAZ-C1/2-NA	FAZ-C1/3-NA	FAZ-C1/4-NA
1.5	FAZ-C1.5/1-NA-SP	FAZ-C1.5/2-NA	FAZ-C1.5/3-NA	FAZ-C1.5/4-NA
2	FAZ-C2/1-NA-SP	FAZ-C2/2-NA	FAZ-C2/3-NA	FAZ-C2/4-NA
3	FAZ-C3/1-NA-SP	FAZ-C3/2-NA	FAZ-C3/3-NA	FAZ-C3/4-NA
4	FAZ-C4/1-NA-SP	FAZ-C4/2-NA	FAZ-C4/3-NA	FAZ-C4/4-NA
5	FAZ-C5/1-NA-SP	FAZ-C5/2-NA	FAZ-C5/3-NA	FAZ-C5/4-NA
6	FAZ-C6/1-NA-SP	FAZ-C6/2-NA	FAZ-C6/3-NA	FAZ-C6/4-NA
7	FAZ-C7/1-NA-SP	FAZ-C7/2-NA	FAZ-C7/3-NA	FAZ-C7/4-NA
8	FAZ-C8/1-NA-SP	FAZ-C8/2-NA	FAZ-C8/3-NA	FAZ-C8/4-NA
10	FAZ-C10/1-NA-SP	FAZ-C10/2-NA	FAZ-C10/3-NA	FAZ-C10/4-NA
13	FAZ-C13/1-NA-SP	FAZ-C13/2-NA	FAZ-C13/3-NA	FAZ-C13/4-NA
15	FAZ-C15/1-NA-SP	FAZ-C15/2-NA	FAZ-C15/3-NA	FAZ-C15/4-NA
16	FAZ-C16/1-NA-SP	FAZ-C16/2-NA	FAZ-C16/3-NA	FAZ-C16/4-NA
20	FAZ-C20/1-NA-SP	FAZ-C20/2-NA	FAZ-C20/3-NA	FAZ-C20/4-NA
25	FAZ-C25/1-NA-SP	FAZ-C25/2-NA	FAZ-C25/3-NA	FAZ-C25/4-NA
30	FAZ-C30/1-NA-SP	FAZ-C30/2-NA	FAZ-C30/3-NA	FAZ-C30/4-NA
32	FAZ-C32/1-NA-SP	FAZ-C32/2-NA	FAZ-C32/3-NA	FAZ-C32/4-NA

Note

① Option for single packaging on single-pole C and D curves only; add suffix SP when ordering.

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Technical Data and Specifications

Trip Curve Chart

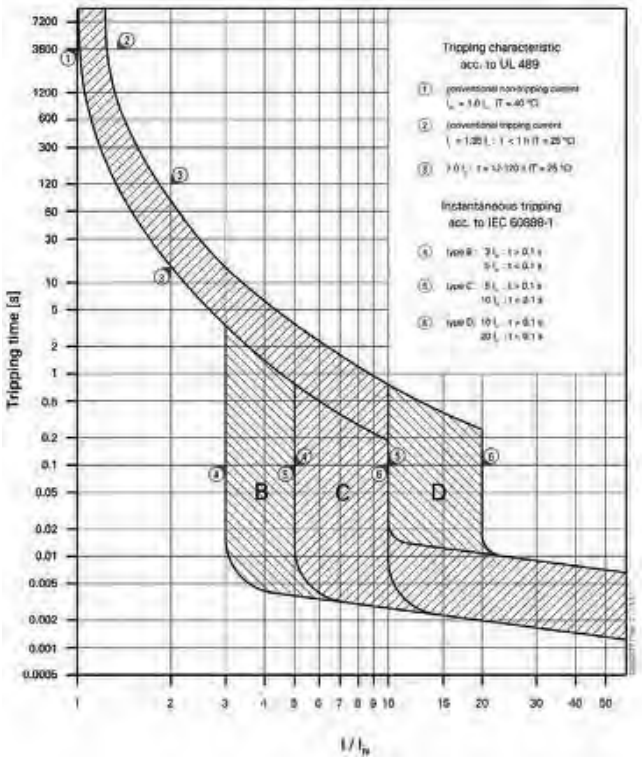
Eaton FAZ-NA and FAZ-NA-L branch circuit breakers are available with "B," "C" and "D" tripping characteristics. B-curve devices are suitable for applications where low levels of inrush current are expected.

C-curve devices are suitable for applications where medium levels of inrush current are expected. Applications include small transformers, lighting, pilot devices, control circuits and coils. C-curve devices provide a medium magnetic trip point.

D-curve devices are suitable for applications where high levels of inrush current are expected. The high magnetic trip point prevents nuisance tripping in high inductive applications such as motors, transformers and power supplies.

Eaton FAZ-NA and FAZ-NA-L devices are current limiting, which means they interrupt fault currents within one half cycle of the fault. Current limiting devices offer superior protection by reducing peak let-through current and energy.

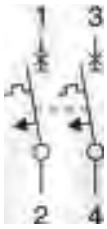
Tripping Characteristics



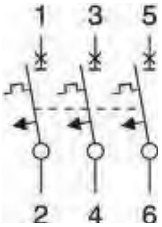
Connection Diagrams

Single-Pole

Two-Pole



Three-Pole



UL 489 Miniature Circuit Breakers Technical Data

Description	FAZ-NA	FAZ-NA-DC	FAZ-NA-L
Electrical			
Design according to	UL 489, CSA C22.2 No.5, IEC 60947-2	UL 489, CSA C22.2 No.5, IEC 60947-2	UL 489, CSA C22.2 No.5, IEC 60947-2
Rated voltage	Single-pole: 277 Vac 2-, 3- or 4-pole: 277/480 Vac	125 Vdc per pole 250 Vdc with 2-poles in connected series	Single-pole: 240 Vac 2-, 3- or 4-pole: 240 Vac
	Single-pole: 48 Vdc per pole 2-pole in series: 96 Vdc	—	Single-pole: 48 Vdc per pole 2-pole in series: 96 Vdc
Rated current	B: 1–32 A C & D: 0.5–32 A	C: 2–40 A	B: 1–63 A C: 0.5–63 A D: 0.5–40 A
Characteristic	B, C, D	C	B, C, D
Current interrupting rating	B curve—10 kA: 1–13 A, 30–32 A C curve—10 kA: 0.5–13 A, 30–32 A B & C curve—14 kA: 15–25 A D curve—10 kA: 0.5–10 A, 25–32 A D curve—14 kA: 13–20 A	10 kA	B curve—10 kA: 1–13 A, 30–32 A C curve—10 kA: 0.5–13 A, 30–32 A B & C curve—14 kA: 15–25 A D curve—10 kA: 0.5–10 A, 25–32 A D curve—14 kA: 13–20 A
Rated frequency	50/60 Hz	50/60 Hz	50/60 Hz
Endurance	≥ 20,000 operations	≥ 20,000 operations	≥ 20,000 operations
Line voltage connection	Suitable for reverse feed	Suitable for reverse feed	Suitable for reverse feed
Mechanical			
Frame size	45 mm	45 mm	45 mm
Device height	105 mm	105 mm	105 mm
Device width	17.7 mm per pole	17.7 mm per pole	17.7 mm per pole
Terminal protection	Finger and hand touch safe according to BGV A3, OVE-EN 6	Finger and hand touch safe according to BGV A3, OVE-EN 6	Finger and hand touch safe according to BGV A3, OVE-EN 6
Mounting	Quick fastening with two lock-in positions on IEC/EN 60715	Quick fastening with two lock-in positions on IEC/EN 60715	Quick fastening with two lock-in positions on IEC/EN 60715
Upper and lower terminals	Open mouth/lift terminals	Open mouth/lift terminals	Open mouth/lift terminals
Terminal capacity	One wire: AWG 18–6 Two wires: AWG 18–10	One wire: AWG 18–6 Two wires: AWG 18–10	One wire: AWG 18–6 Two wires: AWG 18–10
Terminal fastening torque	AWG 18–21: 21 lb-in AWG 10–8: 25 lb-in AWG 6: 36 lb-in	AWG 18–21: 21 lb-in AWG 10–8: 25 lb-in AWG 6: 36 lb-in	AWG 18–21: 21 lb-in AWG 10–8: 25 lb-in AWG 6: 36 lb-in
Mounting	Independent of position	Independent of position	Independent of position
Calibration temperature UL 489, CSA C22.2 No.5	40°C	40°C	40°C
IEC 60947-2	30°C	30°C	30°C

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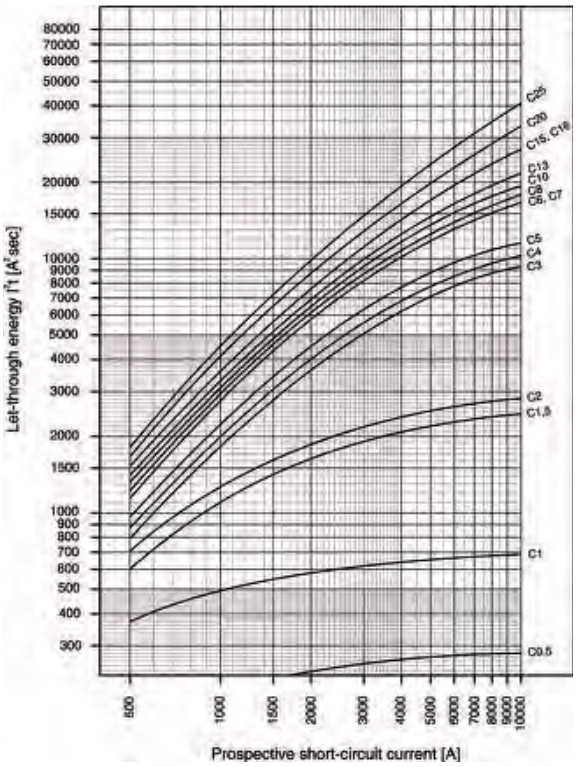
Power Loss at I_n

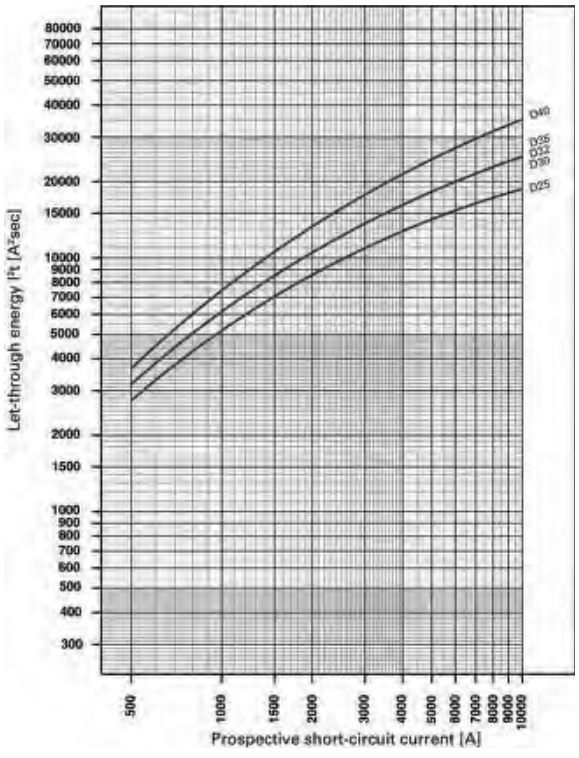
	Characteristic B			Characteristic C			Characteristic D		
	Single-Pole	Two-Pole	Three-Pole	Single-Pole	Two-Pole	Three-Pole	Single-Pole	Two-Pole	Three-Pole
I_n [A]	P [W]	P [W]	P [W]	P [W]	P [W]	P [W]	P [W]	P [W]	P [W]
0.5	—	—	—	1.6	3.2	4.7	1.6	3.2	4.8
1.0	1.1	2.2	3.4	1.1	2.2	3.4	0.8	1.5	2.3
1.5	2.2	4.4	6.6	1.3	2.6	3.9	1.0	2.1	3.1
2.0	1.4	2.8	4.3	1.4	2.8	4.3	1.0	2.1	3.1
3.0	2.1	4.2	6.4	1.2	2.4	3.6	1.2	2.4	3.6
4.0	1.4	2.9	4.3	1.4	2.9	4.3	1.4	2.9	4.3
5.0	1.8	3.7	5.5	1.9	3.7	5.6	1.5	2.9	4.4
6.0	1.7	3.5	5.2	1.2	2.3	3.5	1.2	2.3	3.5
7.0	2.0	4.0	6.0	1.4	2.8	4.3	1.4	2.8	4.3
8.0	2.0	3.9	5.9	1.4	2.8	4.2	1.2	2.4	3.7
10.0	1.8	3.6	5.3	1.8	3.6	5.3	1.5	3.0	4.5
13.0	2.4	4.7	7.1	2.4	4.7	7.1	2.0	4.1	6.1
15.0	1.9	3.8	5.6	1.9	3.8	5.6	1.5	3.1	4.6
16.0	2.1	4.3	6.4	2.1	4.3	6.4	1.7	3.5	5.2
20.0	2.9	5.8	8.7	2.9	5.8	8.7	1.8	3.7	5.5
25.0	3.1	6.2	9.3	3.1	6.2	9.3	2.6	5.1	7.7
30.0	3.0	6.0	9.0	3.0	6.0	9.0	2.7	5.4	8.1
32.0	3.4	6.8	10.2	3.4	6.8	10.2	3.1	6.2	9.3
35.0	4.0	8.1	12.1	3.7	7.4	11.0	3.8	7.6	11.3
40.0	4.0	8.1	12.1	4.0	8.1	12.1	3.9	7.8	11.6

Let-Through Energy

Characteristic C (0.5–32A), 277V

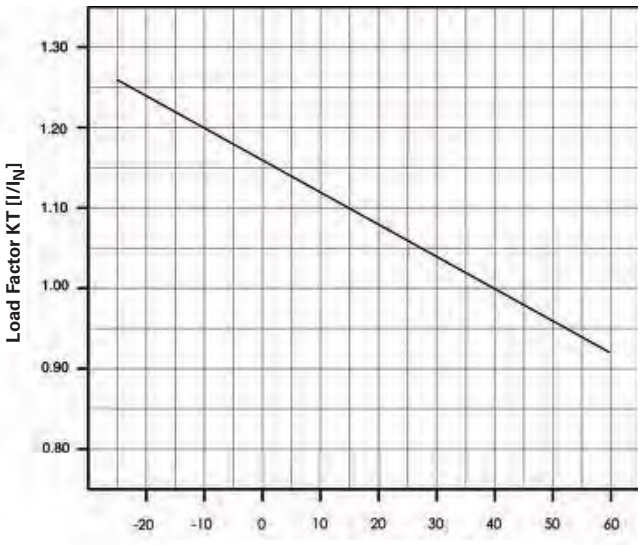


Characteristic C (35–63A), 240V



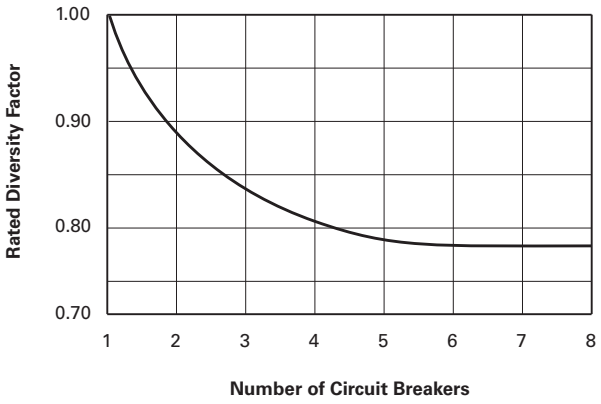
Influence of Ambient Temperature T on Load Carrying Capacity

Device Market Current Rating I_n (A) at 40°C	I_n (A) at Higher Ambient Temperature							
	15°C	20°C	25°C	30°C	40°C	50°C	55°C	60°C
0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1.0	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9
1.5	1.7	1.6	1.6	1.6	1.5	1.4	1.4	1.4
2.0	2.2	2.2	2.1	2.1	2.0	1.9	1.9	1.8
3.0	3.3	3.2	3.2	3.1	3.0	2.9	2.9	2.8
4.0	4.4	4.3	4.2	4.2	4.0	3.8	3.8	3.7
5.0	5.5	5.4	5.3	5.2	5.0	4.8	4.7	4.6
6.0	6.6	6.5	6.4	6.2	6.0	5.8	5.6	5.5
7.0	7.7	7.6	7.4	7.3	7.0	6.7	6.6	6.4
8.0	8.8	8.6	8.5	8.3	8.0	7.7	7.5	7.4
10.0	11.0	10.8	10.6	10.4	10.0	9.6	9.4	9.2
13.0	14.3	14.0	13.8	13.5	13.0	12.5	12.5	12.0
15.0	16.5	16.2	15.9	15.6	15.0	14.4	14.1	13.8
16.0	17.6	17.3	17.0	16.6	16.0	15.4	15.0	14.7
20.0	22.0	21.6	21.2	20.8	20.0	19.2	18.8	18.4
25.0	27.5	27.0	26.5	26.0	25.0	24.0	23.3	23.0
30.0	33.0	32.4	31.8	31.2	30.0	28.8	28.2	27.6
32.0	35.2	34.6	33.9	33.3	32.0	30.7	30.1	29.4
40.0	44.0	43.2	42.4	41.6	40.0	38.4	37.6	36.8



Maximum Load I_L at ambient temperature T: I_L (T) = I_N K_T(T)

Load Carrying Capacity of Adjoining Miniature Circuit Breakers



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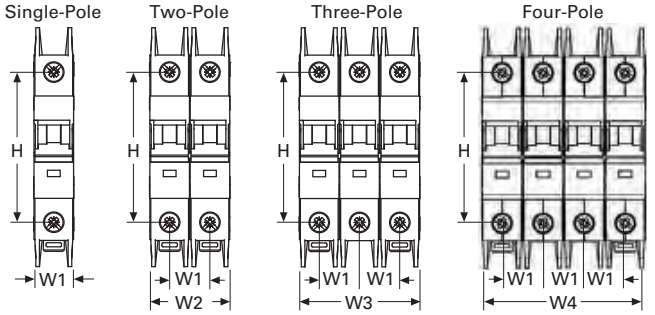
Dimensions

Approximate Dimensions in Inches (mm)

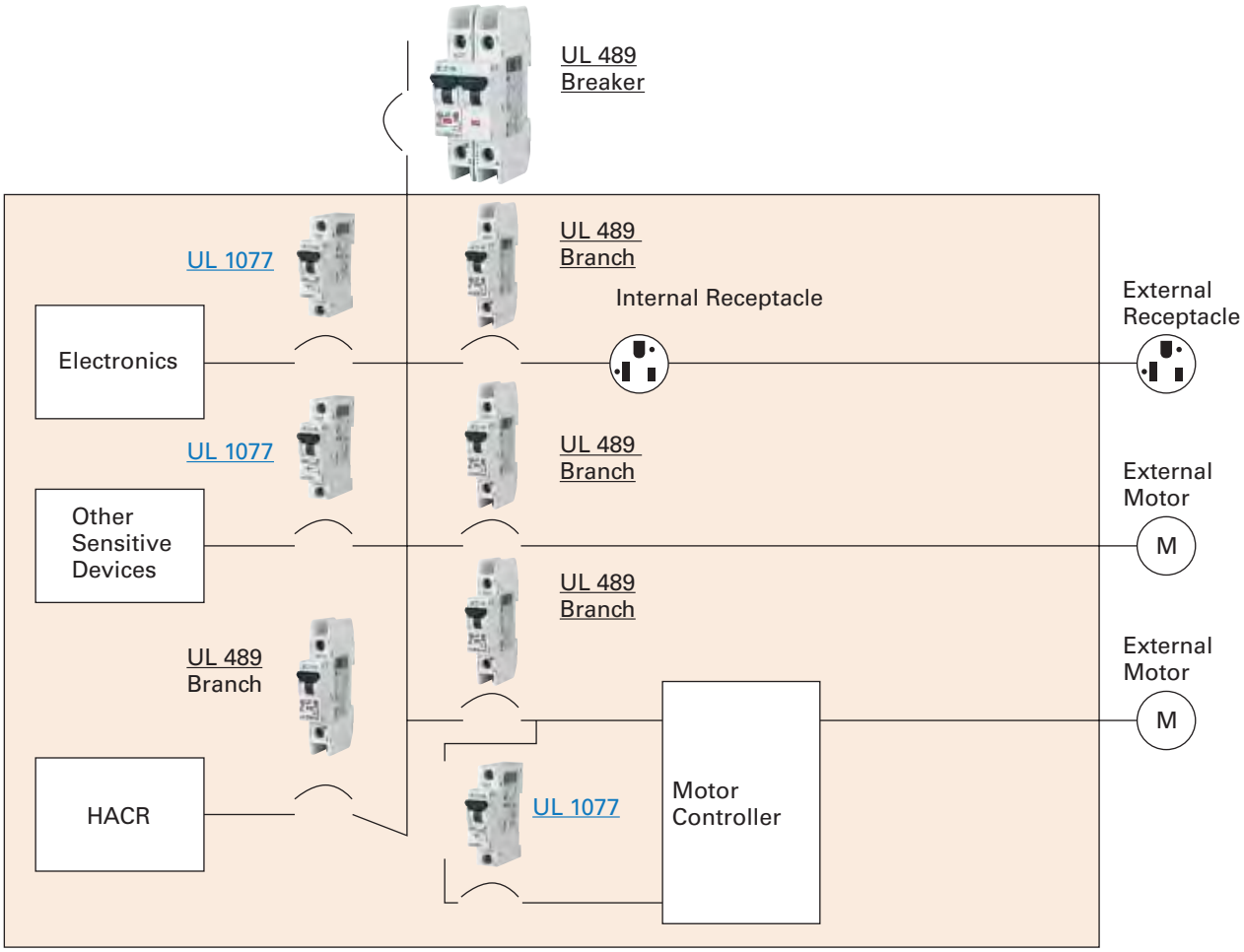
Miniature Circuit Breakers



H	W1	W2	W3	W4
4.13 (105.0)	0.70 (17.7)	1.39 (35.3)	2.09 (53.1)	2.79 (70.8)

Application Guidelines

Example of UL 489 and UL 1077 Application



Example of UL 489 and UL 1077 Application

UL 489 circuit breakers

Used for branch circuit protection, internal/external receptacles, external motors and HACR equipment (heating, air conditioning and refrigeration).

UL 1077 supplementary protectors

Used for overcurrent protection within appliances or electrical equipment, where branch circuit protection is already provided or not required.

Note: UL 489 devices can be used in place of UL 1077; UL 1077 devices cannot be used in place of UL 489.

Product specifications

Eaton FAZ-C20/1-NA-SP

Catalog Number: FAZ-C20/1-NA-SP

Eaton FAZ branch protector,UL 489 Industrial miniature circuit breaker - supplementary protector,Single package,Medium levels of inrush current are expected,20 A,10 kAIC,Single-pole,277 V,5-10X /n,Q38,50-60 Hz,Screw terminals,C Curve

General specifications

Product Name
Eaton FAZ branch protector

Catalog Number
FAZ-C20/1-NA-SP

EAN
4015081636365

Product Length/Depth
0.7 in

Product Height
4.13 in

Product Width
2.75 in

Product Weight
0.18 lb

Warranty
1 year

Certifications
UL 489
CSA Std. C22.2 No. 235

Catalog Notes
Positioned for medium inrush startup currents to provide protection for small transformers and pilot devices. Single packaging of single-pole curves B, C and D for select amperages only.

Powering Business Worldwide

Physical Attributes

Number of poles

Single-pole

Terminals

Screw

Type

UL 489 Industrial miniature circuit breaker - supplementary protector

Performance Ratings

Amperage Rating

20 A

Circuit protection

C curve

Frequency rating

50-60 Hz

Interrupt rating

10 kAIC

Trip Type

5-10X /n

Voltage rating

277V

Miscellaneous

Application

Suitable for applications where medium levels of inrush current are expected

Quantity

38

Special features

Single package

Resources

Brochures

Industrial miniature circuit breakers UL 489

Catalogs

Eaton's Volume 4—Circuit Protection

Specifications and datasheets

Eaton Specification Sheet - FAZ-C20/1-NA-SP

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30 Pembroke Road
Dublin 4, Ireland
Eaton.com

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Eaton.com/socialmedia

Product specifications

Eaton FAZ-C10/1-NA-SP

Catalog Number: FAZ-C10/1-NA-SP

Eaton FAZ branch protector,UL 489 Industrial miniature circuit breaker - supplementary protector,Single package,Medium levels of inrush current are expected,10 A,10 kAIC,Single-pole,277 V,5-10X /n,Q38,50-60 Hz,Screw terminals,C Curve

General specifications

Product Name
Eaton FAZ branch protector

Catalog Number
FAZ-C10/1-NA-SP

EAN
4015081636334

Product Length/Depth
4.5 in

Product Height
3 in

Product Width
1 in

Product Weight
0.2 lb

Warranty
1 year

Certifications
UL 489
CSA Std. C22.2 No. 235

Catalog Notes
Positioned for medium inrush startup currents to provide protection for small transformers and pilot devices. Single packaging of single-pole curves B, C and D for select amperages only.

Powering Business Worldwide

Physical Attributes

Number of poles

Single-pole

Terminals

Screw

Type

UL 489 Industrial miniature circuit breaker - supplementary protector

Performance Ratings

Amperage Rating

10 A

Circuit protection

C curve

Frequency rating

50-60 Hz

Interrupt rating

10 kAIC

Trip Type

5-10X /n

Voltage rating

277V

Miscellaneous

Application

Suitable for applications where medium levels of inrush current are expected

Quantity

38

Special features

Single package

Resources

Brochures

Industrial miniature circuit breakers UL 489

Catalogs

Eaton's Volume 4—Circuit Protection

Specifications and datasheets

Eaton Specification Sheet - FAZ-C10/1-NA-SP

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Product specifications

Eaton FAZ-C5/1-NA-SP

Catalog Number: FAZ-C5/1-NA-SP

Eaton FAZ branch protector,UL 489 Industrial miniature circuit breaker - supplementary protector,Single package,Medium levels of inrush current are expected,5 A,10 kAIC,Single-pole,277 V,5-10X /n,Q38,50-60 Hz,Screw terminals,C Curve

General specifications

Product Name
Eaton FAZ branch protector

Catalog Number
FAZ-C5/1-NA-SP

EAN
4015081636297

Product Length/Depth
0.7 in

Product Height
4.13 in

Product Width
2.97 in

Product Weight
1 lb

Warranty
1 year

Certifications
UL 489
CSA Std. C22.2 No. 235

Catalog Notes
Positioned for medium inrush startup currents to provide protection for small transformers and pilot devices. Single packaging of single-pole curves B, C and D for select amperages only.

Powering Business Worldwide

Physical Attributes

Number of poles

Single-pole

Terminals

Screw

Type

UL 489 Industrial miniature circuit breaker - supplementary protector

Performance Ratings

Amperage Rating

5 A

Circuit protection

C curve

Frequency rating

50-60 Hz

Interrupt rating

10 kAIC

Trip Type

5-10X /n

Voltage rating

277V

Miscellaneous

Application

Suitable for applications where medium levels of inrush current are expected

Quantity

38

Special features

Single package

Resources

Brochures

Industrial miniature circuit breakers UL 489

Catalogs

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Eaton Specification Sheet - FAZ-C5/1-NA-SP

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Product specifications

Eaton FAZ-C2/1-NA-SP

Catalog Number: FAZ-C2/1-NA-SP

Eaton FAZ branch protector,UL 489 Industrial miniature circuit breaker - supplementary protector,Single package,Medium levels of inrush current are expected,2 A,10 kAIC,Single-pole,277 V,5-10X /n,Q38,50-60 Hz,Screw terminals,C Curve

General specifications

Product Name
Eaton FAZ branch protector

Catalog Number
FAZ-C2/1-NA-SP

EAN
4015081636648

Product Length/Depth
0.7 in

Product Height
4.13 in

Product Width
2.97 in

Product Weight
1 lb

Warranty
1 year

Certifications
UL 489
CSA Std. C22.2 No. 235

Catalog Notes
Positioned for medium inrush startup currents to provide protection for small transformers and pilot devices. Single packaging of single-pole curves B, C and D for select amperages only.

Powering Business Worldwide

Physical Attributes

Number of poles

Single-pole

Terminals

Screw

Type

UL 489 Industrial miniature circuit breaker - supplementary protector

Performance Ratings

Amperage Rating

2 A

Circuit protection

C curve

Frequency rating

50-60 Hz

Interrupt rating

10 kAIC

Trip Type

5-10X /n

Voltage rating

277V

Miscellaneous

Application

Suitable for applications where medium levels of inrush current are expected

Quantity

38

Special features

Single package

Resources

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Industrial miniature circuit breakers UL 489

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Eaton Specification Sheet - FAZ-C2/1-NA-SP

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Product specifications

Eaton FAZ-C1/1-NA-SP

Catalog Number: FAZ-C1/1-NA-SP

Eaton FAZ branch protector,UL 489 Industrial miniature circuit breaker - supplementary protector,Single package,Medium levels of inrush current are expected,1 A,10 kAIC,Single-pole,277 V,5-10X /n,Q38,50-60 Hz,Screw terminals,C Curve

General specifications

Product Name
Eaton FAZ branch protector

Catalog Number
FAZ-C1/1-NA-SP

EAN
4015081636624

Product Length/Depth
0.7 in

Product Height
4.13 in

Product Width
2.97 in

Product Weight
1 lb

Warranty
1 year

Certifications
CSA Std. C22.2 No. 235
UL 489

Catalog Notes
Positioned for medium inrush startup currents to provide protection for small transformers and pilot devices. Single packaging of single-pole curves B, C and D for select amperages only.

Powering Business Worldwide

Physical Attributes

Number of poles

Single-pole

Terminals

Screw

Type

UL 489 Industrial miniature circuit breaker - supplementary protector

Performance Ratings

Amperage Rating

1 A

Circuit protection

C curve

Frequency rating

50-60 Hz

Interrupt rating

10 kAIC

Trip Type

5-10X /n

Voltage rating

277V

Miscellaneous

Application

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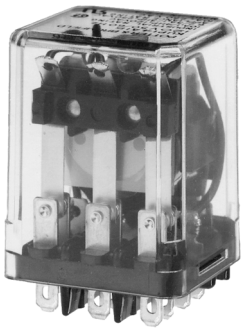
POTTER & BRUMFIELD
KUP SERIES PANEL PLUG-IN RELAY

GENERAL PURPOSE
PANEL/PLUG-IN RELAYS

INTRODUCTION

TE Connectivity (TE)'s Potter & Brumfield KUP Series Panel Plug-In Relay is a reliable solution for industrial and commercial applications. It supports AC (12-240V) and DC (5-110V) coils, with multiple contact configurations and mounting options. Features like push-to-test buttons, indicator lamps, and Class B coil insulation enhance usability. Compatible sockets for panel, DIN rail, or PCB mounting ensure easy installation.



FEATURES

- AC coils: 12-240VAC, 50/60 Hz.; DC coils 5-110VDC
- Contact arrangements of 1-3 form C
- Wide selection of termination and mounting styles
- PC terminals available
- Push-to-test button and indicator lamp options
- Sockets available for panel, DIN rail or PCB mounting
- Class B coil insulation

APPLICATIONS

- Vending
- Commercial sewing
- Tool/die equipment
- Robotics
- Timers
- Welding
- HVAC
- Medical
- Power generators

APPROVALS

- UL E214025
- CSA LR15734

Technical data of approved types on request

CONTACT DATA

Contact arrangement	1-3 form C (CO)	
Rated voltage	240VAC	
Rated current	10A	
Contact material	Ag, AgCdO	
Contact material	Ag	AgCdO
Min. recommended contact load	100mA, 12VDC	300mA, 12VDC
Frequency of operation	360 ops./hour	360 ops./hour
Operate/releases time max.	15/10ms	
Bounce time max.	17ms	

CONTACT RATINGS

Type	Load	Cycles
UL 508		
Ag, 1, 2 and 3 pole	5A, 240VAC	-
	5A, 28VDC	-
	1/6HP, 120VAC	-
	2.5A, 120VAC, tungsten	-
	1/3HP, 240VAC	-
	0.5A, 120VDC	-
	5FLA, 15LRA, 250VAC	-
AgCdO, 1, 2 and 3 pole	10A, 240VAC	-
	10A, 32VDC	-
	5FLA, 15LRA, 250VAC	-
	1/3HP, 120VAC	-

Type	Load	Cycles
AgCdO, 1, 2 and 3 pole	5A, 120VAC, tungsten	-
	1/2HP, 250VAC	-
	0.5A, 125VDC	-
	10FLA, 40LRA, 125VAC	-
	3A, 600VAC	-
	1/2HP, 480VAC	-
	1/2HP, 600VAC	-
	1HP, 480 VAC, 3 phase	-
Mechanical endurance		$10x10^6$ ops.

Note: Indicated contact ratings and electrical endurance data apply only for direct wiring of the relay (according to UL 508/61810-1); for relays mounted on sockets, deratings may apply.

COIL DATA

Coil voltage range	5 to 110VDC 12 to 240VAC
Coil insulation system according UL	Class B

COIL VERSIONS, DC COIL

Coil code	Rated voltage VDC	Operate voltage VDC	Coil resistance Ω±10%	Rated coil power W
1, 2 and 3 pole				
5	5	3.75	21	1.2
6	6	4.5	32.1	1.125
12	12	9.0	120	1.2
24	24	18.0	472	1.25
36	36	27.0	1080	1.2
48	48	36.0	1800	1.3
110	110	82.5	10000	1.25

All figures are given for coil without preenergization, at ambient temperature +23°C.

COIL VERSIONS, AC COIL

Coil code	Rated voltage VDC	Operate voltage VDC	Coil resistance Ω±10%	Rated coil power W
1 and 2 pole				
12	12	10.2	24	2.0
24	24	20.4	85	2.0
120	120	102.0	2250	2.1
240	240	204.0	9110	2.1
3 pole				
12	12	10.2	18	2.8
24	24	20.4	72	2.8
120	120	102.0	1700	2.9
240	240	204.0	7200	2.9

INSULATION DATA

Initial dielectric strength	
between open contacts	1200Vrms
between contact and coil	2200Vrms
between adjacent contacts	2200Vrms
Initial insulation resistance	
between insulated elements	100MΩ, 500VDC

ACCESSORIES

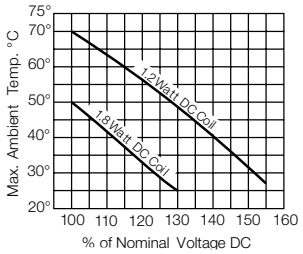
For details see datasheet	Sockets and Accessories, KUP Relays

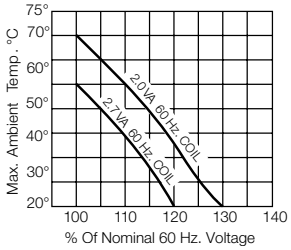
Product Code	Description	TE Part Number
27E893	DIN socket (use 20C318 clip)	2-1419106-5
27E121	Track mount socket (use 20C314 clips)	1393143-5
27E043	Chassis mount/solder eyelet socket (use 20C254 clip)	1393143-1
27E046	Chassis mount/PCB socket (use 20C254 clip)	1419106-4
27E067	Chassis mount/quick connect socket (use 20C254 clip)	1393143-2
27E396	Snap-in/quick connect socket (use 20C254 clip)	3-1393143-8

OTHER DATA

Material compliance	EU RoHS/ELV, China RoHS, REACH, Halogen content refer to the Product Compliance Support Center at www.te.com/customersupport/rohssupportcenter
Ambient temperature	
DC coil	Enclosed relays, 1-3 pole: -45ºC to 70ºC
AC coil	Enclosed relays, 3 pole: -45°C to +45°C
	Enclosed relays, 1 and 2 pole: -45ºC to +55ºC
Category of environmental protection	
IEC 61810	RTI - dust protected
Terminal type	Quick connects (QC), .187 PCB-THT
Terminal retention, push force	
QC .187PCB	25 lbs for 3s
Weight	85g
Packaging unit	tray/25 pcs., box/150pcs.

MAXIMUM ALLOWABLE AMBIENT TEMPERATURE VS VOLTAGE (KUP ENLCOSED)

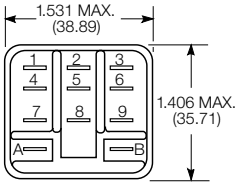




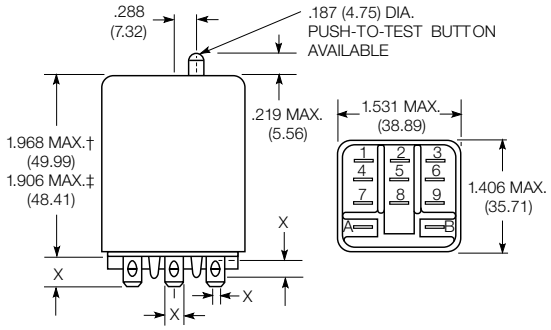
DIMENSIONS (Unit:mm)

RELAY FRONT DIAGRAMS

1-3 pole models

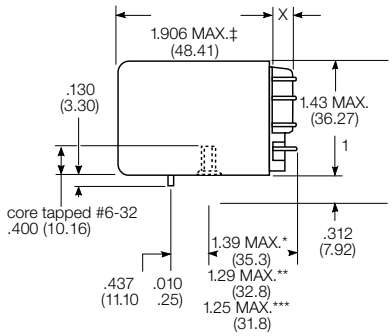


KUP PLAIN CASE



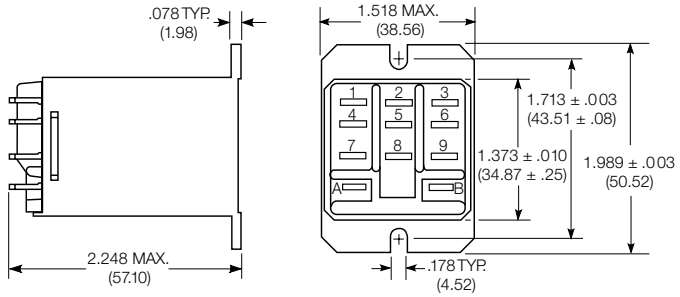
X Is For Terminal Dimensions.
See Teminal Drawings.

KUP CORE / STUD MOUNT CASE

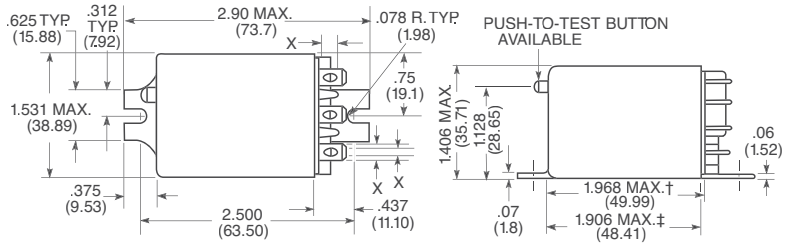


‡ Dimensions with .187" (4.75mm and .205" 5.21mm) terminals
***Dimensions with .187" (4.75mm) terminals.

KUP TOP FLANGE CASE

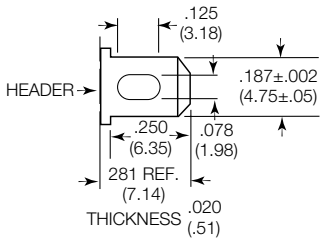


KUP BRACKET MOUNT CASE

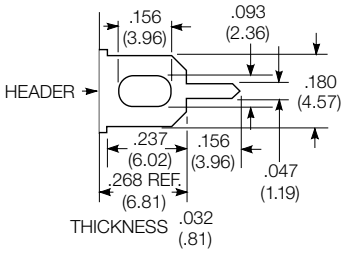


TERMINAL DIMENSIONS

4.75mm (.187) quick connect

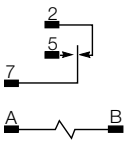


1.19mm (.047) printed circuit

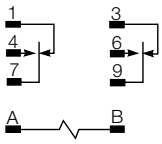


TERMINAL ASSIGNMENT

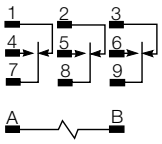
1 form C



2 form C



3 form C

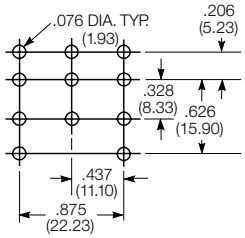


PCB LAYOUT

Bottom view on solder pins

3 Pole Version

(Omit unnecessry holes for 2 pole types)



PRODUCT CODE STRUCTURE

Part Number					
KUP	-14	A	1	5	-120

Type

KUP	Enclosed relay

Contact arrangement

5	1 form C (1 CO)
11	2 form C (2 CO)
14	3 form C (3 CO)

Coil Input

A	AC, 50/60Hz
D	DC

KUP

1	Socket mount (plain) case
2	Socket mount (plain) case with push-to-test button
3	Socket mount (plain) case with indicator lamp 1
4	Socket mount (plain) case with indicator lamp and push-to-test button 1)
5	Bracket mount case
E	Plain case with #6-32 tapped core and locating tab
T	Top flange case

1) Indicator lamps are available on models with the following coils: 6-24VAC and VDC, 110VDC and 120-240VAC. Only models with 120-240VAC coils are UL recognized.

Coil voltage

Coil code:	please refer to coil versions table

Au flashed contact option

Leave Blank	No Au flashing on contacts
F	Optional Au flashing on contacts

Terminal and contact material

1 and 2 pole models	
1	4.75mm (.187in) quick connect/ solder; Ag, 5A
5	4.75mm (.187in) quick connect/ solder; AgCdO, 10A
7	1.19mm (.047in) PCB; AgCdO, 10A
3 pole models	
1	4.75mm (.187in) quick connect/ solder; Ag, 5A
5	4.75mm (.187in) quick connect/ solder; AgCdO, 10A

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03/25 ED

POTTER & BRUMFIELD
SOCKETS & ACCESSORIES, KUP RELAYS

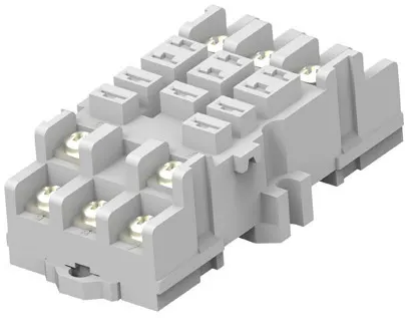
GENERAL PURPOSE ACCESSORIES

INTRODUCTION

Relay accessories are devices to support the design and maintenance of relays in electrical circuits. This relay series include clips, mounting adapters and sockets. Mounting adapters provide adaptation between standard socket types. Sockets are used for relay mounting in configurations, including panel mount, PCB types and DIN rail and clips are used to secure the relay in the connector.

FEATURES

- Sockets for 1 - 3 pole relays with .187" (4/75mm) quick connects
- Solder, PCB or screw terminal sockets
- Hold down springs
- Various mounting options



APPROVALS

- UL E59244
- CSA LR15734

Technical data of approved types on request.

TECHNICAL DATA

Socket contact material	Spring brass, tin plated
Socket body material	
Solder, PCB and QC terminal models	Nylon
Screw terminal models - 3 pole	Glass-filled polyester
Maximum current	15A (300 VAC) 10A (300 VAC) for 27E893

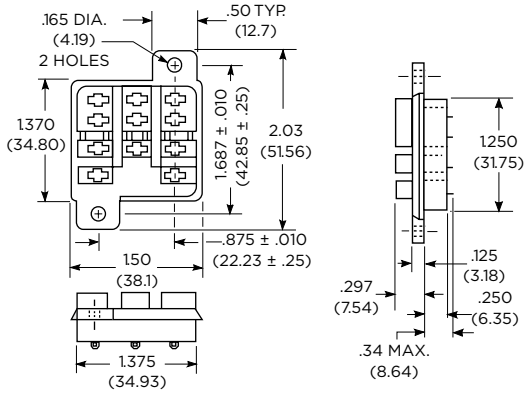
DIMENSIONS: Inch(mm)

Hard Mount Sockets For Relays Through 3 Poles

Sockets with .187" (4.75mm) quick connect, solder or printed circuit terminals are available for KUEP, KUL, KUMP and KUP relays, through 3 poles, with .187" (4.75mm) quick connect terminals.

27E043–with solder eyelet terminals.

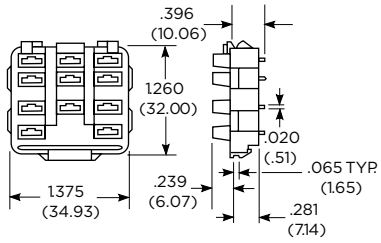
27E067–with .187" (4.75mm) quick connect terminals.



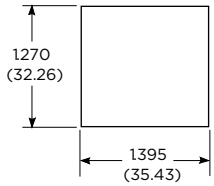
Snap-in Socket For Relays Through 3 Poles

Socket with .187" (4.75mm) quick connect terminals is available for KUEP, KUL, KUMP and KUP relays, through 3 poles, with .187" (4.75mm) quick connect terminals.

27E396–with .187" (4.75mm) quick connect terminals.



Recommended chassis cutout
snap-in socket



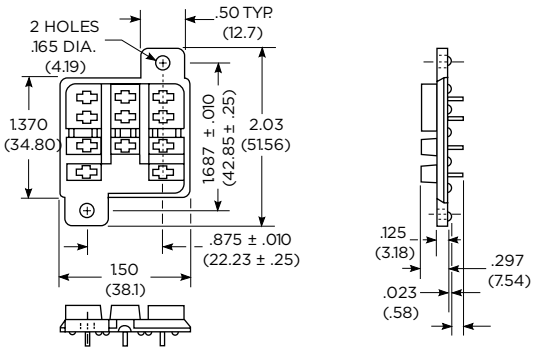
Recommended chassis thickness
.031" (.79mm) to .062" (1.57mm).

PCB Hard Mount Sockets For Relays Through 3 Poles

Sockets with .144" (3.66mm) and .184" (4.67mm) long solder PCB/Solder terminals are available for KUEP, KUL, KUMP and KUP relays,

27E046–with .144" (3.66mm) long PCB/Solder terminals.

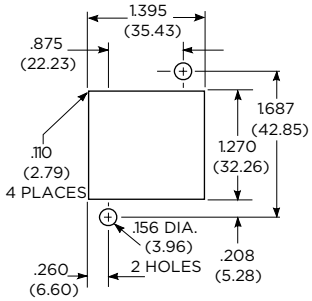
27E305-with .184" (4.67mm) long PCB/Solder terminals.



Caution:

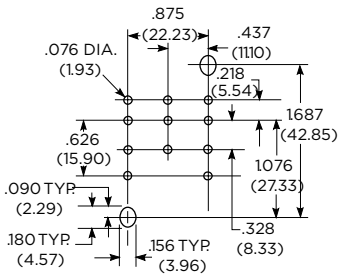
Printed circuit sockets are manufactured with "floating" (Loose) terminals. This permits them to align with holes in the circuit board and with the relay terminals. During the mounting and soldering of the socket, vertical float should be eliminated and the terminals seated on the board. (This may be accomplished by inserting a dummy relay in the socket.) Failure to eliminate float may cause fracture of the solder joint or separation of the copper conductor from the printed circuit board when a relay is inserted in the socket after soldering.

Recommended chassis cutout
for solder terminal socket



Recommended Chassis Thickness
.031 (.79) to .062 (1.57)

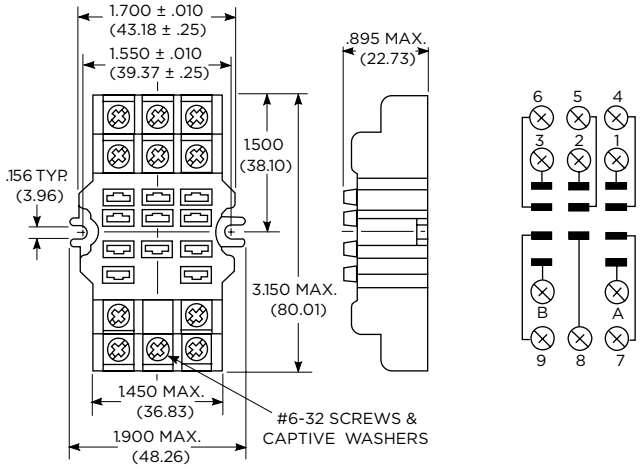
PCB layout for 3 pole PCB
terminal socket



Potter & Brumfield
Sockets & Accessories, KUP Relays

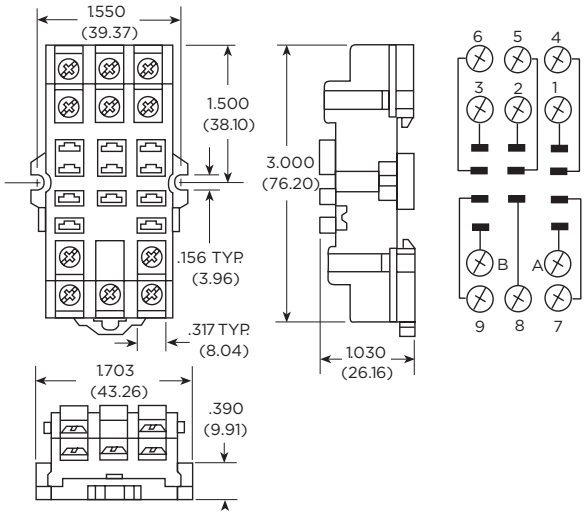
Screw terminal socket for relays through 3 poles 27E121

Offers screw termination for KUEP, KUL, KUMP and KUP relays, through 3 poles, with .187" (4.75mm) quick connect terminals. This socket stacks on 1.700" (43.18mm) centers. When surface mounting, two #6-32 screws of suitable length are required. When track mounting, two 24A071 retainer clips (not shown) are required.



Screw terminal, DIN rail, snap-mount socket 27E893

Offers screw termination for KUEP, KUL, KUMP and KUP relays, through 3 poles, with .187" (4.75mm) quick connect terminals. This socket is constructed with a spring-loaded latch which allows it to be quickly snapped onto or removed from a DIN or "top hat" style mounting track. No special tools or extra hardware is required for installation.



ORDERING CODE FOR SOCKETS

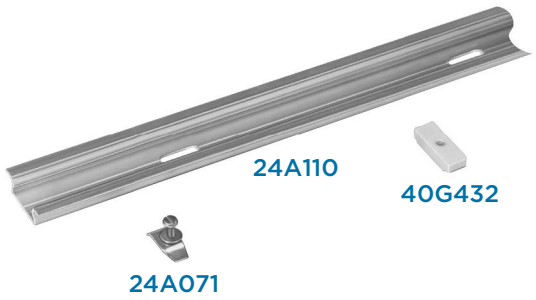
Product Code	Poles	Terminal type	Mounting	Rating	Part number
27E043	3	Solder eyelet	Hard mount	15A	1393143-1
27E067	3	.187 in (4.75) quick connect	Hard mount	15A	1393143-2
27E046	3	PCB/Solder .144 in (3.66) long	Hard mount	15A	1419106-4
27E305	3	PCB/Solder .184 in (4.67) long	Hard mount	15A	3-1393143-2
27E396	3	.187 in (4.75) quick connect	Snap-in	15A	3-1393143-8
27E121	3	Screw	Panel/rail	15A	1393143-5
27E893	3	Screw	DIN-rail	10A*	2-1419106-5

All accessories must be ordered separately.

Recommended installation torque for terminal screws is 7.5 in-lb.

*Rating is per pole with a maximum total rating per device of 20 A, 300 V or 30 A, 150 V.

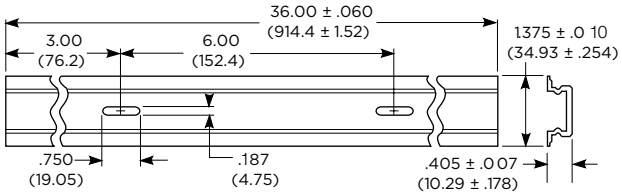
TRACK AND MOUNTING ACCESSORIES



DIMENSIONS: Inch(mm)

24A110 DIN rail style mounting track

24A110 mounting track is designed to accept snap-mount sockets, as well as other P&B screw terminal sockets. Track is made of lightweight, sturdy extruded aluminum and is shipped in three-foot (914cm) lengths with mounting holes on six-inch (152mm) centers. Track can be cut to shorter lengths or used end-to-end.



End Clip

24A071 steel mounting clip with one #6-32 screw 7/16" (11.1 mm) long is used with a 40G432 insulator to prevent sockets form moving sideways or sliding off the end of the track.

ORDERING CODE FOR ACCESSORIES

Product Code	Terminal type	Part number
20C254	Snap-in relay hold down spring for use with all KUP sockets listed on these pages except 27E396 ,27E121 and 27E893.	3-1393159-9
20C228	Relay hold down spring for use with hard mount KUP sockets. Is held in place by socket mounting hardware.	1419111-3
20C318	Relay hold down spring for use with 27E893 DIN rail screw terminal socket	4-1393159-8
20C314	Relay hold down clip for use with 27E121 screw terminal socket. 2 required per socket.	4-1393159-6
24A110	Mounting track	1419111-6
24A071	Steel mounting clip with #6-32 screw - use with 27E166 on 24A110 track	1419111-5
40G432	Plastic insulator - use with 24A071 to make end clip for 24A110 track	9-1393159-5

All accessories must be ordered separately.

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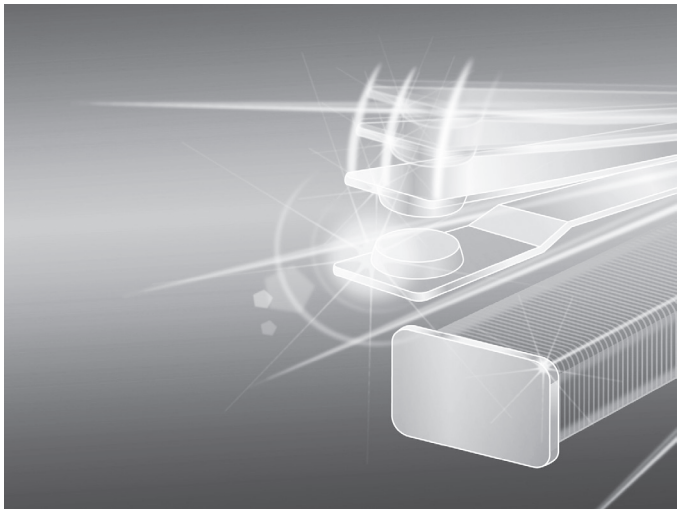

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Testing . . . . . page 18
Use . . . . . page 19

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Definitions (Continued)

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TE Connectivity strongly recommends to monitor the life cycle of the product and to verify the relevant failure mode per IEC 61810-1.

Technical data
Unless otherwise stated, the stated technical data are based on laboratory tests under standardized conditions and are within the conditions of normal use for these components. The vast number of influencing factors does not allow TE to test its products for all imaginable applications and processes. Furthermore, the large number of possible variations within a relay family makes it impossible to give a comprehensive description of the different characteristics for all variants in one datasheet. Typical data are derived from the standard versions.
The decision on the suitability of a specific component is solely responsibility of the user. To ensure the suitability of the product for a specific application the user has to test these products before the use under the most stringent conditions they will be exposed to in the actual application. Taking into consideration the aspects of operational availability and safety, the user has to rate the actual service life in an adequate relation to the expected life of the relay.
The use of the relay beyond its specified characteristics or beyond sufficiently tested life expectancy bears the risk of dangerous conditions; the user has to prevent such conditions by adequate measures, being entirely responsible in case of non-observance.

All product data are intended for users with knowledge and experience in the application of such specifications. The utilization is at the entire risk of the user.
The user has to verify the accordance with existing regulations and relevant standards for the application; in particular with reference to the insulation requirements as function of applied voltages and ambient conditions.
The standards (e.g. IEC 61810 'Electrical endurance') are based on the principal assumption of occurences of malfunctions such as malfunction to make contact, malfunction to break or as insufficient dielectric strength. Such malfunctions have to be taken into consideration and must not generate risks. Depending on the specific load, its characteristics and power in the contact set, a relay malfunction situation may generate various risks such as malfunction of the equipment and its controls, electrical shock, the risk of excessive heat and fire and others. It is in the entire responsibility of the user to provide for additional precautions against such possible effects according to the relevant application standards.
Protection against risks under all operation conditions even in case of malfunction can only be ensured by the design of the equipment as well as by application instructions for the end user; it is the responsibility of the manufacturer of the equipment to take the appropriate measures. Incorrect connections by the user may lead to risks, faulty operation and abnormal heating or fire. It is also the responsibility of the manufacturer of the equipment to take appropriate measures to avoid potential danger of electrical shock by preventing access to live parts of the relay including parts as terminals and accessories.

Specification
In order to improve performance and quality, we continuously develop our products. We reserve the right to change technical parameters and product specifications. The technical data listed are for description purposes of the components only and are not an agreement and do not guarantee specific characteristics and parameters; for detailed questions, please contact our application support. Drawings, photos data and descriptions are subject to change without prior notice.

Availability
The databooks and datasheets list a broad range of products and the descriptive part code structure (product code) does allow a large number of possible variations, but not all possible variations are defined as standard types in the current product portfolio (product code) and thus may not be included in the product range. Some products are normally maintained in stock for immediate delivery, or are available within 'normal leadtimes for industry'; however, there may be extended leadtimes for some non-stock items. Special versions to customer specifications may be supplied. Additionally, minimum quantity requirements apply and these requirements may differ from indicated packaging units. Please consult with your TE sales organization or authorized distributor regarding availability and minimum order requirements.
Right to change the availability and delivery conditions reserved.

'Definitions', datasheets, product data, application notes and all specifications are subject to change.

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Definitions (Continued)

AC-coil
Relays for direct energization with AC supply. If not otherwise stated, the data is given as V_{rms} for 50 Hz supply.

Adjacent contacts
Insulation parameters between two adjacent contact circuits (poles of a relay), which do not have a conductive connection. The level of insulation depends on the relays design, rated voltage and ambient conditions.

Ambient temperature (function, in operation)
The temperature in the vicinity of the relay (distance according to IEC 61810-1).The minimum ambient temperature is the miniumum operating temperature, the maximum ambient temperature is the maximum operating temperature for the use of the relay or accessory when operated. This temperature range should not be exceeded; within the indicated temperature range the ambient temperature does influence the electrical endurance. Ambient temperature range according to IEC 61810-1 and indicated in °C. Unless otherwise stated data is referred to an ambient temperature of 23°C.

Approvals
With the approval label the independent approval agency and/or test house confirms the compliance with the relevant product standards and/or certain product characteristics.

NOTE: the ordering code structure does allow a large number of possible variations, but not all variations are defined as standard types (ordering codes) and thus some relays may not be included in the list of approved relays. It is recommended that users also seek the pertinent approval files of the agencies/laboratories and review them to ensure that the selected product is filed and meets the requirements. Technical data and approved types on request.

	BEAB	British Electrotechnical Approvals Board, England
CE	CE	Conformité Européenne, marking for specific products relating to product safety in accordance to European Laws
cqc	CQC	China Quality Certification Center, People's Republic of China
SP	CSA	Canadian Standards Association, Canada
D	DEMKO	Danmarks Elektriske Materielkontrol, Denmark
FI	FIMKO	Sähkötarkastuskeskus Elinspektionscentralen, Finnland
KEMA KEUR	KEMA	Naamloze Vennootschap tot Keuring van, Electrotechnische Materialien, Netherlands
	LLOYD's	Lloyd's Register of Shipping
N	NEMKO	Norges Elektriske Materiellkontroll, Norway
ÖVE	ÖVE	Österreichischer Verband für Elektrotechnik, Austria
S	SEMKO	Svenska Elektriska Materiellkontrollanstalten AB, Sweden
S	SEV	Eidgenössisches Starkstrominspektorat, Switzerland
	TÜV	Technischer Überwachungs-Verein, Germany
	UL	Underwriters Laboratories, Inc., USA; UL Component Recognition Mark for the United States
c	UL	UL Component Recognition Mark for Canada
c US	UL	UL Component Recognition Mark for the United States and Canada
VDE	VDE	VDE-Prüfstelle, certificate of conformity with factory surveillance, Germany

Bandwidth
The range of frequencies for which the performance falls within the specified limits.

Bifurcated contact
See > 'Twin contact'.

Bistable relay, latching relay
In a bistable or latching relay the contacts remain in the last switching position once the coil input voltage is disconnected.
Bistable relays only require a short set respectively reset pulse and do not need any energization once the switching position changed. Unless otherwise stated the bistable relays can endure a permanent energization.
NOTE: for some relay series a permanent coil power supply is not permitted; in this case the maximum energization duration or the required coil power reduction is indicated in the respective datasheet.

Bistable relay, switching characteristics
In a bistable relay, the contacts remain in the last switching position after the input voltage is disconnected.
NOTE: Unlike monostable relays which return to their predefined contact rest state in case of power supply break down and thus might be showing a fail safe behaviour, bistable relays do not automatically return to such predefined position. Therefore the application and relay control has to be designed to cover such situations and bistable relays should not be used in applications that are rated according to ISO/TS 16949 7.5.3 'Product Identification and Traceability'.
NOTE: Even though the bistable relays are leaving production preferrably in reset contact position, the position of the contact (set position/reset position) is not defined at delivery unless otherwise stated. The user needs to check the contact position and to set/reset the relay to the required position.

Bounce
An unintentional phenomenon that can occur during the making or breaking of a contact circuit when the contact elements touch successively and separate again before they have reached their final position.

Bounce time
The time from the first to the last closing or opening of a relay contact. Unless otherwise stated the indicated times are maximum values and are for energization with rated voltage, without any components in series or parallel to the coil, and at reference temperature. Also see > 'Relay cycles' .

Breaking capacity max.
Product of the switching current and switching voltage (in W for direct current, in VA for alternating current). Also see > 'DC breaking capacity'

Bridging contact
Double contact configuration, where two movable contacts are mechanically connected and operate simultaneously. In a bridge configuration, the load current flows from one stationary contact via the bridge to a second stationary contact. See also table 'Contact arrangement'.
See > 'Form X contact', 'Form Y contact', 'Form Z contact'.

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Definitions (Continued)

Category of protection (IEC 61810)
The ´Relay Technology Categories´ (IEC 61810) describe the degree of sealing of the relay case or its contact unit:

RT 0: unenclosed relay
Relay not provided with a protective case.
RT I: dust protected relay
Relay provided with a case which protects its mechanism from dust.
RT II: flux proof relay
Relay capable of being automatically soldered without allowing the migration of solder fluxes beyond the intended areas. These are the contacts, movable parts of the magnetic system and their immediate environment.
RT III: wash tight (washable) relay
Relay capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents.
The test to evaluate the sealing of the case for wash tight relays is performed according to the IEC 60068-2-17, Qc test.

NOTE - Please refer to the 'Processing' section for additional information.
In service this type of relay is sometimes vented to the atmosphere after soldering or washing process; in this case the requirements with respect to clearances and creepage distances can change.

RT IV: sealed relay
Relay provided with a case which has no venting to the outside atmosphere, and having a time constant better than $2x10^4$s in accordance with IEC 60068-2-17.
RT V: hermetically sealed relay
Sealed relay having an enhanced level of sealing, assuring a time constant better than $2x10^6$s in accordance with IEC 60068-2-17.

Changeover contact, CO contact
See > 'Form C contact, CO contact, changeover contact'

China RoHS compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Clearance distance
Shortest distance in air between two conductive parts or between a conductive part and the accessible surface of the relay.

Coil data
The coil data is specified according to IEC 61810-1.
Unless otherwise indicated the data is given for
- ambient temperature 23°C,
- coil temperature equal to ambient temperature (cold coil, without pre-energization),
- 50Hz for AC supply,
- no other devices (e.g. diode) in parallel or in series to the coil
- single mounting of relays.

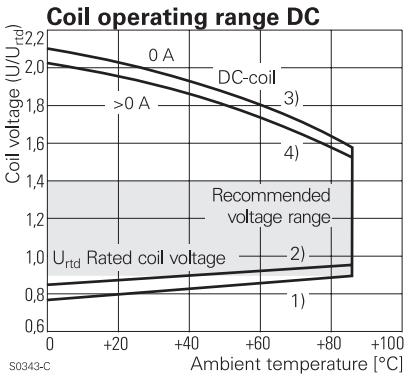
Indicated data for the operative range class, is given for the minimum allowed mounting distance.
Unless otherwise stated a duty factor of 100% (permanently operated) is permissible.

Coil inductivity
The inductivity is a nonlinear parameter due to saturation effects and depends, amongst others, on the position of the armature. The value of the relay coil inductivity depends on the measurement method and its parameters. Therefore the inductivity is not a generally guaranteed parameter; for technical questions, please contact our technical support.

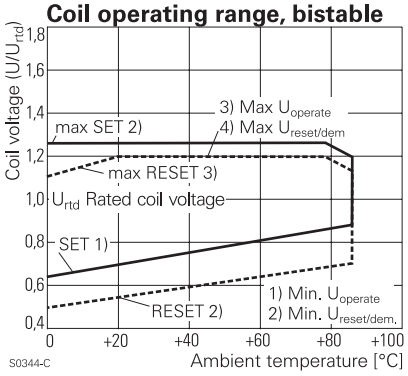
Coil insulation system according to UL1446
These requirements cover test procedures to be used in the evaluation of electrical insulation systems intended for connection to branch circuits rated 600V or less. This standard refers to insulation systems and does not cover individual insulating materials.

Coil Operative range (graph)
Admissible range of energizing voltage with respect to the ambient temperature. The upper limit is the maximum coil voltage, the lower limit is the operate voltage U_{min} (coil without pre-energization) and/or the operate voltage U_1 (pre-energized coil).
The diagrams are valid for single mounting of relays without thermal interference and connection wiring according to IEC 61810-1; unless otherwise stated the data is indicated without contact load, thus not taking into account the temperature rise due to the contact current.
The use of a relay with an energizeing voltage other than the rated coil voltage may lead to reduced electrical life (mechanical and dynamic effects).
In case the application requires an energization with other than the rated coil voltage and a recommended voltage range is indicated, the coil voltage should be within the recommended voltage range (shaded area) to keep the effects on electrical life to a minimum.

curve 1: operate-/minimal voltage U_0 (without pre-energization)
curve 2: operate-/minimal voltage U_1 (pre-energized coil)
curve 3: maximum voltage at contact current = 0 A
curve 4: limiting voltage U_2 at rated contact current I_{rated}
recommended voltage range (shaded area):
the coil voltage should be within the recommended voltage range to keep adverse effects on electrical life to a minimum.



Coil operative range for bistable relays
curve 1: operate voltage at coil temperature equal to ambient temperature
curve 2: minimum reset voltage
curve 3: maximum operate voltage
curve 4: maximum reset voltage
For bistable relays, all curves are given for pulse energization (short energization duration).



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Definitions (Continued)

Coil power
Power consumption of the coil at rated coil voltage and coil resistance, with coil temperature at 23°C, given as rated typical value.

Coil resistance
Electrical resistance of the relay coil at reference temperature; this value is indicated for the coil without any other devices in parallel (e.g. coil suppression, diode, etc.).

Coil suppression circuit
Circuit to reduce the inductive switch off voltage peak of the relay coil (EMC protection, switch off voltage peak). Most of such circuits reduce the armature release speed, which may decrease the relay lifetime depending on the application load. Especially diodes or any pn-junction of the electronic control system in parallel to the coil will significantly reduce the electrical lifetime. Recommended that relay performance testings to be evaluated with the suppression that will be used.
Note: unless otherwise specified the indicated relay data refers to coils without any components in parallel or in series to the coil.

Coil voltage
Voltage applied across the coil terminals.

Coil voltage range
Voltage range at which the relay displays the operating characteristics. These specified operating characteristics are given for a constant DC supply or sinusoidal AC supply. Other operating conditions (e.g. pulse control, ramp voltage, half wave rectifying, etc.) may lead to characteristics other than specified.

Coil-contact circuit data
Insulation parameters between the coil system and the contact circuit/system.

Combination of relay and socket, insulation requirements
The relay standard IEC 61810-1 has an important impact on the combination of a relay and the respective socket. The relay sockets have to comply with the requirements of IEC 61984 and the insulation reqirements of the IEC 61810-1. Even if the socket alone fullfills or exceeds the insulation reqirements as clearance/creepage for the relay, the combination of a relay with a socket may reduce the creepage and lead to a lower rated insulation voltage. Hence restrictions for the combination relay-socket may be the consequence, e.g. a reduction of the voltage range or of the pollution degree. Especially for miniature multi-pole relay and respective sockets with small distance between the contact circuits, these restrictions have a big impact.
Apart from the insulation properties, the thermal characteristics of the combination relay and socket are of utmost importance (see > 'Derating curves'). As sockets from different sources are not directly comparable, the compliance with the technical specification can only be confirmed for an approved combination relay-socket. As design details and characteristics for non TE products are beyond our control, confirmations for technical parameters and characteristics regarding such combinations is not possible. Risks as reduced dielectric strength, fire hazard, etc. due to use based on unclear or omitted data, limitations or restrictions must not be underestimated.
NOTE: We only confirm the characteristics and parameters for the approved combinations of relays and sockets as indicated in the catalog and datasheets.

Contact arrangement
Different applications require specific switching functions of the relay contacts; various contact arrangements are specified and described in different ways.

The most common are:

	Form description	Short description	NARM designator	Circuit symbol
Make contact	Form A	NO	SPST-NO	
Break contact	Form B	NC	SPST-NC	
Changeover contact	Form C	CO	SPDT	
Double make on armature	Form U		SPST-NO DM	
Double break on armature	Form V		SPST-NC DB	
Double make contact	Form X		SPST-NO DM	
Double break contact	Form Y		SPST-NC DB	
Double break, double make contact	Form Z		SPDT-NC-NO DB-DM	
Triple make contact	Form 3			

Examples for descriptions of multi- pole configurations:

Multi pole configurations	Form description	Short description	NARM designator	Circuit symbol
2 Make contacts	2 Form A	2 NO	DPST-NO	
3 Break contacts	3 Form B	3 NC	3PST-NC	
4 Changeover contacts	4 Form C	4 CO	4PDT	

Abbreviations
NO: normally open, NC: normally closed, CO: changeover
SPST: single pole, single throw, SPDT: single pole, double throw, DPST: double pole, single throw

Contact current
See >
- 'Rated current'
- 'Limiting making current'
- 'Limiting continuous current'
- 'Limiting short-time current'
- 'Limiting breaking current'.

Contact gap
Shortest distance between the open contact points.

Contact material
The list gives an overview of the most important plating- and contact materials and their use in signal-, automotive and general purpose relays.
The switching capacity of the contacts and the respective electrical endurance depends not only on the contact material but also to a high degree on the relay design. Decisive for the application therefore is the optimal combination of the mechanical system and the contact material. The characteristics for certain relay types cannot be transferred to other designs, nor can

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Definitions (Continued)

these values be used as given limits for existing products.
1) Plating materials:
Fine gold
- best corrosion resistance, not used as solid material because too soft, high tendency towards cold-welding, not used or only used in combination with a material with resistance against cold welding. Gold alloys (AuNi, AuAg, AuPd, AuCo)
- gold platings ≤ 1 µm (gold flashed), only as storage protection, no protection against aggressive atmosphere.
- hard gold plated: very good corrosion resistance, low and stable contact resistance at lowest loads, low tendency to cold welding
- dry-circuit switching (switching without current/voltage), recommended range of application ≥ 1 V, 1 mA, 50 mW.

2) Contact materials:
Silver-Palladium
- high resistance against material transfer in signal DC circuits, low welding tendency, higher contact resistance than Ag
- circuits with medium loads, DC- and AC-circuits, recommended for telecommunication applications.

Palladium-Ruthenium
- highest resistance against material transfer in signal DC-circuits, low welding tendency, higher contact resistance than Ag
- circuits with medium loads, DC- and AC-circuits, recommended for telecommunication applications.

Silver-Nickel AgNi90/10
- high resistance against electrical wear, low welding tendency, higher contact resistance than AgNi0.15
- circuits with medium to high loads, DC- and AC-circuits, recommended range of application ≥ 12 V, 10 mA.

Fine-grain silver AgNi0.15
- relatively low contact resistance, low resistance against aggressive atmosphere
- universally applicable in medium and low load range, especially in DC-circuits, recommended range of application ≥ 12 V, 10 mA.

Silver-Tin-Oxide $AgSnO_2$
- low welding tendency, high wear resistivity with heavy loads, low material transfer
- circuits with high requirements to make- and break currents, DC- and AC loads, recommended range of application ≥ 12 V, 100 mA.

Tungsten W
- highest melting point, for high switching rates and low ON-time
- as prerun contact in circuits with highest make loads.

Silver-Cadmium-Oxide AgCdO
- compliant with RoHS directive (Directive 2002/95/EC) only under time limited exception, therefore not recommended for new designs
- low welding tendency, high wear resistance
- for switching of inductive loads, AC-circuits, ≥ 12 V, 100 mA.

Contact materials for the use in automotive applications:

Current range	Automotive load type (DC load)	Recommended contact material
Switching and carrying 0.5 A < I < 10 A at 12 V	In low power applications	AgNi0.15 or $AgSnO_2$
Periodical switching and approx. 10^6 ops, 1 A < I < 10 A at ≥ 12 V	Long-life indicator switches	$AgSnO_2$
Switching and carrying I > 10 A capacitive load	Lamps, Capacitors	$AgSnO_2$
Switching and carrying I > 10 A resistive and inductive load	Motors, Valves	AgNi0.15 or $AgSnO_2$
Switching high inrush I > 100 A	Lamp (e.g. H4), Spark plugs, short circuit	$AgSnO_2$ in special cases: AgNi20 or Tungsten pre-contact

Contact protection circuits
The effect of an electrical arc causes primarily local contact erosion resulting in contact wear and migration and as secondary effect the generation of adverse atmosphere inside the relay (see > 'Electrical arc' and 'Vent hole' in processing section). These effects eventually lead to the end of the useful life of a relay. To reduce the negative effect of the electrical arc and thus prolong the life of a relay, contact protection circuits are recommended. This is especially important for switching of DC applications (e.g. automotive applications). The user has to ensure the correct design of the protection circuit in the respective application, as unless designed correctly, the protection circuit may even generate adverse effects.

Contact rating
In context of our datasheets this term is primarily used in context with ratings as tested/approved by external approval agencies whereas the term 'electrical endurance' is used primarily for internal test results. See > 'Electrical endurance'.
Indicated contact ratings for direct wiring of relays (according IEC 61810-1); for relays mounted on sockets or when using connectors deratings may apply.

Contact resistance
Electrical resistance between the relay terminals of a closed contact, measured with indicated measuring current and indicated source voltage. The specified contact resistance is reached reliably only above a particular load. Considerably increased contact resistances can occur with smaller loads. After a prolonged period of a steady state operate/release position or storage of the relay a certain number of cycles are recommended before measurement of the contact resistance.
According to IEC 61810-7 the following measurement parameters are applied (for general purpose relays category CC2 is applicable):

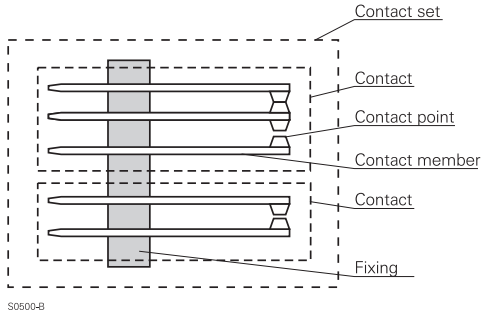
Category	Load		Measurement	
	V	A	V	A
CC0	0.03	0.01	0.03	0.01
CC1	without electrical arc		10	0.1
CC2	with electrical arc		30	1

Contact style
On one side indicates the design of the contact point itself , see >
- 'Single button contact'
- 'Twin contact, bifurcated contact'

indicating the contact function, see >
- 'Forcibly guided contact'

as well as the total configuration of the contacts within a relay
- number of poles and
- contact arrangement (see > 'Contact arrangement').

Contact terms



Creepage distance
Depending on the insulation design, usually the shortest distance along the surface of the insulating material between conductive parts according to IEC 61810-1.

Cross talk
Signal interference between adjacent conductors caused by the pick-up of stray energy.

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Definitions (Continued)

CTI
See > 'Tracking index'.

Cycle
Operation/set and subsequent release/reset of a relay.

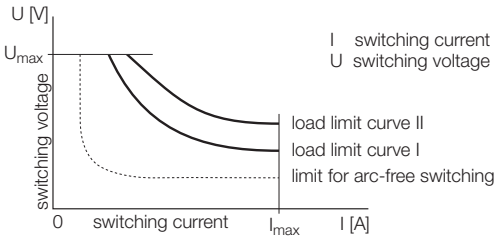
Cycle time
Sum of ON and OFF time (make, break and bounce time) of a contact. See also > 'Duty factor'.

dBm
Relative measure of signal power where the reference 0 dBm is equal to one milliwatt. See also > 'Decibels'.

DC breaking capacity
Switching of loads at voltage and current below the max. DC load breaking capacity curve is possible for a limited number of switching operations. Unless otherwise stated, the indicated curves in the DC breaking capacity diagram represent the load limit curve II (the arc extinguishes within 10ms at resistive load). The breaking capacity curve is affected in both position and shape by the contact material and relay design (contact distance, break speed of the contacts, etc.). No statement on the electrical endurance can be derived from these curves. For practical use it is recommended to keep a distinct margin from the DC load breaking capacity curve.

- Load limit curve (II) The switching arc for loads below this curve extinguishes within 10 ms (the relay is already in release position). Unless otherwise stated the indicated curve for DC breaking capacity relates to the load limit curve II
- Load limit curve (I) The switching arc of loads below this load limit curve extinguishes during the transit time of the moving contact. This limit is especially important for change over relays, when the NC and NO contacts are at different voltage levels; if the arc does not extinguish before reaching the other contact, the arc will establish a short circuit, a situation that may lead to the destruction of the relay and equipment.
- Load limit curve for arc-free switching. Load voltage/current combinations below this load limit curve in general cause no arc or an arc with max. duration of 1ms.

Unless otherwise stated the curves in the graphs refer to a 'load limit curve II'.



Decibel, dB
A relative and dimensionless unit calculated as ten times the logarithm to the base of 10 of a power ratio.

Degree of protection (IEC 60529)
Degrees of protection provided by enclosures (IP Code) for electrical equipment.
Under certain circumstances this data is relevant for industrial relays and accessories. For relays as components (e.g. PCB relays) the IP classification is generally not used, see > Category of protection; there is no direct correlation between the IP-code and the RT-category.

Definition of degree of protection (IP code) IEC 60529 outlines an international classification system for the sealing effectiveness of enclosures of electrical equipment against the intrusion into the equipment of foreign bodies (i.e., tools, dust, fingers) and moisture. This classification system utilizes the letters IP (Ingress Protection) followed by two digits.

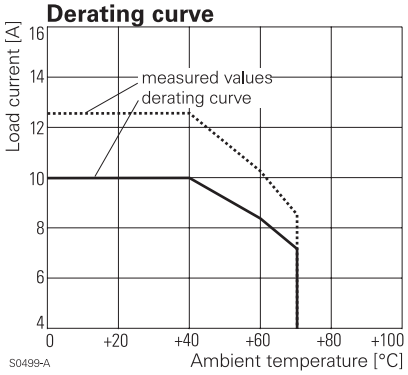
Degree of protection - First digit:
The first digit of the IP code indicates the degree that connection is protected against contact with moving parts and the degree that equipment is protected against solid foreign bodies intruding into an enclosure.

0 No special protection
1 Protection from a large part of the body such as hand or from solid objects greater than 50 mm in diameter
2 Protection against objects not greater than 80 mm in length and 12 mm in diameter
3 Protection from entry by tools, wires, etc., with a diameter or thickness greater than 2.5 mm
4 Protection from entry by solid objects with a diameter or thickness greater than 1.0 mm
5 Protection from the amount of dust that would interfere with the operation of the equipment
6 Dust-tight.

Degree of protection - Second digit:
Second digit indicates the degree of protection of the equipment inside the enclosure against the harmful entry of various forms of moisture (e.g. dripping, spraying, submersion, etc.)

0 No special protection
1 Protection from vertically dripping water
2 Protection from dripping water when tilted up to 15°
3 Protection from sprayed water
4 Protection from splashed water
5 Protection from water projected from a nozzle
6 Protection against heavy seas, or powerful jets of water
7 Protection against temporary immersion
8 Protection against complete continuous submersion in water (up to 1 meter deep for 15 minutes).

Derating curve (sockets and relay-socket sets)
EN61984:2001 table 12: according to this standard the derating curve given for a specific combination relay-socket and its accessories - indicates the maximum permissible continuous current (limiting continuous current) of a socket, loaded on all contact circuits, unless otherwise stated supplied with rated coil voltage, over the entire temperature range, measured in dense packing (usually 3 relay-socket sets).
In case of reduced duty factor of the contact load or with higher mounting distance up to single mounting, a higher load current is permissible. Please contact our technical support for specific data. According to the standards the derating curve is derived from the measured curve by applying a reduction factor of 0.80.



Other standards: the test conditions (e.g. UL508) differ from the EN standard, hence under these conditions other temperature/current combinations may be permissible; please contact our technical support for details.
In case no derating curves are given, the indicated temperature and load current refer to the approved standards for the specific product and not to the EN61984.

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Definitions (Continued)

Dimensions
Dimensions are indicated in mm and/or inches and are shown for reference purposes only.
PCB pin dimensions are indicated without solder (pre-tinning).

Dimensions, drawings
Technical drawings for product dimensions are using both ISO projections (ISO Method E or ISO Method A) according to ISO/R 128. In cases of ambiguity the projection is defined by the respective international symbol (see below).

ISO Method E projection - symbol

ISO Method A projection - symbol

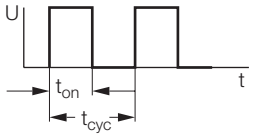
DIN-rail
Unless otherwise stated, our products for DIN-rail mounting are designed and tested for DIN-rails according to TH35-7.5 / EN60175.
Use of other rails (e.g. according to TH35-15) is neither tested nor approved.
When mounting the sockets on a DIN-rail, assembling the socket accessories and mounting/dismounting relays provide an adequate temperature (unless otherwise stated -10°C to +40°C) during the mounting process.

Drop test, free fall
Relays are dropped from a specified height onto a solid ground; this simulates the resistance to bad handling e.g. fall from a table. The test is to verify that the component meets its specification. However we strongly recommend to scrap dropped relays.

Dry switching
Defined as contact category 0 (CC0) according to IEC61810-1: a contact characterized by a maximum contact voltage of 30mV and a maximum contact current of 10mA. See also chapter 'Testing / diagnostics of relays'.

Dust-proof relay
Relay with a case to protect against penetration of dust. See > 'Category of environmental protection (IEC 61810)' - RT I.

Duty factor, duty cycle
Ratio of the duration of energization to the total period in which intermittant or temporary operation of the relay place. Duty factor is expressed as percentage of the total period at a specified frequency of operation; e.g. 30% duty cycle means that the relay is operated for 30% during a cycle time.



$$df = \frac{t_{on}}{t_{cyc}} \times 100\ (\%)$$

df Duty factor
t_{on} On time
t_{cyc} Cycle time

Electrical arc
Is an electric phenomenon caused by plasma current flow between opening and closing relay contacts. An arc is generated by the electric energy of the load circuit (turn off spark) or the voltage gradient at closing contacts, ionizing the gas between the contacts and thus establishing an electrical conductive path. The stability of the arc depends on various parameters such as contact material, air pressure, contact gap, etc.
Apart from positive effect of the electrical arc as limitation of overvoltage when switching of inductive loads, reduction and dissipation of electrical load energy and electrical cleaning of contact surfaces, the arc locally produces high temperature and causes contact erosion (also see > 'contact protection circuits'). Special consideration has to be given to DC and high frequency AC-circuits where, depending on the conditions (e.g. contact gap) an arc of extended or infinite duration could occur; in this case the relay may be destroyed due to the extreme thermal stress. Also the switching of different voltages with a generation of an electrical arc and the switching of reverse polarity on adjacent contact circuits of a multi-pole relay may lead to non-extinguishing arcs.

Electrical endurance
Number of cycles a relay can perform with electrical contact load defined under specified conditions according IEC 61810-1 and IEC 61810-2. Unless otherwise specified the electrical endurance refers to:
- NO contact
- AC mains, 50 Hz for general purpose relays (schematic for contact loading A) ; 12 VDC for automotive relays
- duty factor 50%
- rated frequency of operation
- resistive load
- rated voltage (coil)
- contact opening and/or closing not synchronized to line frequency
- ambient temperature 23°C
- no failsafe behaviour (see > 'Failsafe')
- category of protection RTII - flux proof
- individual mounting of relays without thermal interference and connection wiring according to IEC 61810-1, table 12.
- relay in upright position (terminals of a print relay pointing downwards).
- direct wiring of relays (according IEC 61810-1); for relays mounted on sockets or when using connectors deratings may apply.

Unless otherwise stated, the electrical endurance is specified according to severity level B according IEC 61810-2. For relay failure modes see also > Failure criteria. Any use beyond the specified electrical endurance is not in scope of the specified data, the avoidance of such situation requires consideration by the user.

Electrical endurance graph
The electrical endurance graph indicates the typical electrical endurance with resistive load and 250 VAC rated voltage as “Mean Cycles to Failure” (MCTF) according Weibull distribution. These statistical data do not guarantee a minimum value; this data can be used to estimate the MCTF value.
Please note:
- the graph for electrical endurance is only valid for the indicated contact material (in case no contact material is specified, it is valid for the contact materials as listed in the respective datasheet), it is not permissible to deduce electrical endurance information for other contact materials.
- it is not permissible to deduce electrical endurance information by extrapolation beyond the range indicated by the curve. This applies especially to the range below 0.5 A as at this level the contact wear is small and other failure modes are dominant.

For details please contact our technical support. Also see > 'Electrical endurance'.

ELV compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Endurance
Electromechanical components as relays, are subject to wear (mechanical and electrical). For the reliability the typical bath-tub curve applies, hence singular statistical failure events below typical reliability values may occur.

Environmental data and tests
Relays undergo extensive environmental tests. The selection of tests depends on the product group and the intended application fields; e.g. for automotive relays, common environmental tests are:
- cold storage test, IEC 600 68-2-1
- dry heat, IEC 600 68-2-2
- climatic cycling with condensation. EN ISO 6988
- temperature cycling, IEC 600 68-2-14 Na (shock), IEC 600 68-2-14 Nb
- damp heat cycling, IEC 600 68-2-30 Db variant1
- operational humidity, IEC600 68-2-38
- corrosive gas, IEC 600 68-2-42
- flowing mixed gas corrosion, IEC 600 68-2-60 Ke method 54
- drop test, free fall, IEC 600 68-2-32.

Environmental endurance
Generic term for the relay endurance under different climatic conditions. Appropriate test conditions are classified in IEC 60068.

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Definitions (Continued)

Failure criteria
Set of rules used to decide whether an observed event constitutes a failure. A contact failure is the occurence of break and/or make malfunctions of a contact under test, exceeding a specified number.

Failure mode
The IEC 61810 defines a relay failure as occurrence of malfunctions, exceeding a specified number:
- malfunction to make
- malfunction to break (contact bridging on a CO contact as a special form of malfunction to break), or as
- insufficient dielectric strength.

Such malfunctions have to be taken into consideration and must not generate risks. Depending on the specific load, its characteristics and power in the contact set, a relay malfunction situation may generate various risks such as malfunction of the equipment and its controls, electrical shock, the risk of excessive heat and fire and others. It is in the responsibility of the user to provide for additional precautions against such possible effects according to the relevant application standards.
Standards (e.g. IEC 695-1-1'Guidance for assessing fire hazard of electrotechnical products') are based on the principal assumption of heating effects and risk of fire in case electrical currents of certain magnitude being conducted and switched. Our relays are manufactured with self extinguishing plastics corresponding to the up-to-date technology and standards requirements. Protection against excessive heat and possible spread of fire under all operation conditions even in case of malfunction can only be ensured by the design of the equipment as well as by application instructions for the end user; it is the responsibility of the manufacturer of the equipment to take the appropriate measures. Incorrect connections by the user may lead to risks, faulty operation and abnormal heating or fire. It is also the responsibility of the manufacturer of the equipment to take appropriate measures to avoid potential danger of electrical shock by preventing access to live parts of the relay including parts as terminals and accessories.
NOTE: Relays normally do not have a failsafe behaviour. See > 'Failsafe'

Failsafe
Failing behaviour with definite failing characteristic, e.g. component always fails with contacts do not open. Electromechanical relays normally do not have a failsafe behaviour

Flux proof/suitable for processing on soldering lines
See > 'Category of environmental protection (IEC 61810)' - RT II.

Force guided contact
Contact configuration according to EN61810-3 (formerly EN50205) with at least one NO contact, one NC contact and a mechanically linked system, designed that the NO and NC contacts within the complete contact set are never closed at the same time, even in case of malfunction. These relays are implemented in the control of safety technology for the protection against damage to persons or objects.
See > 'Relays with force guided contacts'.

Form 3 contact, triple make contact
Three make contacts configuration with three electrically connected movable contacts operating simultaneously. There is no external connection to the armature. See also table 'Contact arrangement'.

Form A contact, NO contact, normally open contact
A contact that is open when the relay is in its release condition (unenergized position for monostable relays) and which is closed when the relay is in its operate condition. For circuit schematic see table 'Contact arrangement'.

Form B contact, NC contact, normally closed contact
A contact that is closed when the relay is in its release condition (unenergized position for monostable relays) and which is open when the relay is in its operate condition. For circuit schematic see table 'Contact arrangement'.

Form C contact, CO contact, changeover contact
Compound contact consisting of Form A (NO, make) contact and a Form B (NC, break) contact with a common terminal. On changing the switch position, the contact previously closed opens first followed by the closing of the contact that was previously open. For circuit schematic see table in 'Contact arrangement'.
Note: in case of a switching arc the NO and NC contact may be temporarily electrically connected.

Form U contact
Two make contact configuration, with two electrically connected movable contacts which operate simultaneously. As special version main contact with pre-contact. See also table 'Contact arrangement'.

Form V contact
Two break contact configuration, with two electrically connected movable contacts which operate simultaneously. See also table 'Contact arrangement'.

Form X contact
Two make contact configuration with two electrically connected movable contacts operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Form Y contact
Two break contact configuration with two electrically connected movable contacts operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Form Z contact
A contact configuration with
- two make contacts and
- two break contacts

with two electrically connected movable contacts each operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Frequency of operation
Number of operation cycles (opening and closing of contacts) per unit of time. The switching rate is usually indicated for switching under rated load; unless otherwise stated at ambient temperature 23°C and without any circuitry in parallel to the coil (no coil suppression circuit, e.g. diode). With contact loads considerably below rated load a higher frequency of operation may be admissible. This has to be tested for the specific application. For further assistance please contact our application support.

Full disconnection
Contact separation for the disconnection of conductors so as to provide the equivalent of basic insulation between those parts intended to be disconnected. NOTE: there are dielectric strength and dimensional requirements regarding the relay design but also referring to the connection, wiring and design on the outside of the relay.

Halogen content
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Immersion cleanable/sealed relays
See > 'Category of protection (IEC 61810)' - RT III.
Relays which are sealed against the penetration of specified PCB cleaners or protection lacquers; for more information refer to chapter 'Processing Information'.

Impedance, Z0
Characteristic property of a transmission line describing the ratio between electric and magnetic fields.

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Definitions (Continued)

Industrial relays and accessories
Relays and accessories are designed for use in closed and electrically secure switching cabinets. In these applications lower standard requirements of the insulating properties of components could apply.
CAUTION: These products are to be handled by trained personnel only.

Initial contact resistance
Contact resistance measured at the time of production/final testing. Prolonged storage and adverse environmental conditions (e.g. gases) can lead to increased resistance values. The effect of electrical cleaning due to sufficient load can bring the contact resistance back to lower levels.
See > 'Contact resistance'.

Initial dielectric strength
Voltage (rms value in AC voltage, 50 Hz 1 min) the insulation can withstand between relay elements that are insulated from one another, measured at the final production test.

Initial insulation resistance
Electrical resistance (initial product condition) measured by applying a DC voltage of 500 V between two elements of a component that are insulated from one another as measured at the final production test.
The requirements according to IEC 61810-1 are:
- for functional insulation > 2 MOhm
- for basic insulation > 2 MOhm and
- for reinforced insulation > 7 MOhm.

Initial pulse withstand voltage, initital surge voltage resistance
Amplitude of a voltage impulse of short duration with a specified impulse form (e.g. 1.2/50µs) and polarity applied to test insulation paths in a relay, especially where relays are subject to overvoltage situations (e.g. effects of lightning).

Insertion cycles
The symbol A indicates that the insertion and extraction must be done without any load current on the relay/socket contacts.
Unless otherwise stated the accessories are designed for max. 10 insertion cycles, insertion and extraction without load; A (10).

Insertion loss
The loss in load power due to the insertion of a component at some point in a transmission system. Generally expressed in decibels as the ratio of power received at the load before insertion of the apparatus to the power received at the load after insertion.

Insulation
Unless otherwise stated, the insulation characteristics are indicated for the relay component, the design of the application, mounting and wiring also has to provide for required insulation properties.
In general, the relays are designed to be used within enclosures; the relay surfaces are not to be accessible for direct contact by the end user. Specific insulation requirements of the equipment and protection egainst environmental effects need special consideration.

Jump start test
Short time relay use at higher system voltages (like car start after flat vehicle battery).

Latching relay
See > 'Bistable relay'.

Limiting breaking current
The max switching current the contact is intended to break under specified load conditions. The switching current must not exceed the indicated rated current. For DC switching also see > 'DC breaking capacity'.

Limiting continuous current
Is the highest steady state load current a relay or an accessory can withstand continuously while satisfying specified temperature rise requirements; it is identical with the limiting continuous thermal current I_{th}.
NOTE that this is not necessarily the current that can be switched over the specified lifetime. Unless otherwise stated the data for relays is given under following condition: all contacts equally loaded with the respective current, input voltage 110% of nominal coil voltage, max ambient temperature, minimum allowed mounting distance, test conditions according to the heat test arrangement IEC EC 61810-1 Annex B. In combinations with accessories/ sockets the limiting continuous current is specified by the derating curve (see > 'Derating curve').

Limiting making current, inrush current
The limiting making current expressed as a current with a power factor of 1.0 (resistive load) a contact is able to make under specified conditions; for 20 ms data expressed as peak value, for 4 s data expressed as rms value. Unless othwerwise stated the data refers to the Form A contact (NO contact), rated voltage and a current for a duration of max. 20 ms for at least 100 cycles or 4 s with duty factor of 10%.
Inrush current for some loads can be significantly higher than its specified steady state current. For these load types the inrush current has to be within the limits for the limiting making current. Typical examples for loads with high inrush currents are all type of lamps (incandescent, halogen, fluorescent, etc.) as well as motors, solenoids, transformers and capacitive loads.

Limiting short-time current, Overload current
This test is done to confirm, that our relays withstand normal overload conditions, e.g. withstand short circuit conditions until a fuse opens.

For automotive applications, current and time are compatible to circuit protection by a typical automotive fuse according to ISO 8820-3 (2002) as shown in the table below. Relay will carry the specified currents at 23°C (Irated = rated current as given in contact data section for each relay).

Test current in A	Operating time in seconds	
	Minimum	Maximum
6.00 * I_{rated}	0.02 s	0.20 s
3.50 * I_{rated}	0.08 s	0.50 s
2.00 * I_{rated}	0.25 s	5.00 s
1.35 * I_{rated}	0.75 s	1800 s
1.10 * I_{rated}	100 h	No requirement

For mains fuses and fuses other than automotive, customers have to refer to the respective standards (mains condition, prospective short circuit, etc.) to test for their application.

Limiting voltage (coil)
The highest permissible input voltage (coil voltage) at the reference temperature at which the relay, with continuous energization and, unless otherwise stated under rated contact load, heats up to its max. permissible coil temperature.

Load dump
Short relay use at overvoltage (disconnection of the battery during running engine).

Load dump test
Short relay use under overvoltage conditions (simulated disconnection of the battery with charging alternator).

Magnetic system
Magnetic systems can be categorized by the switching characteristic
- monostable relays return automatically to the rest position (release state) after the coil is de-energized.
- bistable relays maintain their switching position after the energization or input voltage is disconnected. See > bistable relays

and the design of the magnetic circuit:
- neutral (non-polarized) relays operate independently of the polarity of the applied voltage (coil voltage)
- polarized relays use an additional magnet within the magnetic circuit and therefore only operate with a specific polarity of energization.
- remanent bistable relays adopt a particular switching position following an energizing direct current in any direction and are then held in this position by the remanence in the magnetic circuit.

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Definitions (Continued)

Make-before-break contacts
Contact mechanism where Form A contacts (normally open contacts) close before Form B contacts open (normally closed contacts).

Material group of insulation parts
Categorization of insulation materials according to their tracking indices, according to IEC 60664-1.

Material substance specification
For material information regarding ELV, China RoHS compliance, European RoHS compliance, Halogene and REACH refer to product specific information on TE's Website: www.te.com/customersupport/rohssupportcenter.

Max. coil power
The highest permissible input power at the reference temperature at which the relay, with continuous energization, heats up to its max. permissible coil temperature. Unless otherwise stated the data is indicated without contact load.

Max. coil temperature
As general term refers to the max. approved coil temperature, measured by change of resistance method.
UL classifies max. coil temperatures according to UL1446; this standard refers to insulation systems and does not cover individual insulating materials:
- class B - max. 130°C
- class F - max. 155°C.

Maximum energization duration
Maximum duration a coil may be energized with rated DC voltage; energization beyond the indicated duration will overheat the coil system and the relay.

Max. insertion force total
The force during the insertion of the relay into the socket has to be applied in insertion direction (no tilting) and equally on all connections. The maximum applied force must not exceed the indicated max. insertion force.

Max. operate/reset duration
Maximum duration a bistable coil may be energized with rated DC voltage.

Max. switching voltage
Maximum voltage that may occur between the switching contacts before closing or after opening the contact. Data given for AC refer to V_{rms} in a mid-point earthed 3-phase supply system.

Maximum energization duration
Maximum duration a coil may be energized with rated DC voltage; energization beyond the indicated duration will overheat of the coil system and the relay.

Maximum voltage (coil), U_{max}
The highest permissible input voltage (coil voltage) at the reference temperature at which the relay, with continuous energization and without contact load, heats up to its max. permissible coil temperature.
Also see > 'Limiting voltage'.

MCTF - Mean cycles to failure
Expected value of the distribution of operations to failure, average number of operations according to Weibull.

Mechanical endurance
Number of cycles without contact load during which the relay remains within the specified characteristics.
NOTE that the failure criteria for mechanical endurance are not the same as for electrical endurance, therefore the value for mechanical endurance has no relation and cannot be directly compared to electrical endurance for very low loads!

Mechanical life
See > 'Mechanical endurance'.

Minimum energization duration
Minimum duration the coil needs to be energized with rated DC voltage. Unless otherwise stated the proposed minimum energization duration is 100 ms.

Minimum recommended contact load
The minimum contact load a relay can reliably switch/carry depends on the relay design and used materials; there is no physical limit as for the definition of a minimum switching voltage or current. The indicated value is a recommendation, it is influenced by switching frequency, required contact resistance and its stability over time and ambient conditions. Low contact resistance is reached reliably only above a particular load, considerably increased contact resistance can occur with lower loads.
- Signal relays are capable to carry and switch minimum contact loads in the range of the thermoelectric potential which is approx. 100µV.
- General purpose relays are designed for category CC2 loads according IEC61810; basically these relays are designed for switching loads with the effect of switching arcs. Specific insulation requirements however may call for the use of general purpose relays in applications with low signal loads or for dry switching (switching without the generation of an electrical arc). NOTE that increased contact resistance may occur if the load conditions are not in scope of the test conditions for category CC2 according IEC61810. Also see the minimum contact loads recommended for the different contact materials.
- Automotive relays usually are switching higher DC loads with switching voltages above the fritting voltage and with switching power within the contact cleaning effect of an electrical arc.

Minimum recommended switching power
Product of switching current and switching voltage for reliable switching. Low contact resistance is reached reliably only above a particular load, considerably higher contact resistances can occur with smaller loads.

Minimum set/reset duration
Minimum duration a bistable coil needs to be energized with rated DC voltage.

Minimum voltage (coil)
For
- monostable relays see > 'Operate voltage'
- bistable relays see > 'Set voltage' and 'Reset voltage'.

Monostable, neutral relay, non-polarized relay, polarized relay
A relay is called monostable when its contacts return automatically to the rest position (release state) after the coil is de-energized.
Non-polarized relays operate independently of the polarity of the applied voltage (coil voltage) whereas polarized monostable relays only operate with a specific polarity of energization.

Mounting
Describes specific mounting options of the relay. See >
- 'Through-hole-technology (THT)'
- 'Through-hole-reflow (THR)'
- 'Surface mount technology (SMT)
- for Mounting on DIN-rail (relays and accessories) see > 'DIN-rail'.

See also > 'Mounting' in the processing section.

Mounting distance
The distance between two adjacent relays in parallel and unidirectional mounting according to IEC 61810-1 or distance to other electrical components including the pc-board. Insulation requirements may stipulate an increase to the minimum distance between the relays or to choose a different placement.
If not otherwise stated the product data refers to relays in 'single mounting'.
In addition to this definition we use:
- dense packing: relays mounted at minimum distance; this minimum distance is defined by the requirements of the insulation coordination at rated voltage 230 VAC, and/or by mechanical requirements for the mounting of the relay (e.g. use of sockets)
- single packing: relays mounted at a distance without any thermal impact of adjacent relays or components.

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Definitions (Continued)

Mounting position / Placement
Unless other restrictions are stated the relays can be mounted in any direction. The relay connections have to be fully contacted and with adequate cross-sections to ensure the current flow and heat dissipation.
For the arrangement of the relays the insulation requirements, heat dissipation and the magnetic interrelation have to be taken into consideration.

MTBF - Mean time between failure
Expected value of the distribution of the time between failure. For components with limiting failures due to wear (e.g. contact wear), see > 'MCTF-Mean cycles to failure'.

Nominal power (coil)
See > 'Rated coil power'.

Nominal voltage (coil)
See > 'Rated coil voltage'.

Normally closed contact, NC contact
See > 'Form B contact, NC contact, normally closed contact'.

Normally open contact, NO contact
See > 'Form A contact, NO contact, normally open contact'.

Open contact circuit data
Insulation parameters of the contact circuit.

Operate
Process in which a relay shifts from the release/rest condition to the operate condition.

Operate state, operate condition
For a monostable relay, specified condition of the relay when it is energized by the specified energizing quantity and has responded to that energization. For a bistable relay, it refers to the condition other than the release/reset condition as declared by the manufacturer.

Operate time (DC coils)
The time interval that elapses from energizing a monostable relay in the rest state with the rated voltage (pulse or square signal) at an ambient temperature of 23°C to the moment when the last output circuit is closed or opened (bounce time not included). The operate time varies with the applied coil voltage and the ambient/coil temperature.
This definition refers to DC-coils only, due to the dependency of the phase angle considerably longer operate times may occur with AC magnetic systems.

Operate voltage
Value of coil voltage at which a monostable relay operates. For bistable relays see > 'Set voltage'.

Operate voltage U_1
Value of the coil voltage at which a relay operates, having previously been energized at the same voltage and with rated contact load (thermal equilibrium has to be achieved).
Operate voltage without preenergizing U_0
Minimum permissible input voltage at which the relay operates, for a coil temperature equal to the reference temperature (23°C coil temperature without preenergizing).

Operation
One switching cycle including energizing and de-energizing of the relay coil.

Operative range
According to IEC 61810-1.
Class 1: 80%..110% of the rated coil voltage (or range)
Class 2: 85%..110% of the rated coil voltage (or range)
For diagram specification see > 'Coil operative range'.

Packaging unit
Minimum delivery quantity (e.g. per carton/plastic bar) and quantity per box. Additionally, minimum quantity requirements apply and these requirements may differ from indicated packaging units. Please consult with your TE sales organization or authorized distributor.

PCB
Printed circuit board.

Peak inrush current
See > 'Limiting making current'.

Pre-contact, pre-make contact
Contact with two operating contact points usually of different material, with one contact switching prior to the other one. Pre-make contacts are used mainly for high inrush currents.

Product code
The ordering code structure does allow a large number of possible variations, but not all possible variations are defined as standard types (ordering codes) and thus not included in the product range.
Special versions to customer specifications can be supplied. Please contact your local sales organization.

Product date code
Printed on the product. Indicates the date of production of the product; the most common format is 'year+week', 'yymm' (e.g. 0412 indicates production in 2004 week 12); this code may be followed by additional related information.

Product marking/specials

	'Caution' - this symbol indicates a general possible cause of risk - refer to the specification/data sheet for details.
	'Read instructions' - this symbol refers to important information in the respective data sheets or specification
	Symbol for a NO contact
	Symbol for a NC contact
	Symbol for a CO contact
	Symbol for a forcibly guided contact set
	Symbol for coil information

For information on production date code see > 'Product date code'.

Protection class
See > 'Degree of protection (IEC 60529)'.

Protection to heat and fire
Data of the flammability class according to the UL 94 (Underwriters Laboratories, Inc., USA) specification.
UL 94 flammability testing, conducted on plastic materials to measure flammability characteristics, determines the material's tendency either to extinguish or to spread the flame once the specimen has been ignited. According to IEC61810-1, all plastic materials have to fulfil the Glow Wire test requirements with min. 650°C.

PTI
See > 'Tracking index'.

Push-to-test button, test tab
For manual operation of the relay. The test button is to be used for test purposes of an equipment or installation. The push-to-test button is not de-

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Definitions (Continued)

signed for standard ON/OFF operations, for continuous electrical operation in the manually set ON state, and is not to be used as a switch.
Before operating the test tab, the operator has to make sure that the load and any other connected item will operate safely.
As safety functions of the equipment might be bypassed and reduced insulation requirements apply, the test button is to be operated by trained personnel only.

Quick connect terminals (spade terminals)
The connectors indicated in the datasheet may be used for the connection to the relay. When using this connector type the given plug cycles and the maximum permissible current have to be taken into consideration. The connector and wire cross section have to be selected so that under the current load the increase of the temperature at the connector point must not exceed 45 K. For high contact currents it is recommended to solder the connection.
Furthermore the correct insulation of the connectors/plugs have to be respected.

Rated coil power
Product of coil current and voltage at rated coil voltage (in mW or W for DC-coils and in VA for AC-coils)

Rated coil voltage, Nominal voltage (coil)
Rated voltage at which the relay displays the operating characteristics, given for a constant DC supply or sinusoidal AC supply. Other operating conditions (e.g. pulse control, ramp voltage, half wave rectifying, etc.) may lead to characteristics other than specified.

Rated current
Current a relay can switch on and off and a relay or accessory can carry under specified conditions. Unless otherwise defined the rated current covers:
- contact current, switching current
- limiting continuous current: For a relay the specified conditions are defined under contact ratings; see > contact ratings. For accessories the rated current is specified for a duty factor of 50% at rated frequency of operation and at ambient temperature 23°C; the respective derating curves should be followed.

Rated values
Standard values the relay is designed for. Values are used to classify relays.

Rated voltage (contacts)
Voltage between the switching contacts before closing or after opening of the contact.

REACH SvHC compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

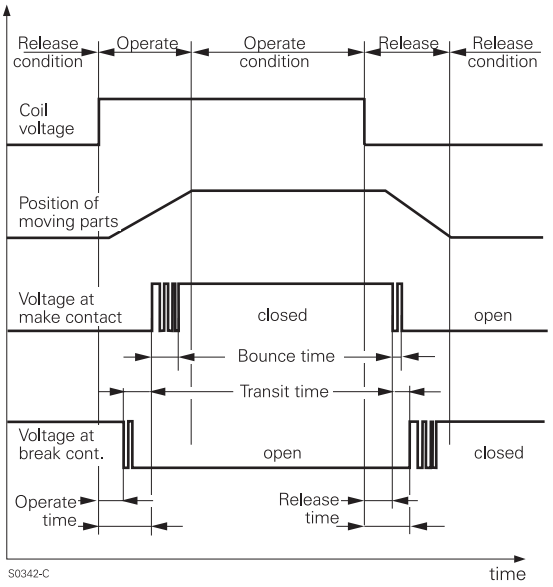
Reference temperature
Unless otherwise indicated the reference temperature refers to an ambient temperature of 23°C ('room temperature'). Also see > 'Coil data'.

Reference values
Reference values for all tests according to IEC 61810-1.

Reflection loss, Return loss
The part of a signal which is lost due to the reflection of power at a line of discontinuity.

Reinforced insulation
A single insulation system applied to live parts which provides a degree of protection against electric shock, comparable to a system comprising basic insulation and supplementary insulation (refer to IEC 61810-1, Type of insulation).

Relay cycles
Due to the self induction of the coil and the inertia of the parts to be moved, on activating a relay the operations do not take place suddenly. The function diagram below shows the different cycles for the most important relay configurations of undelayed power relays. Unless otherwise stated the indicated times are maximum values, the cycles specified apply to DC-coils energized with rated voltage (without any components in series or parallel to the coil) and at the reference temperature.
See
- 'Operate time'
- 'Release time', 'Reset time'
- 'Bounce time'
- 'Minimum energization duration'



Relay with force guided contacts
The compliance with regulations for the safety of persons and material is imperative in our technical world. National and international regulations take various risks into account. These safety standards also make demands on components which share with their function the safety level of a plant, machine or the equipment. For relays being used for safe contact monitoring purposes the contacts have to be linked mechanically in a way, that NO and NC contacts must not be closed at the same time. It has to be ensured, that over the entire life and even in case of malfunction (e.g. contact welding) the open contact gap will be at least 0.5 mm. Relays with force guided contacts comply with the requirements of EN61810-3 (formerly EN50205).

Release
Process in which a monostable relay shifts from the operate state back to the rest state.

Release state (normal position)
Switch position of a non-energized monostable relay.

Release time
The time interval that elapses from the point of time at which a monostable relay in the operating state has the rated voltage disconnected to the point of time at which the last output circuit has closed or opened (not including the bounce time). Unless otherwise stated the indicated times are maximum values and are valid for energization with rated voltage, without any components in series or parallel to the coil, and at reference temperature.

Release voltage
The input voltage at or below which a monostable relay releases to the rest state at the reference temperature.

Reliabilty
Electromechanical components as relays, are subject to wear (mechanical and electrical). For the reliability the typical bath-tub curve applies, hence singular statistical failure events below typical reliability values may occur.

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Definitions (Continued)

Reset
Process in which a bistable relay returns from the operate state back to the rest state.

Reset state
Switch position of a bistable relay as specified by the manufacturer. Unless otherwise stated the reset state is the contact position where the normally open contacts (form A, NO contact) are open and the normally closed contacts (form B, NC contact) are closed. Please note that the contact position for bistable relays is not defined at delivery.

Reset time
The time interval that elapses from the point of time at which a bistable relay in the operating state has the rated voltage (applied in the opposite direction for 1-coil systems and to the reset coil for 2-coil systems) to the point of time at which the last output circuit has closed or opened (not including the bounce time).

Reset voltage
The input voltage to a bistable coil for reset to the rest state at the reference temperature. Please note the wiring diagram and the polarity (see > 'Bistable relay').
- Reset voltage max.
  The input voltage that must not be exceeded to a bistable coil for reset to the rest state at the reference temperature.
- Reset voltage min.
  The input voltage that has to be applied to a bistable coil for reset to the rest state at the reference temperature.

Resistance to soldering heat
According to IEC 60068-2-20, method 1A.

Rest state
Switch position of a monostable relay in the unenergized state.
For bistable relays see> 'Reset state'.

RoHS - Directive 2002/95/EC, EU RoHS compliance
Directive on the Restriction of Hazardous Substances (Directive 2002/95/EU, RoHS directive) restricting the use of certain materials as Lead (Pb), Cadmium (Cd), Mercury (Hg), hexavalent Chromium (Cr6), polybrominated Biphenyls (PBB) and polybrominated Diphenylethers (PBDE).
'Compliant'
indicates that the entire product group is compliant with the RoHS directive and none of the above materials is intentionally added and/or below the limits set forth in the directive.
'Compliant versions'
indicates that certain products within the respective product group are compliant with the RoHS directive. The RoHS compliant selection is indicated together with the information on the RoHS compliance. Some products of that product group however do contain materials (e.g. Cd) listed above and thus are not compliant with the RoHS directive.

Safety relay
See > 'Relay with force guided contacts'.

Sealed relay
See > 'Category of protection (IEC 61810)' - RT IV and RT V.

Set time
The time interval that elapses from operating a bistable relay with the rated voltage (pulse or square signal) at an ambient temperature of 23°C to the moment when the last output circuit is closed or opened (bounce time not included). The operate time varies with the applied coil voltage and the ambient/coil temperature.

Set voltage
Value of coil voltage at which a bistable relay operates. For monostable relays see > 'Operate voltage'.

Shock resistance (destruction)
This test is used to evaluate the resistance of the relay to heavy mechanical shocks leading to a permanent damage to the relay. This test is performed according to the IEC 60068-2-27, Ea test.

Shock resistance (function)
This test is used to evaluate the resistance of the relay to mechanical shocks such as those that could occur in transport or during operation (no opening of closed relay contacts with a duration >10 µs). This test is performed according to the IEC 60068-2-27, Ea test.
Data valid for all relay axes unless otherwise stated. Nevertheless it is recommended to avoid shock especially in armature and contact movement direction.

Single contact
Contact system with one contact point per contact member (contact blade).

Single/double throw contact
A single throw contact connects one common line (movable contact) to one load line (stationary contact). See > 'Form A contact' and 'Form B contact'.
A double throw contact switches one common line between two stationary contacts, for example between a NO contact and a NC contact. See > 'Form C contact, CO contact, changeover contact'.

Single/double/multi pole
A single pole relay connects one common line (movable contact) to one load line (stationary contact).
A double pole relay switches two, electrically disconnected common lines with two electrically independent load lines (like two separate make relays); the same stands for multi-pole relays, the number of poles indicate the number of independently switches load lines.

Switching of different potentials on adjacent contact circuits of a multi-pole relay is permitted as long as the sum of applied voltages does not exceed the rated insulation voltage.
The switching of different voltages with the generation of an electrical arc and the switching of reverse polarity on adjacent contact circuits of a multi-pole relay without contact separated chambers however is not permitted. The contact load has to be connected to the same contact side.

Sockets and accessories
All listed sockets and accessories have been tested and approved only with the indicated relays from the TE product range.
For combinations of sockets with other relays with similar design and pinning TE cannot take responsibility for any malfunction.
Also see > 'Combination of relay and socket'.

Soldering temperature/time, IEC 60068-2-20
See > 'Resistance to soldering heat'.

Solid insulation
Solid insulating material between two conductive parts.

Steady state current limit
See > 'Limiting continuous current'.

Stripline
A type of transmission line configuration which consists of a single narrow conductor parallel and equidistant to two parallel ground planes.

Switching capacity
See > 'Switching power'.

Switching current
See >
- 'Rated current'
- 'Limiting making current'
- 'Limiting breaking current'.

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Definitions (Continued)

Switching power
Product of the switching current and switching voltage (in W for direct current, in VA for alternating current).

Switching rate
See > 'Frequency of operation'.

Switching voltage
See > 'Rated voltage (contacts)'.

Switching voltage max.
See > 'Max. switching voltage'.

Terminal assignment
For historical reasons and due to typical application nomenclature (e.g. relays in automotive applications) different terminal assignment schemes are used:
Terminal assignment to IEC 67
The terminals are identified by consecutive numbers. Please note that two digit identifiers exist in both the IEC 67 and the EN 50005 identification systems and may have different meaning.
Terminal assignment to EN 50005: the terminals are defined by a two digit code:
for the coil terminals 'A1', 'A2' are used
for contacts the first number indicates the pole, the second number indicates the function
1 for the movable form C, CO contact,
2 for the form B, NC contact,
4 for the form A, NO contact
e.g. a terminal '24' indicates the form A, NO contact of the second pole of a relay.
Automotive relays
Quick connect style coil and load terminals ISO relays may be numbered according to two different standards, the terminals have the same location and function. The respective numbers are:
1 or 86 for the first coil pin;
2 or 85 for the second coil pin;
3 or 30 for the common load pin;
4 or 87a for the form B, NC load pin;
5 or 87 for the form A, NO load pin.

NOTE that the terminal assignment graphs are indicated either 'bottom view' (as seen from the solder wave side of pcb's, pin side of the relays) or 'top view' (as seen from the component side of single sided pcb's or the cover side of a relay).

Terminal torque, screw type terminals
For screw type terminals the maximum indicated screw torque must not be exceeded.
No torque must be applied to any other terminal types of relays or accessories.

Test voltage/dielectric test voltage/dielectric strength
Voltage applied during dielectric (high voltage) tests between intentionally not electrically connected parts of the relay.

Thermal resistance
Relay parameter measured in Kelvin per Watt, which relates the consumed power with the respective temperature increase in the state of thermal equilibrium measured without load and without components in parallel or in line to the coil. Multiplied with its power consumption (at the actual coil temperature) it indicates the temperature rise of the coil above ambient temperature.

Thermoelectric potential
Voltage at the relay terminals of a closed contact resulting from a temperature difference of the different metal junctions (terminal, spring, contacts,...) inside the relay.

Through-hole reflow (THR)
An assembly process, where THT components are soldered in a reflow process instead of traditional wave soldering (also referred to as pin-in-paste). For details see chapter Processing Information.

Through-hole technology (THT)
An assembly process for mounting components where terminals are passed through supported (plated through) or unsupported (bare) holes in an interconnection substrate. Normally, traditional wave soldering is used with THT components.

Tracking
Progressive degradation of a solid insulating material by local discharges to form conducting or partially conducting paths.

Tracking index
- PTI - Proof tracking index - numerical value of the proof voltage expressed in volts which a material in test can withstand without tracking under specified conditions (according IEV 212-01-45).
- CTI - Comparative tracking index - numerical value of the maximum voltage expressed in volts which a material in test can withstand without tracking under specified conditions (according IEV 212-01-45).

Transit time
The movement time of the armature after opening of one contact set (e.g. NC) before closing of the other (e.g. NO) of a changeover relay. See > 'Relay cycles'.

Twin contact, bifurcated contact
Contact with two simultaneously operating contact points. Twin contacts increase the contact reliability considerably, especially when switching low currents and voltages (dry circuits) and/or are used for reduction of contact resistance. Bifurcated contacts are twin contacts with the two contact points on one contact member (contact blade).

U_{rtd}
See > 'Rated voltage'.

Vibration resistance (destructive)
This test is used to evaluate the resistance of the relay to heavy mechanical vibration leading to a permanent damage to the relay. This test is performed according to the IEC 60068-2-27, Ea test.

Vibration resistance (functional)
This test is used to evaluate the resistance of the relay to harmonic mechanical oscillations such as those that could occur in transport or during operation. No opening of closed relay contacts or closing of open relay contacts with a duration >10 µs is allowed to occur during the test. This test is performed according to the IEC 60068-2-6, Fc test. Unless otherwise stated the values refer to a frequency range 30...150 Hz.

Voltage drop
Effect of contact resistance, measured as voltage drop across closed contacts. See > 'Contact resistance'.

VSWR
Abbreviation for 'Voltage Standing Wave Ratio'. The ratio of the maximum to the minimum voltage set up along a transmission by reflections.

Wash tight/immersion cleanable
See 'Category of protection (IEC 61810)' - RT III.
Relays that can be cleaned together with the printed circuit board after soldering. The washing requires a suitable solvent. The term „immersion cleanable/wash tight“ is not identical with „hermetically sealed“!
Unless otherwise stated the relays are wash tight according to Qc2 IEC 60068-2-17, tested with a water immersion test at max. ambient temperature for 1 minute.
Contact our technical support for suitable solvents and washing parameters. The user needs to verify the compatability of lacquer, solvants and drying process.

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Handling, Processing, Testing and Use

Electromechanical relays are one of the most robust and reliable components. To achieve the specified performance some precautions must be taken during transportation, storage, handling, processing and testing.
CAUTION: ANY TRANSPORT, PACKAGING, HANDLING OR USE DIFFERENTLY THAN HEREIN RECOMMENDED BY TE MAY CAUSE RISKS AND IN THIS SITUATION SHALL BE ENTIRELY BORNE BY USER.

Handling / Logistics

Transport
During transport, care has to be taken to avoid excessive shock and vibration. Mechanical stress can lead to changes in operating characteristics or to internal damage of the relay (see > 'Vibration and shock resistance'). When a potential excess of mechanical stress is suspected (e.g. damaged packaging, dropped packages or relays, etc.), the relays should be checked and tested before use.

Packaging
Depending on the relay type and design and with regard to specific requirements various packaging types and technolgies are used for shipment of our products.
- THT and THR relays
  are packed in trays, cardboard or plastic tubes with stoppers on both sides of the tubes. For unpacking from plastic tubes the plugs on both sides shall be removed to prevent any relays sticking to the plugs and possible falling down onto the pick place.
- SMT relays
  the standard packing are blisters tapes wound on a reel (tape & reel) and dry packed in order to prevent the relays from humidity. The SMT relays should be kept in these containers for storage and should be removed from the box just only before the assembly process preferrably at the SMT assembly line. The boxes are equipped with shock absorbers, which protect the relays from mechanical impacts.
- Industrial relays are packed in trays or in tubes.

Handling
Modern relays are high precision components, sensitive to mechanical stress and abusive handling. Care must be taken when handling the relay during all stages of production.
- special attention must be paid, not to apply mechanical shock, e.g. by dropping relays onto the floor or other hard surfaces (e.g. assembly tables). Once dropped, relays should not be used anymore and shall be scrapped. In case of relays assembled to long wires or harnesses any mechanical shock due to whiplash effect has to be avoided.
- care has to be taken when opening tubes to prevent relays from falling out or during splicing of reels, where the loose end of the tape should not drop to the floor.
- special care must be taken, that the terminals of the relays are not bent. Straightening of bent terminals and pins is not allowed.
- handling or processing of relays in bulk is not permitted.

Storage
Generally TE's products should not be exposed to extreme high temperatures, high humidity or damaging media such as sulphurous, acid or basic atmospheres. Unless other specific requirements are documented, TE recommends in accordance with IEC 60068-1 a standard atmospheric conditions a storage temperature between 15 and 35°C (59 to 95°F) and a relative humidity between 25 and 75 %.

Dry packed SMT relays: when the packing is opened, the relays must be soldered within a defined time frame, indicated by the moisture sensitive level MSL (max time from opening the bag to soldering). When the open time is exceeded, remaining relays shall be dry repacked, or the relays must be dried before soldering.

For more information, refer to our application notes in the internet.

Processing

Testing
For electrical incoming inspection tests refer to sections > 'Contact resistance', 'Diagnostics of relays' and 'Storage'.
During incoming inspection and respective handling, special care has to be taken not to bend the relay terminals. The degradation of sealing properties up to internal failures (e.g. breaking of coil wires) could be the consequence.

Handling during processing
Relays are high precision components, sensitive to mechanical stress and abusive handling. Care must be taken when handling the relay during all stages of production. Do not exert any pressure on the pins.

Manual handling
- the relays have to be removed from the packaging in on orderly way
- processing of relays in bulk is not permitted
- when relays are manually handled and placed on PCB's, special attention must be paid, not to drop relays onto the floor or other hard surfaces (e.g. assembly tables). Once dropped, there is a risk of high mechanical shock and potential damage of the relay; these relays should not be used anymore. In case of relays assembled to long wires or harnesses any mechanical shock due to whiplash effect has to be avoided.
- open packages, tubes or splice reels with care: after prolonged storage at higher temperature there is a risk of relays sticking to the stopper plugs of tubes and for reels the loose end of the tape shall not drop to the floor.
- special care must be taken, that the terminals of the relays are not bent. Straightening of bent terminals and pins is not allowed.
- do not exert undue force (e.g. by hand tools) when inserting the relays onto a pcb or into a socket.

Automatic handling
- the mechanical stress caused by handling and/or force of automatic feeders or robots has to be adjusted to avoid mechanical damage (e.g. cracking of the relay case, detaching cap from relay base).
- the clamping force shall not exceed the values given for x, y, z direction, in order to provide for the proper internal function of the relay. The force shall be applied in the largest possible area. Picking in the dashed area would be preferred. Unless otherwise stated the clamping force should not exceed 5 N in any of x/y/z direction.
- do not excert undue force when inserting the relays onto a pcb or into a socket.

Mounting on PCB's
- the relays have to be removed from the packaging in an orderly way, processing of relays in bulk is not permitted. Dimensions and pcb layout indicated in the datasheet are indicated for the manual placement on the pcb's. For automated pick-and-place we refer to detailled component drawings.
- unless otherwise stated the relay can be mounted in any position. The relays can be further processed in the industry standard commercial soldering and cleaning (for suitable products) plants.
- when inserting the relay into the PCB, do not exert any pressure or use undue force or torque on the pins as this may compromise the pin seal or affect the integrity of the coil connections.
- no pressure should be exerted on the relay cover and terminal pins after the relay has been inserted in the printed circuit board.
- after insertion in the printed circuit board, the terminal pins must not be bent or twisted for fixation or attachment. Bending or applying mechanical stress to the pins may affect the relay parameters. Bending the terminal pins of sealed relays (wash-tight, immersion proof, sealed) may damage the sealing. However, if fixing must be carried out before soldering, please contact our application support. Also see > 'Clinching'.

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Handling, Processing, Testing and Use (Continued)

Mounting of relays and accessories on sockets and DIN-rails
When inserting the relay onto sockets, do not exert undue force on the relay and/or pins (e.g. indicated max. insertion force).
Reduced ambient temperature ranges may apply for mounting and handling of sockets and accessories (mounting on DIN-rail, assembly of retaining clips, mounting/dismounting of relays etc.); unless otherwise stated provide a temperature of -10°C to +40°C for ambient and parts for such mounting processes.

Clinching
Terminals should not be bent to hold the relay in place on the PCB to aid flow soldering. Bending or cutting the pins after insertion generates extreme mechanical stress, especially in the case of rectangular PCB terminals. Neither the relay performance nor sealing of flux resistant and plastic or hermetically sealed relays can be guaranteed if the terminals have been bent.
Also see > 'Mounting on PCB's'

Fluxing
Fluxing has to be carefully considered depending on the type of relay.

- Sealed relays, wash-tight relays:
  these relays may be processed on all standard commercial fluxing, solder and cleaning equipment for this type of electrical and electromechanical components.

- Unsealed relays, open relays, dust-proof relays:
  should be hand soldered to avoid flux contamination of the relay. Flux should be used sparingly and evenly and joints examined after soldering. If flow soldering is used however, the flux level has to be set so that it merely touches the bottom of the PCB and only wets the underside of the printed circuit board. It must not flood onto the upper surface of the PCB. This is particularly critical if multilayer PCB are used and there are unused holes under the body of the unsealed relay, the flux should only be visible as foam flux through any open perforations in the printed circuit board. If the printed circuit board is flooded by flux, bursting flux bubbles can lead to contamination in open relays and, consequently, to failures. To protect against corrosion, no acidiferous flux should be used.The recommended flux types are 1.1.3, 1.2.3 or 2.2.3 according to DIN EN 29454 T.1 or type F-SW 32 to 34 to EN 29454-1 (ISO 9454-1).

  If there is any doubt about the fluxing process, sealed relays (wash-tight, plastic or hermetically sealed) should be used.

  Acidic fluxes are not suitable for open relays due to the risk of corrosion, especially inside the coil.

Preheating
During preheating for common wave soldering processes, the temperature of the upper surface of the printed circuit board should not exceed 130°C (EN61760-1). Excessive exposure to high temperatures may affect the relay characteristics. NOTE that any not completely dried flux might evaporate in an explosive reaction and sputter; ensure that no flux penetrates the insides of open relays.

Soldering
The soldering process has to be controlled carefully in order not to impair the performance of the relays. No external force to be applied on the pins during the soldering process.

Our relays can be processed in commercial soldering and washing installations (if classified as washable). They cover the following regulations:
Flux tight type relays; open relays without cover:
- Solderability according to IEC 60068-2-20, Test Ta, method 1, aging 3: 4 hours at 155°C, dewetting
- Resistance to soldering heat according to IEC 60068-2-20, test Tb, test method 1A

Sealed type open vent hole relays:
- Solderability according to IEC 60068-2-58; dewetting
- Resistance to soldering heat according to IEC 60068-2-58

Sealed type washable relays:
- Such relays are capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents
- Sealing complies to IEC 60068-2-17; Test Qc: method 2, the relay will withstand a bubble test at 70°C for 1 min
- See also > 'Chemical Cleaning'
- Avoid designs with considerable thermal mass below the relay (e.g. high number of solder filled interlayer connections).

Soldering, wave soldering
The automated soldering process has to be controlled carefully in order not to impair the performance of the relays. Flux resistant and sealed relays can be used with most dip or wave soldering processes. The solder level has to be adjusted so that it does not flood the printed circuit board surface. The pre-soldered pins are suited for standard soldering processes with Pb-solder as well as for Pb-free solder processes.
Leadfree processing:
- for processing of relays under leadfree conditions refer to the indicated 'resistance to soldering heat', exceeding the limit may have negative impact on relay parameters. We recommend that leadfree processes should be carried out using SnAgCu-solder. The solder bath temperature for i.e. double wave soldering should be in the range of 250 to 260°C.
- the solder bath temperature should not exceed
  - 270°C for 10 s for flux-proof relay versions (RT II)
  - 260°C for 5 s for wash-tight and sealed relays (RT III and higher).
- for other bath temperatures and solder time (e.g. higher solder bath temperature with reduced dipping time) contact our technical support.

SnPb processing
- for this process refer to maximum permissible temperatures at the terminals according to CECC 00802. For SnPb Eutectic Process we recommend a maximum peak temperature Tp < 225°C. For Pb-free processing we recommend a maximum temperature Tp < 245°C. These soldering temperature profiles indicate the Pad/Pin temperature.

Soldering, reflow soldering
Unless otherwise stated the soldering should be carried out according to the recommendation of IEC 60068-2-58 and according to the recommendations of CECC 00802.

Please note that in some cases the ambient temperature may be considerably higher on top area of the relay component. In this case the component temperature should not exceed 260°C. Check for specific mounting conditions. In addition the time, parameter t_L (time span for temperature above preheating temperature) should be below 150 s.

In general, electromechanical relays should be soldered at the lower process limits of a soldering process.

Soldering, manual soldering
The relay programme offers products with various terminal styles. Some products with solder lugs are specifically designed for manual soldering whereas some products (e.g. with quick connect terminals) are not intended to be soldered. Most PCB mount relays are designed for processing in a wave soldering process. For manual soldering and repair the soldering time should be kept to a minimum and no mechanical force or torque must be applied to the relay terminals.
Unless otherwise stated we recommend for manual soldering a soldering temperature of 300 to 350°C for a maximum soldering time of 3 s.

Cooling
After wave or reflow soldering, the assemblies should be cooled in order to reduce thermal stress and to minimize the pressure difference between inside of the relay and ambient. Do not change the temperature suddenly, especially avoid thermal shock for the hot relay. Do not cool down by using cold liquids or aerosols. In case of thermal shock, the relay sealing could break and through micro-cracks cleaning fluid with dissolved flux might be sucked inside the relay; such ingress of liquids into the relay can lead to failures in operation.

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Handling, Processing, Testing and Use (Continued)

Cleaning, chemical
Preferrably a non clean flux process should be used; in this case there is no need to wash the PCB and we recommend avoiding washing processes in order to protect the environment. If cleaning is necessary, certain precautions have to be taken:

Flux tight type relays and sealed relays with open vent hole:
- immersion cleaning is not possible with these types of relays. Only the soldered side of the PCB (THT) should be cleaned and care has to be taken not to allow washing solution to flood the PCB surface to prevent penetration of solvent and dissolved flux into the relay. Any other cleaning method involving potential contamination of unsealed relays must be avoided.

Sealed relays (wash-tight, sealed and hermetically sealed), closed vent-hole:
- do not stress the terminals mechanically before or during the mounting, soldering or cleaning process
- the PCB should be allowed to cool prior to the washing process to avoid thermal shock and potential damage to the seal as well as a pressure difference (see > 'Cooling')
- the printed circuit must be washed in a timely manner after the soldering process
- do not lower the temperature while the relay is in contact with any liquid, e.g. some residue of cleaning medium can be between relay and PCB
- modern cleaning equipment uses water or alkaline solutions, if other cleaning solvents are used, ensure that the chemicals are suitable for the relay. The use of unsuitable solvents can cause cracking or discoloring of the plastic parts. Suitable solvents include isopropyl alcohol (alcohol-based solvents), water with wetting agents. Unsuitable solvents are, e.g., acetone, ethyl acetate, aqueous alkalines, phenolic combinations, thinner-based solvents, chlorosenebased solvents, trichlene-based solvents and chlorine.
- when using high pressure cleaning processes, special care has to be taken to avoid any ingress into the relay as liquids under high pressure can damage the seal of the relay. Do not use jet pressure higher than 1,5 bar or ultrasonic pressure higher than 0,5 bar.
- avoid and do not use any ultrasonic pressure for relays with gold plated contacts. See > 'Cleaning, ultrasonic'
- special care must be taken on the temperature of the cleaning and rinsing liquid; their temperature shall be similar and not deviate by more than 10°C.
- the individual wash stations must be separate from one another to prevent cross-contamination!
- after the final washing process, the printed circuit boards must be cleaned again using a clean washing medium!

Cleaning, ultrasonic
Ultrasonic cleaning is generally not recommended as this can cause friction welding of the contacts and in addition it may cause coil wire breaks. If ultrasonic cleaning cannot be avoided, it is on user's own responsibility and must be completed as quickly as possible.
For gold plated contacts ultrasonic cleaning is NOT recommended at all as this might result in cold welding of the gold contacts.

Protective coating
Relays with a category of protection II and below are not suited for coating processes. Relays with category of protection III and higher are suitable for washing processes but not all relays are necessarily suited for coating processes. In this case, please contact our application support for recommended relay versions and processes.
In case relays with insufficient protection are coated, there is a high risk that resin will enter the relay and destroy the relay. Sealed relays with an opened vent hole can only be partly coated.
- for the protective lacquering and varnishing of the mounted printed circuit boards, we recommend single-component lacquer (epoxy-based). Suitable are Epoxy, Urethane and Fluorine coatings. Silicon containing laquer or potting compound must not be used!
- we recommend a coating technology that avoids uncured varnish in the surrounding of the relay.
- the maximum drying temperature should be 70°C.
- the user has to conduct thorough testing with their processes, used lacquers, coatings or casting compound. Solvants may damage the component case or compromise their sealing properties.
- do not allow de-varnishing of PCB for repair, if unavoidable the relay has to be replaced.

NOTE:
- Lacquer or potting compound containing silicon MUST NOT be used!
- Coatings, especially potting compounds may impact the heat dissipation of the relay. Therefore it is necessary to conduct thermal tests of relays in potted assemblies.

Vent hole, nip-off pin, opening
Most PCB relays, reflow solderable relays as well as THR and SMD relays, are provided with a closed vent hole on top of the cover (removable sealing pin on relay cover).
Inside a sealed relay certain load conditions (e.g. heavy loads with generation of pronounced arcing) and/or extreme ambient conditions can generate aggressive atmosphere (diffusion, arc ionization), corrosive condensate or overpressure. To avoid such conditions and a possible reduction of electrical endurance a gas exchange with the atmosphere is advised. To allow the gas exchange, break off the vent hole or nip-off pin.

Silicone
Materials containing silicone or its derivatives must not be used in any form in or near to processing and packaging of subcomponents and the final relay assembly. Silicone and its derivatives are not allowed in the material of any component in the vicinity of the relays.
Silicone atmosphere can diffuse through the relay housing and cause contact failures, siliceous compound deposits can create an insulating abrasive layer on the contact surface.
Contamination can occur with all silicone-based materials before and after cure (contain silicone volatiles), silicone aerosols, silicone fluids, grease and hand cream, etc..
Some types of signal relays are suited for application in Silicone environment, however the suitability MUST be verified; please contact our application support.

Testing

Testing
During incoming inspection, special care has to be taken not put mechanical stress on the relays and terminals and not to bend the relay terminals; internal failure or long term effects as a result of a degradation of sealing properties could be the consequence.

Bistable relay, incoming and in-process testing
In a bistable or latching relay the contacts maintain the last switching position when the coil input voltage is disconnected.
NOTE that even though the bistable relays are leaving production preferrably in reset contact position, the position of the contact (set position/ reset position) is not defined at delivery or after transport. Thus, at the time of incoming and in-line testing, the customer needs to check the contact position and to set/reset the relay to the required position.

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Handling, Processing, Testing and Use (Continued)

Testing conditions, automated testing/diagnose
With higher integration and use of highly complex electronic circuits and resulting quality and safety requirements (e.g. cars), relays undergo stringent incoming tests and in-circuit testing during and at the end of the assembly process (end-of-line tests).
Special considerations have to be given for the selection of testing parameters, the respective test limits and development of embedded diagnostic routines:

- testing of contact resistance
- testing of magnetic system
- testing of dynamic characteristics.

The most common contact materials contain silver alloys and thus are affected by sulfidation and oxidation. Layers of oxides, sulfides and other compounds will form on the surface of metal contacts within a very short time by absorption from the ambient atmosphere. These layers increase the contact resistance, depending on the thickness of the layer, the effective contact area and the specific resistance of the used contact material and layer. To establish a reliable electric contact these layers have to be destroyed. This can be done by mechanical, electrical or thermal destruction:

- mechanical destruction: high contact pressure and mechanical switching impact
- electrical destruction: requires a specific breakdown voltage and current. This destruction process is called A-fritting. The breakdown voltage depends on the thickness and specific resistance of the layer. For practical testing refer to the values according IEC 61810-7 as indicated above; e.g. for automotive relays the breakdown voltage can be up to 3 V to start the A-fritting.
- thermal destruction: a thermal destruction requires high temperatures, usually generated by
  1) after the electrical breakdown (A-fritting) a small current is forced through very thin channels in the layer. The resulting local high current density heats the conducting channels up quickly, destroying the layers, until finally (within a few ms) a metal to metal bridge is established. This process is called B-fritting. The B-fritting voltage depends on the contact material. For practical testing refer to the values according IEC 61810-7 as indicated above.
  2) generated by high contact currents and/or electric arcs (e.g. disconnecting inductive loads, switching on capacitive loads).

Icing
Under very special environmental conditions (below 0°C) and operational, temporary relay switching failures can occur. Moisture condenses on the surface of the cold contact and forms a thin layer of ice, causing a temporary interruption of the electrical contact.

Magnetic system, coil resistance
For testing the inductivity of relay coils may need consideration (e.g. the inductivity for coils in automotive relays can exceed 1 H in the unsaturated range). This results in a time constants between 1 to 50 ms for the exponential inductive current increase (pulse response). In case the ohmic coil resistance is measured with a 4-pole measurement, the resistance value may be wrong, if measured during the inductive current rise after energization.

Dynamic characteristics
The switching times (e.g. operate time and release time) for DC-coils are usually in the low millisecond-range:

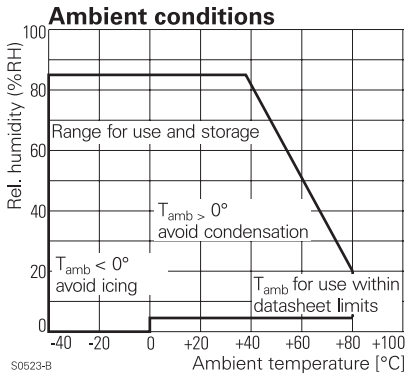
- the operate time depends on the applied coil voltage and coil temperature. Voltages higher than the rated coil voltage generally leading to reduced operate times whereas higher coil temperature and the resulting higher coil resistance leading to increased operate times. A fast dynamic response (e.g short operate and release time) also impacts the bounce time and can increase the bounce time considerably.
- the release time depends mainly on whether a coil suppresion circuit is used and on the type of the used circuit. A low ohmic device (e.g. a diode) in parallel to the relay coil can increase the release time by a considerable factor compared to the typical values shown in the datasheets.

Diagnostics of relays, recommendations
For the development of diagnostic routines these effects need to be considered:

- the contact resistance may be higher than indicated in the datasheet and due to the fritting phenomena (see above > 'testing'), also may show a non-linear characteristic. This implies, that the contact resistance, measured at too low voltage and current levels (e.g. standard tester and multimeter) can be significantly higher than the contact resistance under real application conditions (e.g. supplying a 100 W load). We recommend to perform the diagnostic routine with the actual application load and voltage (e.g. mains or board net voltage) connected to the contacts. If the diagnostic routine cannot be performed with actual application load and voltage, the measurement voltage level must secure an electrical breakdown of possible layers. We recommend a voltage level according to IEC 61810-7.
- the voltage drop can be up to 300 mV. The B-fritting is a physical phenomenon, which can occur on all metal and silver based contacts. For low level and signal applications, special signal and general purpose relays are available. For automotive applications it is recommended to set the diagnostic threshold voltage to min. 500 mV per relay contact (important for H-bridges or serial contact arrangements).
- effects like icing (see > 'Icing').
- consider the maximum possible switching times (due to, e.g., operate voltages other than the rated coil voltage, bounce time effects, ambient temperature and coil suppression circuits). If the status of the contact has to be changed for the diagnostic routine (energize or de-energize relay), the routine must wait until the intended contact status is established. Depending on electrical and ambient conditions (temperature, voltage levels, coil circuits) the times can be significantly longer than the indicated times in the datasheet. We recommend a delay time of min. 10 times of the typical switching times.
- a coil diagnostic routine must secure that the status of the contact does not change during the diagnostic cycle. If the coil driver is monitored by a watchdog routine, the energizing/de-energizing time of the coil must not result in an unintended closing or opening of the contacts. We recommend times of max. 0.5 ms.

Use

Operational humidity / Condensation
Standard conditions:
Annual mean relative air humidity ≤ 75% at ambient temperature 23°C, on 30 complete days distributed naturally over the year 95% at ambient temperature ≤ 25°C, on the remaining days occasionally 85% at 23°C. No condensing or freezing allowed (storage and/or use).
For use and storage at other conditions, condensation or freezing due to temperature changes has to be avoided. Use and storage within the limits as stated in the datasheet and as indicated in the graph.



NOTE: For use conditions the temperature limits as indicated in the datasheets apply.

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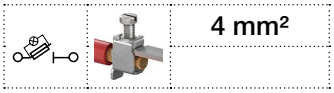
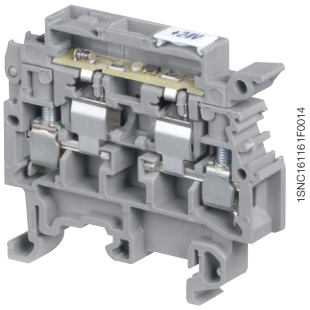
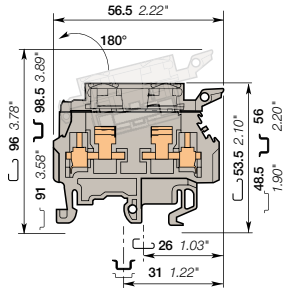
M4/8.SF screw clamp terminal blocks
For 5x20 and 5x25 fuses - With blown fuse indicator - 8 mm 0.315 in spacing





M4/8.SF



8 mm 0.315 in spacing

Description

– Protect your circuits with 5x20 and 5x25 fuse terminal blocks (fuse not supplied with terminal blocks),
– Quickly identify the defective circuit thanks to the blown fuse indicator.

Ordering details

Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
Fuse	With blown fuse indicator by LED 24-60 V DC/ 110 V AC	Grey ☐	M4/8.SFD3	1SNA115935R0400		50	14.00

Main technical data

Connecting capacity		IEC	UL	CSA
1 conductor per clamp	Rigid - Solid / Stranded	0.5-6 mm²		
	Flexible	0.5-4 mm²		
	with insulated ferrule			
	Gauge	A4		
Rated current / Rated cross section		6.3 A / 4 mm²		
Rated short-time withstand current (1s)				
Rated voltage		400 V		
Impulse withstand voltage		4000 V		
Protection		IP20	NEMA 1	

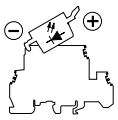
Mounting instructions

Rail		G32, TH 35-7.5, TH 35-15
Wire stripping length		9.5 mm 0.374 in
Tool		Flat screwdriver Ø 4 mm Ø 0.157 in
Torque		0.5 - 0.8 N.m 4.4 - 7.1 lb.in

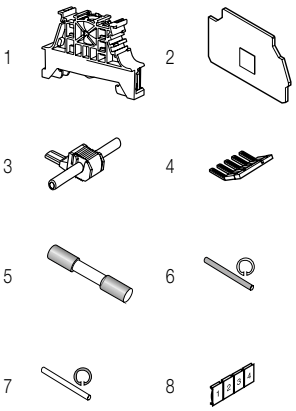
The connecting capacity data for one Rigid - Solid / Stranded - Flexible conductor (when applicable) is a mandatory information required by IEC, UL and CSA standards.
All other data are provided as supplementary information only. For more details, please consult our CB, UL or CSA certificates and technical datasheet available on http://www.te.com

CE RoHS RoHS Gost R

Notes



Blocks with LED indicator are labeled "+" on the outside of the lever. The indicator can be reversed in the field if required.
Leakage current : 24 V : < 0.5 mA / 110 V : < 2.2 mA



Accessories

	Description			Color	Type	Part Number		Pkg qty	Weight (1 pce) g
1	**End stops**	10 mm	0.394 in	Grey ☐	BAM4	1SNK900001R0000		50	12.00
		9 mm	0.354 in		BAZ1	1SNK900002R0000		50	4.70
2	**End sections**	1.5 mm	0.059 in	Grey ☐	FEM8S	1SNA116951R1500		20	2.60
3	**Jumper bars**	1 poles	24 A	Grey ☐	AD2.5	1SNA114205R2000		50	1.60
4	**Lateral jumper bars**	10 poles	35 A		PC81-10	1SNA173523R1100		10	5.00
5	**Fuses**	0.5 A			FU520	1SNA008288R1500		10	
		3.15 A				1SNA008289R1600		10	
		1 A				1SNA008290R1300		10	
		2 A				1SNA008291R0000		10	
		5 A				1SNA008292R0100		10	
6	**Assembly rods**	2 poles			TGA8	1SNA168672R1100		10	1.00
		3 poles				1SNA168673R1200		10	
		4 poles				1SNA168674R1300		10	
7	**Spring retaining rings**				ANT	1SNA168675R1400		10	
8	**Terminal block markers**	Blank card		White ☐	RC810	1SNA234000R0200		1	8.20

Complete list of accessories is indicated in the terminal block datasheet.
Some accessories such as jumper bars may modify the terminal block's ratings: complete information in the accessories catalogue pages.

Technical data valid for copper conductors only.

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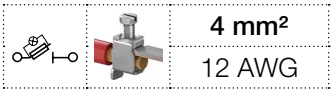

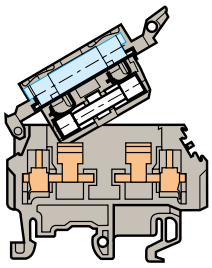

8 mm 0.315 in spacing

With blown fuse indicator

Ordering details

Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
Fuse	With blown fuse indicator by neon 110-230 V AC	Grey ☐	M4/8.SFL	1SNA115661R2100		50	14.00
	With blown fuse indicator by LED 24 V AC/DC	Grey ☐	M4/8.SFD	1SNA115663R2300		50	14.00

Main technical data	IEC	UL	CSA	Leakage current :
Rated voltage	400 V	600 V	250 V	24 V : < 4.5 mA
Impulse withstand voltage	4000 V			110 V : < 0.5 mA
Protection	IP20	NEMA 1		230 V : < 0.7 mA

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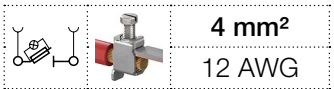
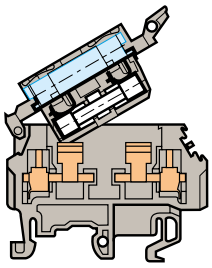




8 mm 0.315 in spacing

With blown fuse indicator and 2 test socket DIA 2 mm 0.079 in

Ordering details

Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
Fuse	With blown fuse indicator by LED 24 V AC/DC and 2 test socket DIA 2 mm 0.079 in	Grey ☐	M4/8.SFDT	1SNA115665R2500		50	14.00
	With blown fuse indicator by neon 110-230 V AC and 2 test socket DIA 2 mm 0.079 in	Grey ☐	M4/8.SFLT	1SNA115667R2700		50	14.00

Main technical data	IEC	UL	CSA	Leakage current :
Rated voltage	400 V	600 V	250 V	24 V : < 4.5 mA
Impulse withstand voltage	4000 V			110 V : < 0.5 mA
Protection	IP20	NEMA 1		230 V : < 0.7 mA

CE · RoHS · USR · CSA · Gost R

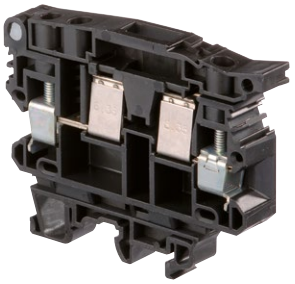
Accessories

	Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
1	**Test plugs**	DIA 2 mm 0.079 in	Black ■	FC2	1SNA007865R2600		100	

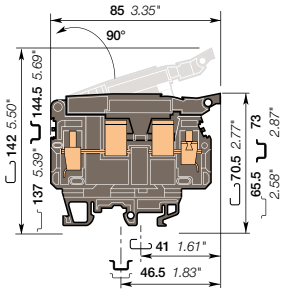
Technical data valid for copper conductors only.

ML10/13.SF screw clamp terminal blocks
For 6.3 x 25 and 6.3 x 32 fuses - 13 mm 0.512 in spacing

10 mm²
10 AWG



ML10/13.SF



13 mm 0.512 in spacing

Description

Protect your circuits with 6.35 x 25.4 mm (¼ x 1 in) and 6.35 x 32 mm (¼ x 1¼ in) fuse terminal blocks (fuse not supplied with terminal blocks).

Ordering details

Description	Color	Type	Part Number	Pkg qty	Weight (1 pce) g
Fuse	Black ■	ML10/13.SF	1SNA199095R1300	20	51.00

Main technical data

Connecting capacity		IEC	UL	CSA
1 conductor per clamp	Rigid - Solid / Stranded	0.5-16 mm²	22-10 AWG	22-8 AWG
	Flexible	0.5-10 mm²		
	with insulated ferrule			
	Gauge	A6		
Rated current / Rated cross section		16 A / 10 mm²	25 A / 10 AWG	25 A / 8 AWG
Rated short-time withstand current (1s)				
Rated voltage		800 V	600 V	600 V
Impulse withstand voltage		8000 V		
Protection			NEMA	

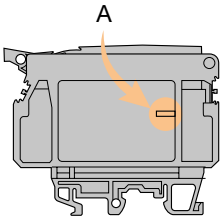
Mounting instructions

Rail		G32, TH 35-7.5, TH 35-15
Wire stripping length		12 mm 0.472 in
Tool		Flat screwdriver Ø 5.5 mm Ø 0.217 in
Torque		1.2 - 1.4 N.m 10.6 - 12.3 lb.in

The connecting capacity data for one Rigid - Solid / Stranded - Flexible conductor (when applicable) is a mandatory information required by IEC, UL and CSA standards.
All other data are provided as supplementary information only. For more details, please consult our CB, UL or CSA certificates and technical datasheet available on http://www.te.com

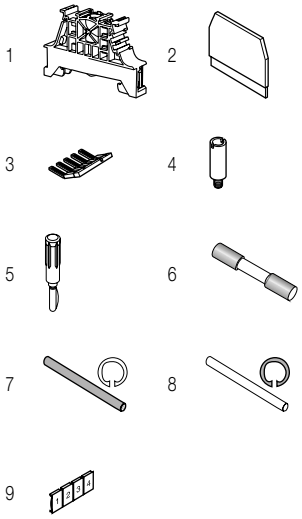
CE RoHS USR CSA Gost R

Notes



A: Use of the BJS requires the user to cut out the partition.

Accessories



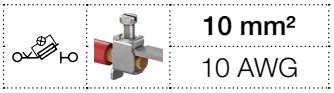
	Description			Color	Type	Part Number	Pkg qty	Weight (1 pce) g
1	End stops	10 mm	0.394 in	Grey □	BAM4	1SNK900001R0000	50	12.00
		9 mm	0.354 in		BAZ1	1SNK900002R0000	50	4.70
2	End sections	1.5 mm	0.059 in	Black ■	FEM13U	1SNA199635R2400	10	5.80
3	Lateral jumper bars	10 poles	70 A		PC13-10	1SNA173510R2000	10	26.00
4	Test sockets	DIA 2 mm	0.079 in		AL2	1SNA163043R2100	50	0.90
		DIA 3 mm	0.120 in		AL3	1SNA163261R0000	50	1.20
		DIA 4 mm	0.157 in		AL4-M3	1SNA206721R0100	50	1.10
5	Test plugs	DIA 2 mm	0.079 in	Black ■	FC2	1SNA007865R2600	100	
		DIA 4 mm	0.157 in	White □	FC4	1SNA167860R0100	10	10.00
6	Fuses	1 A			FU633	1SNA168556R0500	10	
		2.5 A				1SNA168558R1700	10	
		6.3 A				1SNA168560R1500	10	
7	Assembly rods	2 poles			TGA13	1SNA168564R0500	10	
		3 poles				1SNA168565R0600	10	
		4 poles				1SNA168566R0700	10	
8	Spring retaining rings				ANT	1SNA168675R1400	10	
9	Terminal block markers	Blank card		White □	RC1010	1SNA238000R1600	1	1.30

Complete list of accessories is indicated in the terminal block datasheet.
Some accessories such as jumper bars may modify the terminal block's ratings: complete information in the accessories catalogue pages.

Disconnect screw clamp terminal blocks

Description		Color	Type	Part Number	Pkg qty	Weight (1 pce) g
Disconnect	Profile aligned with ML10/13 SF	Black, blue ■	ML10/13.SN	1SNA199105R2200	20	59.00

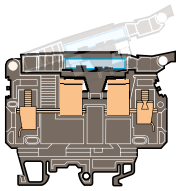
Technical data valid for copper conductors only.



With blown fuse indicator by neon

Ordering details

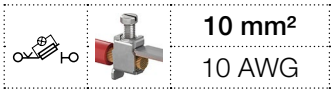
Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
Fuse	With blown fuse indicator by neon 110-230 V AC	Black ■	ML10/13.SFL	1SNA199168R0000		20	54.00



13 mm 0.512 in spacing

Main technical data	IEC	UL	CSA	Leakage current :
Rated voltage	800 V	600 V	600 V	110 V : < 0.5 mA
Impulse withstand voltage	8000 V			230 V : < 0.7 mA
Protection		NEMA		

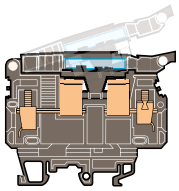
CE · RoHS · USR · CSA · Gost R



With blown fuse indicator by LED

Ordering details

Description		Color	Type	Part Number		Pkg qty	Weight (1 pce) g
Fuse	With blown fuse indicator by LED 24 V AC/DC	Black ■	ML10/13.SFD	1SNA199166R2600		20	54.00



13 mm 0.512 in spacing

Main technical data	IEC	UL	CSA	Leakage current :
Rated voltage	800 V	600 V	600 V	24 V : < 4.5 mA
Impulse withstand voltage	8000 V			
Protection		NEMA		

CE · RoHS · USR · CSA · Gost R

Technical data valid for copper conductors only.

M4/8.SFL

TE Connectivity has acquired the DIN Rail Terminal Block product range from ABB

Products → Low Voltage Products and Systems → Connection Devices → Terminal Blocks → SNA Series

General Information

Extended Product Type:	M4/8.SFL
Product ID:	1SNA115661R2100
EAN:	3472591156614
Catalog Description:	M4/8.SFL Screw Clamp Terminal Blocks - For 5 x 20 and 5 x 25 fuses - wit h blown fuse indicator - Grey
Long Description:	- Protect your circuits with 5x20 and 5x25 fuse terminal blocks (fuse not su pplied with terminal blocks), - Quickly identify the defective circuit thanks to the blown fuse indicator.

Ordering

Color:	Grey
Minimum Order Quantity:	50 piece
Customs Tariff Number:	85361010

Popular Downloads

Data Sheet, Technical Information:	1SNC160019C0202
Instructions and Manuals:	1SNC160019C0202

Dimensions

Product Net Width:	8 mm
Product Net Height:	56.5 mm
Product Net Depth / Length:	41 mm
Product Net Weight:	14 g

Technical

Rated Cross-Section:	4 mm²
Spacing:	8 mm
Connection Type:	Screw clamp
Function:	Fuse
Number of Levels:	1
Connecting Capacity Main Circuit:	Screw Clamp / Flexible 1x 0.5 ... 4 mm² Screw Clamp / Rigid 1x 0.5 ... 6 mm²
Gauge Type:	A4
Rated Current (I_n):	Main Circuit 6.3 A
Rated Voltage (U_r):	400 V

Rated Impulse Withstand Voltage (U_{imp}):	4000 V
Pollution Degree:	3
Degree of Protection:	acc. to IEC 60529, IEC 60947-1, EN 60529 Main Terminals IP20
Insulation Material:	Polyamide
Mounting on DIN Rail:	G32 (32 x 15 mm Mounting Rail) acc. to IEC 60715 TH35-7.5 (35 x 7.5 mm Mounting Rail) acc. to IEC 60715 TH35-15 (35 x 15 mm Mounting Rail) acc. to IEC 60715
Wire Stripping Length:	9.5 mm
Recommended Screw Driver:	4 mm
Tightening Torque:	acc. IEC 60947-1 0.5 N·m Manufacturer 0.8 N·m

Technical UL/CSA

Maximum Operating Voltage UL/CSA:	Main Circuit 600 V
Connecting Capacity Main Circuit UL/CSA:	Screw Clamp / Rigid 1x 22 ... 12 AWG
Connecting Capacity UL/CSA:	Screw Clamp / Rigid 22 ... 12 AWG Stranded 12 AWG
Flammability According to UL94:	V0

Environmental

Ambient Air Temperature:	Operation -55 ... +110 °C Storage -55 ... +110 °C
RoHS Status:	Following EU Directive 2002/95/EC August 18, 2005 and amendment

Certificates and Declarations (Document Number)

CSA Certificate:	1SND161066A0201
cUL Certificate:	1SND161002A0202
Declaration of Conformity - CE:	1SND225016U1000
EAC Certificate:	1SND161009A1100
Environmental Information:	1SND220021E1002
Instructions and Manuals:	1SNC160019C0202
RMRS Certificate:	1SND161007A1101
RoHS Information:	1SND230023F0208

Classifications

Object Classification Code:	X
ETIM 4:	EC000899 - Fuse terminal block
ETIM 5:	EC000899 - Fuse terminal block

ETIM 6:	EC000899 - Fuse terminal block

Container Information

Package Level 1 Units:	50 piece
Package Level 1 Width:	101 mm
Package Level 1 Depth / Length:	265 mm
Package Level 1 Height:	47 mm
Package Level 1 Gross Weight:	0.7 kg
Package Level 1 EAN:	3472591156614
Package Level 2 Units:	450 piece
Package Level 2 Width:	300 mm
Package Level 2 Depth / Length:	500 mm
Package Level 2 Height:	150 mm
Package Level 2 Gross Weight:	6.200 kg
Package Level 3 Units:	21600 piece
Product Packing Type:	Box

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ML10/13.SFL

TE Connectivity has acquired the DIN Rail Terminal Block product range from ABB

Products → Low Voltage Products and Systems → Connection Devices → Terminal Blocks → SNA Series

General Information

Extended Product Type:	ML10/13.SFL
Product ID:	1SNA199168R0000
EAN:	3472591991680
Catalog Description:	ML10/13.SFL Screw Clamp Terminal Blocks - For 6.3 x 25 and 6.3 x 32 fuses - with blown fuse indicator by Neon 480V - Black
Long Description:	- Protect your circuits with 6.35x25.4 and 6.35x32 fuse terminal blocks (fuse not supplied with terminal blocks), - Quickly identify the defective circuit thanks to the blown fuse indicator.

Ordering

Color:	Black
Minimum Order Quantity:	20 piece
Customs Tariff Number:	85361050

Popular Downloads

Data Sheet, Technical Information:	1SNC160019C0202
Instructions and Manuals:	1SNC160019C0202

Dimensions

Product Net Width:	13 mm
Product Net Height:	85 mm
Product Net Depth / Length:	58 mm
Product Net Weight:	54 g

Technical

Rated Cross-Section:	10 mm²
Spacing:	13 mm
Connection Type:	Screw clamp
Function:	Fuse
Number of Levels:	1
Connecting Capacity Main Circuit:	Screw Clamp / Flexible 1x 0.5 ... 10 mm² Screw Clamp / Rigid 1x 0.5 ... 16 mm²
Gauge Type:	A6
Rated Current (I_n):	Main Circuit 10 A
Rated Voltage (U_r):	800 V

Rated Impulse Withstand Voltage (U_{imp}):	8000 V
Pollution Degree:	3
Mounting on DIN Rail:	G32 (32 x 15 mm Mounting Rail) acc. to IEC 60715 TH35-7.5 (35 x 7.5 mm Mounting Rail) acc. to IEC 60715 TH35-15 (35 x 15 mm Mounting Rail) acc. to IEC 60715
Wire Stripping Length:	12.0 mm
Recommended Screw Driver:	5.5 mm
Tightening Torque:	acc. IEC 60947-1 1.2 N·m Manufacturer 1.4 N·m

Technical UL/CSA

Maximum Operating Voltage UL/CSA:	Main Circuit 600 V
Connecting Capacity Main Circuit UL/CSA:	Screw Clamp / Rigid 1x 22 ... 10 AWG
Connecting Capacity UL/CSA:	Screw Clamp / Rigid 22 ... 10 AWG Stranded 10 AWG
Flammability According to UL94:	V0

Environmental

RoHS Status:	Following EU Directive 2002/95/EC August 18, 2005 and amendment

Certificates and Declarations (Document Number)

CSA Certificate:	1SND161066A0201
cUL Certificate:	1SND161000A0203
Declaration of Conformity - CE:	1SND225016U1000
EAC Certificate:	1SND161009A1100
Environmental Information:	1SND220021E1002
Instructions and Manuals:	1SNC160019C0202
RMRS Certificate:	1SND161007A1101
RoHS Information:	1SND230023F0208

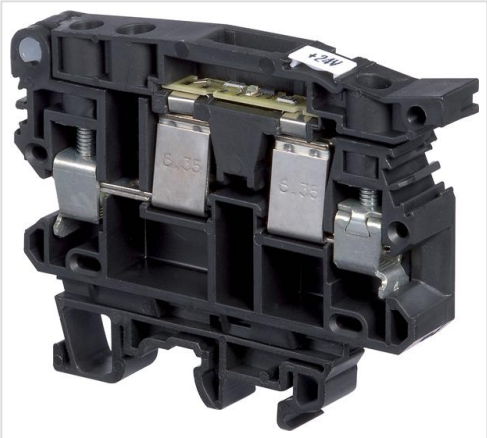
Classifications

Object Classification Code:	X
ETIM 4:	EC000899 - Fuse terminal block
ETIM 5:	EC000899 - Fuse terminal block
ETIM 6:	EC000899 - Fuse terminal block

Container Information

Package Level 1 Units:	20 piece

Package Level 1 Width:	172 mm
Package Level 1 Depth / Length:	155 mm
Package Level 1 Height:	71 mm
Package Level 1 Gross Weight:	1.08 kg
Package Level 1 EAN:	3472591991680
Package Level 2 Units:	200 piece
Package Level 2 Width:	300 mm
Package Level 2 Depth / Length:	500 mm
Package Level 2 Height:	150 mm
Package Level 2 Gross Weight:	11.150 kg
Package Level 3 Units:	9600 piece
Product Packing Type:	Box



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ML10/13.SFD

TE Connectivity has acquired the DIN Rail Terminal Block product range from ABB

Products → Low Voltage Products and Systems → Connection Devices → Terminal Blocks → SNA Series

General Information

Extended Product Type:	ML10/13.SFD
Product ID:	1SNA199166R2600
EAN:	3472591991666
Catalog Description:	ML10/13.SFD Screw Clamp Terminal Blocks - For 6.3 x 25 and 6.3 x 32 fuses - with blown fuse indicator by Neon 480V - Black
Long Description:	- Protect your circuits with 6.35x25.4 and 6.35x32 fuse terminal blocks (fuse not supplied with terminal blocks), - Quickly identify the defective circuit thanks to the blown fuse indicator.

Ordering

Color:	Black
Minimum Order Quantity:	20 piece
Customs Tariff Number:	85361050

Popular Downloads

Data Sheet, Technical Information:	1SNC160019C0202
Instructions and Manuals:	1SNC160019C0202

Dimensions

Product Net Width:	13 mm
Product Net Height:	85 mm
Product Net Depth / Length:	58 mm
Product Net Weight:	54 g

Technical

Rated Cross-Section:	10 mm²
Spacing:	13 mm
Connection Type:	Screw clamp
Function:	Fuse
Number of Levels:	1
Connecting Capacity Main Circuit:	Screw Clamp / Flexible 1x 0.5 ... 10 mm² Screw Clamp / Rigid 1x 0.5 ... 16 mm²
Gauge Type:	A6
Rated Current (I_n):	Main Circuit 10 A
Rated Voltage (U_r):	800 V

Rated Impulse Withstand Voltage (U_{imp}):	8000 V
Pollution Degree:	3
Mounting on DIN Rail:	G32 (32 x 15 mm Mounting Rail) acc. to IEC 60715 TH35-7.5 (35 x 7.5 mm Mounting Rail) acc. to IEC 60715 TH35-15 (35 x 15 mm Mounting Rail) acc. to IEC 60715
Wire Stripping Length:	12.0 mm
Recommended Screw Driver:	5.5 mm
Tightening Torque:	acc. IEC 60947-1 1.2 N·m Manufacturer 1.4 N·m

Technical UL/CSA

Maximum Operating Voltage UL/CSA:	Main Circuit 600 V
Connecting Capacity Main Circuit UL/CSA:	Screw Clamp / Rigid 1x 22 ... 10 AWG
Connecting Capacity UL/CSA:	Screw Clamp / Rigid 22 ... 10 AWG Stranded 10 AWG
Flammability According to UL94:	V0

Environmental

RoHS Status:	Following EU Directive 2002/95/EC August 18, 2005 and amendment

Certificates and Declarations (Document Number)

CSA Certificate:	1SND161066A0201
cUL Certificate:	1SND161000A0203
Declaration of Conformity - CE:	1SND225016U1000
EAC Certificate:	1SND161009A1100
Environmental Information:	1SND220021E1002
Instructions and Manuals:	1SNC160019C0202
RMRS Certificate:	1SND161007A1101
RoHS Information:	1SND230023F0208

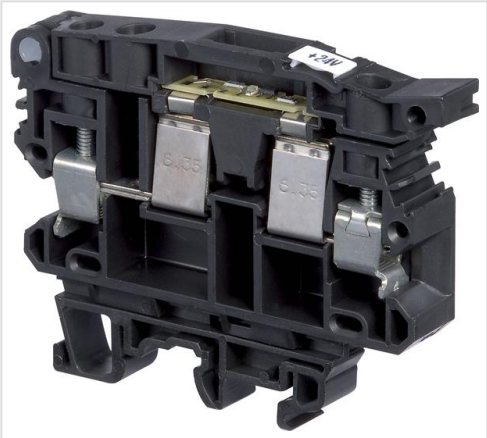
Classifications

Object Classification Code:	X
ETIM 4:	EC000899 - Fuse terminal block
ETIM 5:	EC000899 - Fuse terminal block
ETIM 6:	EC000899 - Fuse terminal block

Container Information

Package Level 1 Units:	20 piece

Package Level 1 Width:	172 mm
Package Level 1 Depth / Length:	155 mm
Package Level 1 Height:	71 mm
Package Level 1 Gross Weight:	1.08 kg
Package Level 1 EAN:	3472591991666
Package Level 2 Units:	200 piece
Package Level 2 Width:	300 mm
Package Level 2 Depth / Length:	500 mm
Package Level 2 Height:	300 mm
Package Level 2 Gross Weight:	11.300 kg
Package Level 3 Units:	4800 piece
Product Packing Type:	Box



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312/318 Series Lead-Free 3AG, Fast-Acting Fuse

Description

The 312 and 318 Series are 3AG Fast-Acting fuses that solve solves a broad range of application requirements while offering reliable performance and cost-effective circuit protection.

Features

- In accordance with UL Standard 248-14
- Available in cartridge and axial lead format and with various forming dimensions
- RoHS compliant and Lead-free

Agency Approvals

Agency	Agency File Number	Ampere Range
UL	E10480	0.062 - 10A
cULus		12A-25A
CSA	29862	312 Series: 0.062A - 30A 318 Series: 0.062A - 10A
PSE	(312 Series) NBK060618-E10480A NBK060618-E10480C	1A - 5A 6A - 10A
	(318 Series) NBK060618-E10480B NBK060618-E10480D	1A - 5A 6A - 10A
cRUus	E10480	318 Series: 12A - 30A
KC	SU05001-6008 SU05001-5005 SU05001-5006	1A - 2A 3A - 6A 7A - 10A
CE	N/A	0.062A - 10A

Applications

Used as supplementary protection in appliance or utilization equipment to provide individual protection for components or internal circuits.

Electrical Characteristics for Series

% of Ampere Rating	Ampere Rating	Opening Time
100%	0.062A – 35A	4 hours, Minimum
135%	0.062A – 35A	1 hour, Maximum
200%	0.062A – 10A	5 sec., Maximum
	12A – 30A	10 sec., Maximum
	35A	20 sec., Maximum

Additional Information

Datasheet 312 Series | **Resources 312 Series** | **Samples 312 Series** | **Accessories 312 & 318 Series**

Datasheet 318 Series | **Resources 318 Series** | **Samples 318 Series**

For recommended fuse accessories for this product series, see 'Recommended Accessories' section.

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Specifications are subject to change without notice.
Revised: GD. 12/14/20

Axial Lead & Cartridge Fuses

3AG > Fast Acting > 312/318 Series

Electrical Characteristic Specifications by Item

Amp Code	Ampere Rating (A)	Voltage Rating (V)	Interrupting Rating	Nominal Cold Resistance (Ohms)	Nominal Melting I²t (A² sec)	Agency Approvals					
						UL	cULus	KC	PSE	CSA	CE
.062	0.062	250	35A@250Vac 10KA@125Vac	24.7	0.000249	x	-	-	-	x	x
.100	0.1	250		11.28	0.00171	x	-	-	-	x	x
.125	0.125	250		7.145	0.00289	x	-	-	-	x	x
.150	0.15	250		5.13	0.00550	x	-	-	-	x	x
.175	0.175	250		3.875	0.00960	x	-	-	-	x	x
.187	0.187	250		3.42	0.0128	x	-	-	-	x	x
.200	0.2	250		3.02	0.0165	x	-	-	-	x	x
.250	0.25	250		2.01	0.0355	x	-	-	-	x	x
.300	0.3	250		1.405	0.0689	x	-	-	-	x	x
.375	0.375	250		0.825	0.185	x	-	-	-	x	x
.500	0.5	250		0.498	0.483	x	-	-	-	x	x
.600	0.6	250		0.362	0.88	x	-	-	-	x	x
.750	0.75	250		0.2445	1.84	x	-	-	-	x	x
001.	1	250		0.19	0.76	x	-	x	x	x	x
1.25	1.25	250	100A@250Vac 10KA@125Vac	0.1385	1.45	x	-	x	x	x	x
01.5	1.5	250		0.1036	2.35	x	-	-	x	x	x
01.6	1.6	250		0.0934	2.8	x	-	x	x	x	x
1.75	1.75	250		0.0856	3.6	x	-	-	x	x	x
01.8	1.8	250		0.0825	3.85	x	-	-	x	x	x
002.	2	250		0.0704	5.2	x	-	x	x	x	x
2.25	2.25	250		0.0594	7.2	x	-	x	x	x	x
02.5	2.5	250		0.0513	9.54	x	-	x	x	x	x
003.	3	250		0.0427	14.0	x	-	x	x	x	x
004.	4	250	200A@250Vac 10KA@125Vac	0.0293	28.5	x	-	x	x	x	x
005.	5	250		0.0224	50.0	x	-	x	x	x	x
006.	6	250		0.0178	118.0	x	-	x	x	x	x
007.	7	250		0.0146	81.0	x	-	x	x	x	x
008.	8	250		0.0122	166.0	x	-	x	x	x	x
010.	10	250		0.0093	298.0	x	-	x	x	x	x
012.	12	32	300A@32 Vac	0.0072	234.6	x†	x**	-	-	x†	-
015.	15	32		0.0052	490.5	x†	x**	-	-	x†	-
020.	20	32		0.0035	1414	x†	x**	-	-	x†	-
025.	25	32		0.0024	2041	x†	x**	-	-	x†	-
030.	30	32		0.0019	3717	-	x**	-	-	x†	-
035.	35	32		0.0013	7531	-	-	-	-	-	-

Notes:
*** -** For 312 and 318 Series: Listed for the US and Canada (cULus)
**** -** For 318 Series (12A-25A) and 312 Series (30A only): Recognized for the US and Canada (cURus).
† - For 312 series only.

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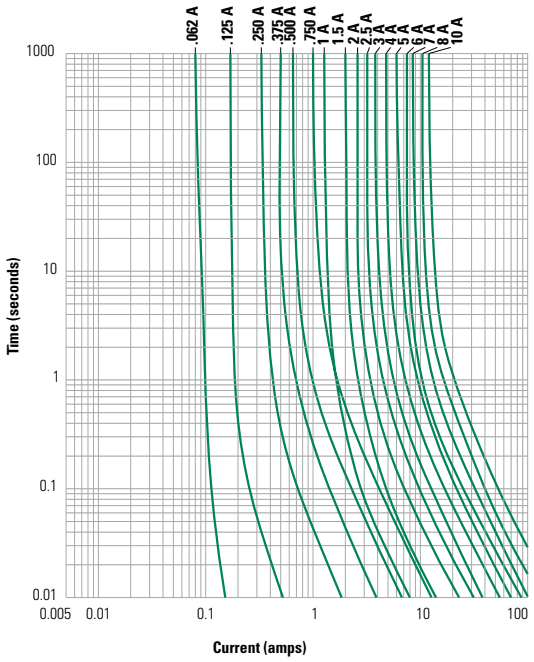
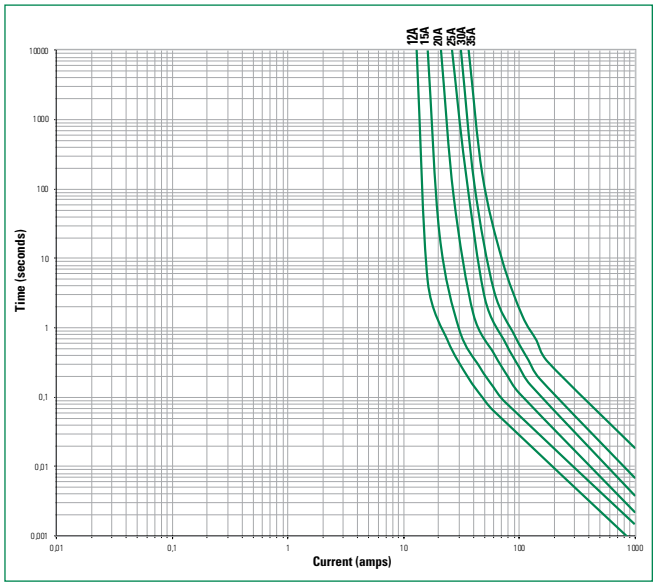
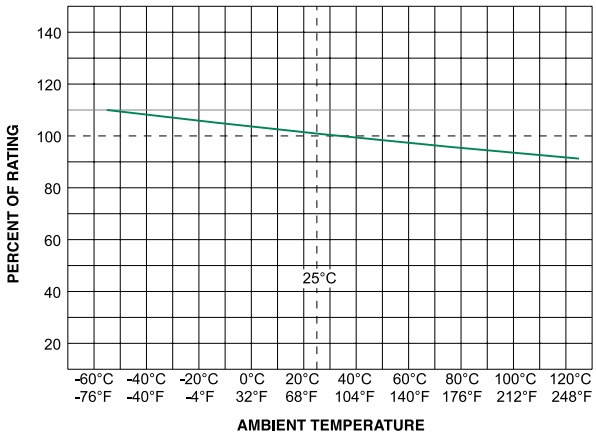
Average Time Current Curves





*Please contact Littelfuse for more details on those T-C Curves of other ampere ratings which are not published.

Temperature Re-rating Curve



Note:
Rerating depicted in this curve is in addition to the industry practice derating of 25% for continuous operation.

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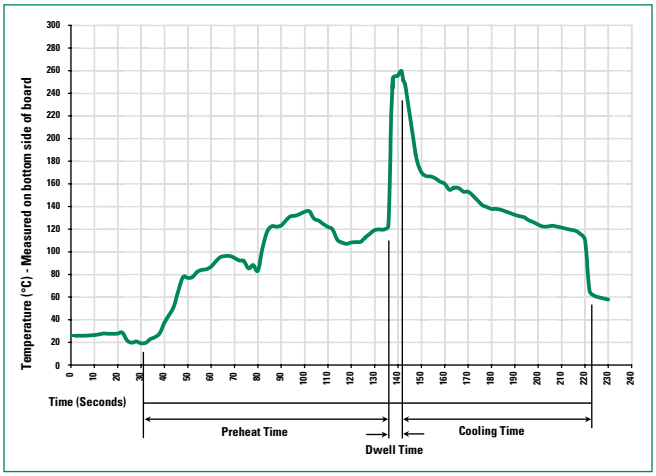
Axial Lead & Cartridge Fuses

3AG > Fast Acting > 312/318 Series

Soldering Parameters - Wave Soldering



Recommended Process Parameters:

Wave Parameter	Lead-Free Recommendation
Preheat: (Depends on Flux Activation Temperature)	(Typical Industry Recommendation)
Temperature Minimum:	100°C
Temperature Maximum:	150°C
Preheat Time:	60-180 seconds
Solder Pot Temperature:	260°C Maximum
Solder Dwell Time:	2-5 seconds

Recommended Hand-Solder Parameters:
Solder Iron Temperature: 350°C +/- 5°C
Heating Time: 5 seconds max.
Note: These devices are not recommended for IR or Convection Reflow process.

Product Characteristics

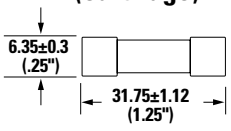
Materials	Body: Glass Cap: Nickel–plated brass Leads: Tin–plated Copper
Terminal Strength	MIL-STD-202, Method 211, Test Condition A
Solderability	MIL-STD-202 method 208
Product Marking	Cap1: Brand logo, current and voltage ratings Cap2: Series and agency approval marks

Operating Temperature	–55°C to +125°C
Thermal Shock	MIL-STD-202, Method 107, Test Condition B: (5 cycles -65°C to +125°C)
Vibration	MIL-STD-202, Method 201
Humidity	MIL-STD-202, Method 103, Test Condition A: High RH (95%), and Elevated temperature (40°C) for 240 hours
Salt Spray	MIL-STD-202, Method 101, Test Condition B

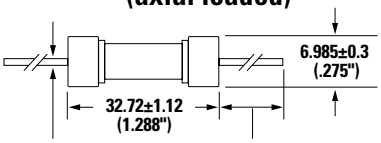
Dimensions

Measurements displayed in millimeters (inches)

312 000 Series (cartridge)



318 000 Series (axial leaded)



0.81±0.05(.032") for (0.062A-15A)
1.02±0.06(.040") for (20A-35A)

Axial Lead Material:

Tin-coated copper

Axial Lead Length:

Standard Length:
38.1±3.15(1.50") TYP.

Short Lead Option:
12.7±2.0(.50") TYP.

Part Numbering System

0312 xxxx M X P

Series
312 = Cartridge
318 = Axial Leaded

Amp Code
Refer to Amp Code column of Electrical Characteristics Table

Quantity Code
M = 1000

Packaging Code
X = Filler

Lead-free

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Packaging

Packaging Option	Packaging Specification	Quantity	Quantity & Packaging Code	Taping Width
312 Series				
Bulk	N/A	1000	MX	N/A
Bulk	N/A	100	HX	N/A
318 Series				
Bulk	N/A	1000	MX	N/A
Bulk	N/A	100	HX	N/A
Bulk	N/A	1000	MXB	N/A

Recommended Accessories

Accessory Type	Series	Description	Max Application Voltage	Max Application Amperage
Holder	155100	Twist-Lock In-Line Fuseholder	32	20
	342	Traditional Panel Mount Fuseholder	250	20
	346	Panel Mount Flip-Top Shock-Safe Fuseholder	250	15
	345	Shock-Safe Fuseholder with PC Mount, Solder Mount and Panel Mount options	250	20
Block	354	Low Profile OMNI-BLOK® Fuse Block	600	30
	359	High Current Screw Terminal Fuse Block		30
Clip	122	High Current Traditional PC Board Fuse Clip	1000	30
	101	Rivet/Eyelet Type Fuse Clip	1000	15

Notes:
1. Do not use in applications above rating.
2. Please refer to fuseholder data sheet for specific re-rating information.
3. Please contact factory for applications greater than the max voltage and amperage shown.

Disclaimer Notice - Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Littelfuse products are not designed for, and may not be used in, all applications. Read complete Disclaimer Notice at: https://www.littelfuse.com/legal/disclaimers/product-disclaimer.aspx..

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GMA

5 mm x 20 mm Fast-acting glass tube fuses

RoHS

Agency information

- UL Listed, Guide JDYX, File E19180, 63mA-6A
- UL Recognized, Guide JDYX2, File E19180, 7-15A
- CSA Certified, Class 1422-01, File 53787, 63mA-6A
- PSE Approval, 1A-15A

Product features

- Fast-acting, low breaking capacity
- Optional axial leads available
- 5 x 20mm physical size
- Glass tube, silver-plated (63mA-315mA) and nickel-plated (500mA-15A) brass endcap construction
- Designed to UL/CSA 248-14

Ordering

- Specify packaging, product, and option code
- Ratings above 6.3A have a 0.8 mm diameter lead
- With TR2 packaging code, lead wire length is 19.05 mm

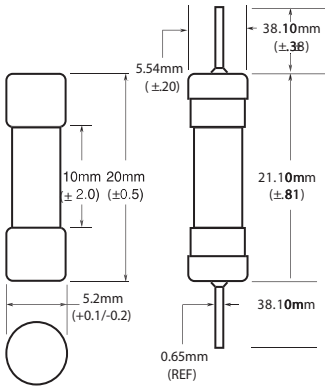
Electrical Characteristics		
Rated Current	% of Amp Rating	Opening Time
63mA - 15A	100%	None
	135%	60 minutes maximum
	200%	2 minutes maximum

Specifications

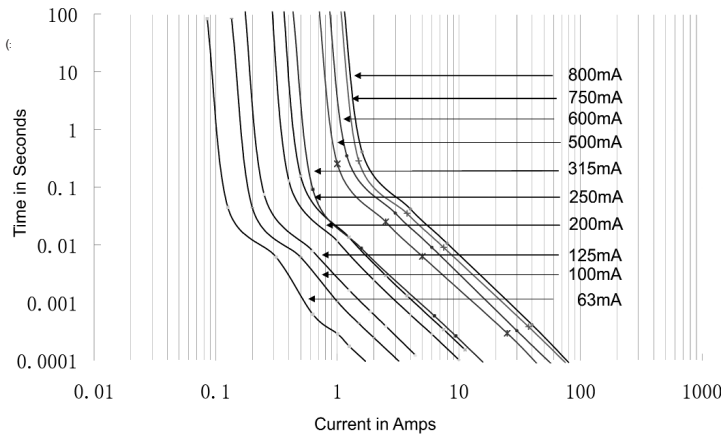
Product Code	Amp Rating	Voltage Rating Vac	Interrupting Rating (amps)*		Typical DC Cold Resistance (Ω)**	Typical Pre-Arc I^2t Vac†	Maximum Voltage Drop (mV)‡
			250Vac	125Vac			
GMA-63-R	63mA	250	35	10,000	15.750	0.00024	4700
GMA-100-R	100mA	250	35	10,000	7.840	0.0001	4300
GMA-125-R	125mA	250	35	10,000	4.895	0.0024	2600
GMA-200-R	200mA	250	35	10,000	2.500	0.001	3400
GMA-250-R	250mA	250	35	10,000	1.735	0.018	2200
GMA-300-R	300mA	250	35	10,000	0.906	0.019	470
GMA-315-R	315mA	250	35	10,000	0.839	0.019	450
GMA-500-R	500mA	250	35	10,000	0.454	0.15	230
GMA-600-R	600mA	250	35	10,000	0.256	0.32	200
GMA-750-R	750mA	250	35	10,000	0.186	0.47	200
GMA-800-R	800mA	250	35	10,000	0.170	0.70	180
GMA-1-R	1	250	35	10,000	0.163	0.48	300
GMA-1.25-R	1.25	250	100	10,000	0.122	0.84	290
GMA-1.5-R	1.5	250	100	10,000	0.090	1.6	270
GMA-1.6-R	1.6	250	100	10,000	0.080	2.0	260
GMA-2-R	2	250	100	10,000	0.066	3.1	250
GMA-2.5-R	2.5	250	100	10,000	0.046	4.9	240
GMA-3-R	3	250	100	10,000	0.039	8.8	215
GMA-3.15-R	3.15	125	-	10,000	0.036	9.7	210
GMA-3.5-R	3.5	125	-	10,000	0.030	13	210
GMA-4-R	4	125	-	10,000	0.026	19	205
GMA-5-R	5	125	-	10,000	0.021	29	200
GMA-6-R	6	125	-	10,000	0.017	45	180
GMA-7-R	7	125	-	200	0.012	150	110
GMA-8-R	8	125	-	200	0.009	280	110
GMA-10-R	10	125	-	200	0.006	280	110
GMA-15-R	15	125	-	150	0.004	950	100

* Interrupting ratings: Interrupting ratings for 63mA - 6A were measured at 70% - 80% power factor on AC. The interrupting ratings for 7A - 15A were measured at 100% power factor on AC.
** DC Cold Resistance (Measured at <10% of rated current)
† Typical Pre-Arching I^2t (I^2t was measured at listed interrupting rating and rated voltage)
‡ Maximum Voltage drop (Voltage drop was measured at 20°C ambient temperature at rated current)

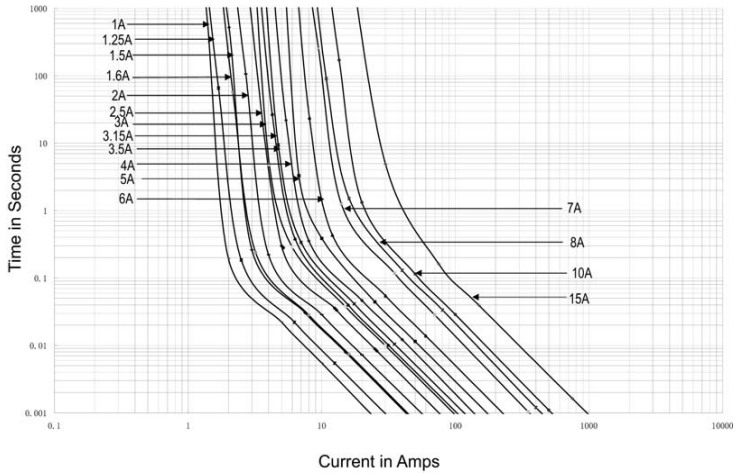
Dimensions - mm



Time-Current Curve – GMA-R 63mA-800mA



Time-Current Curve – GMA-R 1-15A



Packaging Code	
Packaging Code	Description
BK	100 fuses packed into a cardboard carton
BK1	1000 fuses packed into a poly bag
TR2	1500 fuses packed into tape on a reel (19.05mm lead wire length)

Option Code	
Option Code	Description
V	Axial leads - copper tinned wire with nickel-plated brass overcaps

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Powering Business Worldwide

Specifications

Photo is representative

Eaton BK/GMA-2-R

Eaton GMA Series Fast-acting fuse 2A, 250 Vac, 32 Vdc (self certified), BK-GMA-2-R

General specifications

PRODUCT NAME	Eaton Bussmann series GMA fast-acting fuse
CATALOG NUMBER	BK/GMA-2-R
UPC	051712647250
EAN	5027590254601
PRODUCT HEIGHT	20 mm
PRODUCT DIAMETER	5.2 mm
PRODUCT WEIGHT	0.7 g
WARRANTY	Not Applicable
COMPLIANCES	CE Marked RoHS Compliant

Powering Business Worldwide

Product specifications

USED WITH	out axial leads
AMPERAGE RATING	2 A
INTERRUPT RATING	10 kAIC at 125 Vac 0.1 kAIC at 250 Vac
FUSE INDICATOR	Non-indicating
CONNECTION	Ferrule end x ferrule end
RESPONSE TIME	60 min at 135%, 2 min at 200%
MATERIAL	Glass tube Nickel-plated brass end cap construction
QUANTITY	100
VOLTAGE RATING	250 Vac, 32 Vdc (self certified)
TYPE	Electronic
APPLICATION	Electronic circuits

Resources

SPECIFICATIONS AND DATASHEETS	Eaton GMA time delay glass tube fuses data sheet Eaton Specification Sheet - BK/GMA-2-R

PROJECT NAME:	
PROJECT NUMBER:	
PREPARED BY:	
DATE:	

Eaton Corporation plc
Eaton House
30 Pembroke Road
Dublin 4, Ireland
Eaton.com

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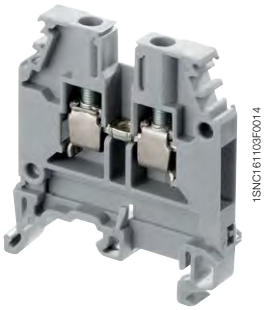
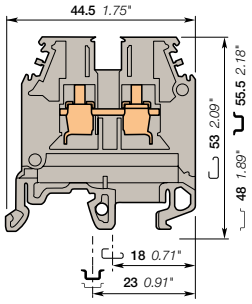
M4/6 screw clamp terminal blocks
Feed-through - 6 mm 0.236 in spacing



M4/6



6 mm 0.236 in spacing

Description

– Flexibility: snap onto symmetrical and asymmetrical rails,
– Many colors are available in addition to our generic grey, to help you quickly identify any of specific functions.

Ordering details

Description	Color	Type	Part Number	Pkg qty	Weight (1 pce) g
Feed-through	Grey	M4/6	1SNA115116R0700	50	8.20
	Blue	M4/6.N	1SNA125116R0100	50	8.20
	Orange	M4/6	1SNA105002R2000	50	8.20
	Yellow	M4/6	1SNA105116R1600	50	8.20
	Green	M4/6	1SNA105001R2700	50	8.20
	Red	M4/6	1SNA105032R1500	50	8.20
	Purple	M4/6	1SNA206404R0500	50	8.20
	Brown	M4/6	1SNA105209R1400	50	8.20
	White	M4/6	1SNA105051R2000	50	8.20
	Black	M4/6	1SNA105031R1400	50	8.20
	Beige	M4/6	1SNA195116R0000	50	8.20

Main technical data

Connecting capacity		IEC	UL	CSA
1 conductor per clamp	Rigid - Solid / Stranded	0.2-4 mm²	22-10 AWG	24-10 AWG
	Flexible	0.22-4 mm²		
	with insulated ferrule			
	Gauge	A4		
Rated current / Rated cross section		32 A / 4 mm²	30 A / 10 AWG	30 A / 10 AWG
Rated short-time withstand current (1s)		480 A		
Rated voltage		1000 V	600 V	600 V
Impulse withstand voltage		8000 V		
Protection		IP20	NEMA 1	

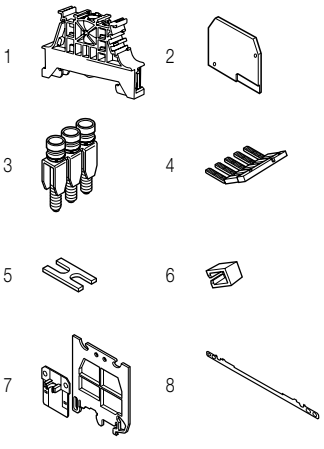
Mounting instructions

Rail		G32, TH 35-7.5, TH 35-15
Wire stripping length		9.5 mm 0.37 in
Tool		Flat screwdriver Ø 4 mm Ø 0.157 in
Torque		0.5 - 0.8 N.m 4.4 - 7.1 lb.in

The connecting capacity data for one Rigid - Solid / Stranded - Flexible conductor (when applicable) is a mandatory information required by IEC, UL and CSA standards.
All other data are provided as supplementary information only. For more details, please consult our CB, UL or CSA certificates and technical datasheet available on http://www.te.com

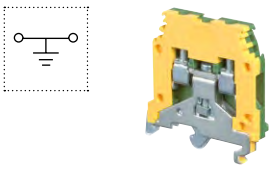
CE RoHS USR CSA Gost R

Accessories



	Description			Color	Type	Part Number	Pkg qty	Weight (1 pce) g
1	**End stops**	10 mm	0.394 in	Grey	BAM4	1SNK900001R0000	50	12.00
		9 mm	0.354 in		BAZ1	1SNK900002R0000	50	4.70
2	**End sections**	2.8 mm	0.110 in	Grey	FEM6	1SNA118368R1600	20	2.40
3	**Jumper bars**	2 poles	32 A		BJMI6-2	1SNA176663R0000	10	4.40
		3 poles			BJMI6-3	1SNA176664R0100	10	6.70
		4 poles			BJMI6-4	1SNA176665R0200	10	8.90
		5 poles			BJMI6-5	1SNA176666R0300	10	11.20
		10 poles			BJMI6-10	1SNA176667R0400	10	22.40
4	**Lateral jumper bars**	2 poles	35 A	Grey	PC6-2	1SNA113546R1400	10	2.00
		10 poles			PC6-10	1SNA113548R2600	10	8.00
5	**Cross spacing jumpers**	5 mm 0.200 in - 6 mm 0.236 in - 8 mm 0.315 in			EL6	1SNA173627R2100	10	0.10
		Universal screw jumper bar kit N°I			BJDP1	1SNA179623R0300	10	7.00
		Universal screw jumper bar kit N°III			BJDP3	1SNA179625R0500	10	5.00
6	**Insulating tips**	For lateral jumper bars type PC...			EIP	1SNA113550R2400	10	
7	**Circuit separators**	0 mm	0 in	Grey	SCM6	1SNA113003R1000	10	0.30
		3 mm	0.118 in		SCF6	1SNA118707R0300	20	
8	**Shield connectors**				CBM5	1SNA178745R1400	50	
9	**Protecting covers**	Length 500 mm 19.70 in		Transparent	CPM	1SNA187312R1400	1	
10	**Terminal block markers**	Blank card		White	RC610	1SNA233000R0100	1	7.50

Complete list of accessories is indicated in the terminal block datasheet.
Some accessories such as jumper bars may modify the terminal block's ratings: complete information in the accessories catalogue pages.



Ground screw clamp terminal blocks

Description		Color	Type	Part Number	Pkg qty	Weight (1 pce) g
Ground	Profile aligned with M4/6...	Green-yellow	M4/6.P	1SNA165113R1600	50	21.00

Technical data valid for copper conductors only.

1SNC161003S0201 - Rev. B

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M4/6

TE Connectivity has acquired the DIN Rail Terminal Block product range from ABB

Products → Low Voltage Products and Systems → Connection Devices → Terminal Blocks → SNA Series

General Information

Extended Product Type:	M4/6
Product ID:	1SNA115116R0700
EAN:	3472591151169
Catalog Description:	M4/6 Screw Clamp Terminal Blocks - Feed-through - Grey
Long Description:	- Flexibility: snap onto symmetrical and asymmetrical rails, - Many colors a re available in addition to our generic grey to help you quickly identify any specific functions.

Ordering

Color:	Grey
Minimum Order Quantity:	50 piece
Customs Tariff Number:	85369010

Popular Downloads

Data Sheet, Technical Information:	1SNC160019C0202
Instructions and Manuals:	1SNC160019C0202

Dimensions

Product Net Width:	6 mm
Product Net Height:	44.5 mm
Product Net Length:	40.5 mm
Product Net Depth / Length:	40.5 mm
Product Net Weight:	8.2 g

Technical

Rated Cross-Section:	4 mm²
Spacing:	6 mm
Connection Type:	Screw clamp
Function:	Feed-through
Number of Levels:	1
Connecting Capacity Main Circuit:	Screw Clamp / Flexible 1x 0.22 ... 4 mm² Screw Clamp / Rigid 1x 0.2 ... 4 mm² Screw Clamp / With Insulated Ferrrule 1x 2.5 mm²
Gauge Type:	A4
Rated Current (I_n):	Main Circuit 32 A

Rated Short-time Withstand Current (I_{cw}):	for 1 s 480 A
Rated Voltage (U_r):	1000 V
Rated Impulse Withstand Voltage (U_{imp}):	8000 V
Dielectric Test Voltage:	2000 V
Pollution Degree:	3
Power Loss:	1 W
Degree of Protection:	acc. to IEC 60529, IEC 60947-1, EN 60529 Main Terminals IP20
Insulation Material:	Polyamide
Mounting on DIN Rail:	G32 (32 x 15 mm Mounting Rail) acc. to IEC 60715 TH35-7.5 (35 x 7.5 mm Mounting Rail) acc. to IEC 60715 TH35-15 (35 x 15 mm Mounting Rail) acc. to IEC 60715
Wire Stripping Length:	9.5 mm
Recommended Screw Driver:	4 mm
Tightening Torque:	acc. IEC 60947-1 0.5 N·m Manufacturer 0.8 N·m

Technical UL/CSA

Maximum Operating Voltage UL/CSA:	Main Circuit 600 V
Connecting Capacity Main Circuit UL/CSA:	Screw Clamp / Flexible 1x 22 ... 10 AWG Screw Clamp / Rigid 1x 22 ... 10 AWG Screw Clamp / Rigid 2x 14 AWG
Connecting Capacity UL/CSA:	Stranded 10 AWG
Flammability According to UL94:	V0

Environmental

Ambient Air Temperature:	Operation -55 ... +110 °C Storage -55 ... +110 °C
RoHS Status:	Following EU Directive 2002/95/EC August 18, 2005 and amendment

Certificates and Declarations (Document Number)

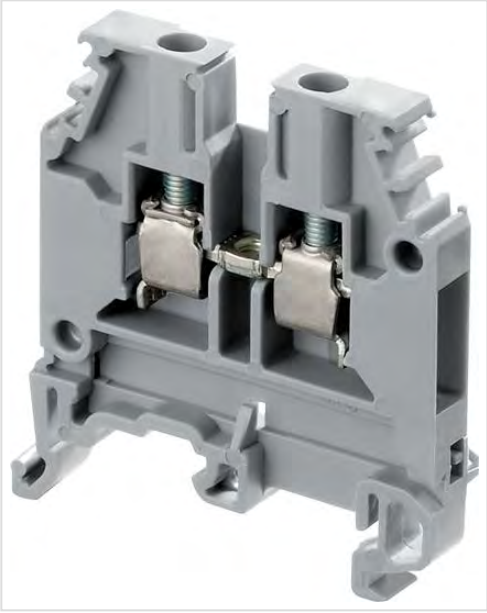
CSA Certificate:	1SND161039A0201
cUL Certificate:	1SND161001A0209
Declaration of Conformity - CE:	1SND225014U1000
EAC Certificate:	1SND161009A1100
Environmental Information:	1SND220001E1002
Instructions and Manuals:	1SNC160019C0202
RMRS Certificate:	1SND161007A1101
RoHS Information:	1SND230023F0208

Classifications

Object Classification Code:	X
E-nummer:	2925506
ETIM 4:	EC000897 - Feed-through terminal block
ETIM 5:	EC000897 - Feed-through terminal block
ETIM 6:	EC000897 - Feed-through terminal block

Container Information

Package Level 1 Units:	50 piece
Package Level 1 Width:	61 mm
Package Level 1 Depth / Length:	220 mm
Package Level 1 Height:	47 mm
Package Level 1 Gross Weight:	0.41 kg
Package Level 1 EAN:	3472591151169
Package Level 2 Units:	2000 piece
Package Level 2 Width:	300 mm
Package Level 2 Depth / Length:	500 mm
Package Level 2 Height:	300 mm
Package Level 2 Gross Weight:	18.100 kg
Package Level 3 Units:	48000 piece
Product Packing Type:	Box



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M4/6.P

TE Connectivity has acquired the DIN Rail Terminal Block product range from ABB

Products → Low Voltage Products and Systems → Connection Devices → Terminal Blocks → SNA Series

General Information

Extended Product Type:	M4/6.P
Product ID:	1SNA165113R1600
EAN:	3472591651133
Catalog Description:	M4/6.P Screw Clamp Terminal Blocks - Ground - Green-Yellow
Long Description:	- Reliable electrical and mechanical contact with the rail, - Flexibility: snap onto symmetrical and asymmetrical rails.

Ordering

Color:	Green-Yellow
Minimum Order Quantity:	50 piece
Customs Tariff Number:	85369010

Popular Downloads

Data Sheet, Technical Information:	1SNC160019C0202
Instructions and Manuals:	1SNC160019C0202

Dimensions

Product Net Width:	6 mm
Product Net Height:	44.5 mm
Product Net Depth / Length:	40.5 mm
Product Net Weight:	21 g

Technical

Rated Cross-Section:	4 mm²
Spacing:	6 mm
Connection Type:	Screw clamp
Function:	Ground
Number of Levels:	1
Connecting Capacity Main Circuit:	Screw Clamp / Flexible 1x 0.22 ... 4 mm² Screw Clamp / Rigid 1x 0.2 ... 4 mm² Screw Clamp / With Insulated Ferrrule 1x 2.5 mm²
Gauge Type:	A4
Rated Short-time Withstand Current (I_{cw}):	for 1 s 480 A
Pollution Degree:	3
Insulation Material:	Polyamide

Mounting on DIN Rail:	G32 (32 x 15 mm Mounting Rail) acc. to IEC 60715 TH35-7.5 (35 x 7.5 mm Mounting Rail) acc. to IEC 60715 TH35-15 (35 x 15 mm Mounting Rail) acc. to IEC 60715
Wire Stripping Length:	9.5 mm
Recommended Screw Driver:	4 mm
Tightening Torque:	acc. IEC 60947-1 0.5 N·m Manufacturer 0.8 N·m

Technical UL/CSA

Connecting Capacity Main Circuit UL/CSA:	Screw Clamp / Rigid 1x 22 ... 12 AWG
Connecting Capacity UL/CSA:	Screw Clamp / Rigid 22 ... 12 AWG Stranded 12 AWG
Flammability According to UL94:	V0

Environmental

Ambient Air Temperature:	Operation -55 ... +110 °C Storage -55 ... +110 °C
RoHS Status:	Following EU Directive 2002/95/EC August 18, 2005 and amendment

Certificates and Declarations (Document Number)

cUL Certificate:	1SND161011A0202
Declaration of Conformity - CE:	1SND225017U1000
EAC Certificate:	1SND161009A1100
Environmental Information:	1SND220004E1002
Instructions and Manuals:	1SNC160019C0202
RMRS Certificate:	1SND161007A1101
RoHS Information:	1SND230023F0208

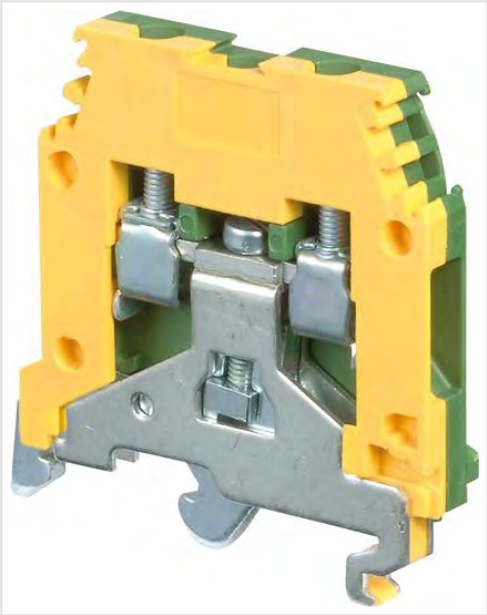
Classifications

Object Classification Code:	X
E-nummer:	2925525
ETIM 4:	EC000901 - Ground terminal block
ETIM 5:	EC000901 - Ground terminal block
ETIM 6:	EC000901 - Ground terminal block

Container Information

Package Level 1 Units:	50 piece
Package Level 1 Width:	61 mm
Package Level 1 Depth / Length:	220 mm
Package Level 1 Height:	47 mm

Package Level 1 Gross Weight:	1.05 kg
Package Level 1 EAN:	3472591651133
Package Level 2 Units:	1000 piece
Package Level 2 Width:	300 mm
Package Level 2 Depth / Length:	500 mm
Package Level 2 Height:	150 mm
Package Level 2 Gross Weight:	21.350 kg
Package Level 3 Units:	48000 piece
Product Packing Type:	Box



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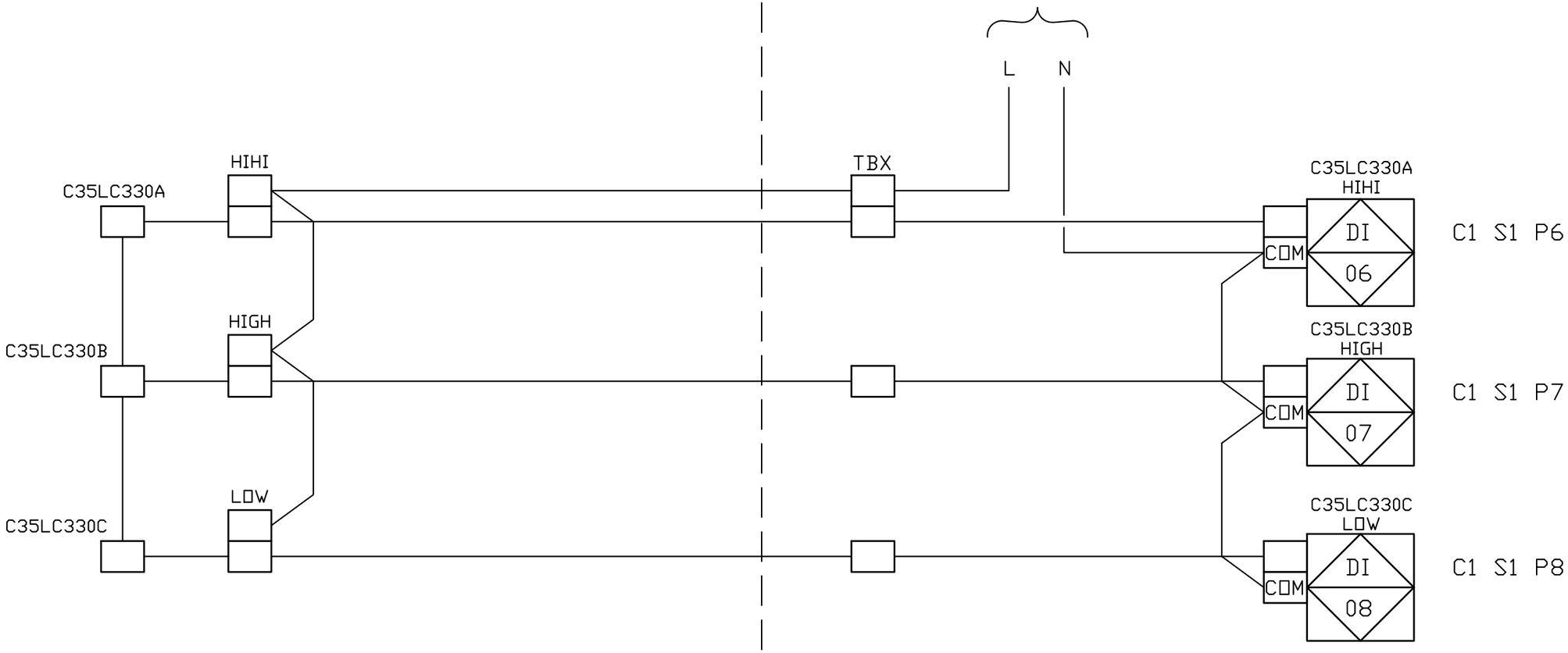

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A	2023.10.23	Original Draft	KCD

REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT: McCLURE & SONS

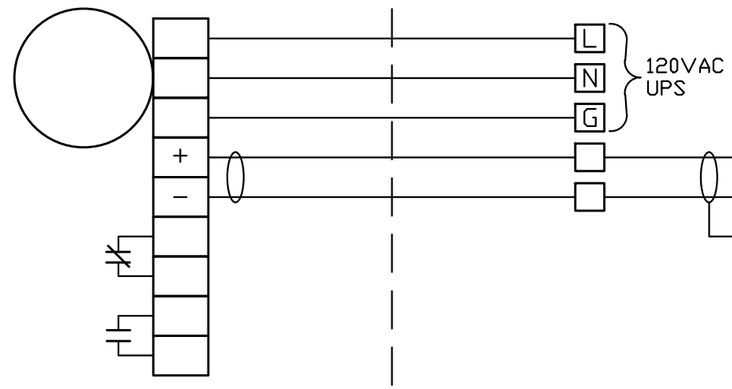
TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35LC330A/B/C

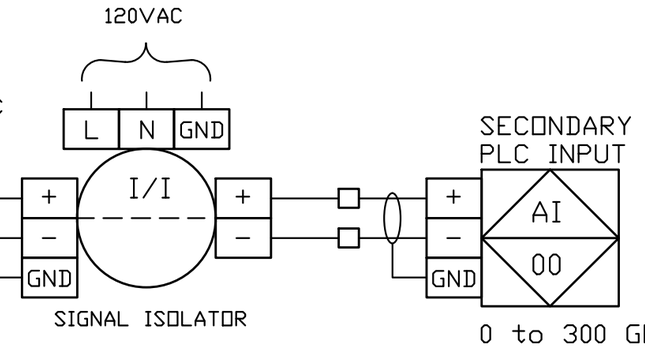
DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.23	DWG NO.: 0723-08MSI-C35LC	
APPROVED: HAD	SCALE: NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C35FET3131
CAL: 0-300 GPM





SIGNAL ISOLATOR

SECONDARY CLARIFER 1 WAS FLOW
PLC INPUT

C0 S3 P00

0 to 300 GPM

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FET3131

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-3131	
APPROVED HAD	SCALE NONE	SHEET 1	OF 7

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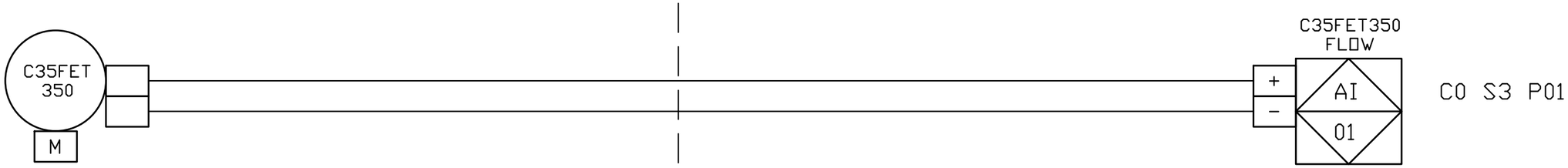
PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FET350

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C35FET	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C35LT3237

PIT

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4 TO 20 MADC

TJB

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LI

C35LI3237
PROCESS VARIABLE
INDICATOR

DC+ DC−

TB0

1

2

3

GND

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AI

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SECONDARY CLARIFER 2
SCUM PIT LEVEL
PLC INPUT

C0 S4 P00

0 to 15 PSI

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2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40LT3237

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-3237	
APPROVED HAD	SCALE NONE	SHEET 6 OF 7	

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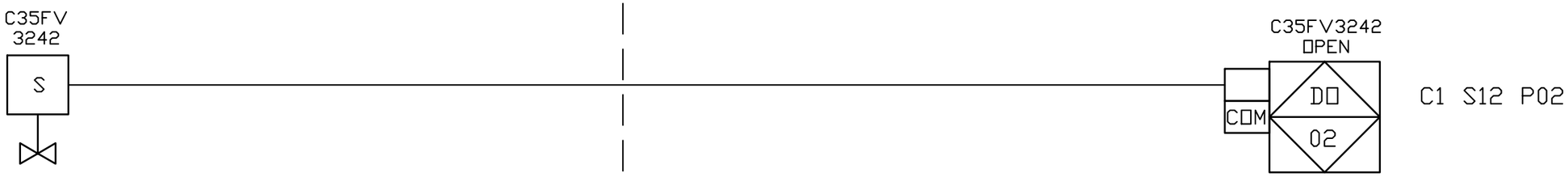
PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FV3242

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C35FV42	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

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PLC PANEL

C35FV
3241

S

C35FV3241
OPEN

COM

DO

03

C1 S12 P03

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REVISIONS

OPTIMAL CONTROL SYSTEMS
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ALBANY, OR 97321
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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FV3241

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C35FV41	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35ZS3202

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C35ZS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C35LE3203

PIT

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4 TO 20 MADC

TO...
PROCESS

TB1

1

2

3

GND

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AI

01

C0 S4 P01

1 to 32 FEET

SECONDARY CLARIFIER 2
SLUDGE BLANKET DEPTH
PLC INPUT

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C335LE3203

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-3203	
APPROVED HAD	SCALE NONE	SHEET 7	OF 7

FIELD

PLC PANEL

C35FET3214
CAL: 0-1500 GPM

E20FE3214

JB-XX

120VAC
UPS

120VAC

L N GND

I/I

GND

SIGNAL ISOLATOR

SECONDARY CLAFIFER 2 RAS FLOW
PLC INPUT

AI
02

C0 S4 P02

0 to 1500 GPM

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FET3214

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
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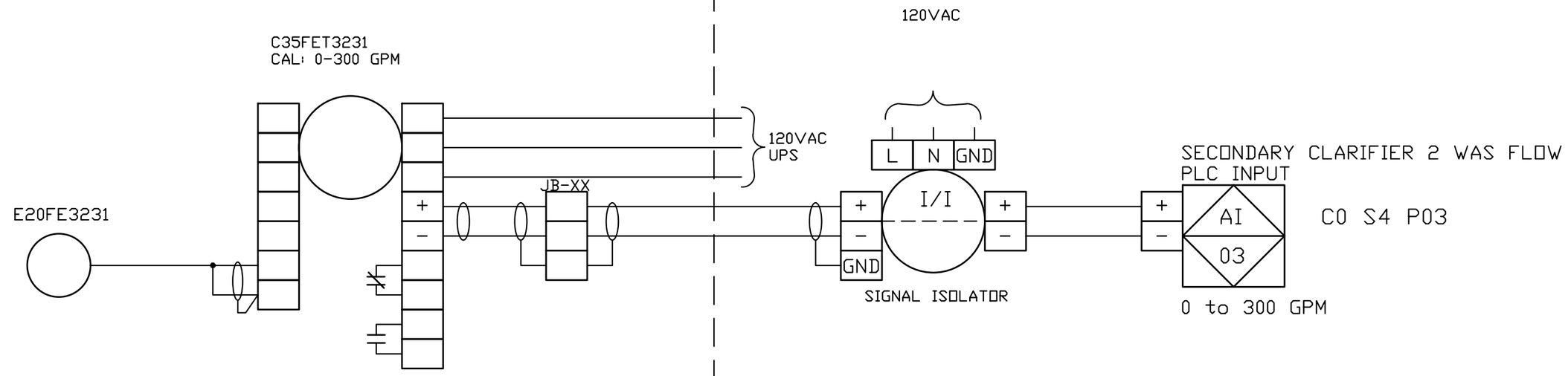
FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35FET3231

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-3231	
APPROVED HAD	SCALE NONE	SHEET 1	OF 7

FIELD

PLC PANEL

C40FI0601
CAL: 0-29 GPH

E20FE0601

120VAC
UPS

JB-XX

120VAC

L N GND

I/I

GND

SIGNAL ISOLATOR

SODIUM BISULFITE RESIDUAL
PLC INPUT

AI
02

C0 S3 P02

0 to 29 GPH

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ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40FI0601

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
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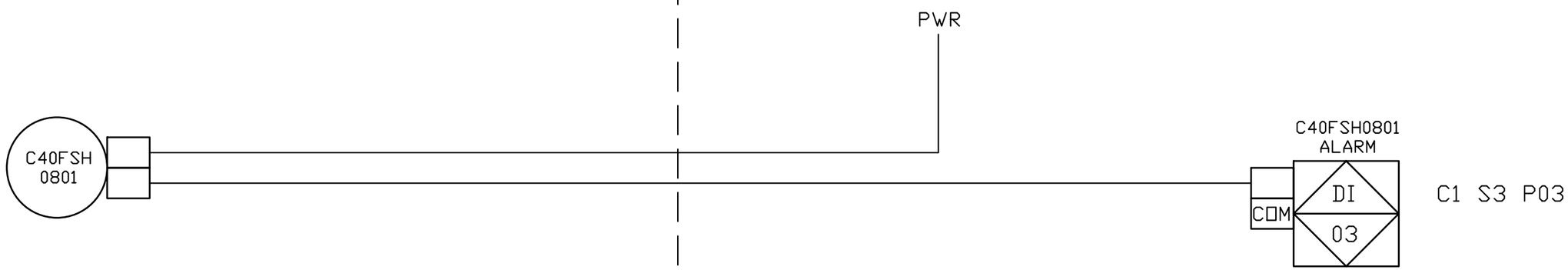
PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40FSH0801

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
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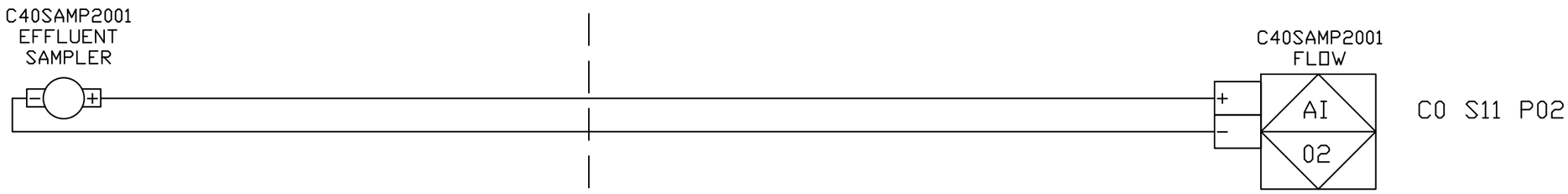
PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

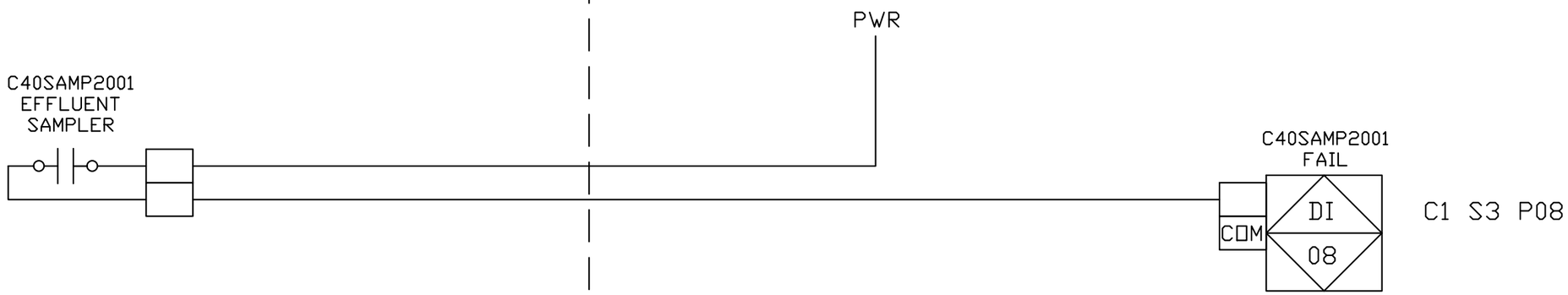
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40SAMP2001 FLOW

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C40FLOW	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

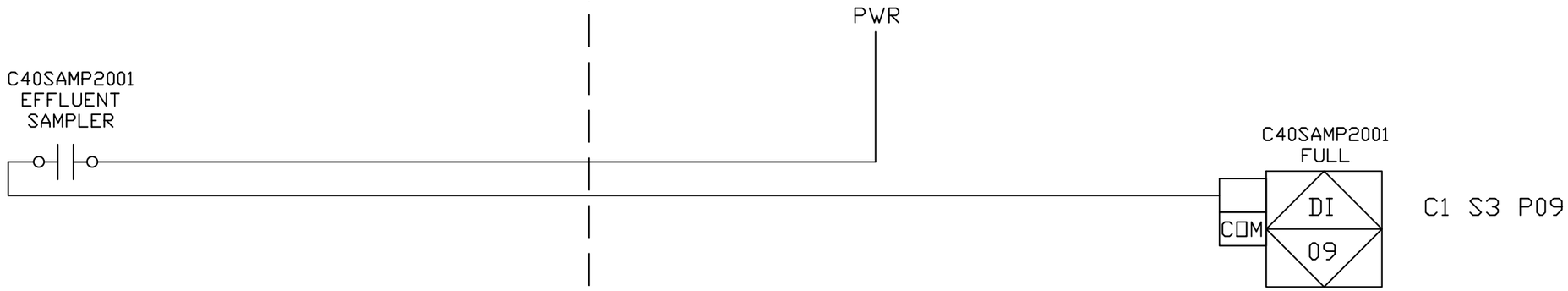
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40SAMP2001 FAIL

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C40FAIL	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40SAMP2001 FULL

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C40FULL	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C40LT0211

PIT

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4 TO 20 MADC

TJB

TBX

1

2

3

GND

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CHLORINE CONTACT BASIN
UPSTREAM LEVEL
PLC INPUT

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AI

06

C0 S3 P06

0 to 9 PSI

\− \+

LI

C40PI0211
PROCESS VARIABLE
INDICATOR,

TO
PROCESS

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

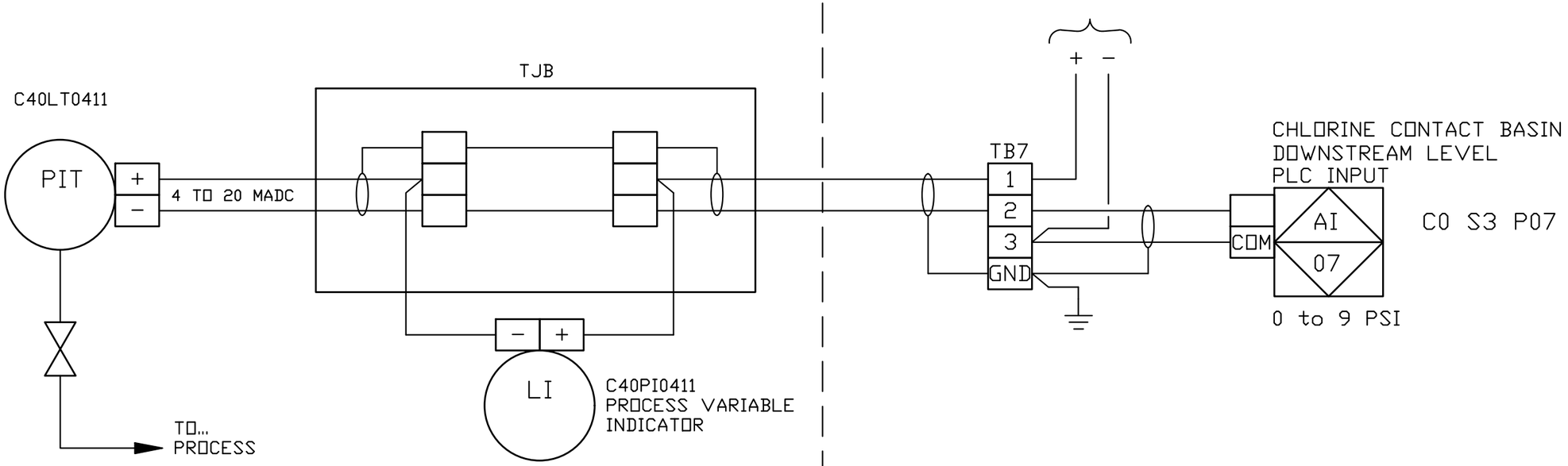
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40LT2011

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0211	
APPROVED HAD	SCALE NONE	SHEET 6	OF 7

FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40LT0411

DRAWN: KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED: ME	DATE: 2023.10.23	DWG NO. 0723-08MSI-0411	
APPROVED: HAD	SCALE: NONE	SHEET 6 OF 7	

FIELD

PLC PANEL

C40FI0501
CAL: 0-29 GPH

E20FE0501

120VAC
UPS

JB-XX

120VAC

L N GND

I/I

GND

SIGNAL ISOLATOR

CHLORINE CONTACT BASIN 1
HYPCHLORITE RESIDUAL
PLC INPUT

AI
03

C0 S3 P03

0 to 29 GPH

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40FI0501

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0501	
APPROVED HAD	SCALE NONE	SHEET 3 OF 7	

FIELD

PLC PANEL

C40FI0502
CAL: 0-29 GPH

E20FE0502

JB-XX

120VAC
UPS

120VAC

L N GND

I/I

GND

SIGNAL ISOLATOR

CHLORINE CONTACT BASIN 2
HYPOCHLORITE RESIDUAL
PLC INPUT

AI
05

C0 S4 P05

0 to 29 GPH

REV	DATE	DESCRIPTION	INIT
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B	2024.01.30.	REVIEW	KCD
A	2023.10.23	Original Draft	KCD

REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

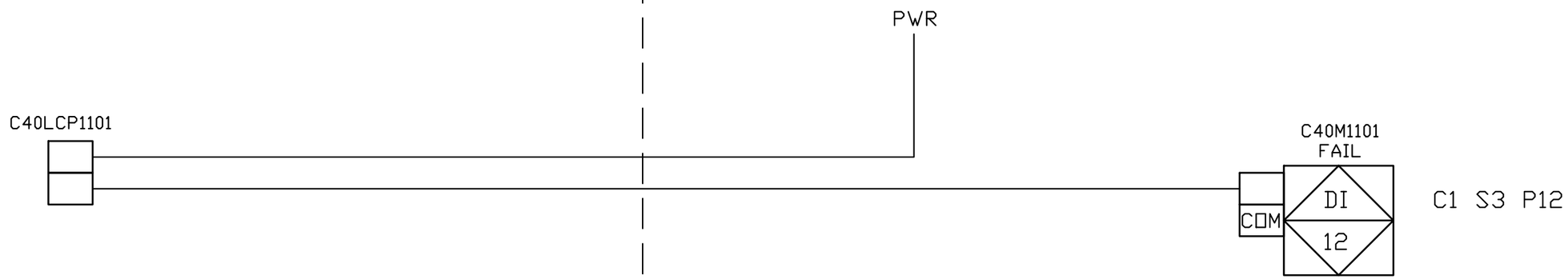
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40FI0502

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0502	
APPROVED HAD	SCALE NONE	SHEET 3 OF 7	

FIELD

PLC PANEL



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B	2024.04.23.	REVIEW	KCD
A	2023.10.23	Original Draft	KCD

REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

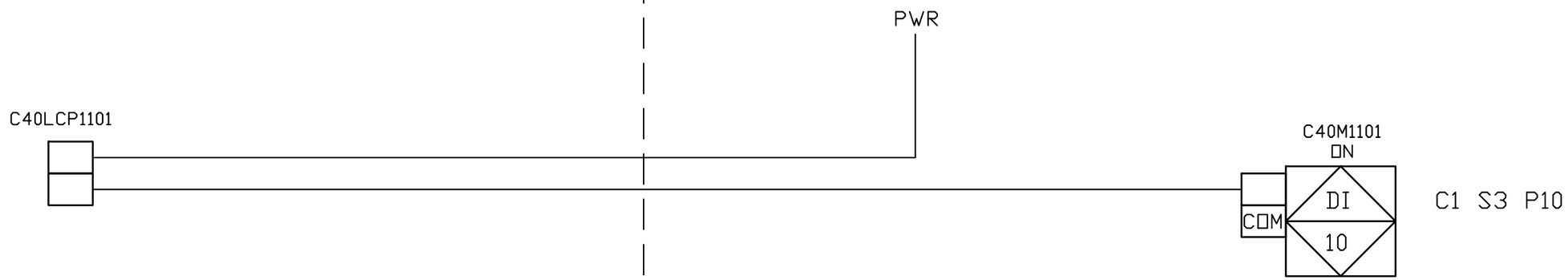
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40M1101 FAIL

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C40MFAIL	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40M1101 ON

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C40MON	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C40PIT1201

PIT

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4 TO 20 MADC

TO...
PROCESS

TB3

1

2

3

GND

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W3 PRESSURE
PLC INPUT

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AI

04

C0 S3 P04

-14.7 to 150 PSI

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A	2023.10.23	Original Draft	KCD

REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

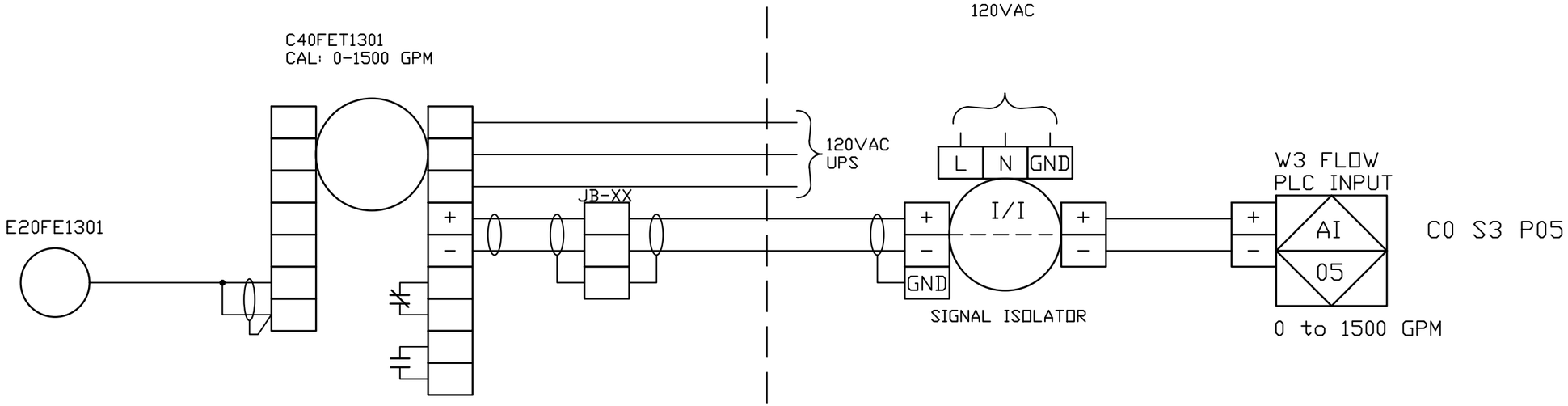
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40PIT1201

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-1201	
APPROVED HAD	SCALE NONE	SHEET 7 OF 7	

FIELD

PLC PANEL



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B	2024.01.30.	REVIEW	KCD
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

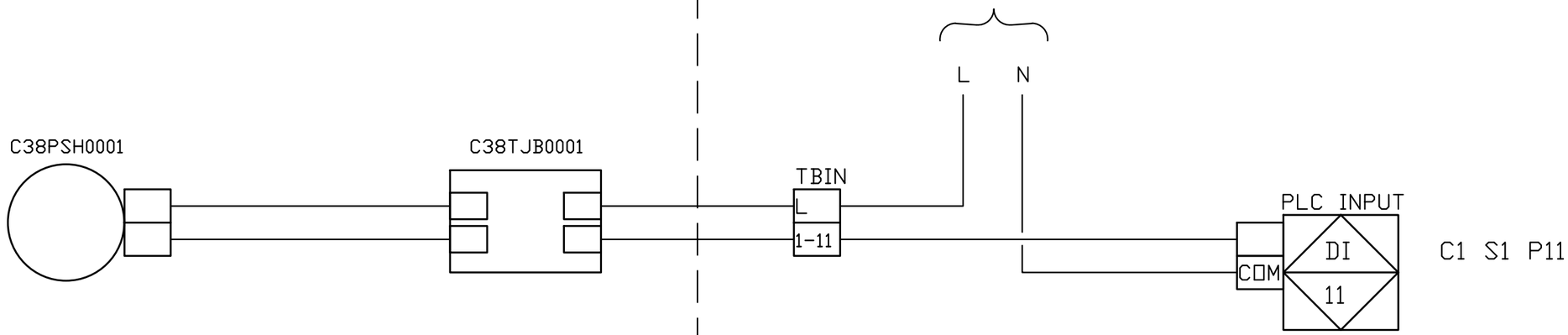
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C40FET1301

DRAWN: KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED: ME	DATE: 2023.10.23	DWG NO. 0723-08MSI-1301	
APPROVED: HAD	SCALE: NONE	SHEET 2 OF 7	

FIELD

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

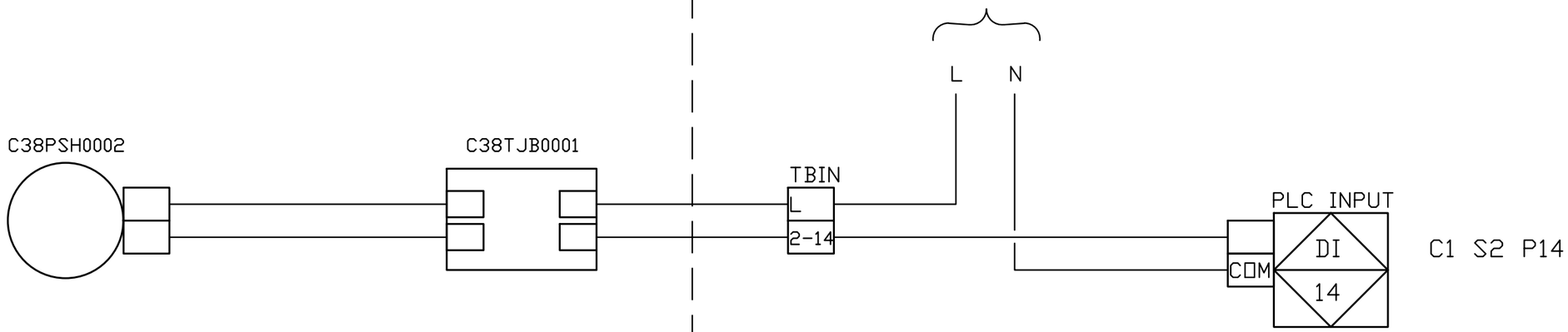
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38PSH0001

DRAWN: KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED: ME	DATE: 2023.10.23	DWG NO. 0723-08MSI-0001	
APPROVED: HAD	SCALE: NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



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REVISIONS

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2324 THREE LAKES RD / PO BOX 462
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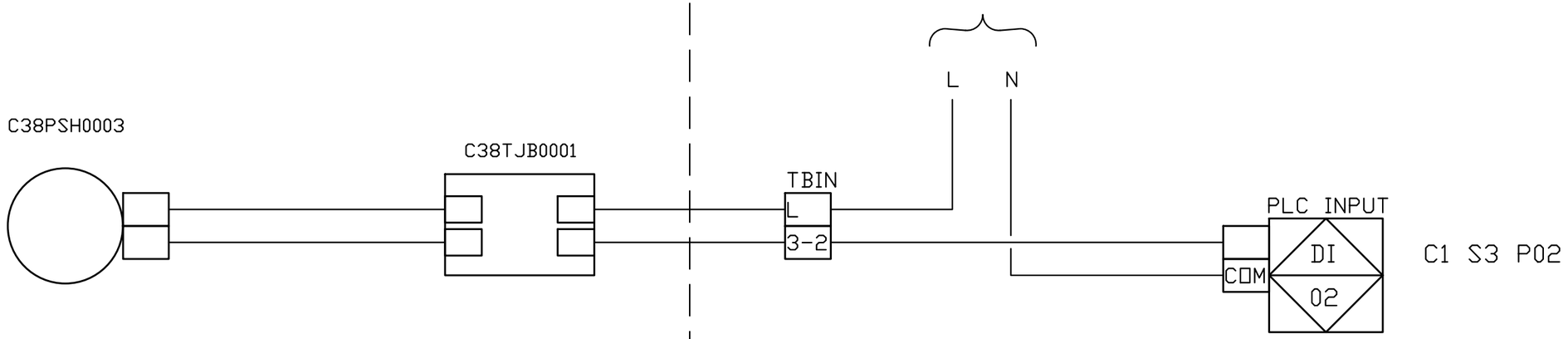
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38PSH0002

DRAWN: KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED: ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0002	
APPROVED: HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



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2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

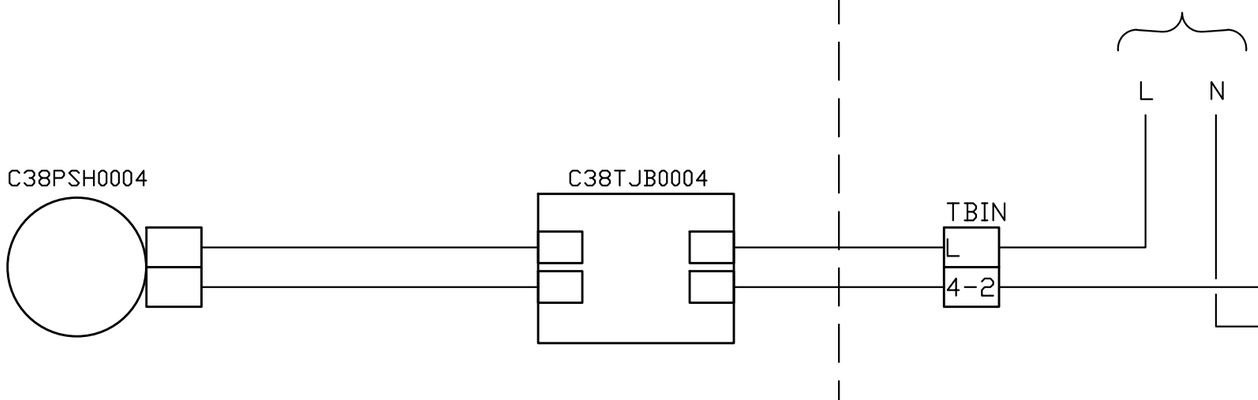
CLIENT: McCLURE & SONS

TITLE: COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38PSH0003

DRAWN: KCD	ISSUED:	JOB NO.: 0723-08MSI	
CHECKED: ME	DATE: 2023.10.23	DWG NO.: 0723-08MSI-0003	
APPROVED: HAD	SCALE: NONE	SHEET 4 OF 7	

FIELD

PLC PANEL



FEED PUMP 4 HIGH PRESSURE
PLC INPUT

C1 S4 P02

REV	DATE	DESCRIPTION	INIT
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B	2024.01.31.	REVIEW	KCD
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

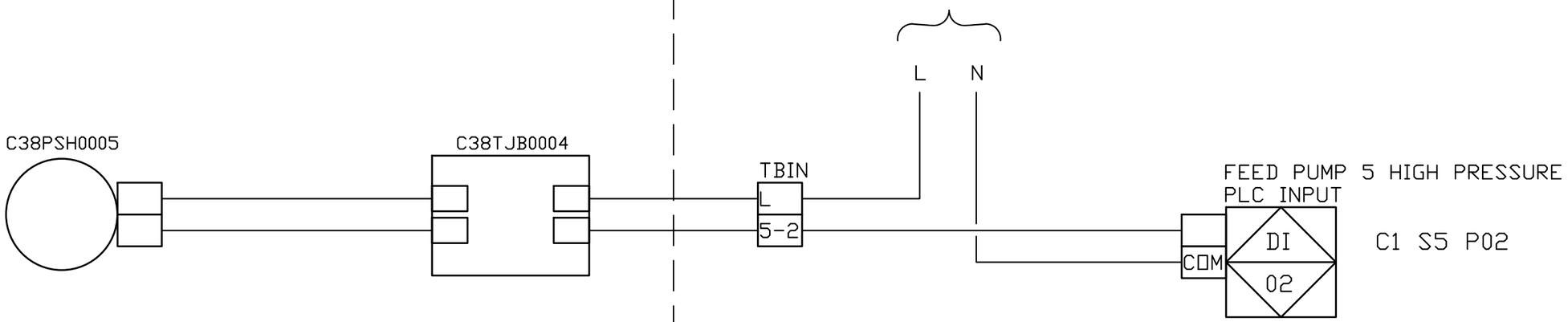
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38PSH0004

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0004	
APPROVED HAD	SCALE NONE	SHEET 5	OF 7

FIELD

PLC PANEL



FEED PUMP 5 HIGH PRESSURE
PLC INPUT

C1 S5 P02

REV	DATE	DESCRIPTION	INIT
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2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

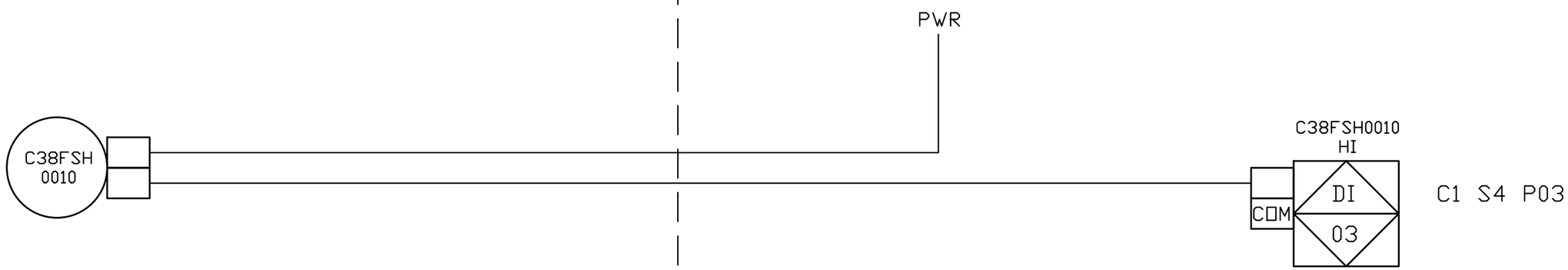
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38PSH0005

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0005	
APPROVED HAD	SCALE NONE	SHEET 5	OF 7

FIELD

PLC PANEL



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A	2023.10.23	Original Draft	KCD

REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
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CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C38FSH0010 HI

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C38FSH	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

PLC PANEL

PWR

DC PWR 1

C92VDC0101A
ALARM

DI
COM
07

C1 S4 P07

PWR

DC PWR 2

C92VDC0101B
ALARM

DI
COM
08

C1 S4 P08

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C35ZS3202

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C35ZS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

PWR

C92ZS
9401

SECONDARY MCC
BUILDING
INTRUSION

C92ZS9401
DOOR

COM

DI
09

C1 S4 P09

REV	DATE	DESCRIPTION	INIT
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B	2024.04.23.	REVIEW	KCD
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C92ZS9401

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C92ZS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

C92TIT0201
CAL: -58 to 842 ºF

E20TE0201

JB-XX

120VAC
UPS

120VAC

L N GND

I/I

GND

SIGNAL ISOLATOR

SECONDARY MCC BUILDING TEMPERATURE
PLC INPUT

AI
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C0 S4 P04

-58 to 842 ºF

REV	DATE	DESCRIPTION	INIT
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C92TIT0201

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-0201	
APPROVED HAD	SCALE NONE	SHEET 2 OF 7	

SECONDARY MCC BUILDING

PLC PANEL

PWR

C92UPS0300
UNINTERRUPTABLE
P.S.

C92UPS0300
FAULT

COM

DI

04

C1 S4 P04

C92UPS0300
ON

COM

DI

05

C1 S4 P05

REV	DATE	DESCRIPTION	INIT
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C92UPS0300 FAULT, ON

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
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APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

FIELD

PLC PANEL

PWR

C92DDC9001
SECONDARY MCC
BUILDING

C92DDC9001
ALARM

COM

DI
06

C1 S4 P06

REV	DATE	DESCRIPTION	INIT
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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C92DDC9001 ALARM

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C92DDC	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

GENERATOR

PLC PANEL

L

N

C80GEN0101

C80GEN0101
ON
DI
03
COM
C1 S5 P03

C80GEN0101

C80GEN0101
ESTOP
DI
04
COM
C1 S5 P04

C80GEN0101

C80GEN0101
AUTO
DI
05
COM
C1 S5 P05

C80GEN0101

C80GEN0101
LOW
DI
06
COM
C1 S5 P06

C80GEN0101

C80GEN0101
LEAK
DI
07
COM
C1 S5 P07

C80GEN0101

C80GEN0101
BAT
DI
08
COM
C1 S5 P08

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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

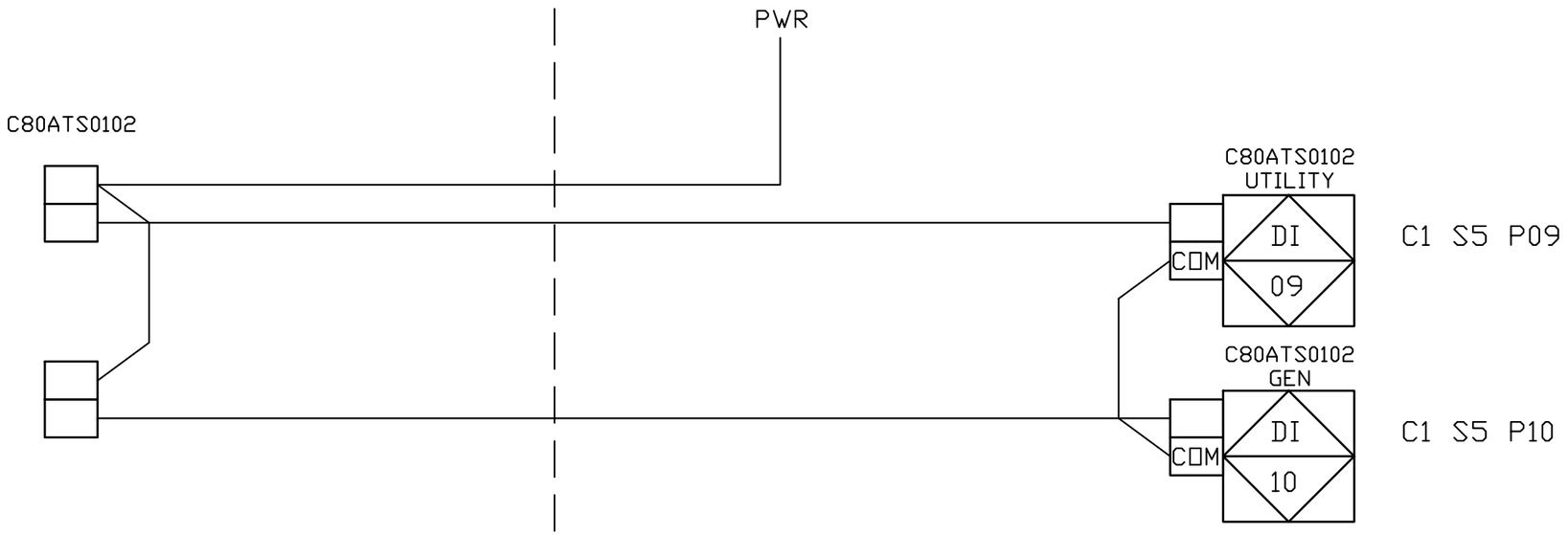
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C80ATS0102 UTILITY, GEN

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C80ATS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

AUTOMATIC TRANSFER SWITCH

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

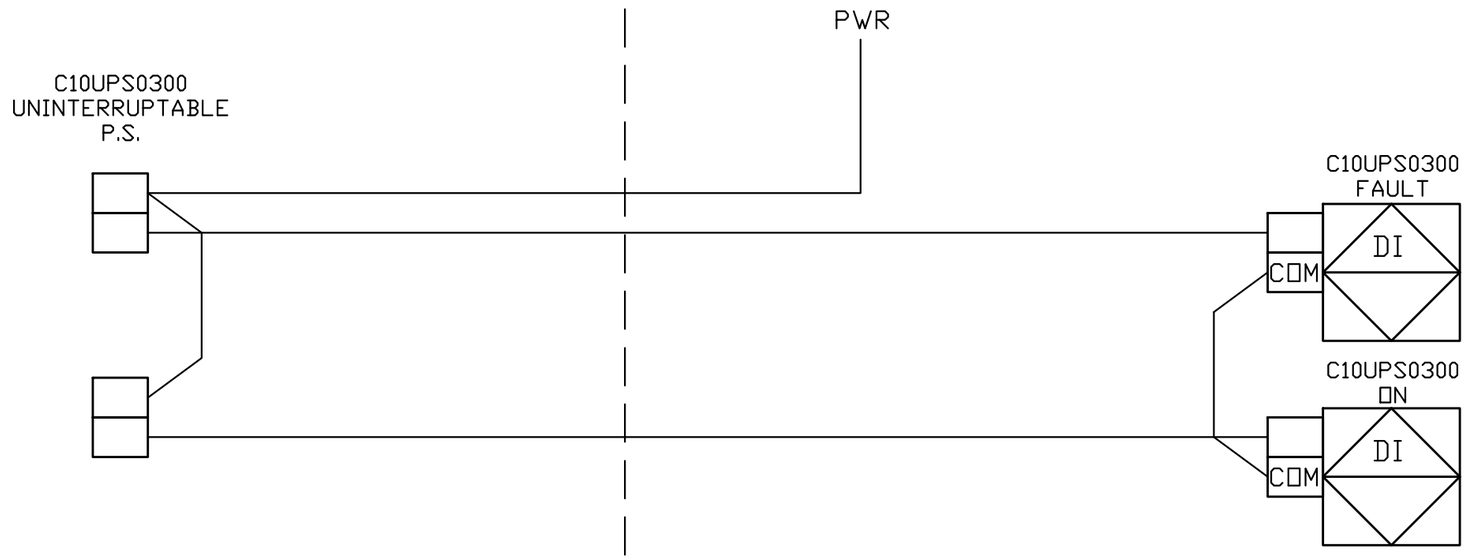
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C80ATS0102 UTILITY, GEN

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C80ATS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

BISULFITE STORAGE BUILDING

PLC PANEL



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OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

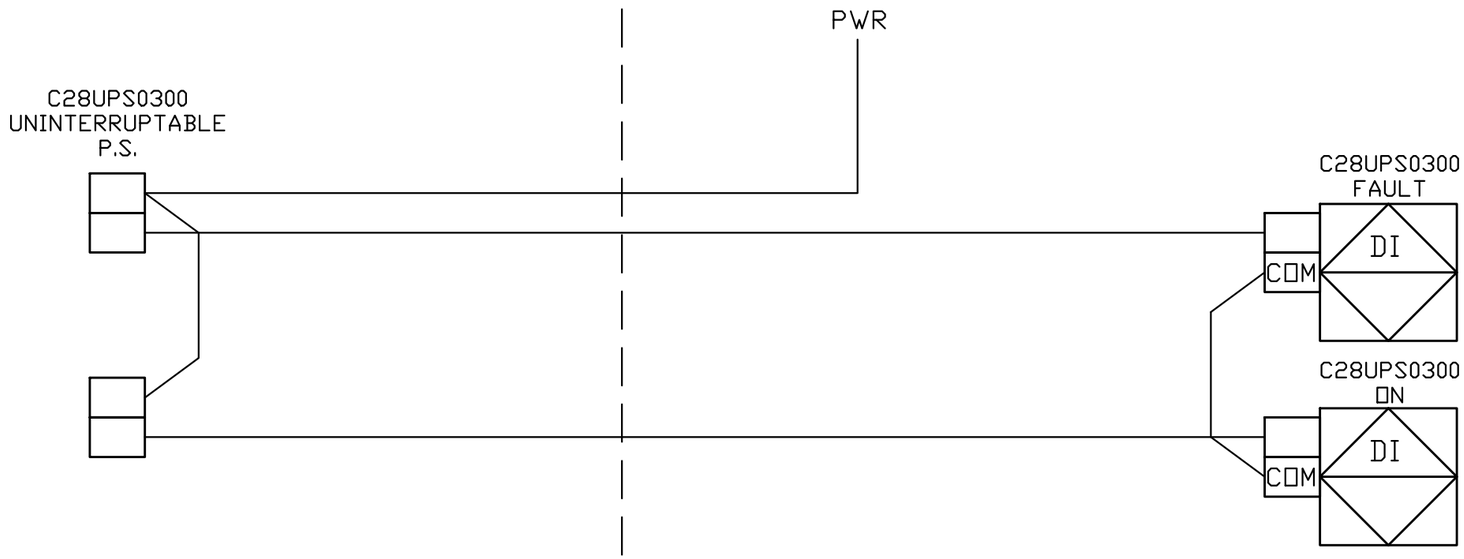
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C10UPS0300 FAULT, ON

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C10UPS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

BLOWER BUILDING

PLC PANEL



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REVISIONS

OPTIMAL CONTROL SYSTEMS
2324 THREE LAKES RD / PO BOX 462
ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

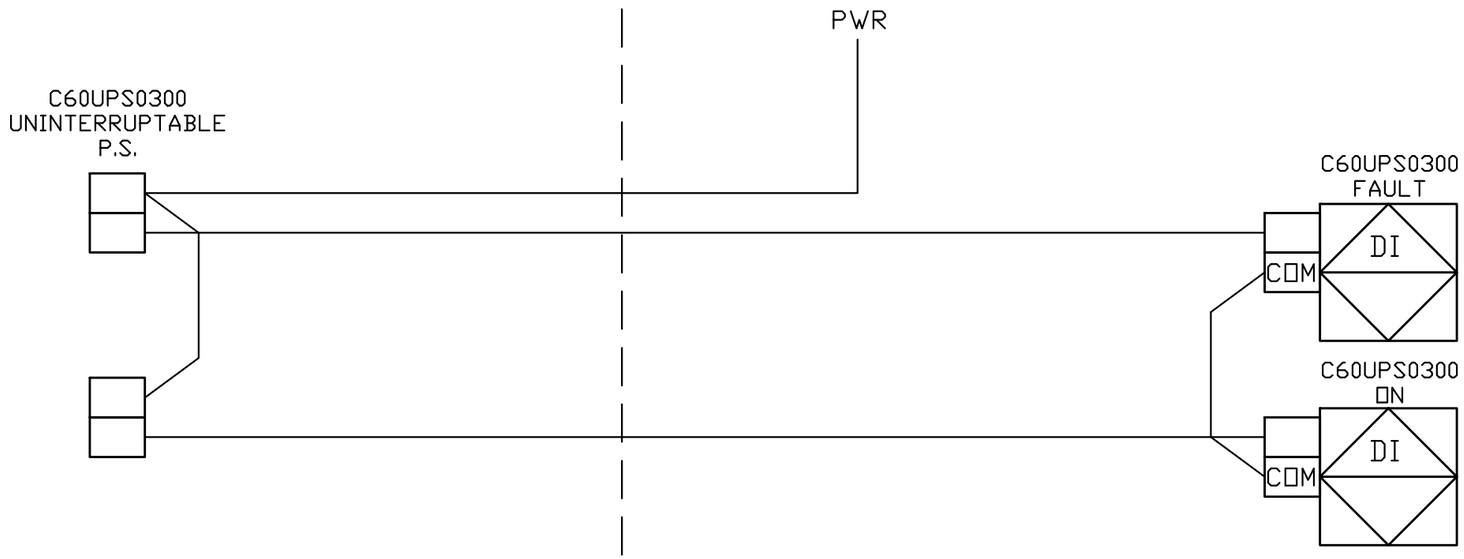
CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C28UPS0300 FAULT, ON

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C28UPS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

OPERATIONS & MAINTENANCE BUILDING

PLC PANEL



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OPTIMAL CONTROL SYSTEMS
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ALBANY, OR 97321
PHONE (541) 967-9323 FAX (541) 967-9485

CLIENT McCLURE & SONS

TITLE COOS BAY WASTE WATER TREATMENT PLANT
LOOP DRAWING C60UPS0300 FAULT, ON

DRAWN KCD	ISSUED	JOB NO. 0723-08MSI	
CHECKED ME	DATE 2023.10.23	DWG NO. 0723-08MSI-C60UPS	
APPROVED HAD	SCALE NONE	SHEET 4 OF 7	

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

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Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

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Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35FET3131	Proline Promag W 400 Electromagnetic Flowmeter, 5W4C1H, DN100 4"	Endress+Hauser	5W4C1H-C6ELHP2DUA1KGA +AAEBI7PBZ1	Section 40 91 00	09-I-002, 4091-219
002	1	"	Promag, Grounding Disc	Endress+Hauser	DK5GD-1HAHL	Section 40 91 00	09-I-002, 4091-219
003	1	C35FET3214	Proline Promag W 400 Electromagnetic Flowmeter, 5W4C2F, DN250 10"	Endress+Hauser	5W4C2F-C6ELHP2DUA1KGA +AAEBI7PBZ1	Section 40 91 00	09-I-004, 4091-219
004	1	"	Promag, Grounding Disc	Endress+Hauser	DK5GD-2FAHL	Section 40 91 00	09-I-004, 4091-219
005	1	C35FET3231	Proline Promag W 400 Electromagnetic Flowmeter, 5W4C1H, DN100 4"	Endress+Hauser	5W4C1H-C6ELHP2DUA1KGA +AAEBI7PBZ1	Section 40 91 00	09-I-004, 4091-219
006	1	"	Promag, Grounding Disc	Endress+Hauser	DK5GD-1HAHL	Section 40 91 00	09-I-004, 4091-219
007	1	C40FET1301	Proline Promag W 400 Electromagnetic Flowmeter, 5W4C1H, DN100 4"	Endress+Hauser	5W4C1H-C6ELHP2DUA1KGA +AAEBI7PB	Section 40 91 00	09-I-006, 4091-219
008	1	"	Promag, Grounding Disc	Endress+Hauser	DK5GD-1HAHL	Section 40 91 00	09-I-006, 4091-219
009							
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039							
040							

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Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71215558	Promag W 400, 5W4C1H, DN100 4" 5W4C1H-C6ELHP2DUA1KGA+AAEBI7PBZ1	1	PC

Details

Format display	1 value, max. size	
Value 1 display	Volume flow	
Value 2 display	None	
Value 3 display	None	
Value 4 display	None	
Display damping	0	s
Totalizer 1		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Totalizer 2		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Totalizer 3		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Curr. output 1	Volume flow	
Current span	4...20 mA US	
Value 0/4 mA	0	USgal/min
Value 20 mA	300	USgal/min
Failsafe mode current output	Max.	
Damping output 1	1	s
Operating mode	Pulse	
Assign pulse output	Volume flow	
Pulse value (per pulse)	2	USgal
Pulse width	100	ms
Failsafe mode pulse output	No pulses	

010	Approval:	C6	CSA C/US NI Cl.I Div.2 Gr. ABCD
011	Design:	E	Fixed flange
015	Power Supply:	L	AC 100...240V, AC/DC 24V

020	Output; Input:	H	4-20mA HART, pulse/freq., switch output
040	Housing:	P	Remote, alu, coated
045	Cable, Remote Version:	2	10m/30ft coil and signal cable
050	Electrical Connection:	D	Thread NPT1/2
060	Liner:	U	Polyurethane
070	Process Connection:	A1K	Cl.150, carbon steel, flange ASME B16.5
075	Electrodes:	G	1.4435/316L, bullet nose
080	Flow Calibration:	A	0.5%
500	>Operation Language Display:	AA	English
540	>>Application Package:	EB	Heartbeat Verification + Monitoring
570	>>Service:	I7	Product documentation on paper
620	>>Accessory Enclosed:	PB	Weather protection cover
895	>>Marking:	Z1	Tagging (TAG), see additional spec.

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
50096876	Promag, grounding disc/protection disc DK5GD-1HAHL	1	PC

010	Nominal Diameter:	1HA	DN100 4", 1.4435/316L
020	Liner:	H	Hard rubber
030	Process Connection:	L	Cl.150 ANSI B16.5

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Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71215562	Promag W 400, 5W4C2F, DN250 10" 5W4C2F-C6ELHP2DUA1KGA+AAEBI7PBZ1	1	PC

Details

Format display	1 value, max. size	
Value 1 display	Volume flow	
Value 2 display	None	
Value 3 display	None	
Value 4 display	None	
Display damping	0	s
Totalizer 1		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Totalizer 2		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Totalizer 3		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	
Curr. output 1	Volume flow	
Current span	4...20 mA US	
Value 0/4 mA	0	USgal/min
Value 20 mA	1,500	USgal/min
Failsafe mode current output	Max.	
Damping output 1	1	s
Operating mode	Pulse	
Assign pulse output	Volume flow	
Pulse value (per pulse)	15	USgal
Pulse width	100	ms
Failsafe mode pulse output	No pulses	

010	Approval:	C6	CSA C/US NI Cl.I Div.2 Gr. ABCD
011	Design:	E	Fixed flange
015	Power Supply:	L	AC 100...240V, AC/DC 24V

020	Output; Input:	H	4-20mA HART, pulse/freq., switch output
040	Housing:	P	Remote, alu, coated
045	Cable, Remote Version:	2	10m/30ft coil and signal cable
050	Electrical Connection:	D	Thread NPT1/2
060	Liner:	U	Polyurethane
070	Process Connection:	A1K	Cl.150, carbon steel, flange ASME B16.5
075	Electrodes:	G	1.4435/316L, bullet nose
080	Flow Calibration:	A	0.5%
500	>Operation Language Display:	AA	English
540	>>Application Package:	EB	Heartbeat Verification + Monitoring
570	>>Service:	I7	Product documentation on paper
620	>>Accessory Enclosed:	PB	Weather protection cover
895	>>Marking:	Z1	Tagging (TAG), see additional spec.

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
50096876	Promag, grounding disc/protection disc DK5GD-2FAHL	1	PC

010	Nominal Diameter:	2FA	DN250 10", 1.4435/316L
020	Liner:	H	Hard rubber
030	Process Connection:	L	Cl.150 ANSI B16.5

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2021-09-01

Technical Information
Proline Promag W 400

Electromagnetic flowmeter

Versatile standard flowmeter for the water and wastewater industry

Application

- The bidirectional measuring principle is virtually independent of pressure, density, temperature and viscosity
- Ideal for water measurement, e.g. drinking water, utility water and industrial/municipal wastewater

Device properties
- International drinking water approvals
- Degree of protection IP68 (Type 6P enclosure)
- Approved for custody transfer to MI-001/OIML R49
- Transmitter housing made of durable polycarbonate or aluminum
- WLAN access
- Integrated data logger: measured values monitoring

Your benefits

- Reliable measurement at constant accuracy with 0 x DN run without pressure loss
- Flexible engineering – sensors with fixed flanges or lap joint flanges
- Application suitability – corrosion protection according to EN ISO 12944 for buried or underwater installations
- Improved plant availability – sensor compliant with industry-specific requirements
- Safe operation – no need to open device
- Time-saving local operation without additional software and hardware – integrated web server
- Built-in verification and build-up detection – Heartbeat Technology

Endress+Hauser
People for Process Automation

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About this document

Symbols

Electrical symbols

Symbol	Meaning
	Direct current
	Alternating current
	Direct current and alternating current
	Ground connection A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
	Protective Earth (PE) A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: ▪ Inner ground terminal: Connects the protectiv earth to the mains supply. ▪ Outer ground terminal: Connects the device to the plant grounding system.

Communication symbols

Symbol	Meaning
	Wireless Local Area Network (WLAN) Communication via a wireless, local network.
	Bluetooth Wireless data transmission between devices over a short distance.
	LED Light emitting diode is off.
	LED Light emitting diode is on.
	LED Light emitting diode is flashing.

Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Visual inspection

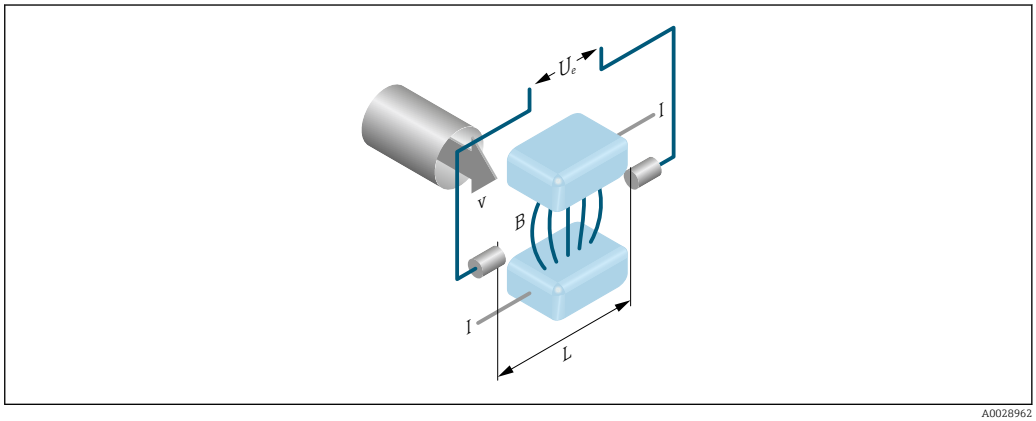
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
	Hazardous area
	Safe area (non-hazardous area)
	Flow direction

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.



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Ue *Induced voltage*
B *Magnetic induction (magnetic field)*
L *Electrode spacing*
I *Current*
v *Flow velocity*

In the electromagnetic measuring principle, the flowing medium is the moving conductor. The voltage induced (U_e) is proportional to the flow velocity (v) and is supplied to the amplifier by means of two measuring electrodes. The flow volume (Q) is calculated via the pipe cross-section (A). The DC magnetic field is created through a switched direct current of alternating polarity.

Formulae for calculation

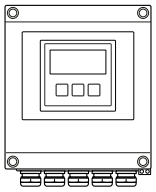
- Induced voltage $U_e = B \cdot L \cdot v$
- Volume flow $Q = A \cdot v$

Measuring system

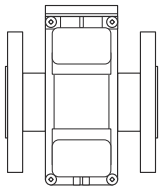
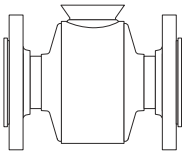
The device consists of a transmitter and a sensor.

Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

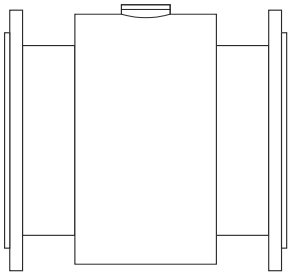
Transmitter

Proline 400
 
A0045222
	Device versions and materials:
	▪ Compact version: compact housing
	  ▪ Polycarbonate plastic
	  ▪ Aluminum, AlSi10Mg, coated
	▪ Remote version: wall-mount housing
	  ▪ Polycarbonate plastic
	  ▪ Aluminum, AlSi10Mg, coated
	
	Configuration:
	▪ External operation via four-line, illuminated local display with touch control and guided menus ("Make-it-run" wizards) for applications
	▪ Via operating tools (e.g. FieldCare)
	▪ Via Web browser (e.g. Microsoft Internet Explorer)
	▪ Also for device version with EtherNet/IP output:
	  ▪ Via Add-on Profile Level 3 for automation system from Rockwell Automation
	  ▪ Via Electronic Data Sheet (EDS)
	▪ Also for device version with PROFIBUS DP output:
	Via PDM driver for Siemens automation system

Sensor

Promag W *Lap joint flange, lap joint flange, stamped plate or fixed flange with aluminum half-shell housing: DN 25 to 300 mm (1 to 12 in)*  A0017040	▪ Nominal diameter range: DN 25 to 3 000 mm (1 to 120 in) ▪ Materials → 🖹 91
Fixed flange with fully welded housing made of carbon steel: DN 25 to 300 mm (1 to 12 in)  A0022673	

Fixed flange with fully welded housing made of carbon steel: DN 350 to 3 000 mm (14 to 120 in)



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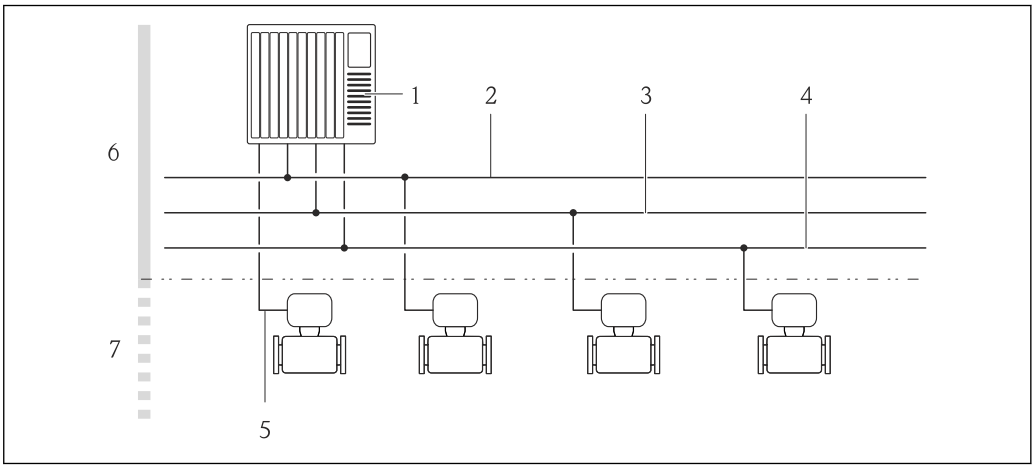
Equipment architecture



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1 *Possibilities for integrating measuring devices into a system*

1 *Control system (e.g. PLC)*
2 *EtherNet/IP*
3 *PROFIBUS DP*
4 *Modbus RS485*
5 *4 to 20 mA HART, pulse/frequency/switch output*
6 *Non-hazardous area*
7 *Non-hazardous area and Zone 2/Div. 2*

Safety

IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section.

Protecting access via a password

Different passwords are available to protect write access to the device parameters or access to the device via the WLAN interface.

- User-specific access code
  Protect write access to the device parameters via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.
- WLAN passphrase
  The network key protects a connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface which can be ordered as an option.

User-specific access code

Write access to the device parameters via the local display or operating tool (e.g. FieldCare, DeviceCare) can be protected by the modifiable, user-specific access code.

WLAN passphrase: Operation as WLAN access point

A connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface, which can be ordered as an optional extra, is protected by the network key. The WLAN authentication of the network key complies with the IEEE 802.11 standard.

When the device is delivered, the network key is pre-defined depending on the device. It can be changed via the **WLAN settings** submenu in the **WLAN passphrase** parameter.

General notes on the use of passwords

- The access code and network key supplied with the device should be changed during commissioning.
- Follow the general rules for generating a secure password when defining and managing the access code or network key.
- The user is responsible for the management and careful handling of the access code and network key.

Access via Web server

The device can be operated and configured via a Web browser with the integrated Web server. The connection is via the service interface (CDI-RJ45) or the WLAN interface. For device versions with the EtherNet/IP and PROFINET communication protocols, the connection can also be established via the terminal connection for signal transmission with EtherNet/IP or PROFINET (RJ45 plug).

The Web server is enabled when the device is delivered. The Web server can be disabled if necessary (e.g. after commissioning) via the **Web server functionality** parameter.

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

For detailed information on device parameters, see:
The "Description of Device Parameters" document → 106

Input

Measured variable

Direct measured variables

- Volume flow (proportional to induced voltage)
- Electrical conductivity

In custody transfer: only volume flow

Calculated measured variables

Mass flow

Measuring range

Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Electrical conductivity: ≥ 5 µS/cm for liquids in general

Flow characteristic values in SI units: DN 25 to 125 mm (1 to 4 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
25	1	9 to 300	75	0.5	1
32	–	15 to 500	125	1	2

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
40	1 ½	25 to 700	200	1.5	3
50	2	35 to 1 100	300	2.5	5
65	–	60 to 2 000	500	5	8
80	3	90 to 3 000	750	5	12
100	4	145 to 4 700	1 200	10	20
125	–	220 to 7 500	1 850	15	30

Flow characteristic values in SI units: DN 150 to 3 000 mm (6 to 120 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
150	6	20 to 600	150	0.025	2.5
200	8	35 to 1 100	300	0.05	5
250	10	55 to 1 700	500	0.05	7.5
300	12	80 to 2 400	750	0.1	10
350	14	110 to 3 300	1 000	0.1	15
375	15	140 to 4 200	1 200	0.15	20
400	16	140 to 4 200	1 200	0.15	20
450	18	180 to 5 400	1 500	0.25	25
500	20	220 to 6 600	2 000	0.25	30
600	24	310 to 9 600	2 500	0.3	40
700	28	420 to 13 500	3 500	0.5	50
750	30	480 to 15 000	4 000	0.5	60
800	32	550 to 18 000	4 500	0.75	75
900	36	690 to 22 500	6 000	0.75	100
1000	40	850 to 28 000	7 000	1	125
–	42	950 to 30 000	8 000	1	125
1200	48	1 250 to 40 000	10 000	1.5	150
–	54	1 550 to 50 000	13 000	1.5	200
1400	–	1 700 to 55 000	14 000	2	225
–	60	1 950 to 60 000	16 000	2	250
1600	–	2 200 to 70 000	18 000	2.5	300
–	66	2 500 to 80 000	20 500	2.5	325
1800	72	2 800 to 90 000	23 000	3	350
–	78	3 300 to 100 000	28 500	3.5	450
2000	–	3 400 to 110 000	28 500	3.5	450

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
–	84	3700 to 125000	31000	4.5	500
2200	–	4100 to 136000	34000	4.5	540
–	90	4300 to 143000	36000	5	570
2400	–	4800 to 162000	40000	5.5	650
–	96	5000 to 168000	42000	6	675
–	102	5700 to 190000	47500	7	750
2600	–	5700 to 191000	48000	7	775
–	108	6500 to 210000	55000	7	850
2800	–	6700 to 222000	55500	8	875
–	114	7100 to 237000	59500	8	950
3000	–	7600 to 254000	63500	9	1025
–	120	7900 to 263000	65500	9	1050

Flow characteristic values in SI units: DN 50 to 200 mm (2 to 8 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
50	2	15 to 600	300	1.25	1.25
65	–	25 to 1000	500	2	2
80	3	35 to 1500	750	3	3.25
100	4	60 to 2400	1200	5	4.75
125	–	90 to 3700	1850	8	7.5
150	6	145 to 5400	2500	10	11
200	8	220 to 9400	5000	20	19

Flow characteristic values in SI units: DN 250 to 300 mm (10 to 12 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
250	10	20 to 850	500	0.03	1.75
300	12	35 to 1300	750	0.05	2.75

Flow characteristic values in US units: DN 1 to 48 in (25 to 1200 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
1	25	2.5 to 80	18	0.2	0.25
–	32	4 to 130	30	0.2	0.5
1 ½	40	7 to 185	50	0.5	0.75
2	50	10 to 300	75	0.5	1.25
–	65	16 to 500	130	1	2
3	80	24 to 800	200	2	2.5
4	100	40 to 1250	300	2	4
–	125	60 to 1950	450	5	7
6	150	90 to 2650	600	5	12
8	200	155 to 4850	1200	10	15
10	250	250 to 7500	1500	15	30
12	300	350 to 10600	2400	25	45
14	350	500 to 15000	3600	30	60
15	375	600 to 19000	4800	50	60
16	400	600 to 19000	4800	50	60
18	450	800 to 24000	6000	50	90
20	500	1000 to 30000	7500	75	120
24	600	1400 to 44000	10500	100	180
28	700	1900 to 60000	13500	125	210
30	750	2150 to 67000	16500	150	270
32	800	2450 to 80000	19500	200	300
36	900	3100 to 100000	24000	225	360
40	1000	3800 to 125000	30000	250	480
42	–	4200 to 135000	33000	250	600
48	1200	5500 to 175000	42000	400	600

Flow characteristic values in US units: DN 54 to 120 in (1400 to 3000 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
54	–	9 to 300	75	0.0005	1.3
–	1400	10 to 340	85	0.0005	1.3
60	–	12 to 380	95	0.0005	1.3
–	1600	13 to 450	110	0.0008	1.7
66	–	14 to 500	120	0.0008	2.2
72	1800	16 to 570	140	0.0008	2.6

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
78	–	18 to 650	175	0.0010	3.0
–	2000	20 to 700	175	0.0010	2.9
84	–	24 to 800	190	0.0011	3.2
–	2200	26 to 870	210	0.0012	3.4
90	–	27 to 910	220	0.0013	3.6
–	2400	31 to 1030	245	0.0014	4.0
96	–	32 to 1066	265	0.0015	4.0
102	–	34 to 1203	300	0.0017	5.0
–	2600	34 to 1212	305	0.0018	5.0
108	–	35 to 1300	340	0.0020	5.0
–	2800	42 to 1405	350	0.0020	6.0
114	–	45 to 1503	375	0.0022	6.0
–	3000	48 to 1613	405	0.0023	6.0
120	–	50 to 1665	415	0.0024	7.0

Flow characteristic values in US units: DN 2 to 12 in (50 to 300 mm) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
2	50	4 to 160	75	0.3	0.35
–	65	7 to 260	130	0.5	0.6
3	80	10 to 400	200	0.8	0.8
4	100	16 to 650	300	1.2	1.25
–	125	24 to 1000	450	1.8	2
6	150	40 to 1400	600	2.5	3
8	200	60 to 2500	1200	5	5
10	250	90 to 3700	1500	6	8
12	300	155 to 5700	2400	9	12

Recommended measuring range

Flow limit → 52

For custody transfer, the applicable approval determines the permitted measuring range, the pulse value and the low flow cut off.

Operable flow range

Over 1000 : 1

For custody transfer, the operable flow range is 100 : 1 to 630 : 1, depending on the nominal diameter. Further details are specified by the applicable approval.

Input signal

External measured values

Various pressure transmitters and temperature measuring devices can be ordered from Endress +Hauser: see "Accessories" section → 105

It is recommended to read in external measured values to calculate the following measured variables: Mass flow

HART protocol

The measured values are written from the automation system to the measuring device via the HART protocol. The pressure transmitter must support the following protocol-specific functions:
- HART protocol
- Burst mode

Digital communication

The measured values can be written from the automation system to the measuring via:
- PROFIBUS DP
- Modbus RS485
- EtherNet/IP

Status input

Maximum input values	▪ DC 30 V ▪ 6 mA
Response time	Configurable: 5 to 200 ms
Input signal level	▪ Low signal (low): DC −3 to +5 V ▪ High signal (high): DC 12 to 30 V
Assignable functions	▪ Off ▪ Reset totalizers 1-3 separately ▪ Reset all totalizers ▪ Flow override

Output

Output signal

Current output

Current output	Can be set as: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA HART ▪ 0 to 20 mA
Maximum output values	▪ DC 24 V (no flow) ▪ 22.5 mA
Load	0 to 700 Ω
Resolution	0.5 µA

Damping	Configurable: 0.07 to 999 s
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1] ▪ Corrected conductivity [1] ▪ Temperature [1] ▪ Electronics temperature ▪ Reference electrode potential [1] ▪ Coil current rise time [1] ▪ Noise [1] ▪ Build-up measured value [1] ▪ Test points 1-3

1) Visible depending on order options or device settings

Pulse/frequency/switch output

Function	▪ With the order code for "Output; Input", option **H**: output 2 can be set as a pulse or frequency output ▪ With the order code for "Output; Input", option **I**: output 2 and 3 can be set as a pulse, frequency or switch output ▪ With the order code for "Output; Input", option **J**: output 2 firmly assigned as certified pulse output
Version	Passive, open collector
Maximum input values	▪ DC 30 V ▪ 250 mA
Voltage drop	At 25 mA: ≤ DC 2 V
Pulse output	
Pulse width	Configurable: 0.05 to 2 000 ms
Maximum pulse rate	10 000 Impulse/s
Pulse value	Configurable
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow
Frequency output	
Output frequency	Configurable: 0 to 12 500 Hz
Damping	Configurable: 0 to 999 s
Pulse/pause ratio	1:1
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1] ▪ Corrected conductivity [1] ▪ Temperature [1] ▪ Electronics temperature ▪ Noise [1] ▪ Coil current rise time [1] ▪ Reference electrode potential [1] ▪ Build-up measured value [1] ▪ Test points 1-3
Switch output	
Switching behavior	Binary, conductive or non-conductive
Switching delay	Configurable: 0 to 100 s

Number of switching cycles	Unlimited

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value:
	  ▪ Off
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ Mass flow
	  ▪ Flow velocity
	  ▪ Conductivity [1)]
	  ▪ Corrected conductivity [1)]
	  ▪ Totalizer 1-3
	  ▪ Temperature [1)]
	  ▪ Electronics temperature
	▪ Flow direction monitoring
	▪ Status:
	  ▪ Empty pipe detection
	  ▪ Low flow cut off
	  ▪ Build-up limit value [1)]

1) Visible depending on order options or device settings

PROFIBUS DP

Signal encoding	NRZ code
Data transmission	9.6 kBaud...12 MBaud

Modbus RS485

Physical interface	In accordance with EIA/TIA-485-A standard
Terminating resistor	Integrated, can be activated via DIP switch on the transmitter electronics module

EtherNet/IP

Standards	In accordance with IEEE 802.3

Signal on alarm

Depending on the interface, failure information is displayed as follows:

Current output 4 to 20 mA

4 to 20 mA

Failure mode	Choose from: ▪ 4 to 20 mA in accordance with NAMUR recommendation NE 43 ▪ 4 to 20 mA in accordance with US ▪ Min. value: 3.59 mA ▪ Max. value: 22.5 mA ▪ Freely definable value between: 3.59 to 22.5 mA ▪ Actual value ▪ Last valid value

0 to 20 mA

Failure mode	Choose from: ▪ Maximum alarm: 22 mA ▪ Freely definable value between: 0 to 22.5 mA

HART current output

Device diagnostics	Device condition can be read out via HART Command 48

Pulse/frequency/switch output

Pulse output	
Failure mode	Choose from: ▪ Actual value ▪ No pulses
Frequency output	
Failure mode	Choose from: ▪ Actual value ▪ 0 Hz ▪ Defined value: 0 to 12 500 Hz
Switch output	
Failure mode	Choose from: ▪ Current status ▪ Open ▪ Closed

PROFIBUS DP

Status and alarm messages	Diagnostics in accordance with PROFIBUS PA Profile 3.02

Modbus RS485

Failure mode	Choose from: ▪ NaN value instead of current value ▪ Last valid value

EtherNet/IP

Device diagnostics	Device condition can be read out in Input Assembly

Local display

Plain text display	With information on cause and remedial measures
Backlight	Red backlighting indicates a device error.

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  - HART protocol
  - PROFIBUS DP
  - Modbus RS485
  - EtherNet/IP
- Via service interface
  - CDI-RJ45 service interface
  - WLAN interface

Plain text display	With information on cause and remedial measures

Additional information on remote operation → 95

Web browser

Plain text display	With information on cause and remedial measures

Light emitting diodes (LED)

Status information	Status indicated by various light emitting diodes The following information is displayed depending on the device version: ▪ Supply voltage active ▪ Data transmission active ▪ Device alarm/error has occurred ▪ EtherNet/IP network available ▪ EtherNet/IP connection established

Low flow cut off

The switch points for low flow cut off are user-selectable.

Galvanic isolation

The following connections are galvanically isolated from each other:
- Inputs
- Outputs
- Power supply

Protocol-specific data

HART

Manufacturer ID	0x11
Device type ID	0x1169
HART protocol revision	7
Device description files (DTM, DD)	Information and files under: www.endress.com
HART load	Min. 250 Ω
Dynamic variables PV, SV, TV, QV	▪ Read out the dynamic variables via HART command 3 ▪ The measured variables can be freely assigned to the dynamic variables
Device variables	▪ Read out the device variables via HART command 9 ▪ The measured variables can be freely assigned ▪ A maximum of 8 device variables can be transmitted
System integration	Operating Instructions for the device → 106

PROFIBUS DP

Manufacturer ID	0x11
Ident number	0x1562
Profile version	3.02
Device description files (GSD, DTM, DD)	Information and files under: ▪ www.endress.com ▪ www.profibus.org
Output values	Output values (from the measuring device to the automation system) ▪ 4 Analog input ▪ 2 Digital input ▪ 3 Totalizer

Input values	Input values (from the automation system to the measuring device) ▪ 2 Analog output (fixed assignment) ▪ 2 Digital output (fixed assignment) ▪ 3 Totalizer
Device address configuration options	Configuration of the device address ▪ Hardware: DIP switches on the I/O electronics module ▪ Software: Via operating tools (e.g. FieldCare)
Supported functions	▪ Identification & Maintenance: Simplest device identification on the part of the control system and nameplate ▪ PROFIBUS upload/download: Reading and writing parameters is up to ten times faster with PROFIBUS upload/download ▪ Condensed status: Simplest and self-explanatory diagnostic information by categorizing diagnostic messages that occur
System integration	Operating Instructions for the device → 🖹 106

Modbus RS485

Protocol	Modbus Applications Protocol Specification V1.1
Device type	Slave
Slave address range	1 to 247
Broadcast address range	0
Function codes	▪ 03: Read holding register ▪ 04: Read input register ▪ 06: Write single registers ▪ 08: Diagnostics ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Broadcast messages	Supported by the following function codes: ▪ 06: Write single registers ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Supported baud rate	▪ 1200 BAUD ▪ 2400 BAUD ▪ 4800 BAUD ▪ 9600 BAUD ▪ 19200 BAUD ▪ 38400 BAUD ▪ 57600 BAUD ▪ 115200 BAUD
Modus data transmission	▪ ASCII ▪ RTU
Data access	Each device parameter can be accessed via Modbus RS485. For detailed information on the "Modbus RS485 register information", see the Description of Device Parameters → 🖹 106
System integration	Operating Instructions for the device → 🖹 106

EtherNet/IP

Protocol	▪ The CIP Networks Library Volume 1: Common Industrial Protocol ▪ The CIP Networks Library Volume 2: EtherNet/IP Adaptation of CIP
Communication type	▪ 10Base-T ▪ 100Base-TX
Device profile	Generic device (product type: 0x2B)
Manufacturer ID	0x49E

Device type ID	0x1069
Baud rates	Automatic 10/100 Mbit with half-duplex and full-duplex detection
Polarity	Auto-polarity for automatic correction of crossed TxD and RxD pairs
Supported CIP connections	Max. 3 connections
Explicit connections	Max. 5 connections
I/O connections	Max. 6 connections (scanner)
Configuration options for measuring device	Configuration options for measuring device ▪ DIP switches on the electronics module for IP addressing ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ Electronic Data Sheet (EDS) integrated in the measuring device
EtherNet interface configuration options	Configuration of the EtherNet interface ▪ Speed: 10 MBit, 100 MBit, auto (factory setting) ▪ Duplex: half-duplex, full-duplex, auto (factory setting)
Device address configuration options	Configuration of the device address ▪ DIP switches on the electronics module for IP addressing (last octet) ▪ DHCP ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ EtherNet/IP tools, e.g. RSLinx (Rockwell Automation)
Device Level Ring (DLR)	No
Assembly	▪ Legacy Input Assembly Fix (Assem 100) ▪ Legacy Input Assembly Configurable (Assem 101) ▪ Legacy Output Assembly Fix (Assem 102) ▪ Legacy Configuration Assembly (Assem 104) ▪ Input Assembly Fix (Assem 120) ▪ Input Assembly Configurable (Assem 121) ▪ Output Assembly Fix (Assem 122) ▪ Configuration Assembly (Assem 124) ▪ Volume Flow Extended Fix Input (Assem 126) ▪ Volume Flow Universal Fix Input (Assem 127) ▪ Dummy Output Assembly Fix (Assem 199)
Requested Packet Interval (RPI)	5 ms to 10 s (factory setting: 20 ms)
System integration	Operating Instructions for the device → 🖹 106

Power supply

Terminal assignment

Transmitter: 0 to 20 mA/4 to 20 mA HART

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with current output 0 to 20 mA/4 to 20 mA HART and other outputs and inputs

Order code for "Output" and "Input"	Terminal numbers							
	Output 1		Output 2		Output 3		Input	
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **H**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency output (passive)		Switch output (passive)		-	
Option **I**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Status input	
Option **J**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Fixed assignment: Certified pulse output (passive)		Switch output		Status input	

Transmitter: PROFIBUS DP

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	Power supply	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

PROFIBUS DP signal transmission

Order code for "Output" and "Input"	Terminal numbers	
	26 (RxD/TxD-P)	27 (RxD/TxD-N)
Option **L**	B	A
Order code for "Output": Option L: PROFIBUS DP, for use in non-hazardous areas and Zone 2/Div. 2		

Transmitter: Modbus RS485

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with Modbus RS485 and other outputs

Order code for "Output" and "Input"	Terminal numbers							
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **M**	Modbus		-		-		-	
	B	A						
Option **O**	Current output 4 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Modbus	
							B	A
Option **P**	Current output 4 to 20 mA (active)		Pulse output certified (passive)		Pulse/frequency/ switch output (passive)		Modbus	
							B	A

Transmitter: EtherNet/IP

The transmitter can be ordered with terminals or a device plug.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
EtherNet/IP (RJ45 plug)	Terminals	Option **D**: thread NPT ½"
Device plug → 🖹 22	Terminals	▪ Option **L**: plug M12x1 + thread NPT ½" ▪ Option **N**: plug M12x1 + coupling M20 ▪ Option **P**: plug M12x1 + thread G ½" ▪ Option **U**: plug M12x1 + thread M20

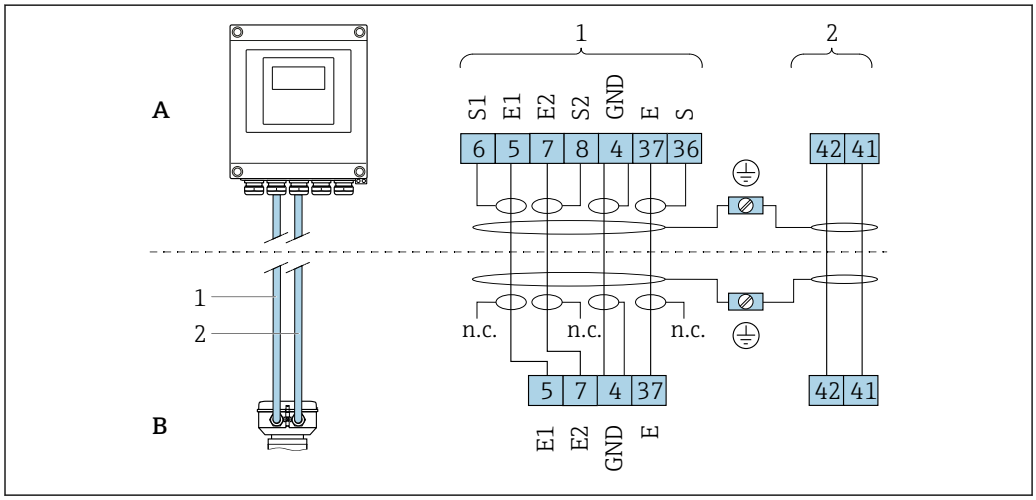
Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

EtherNet/IP signal transmission

Order code for "Output"	Connection via
Option **N**	EtherNet/IP: RJ45 or M12 plug

Remote version



2 *Remote version terminal assignment*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable
n.c. Not connected, insulated cable shields

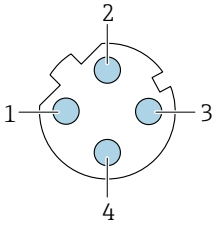
Terminal No. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Pin assignment, device plug

Order codes for the M12x1 plugs, see the "Order code for electrical connection" column: EtherNet/IP → 21

EtherNet/IP

Device plug for signal transmission (device side)



Pin		Assignment	Coding	Plug/socket
1	+	Tx	D	Socket
2	+	Rx		
3	-	Tx		
4	-	Rx		

Recommended plug:
- Binder, series 763, part no. 99 3729 810 04
- Phoenix, part no. 1543223 SACC-M12MSD-4Q
- The device plug is not permitted in the hazardous area, Class I Division 2. The device plug may only be used in the non-hazardous area (General Purpose).

Supply voltage

Transmitter

Order code for "Power supply"	terminal voltage		Frequency range
Option **L**	DC 24 V	±25%	–
	AC 24 V	±25%	50/60 Hz, ±4 Hz
	AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Power consumption

Order code for "Output"	Maximum power consumption
Option **H**: 4-20mA HART, pulse/frequency output, switch output	30 VA/8 W
Option **I**: 4-20mA HART, 2 x pulse/frequency/switch output, status input	30 VA/8 W
Option **J**: 4-20mA HART, certified pulse output, switch output, status input	30 VA/8 W
Option **L**: PROFIBUS DP	30 VA/8 W
Option **M**: Modbus RS485	30 VA/8 W
Option **O**: Modbus RS485, 4-20mA, 2 x pulse/ frequency/switch output	30 VA/8 W
Option **P**: Modbus RS485, 4-20mA, certified pulse output, pulse/frequency/switch output	30 VA/8 W
Option **N**: EtherNet/IP	30 VA/8 W

Current consumption

Transmitter

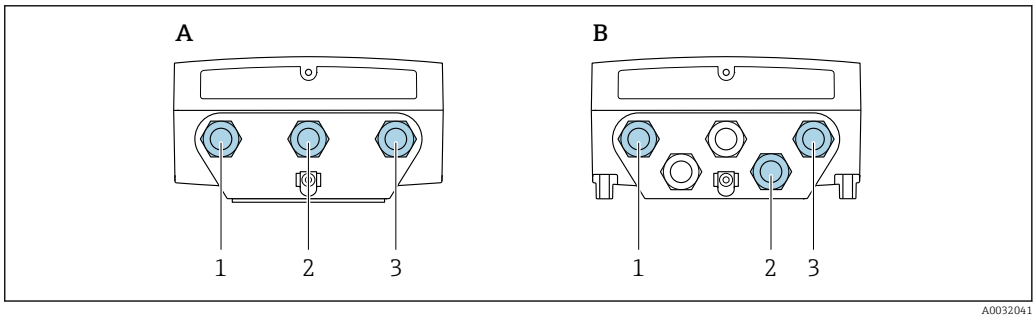
Order code for "Power supply"	Maximum Current consumption	Maximum switch-on current
Option **L**: AC 100 to 240 V	145 mA	25 A (< 5 ms)
Option **L**: AC/DC 24 V	350 mA	27 A (< 5 ms)

Power supply failure

- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memoryor in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Electrical connection

Connecting the transmitter

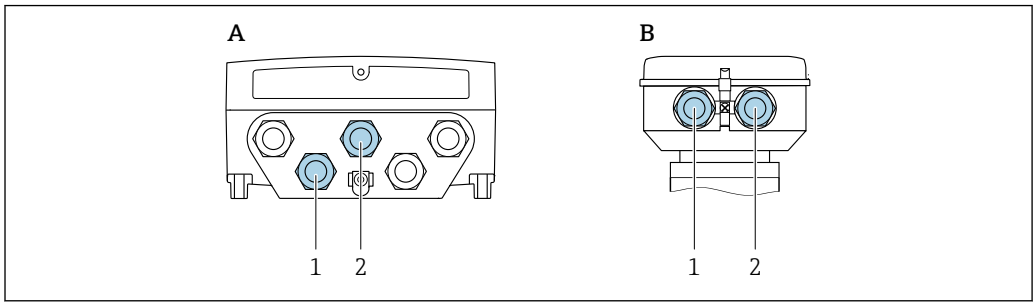


3 Supply voltage and signal transmission connection

A Compact version
B Remote version wall-mount housing
1 Cable entry for supply voltage
2 Cable entry for signal transmission
3 Cable entry for signal transmission

Remote version connection

Connecting cable



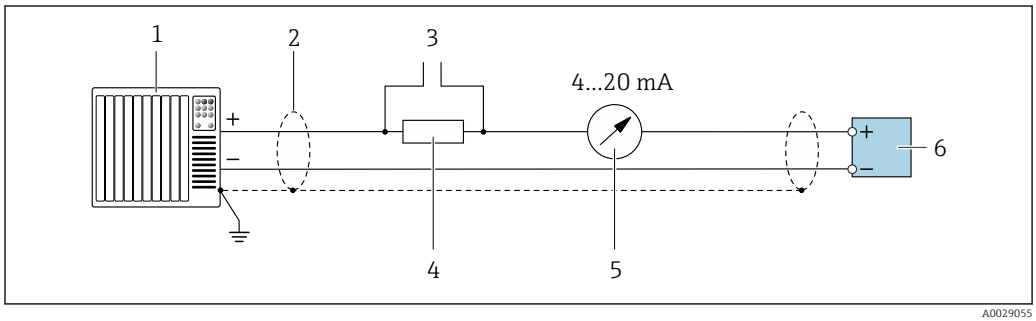
4 Connecting cable connection: electrode and coil current cable

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable

- Fix the cable run or route it in an armored conduit.
  Cable movements can influence the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between the sensor and transmitter → 27.

Connection examples

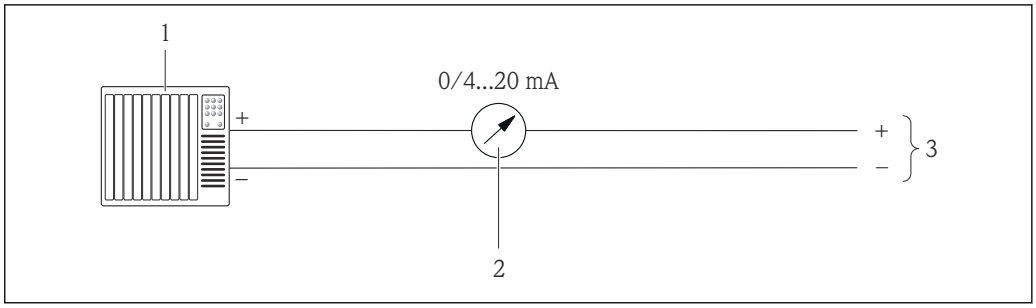
Current output 4 to 20 mA HART



5 Connection example for 4 to 20 mA HART current output (active)

1 Automation system with current input (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications → 31
3 Connection for HART operating devices → 95
4 Resistor for HART communication (≥ 250 Ω): observe maximum load → 13
5 Analog display unit: observe maximum load → 13
6 Transmitter

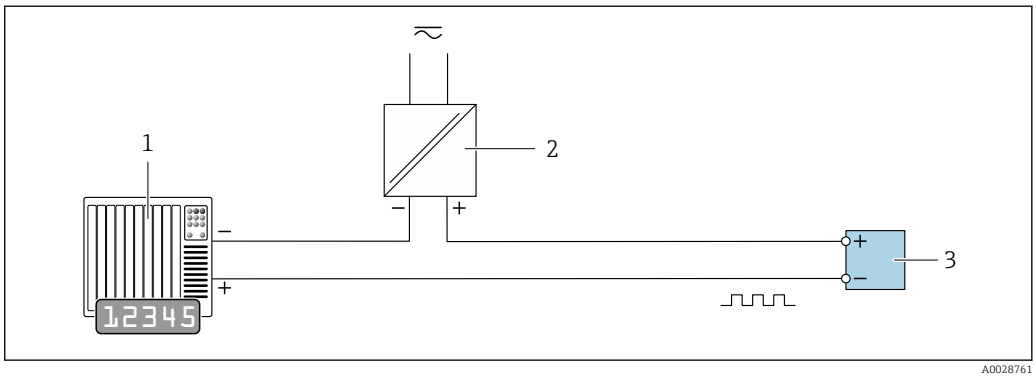
Current output 4 to 20 mA



6 Connection example for 0 to 20 mA (active) and 4 to 20 mA (active) current output

1 Automation system with current input (e.g. PLC)
2 Analog display unit: observe maximum load
3 Transmitter

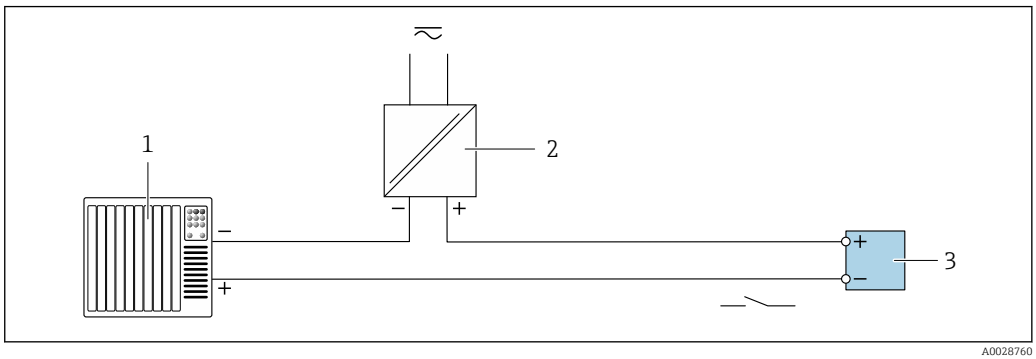
Pulse/frequency output



7 Connection example for pulse/frequency output (passive)

1 Automation system with pulse/frequency input (e.g. PLC)
2 Power supply
3 Transmitter: Observe input values → 14

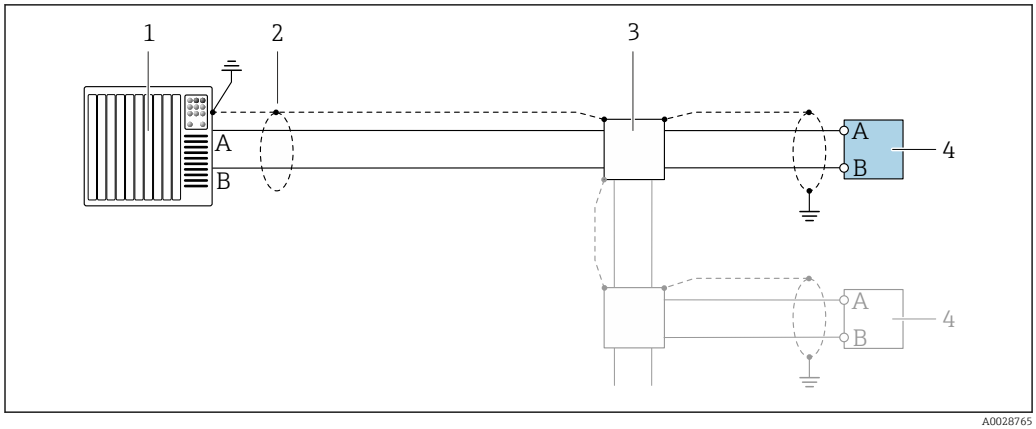
Switch output



8 Connection example for switch output (passive)

1 Automation system with switch input (e.g. PLC)
2 Power supply
3 Transmitter: Observe input values → 14

PROFIBUS DP

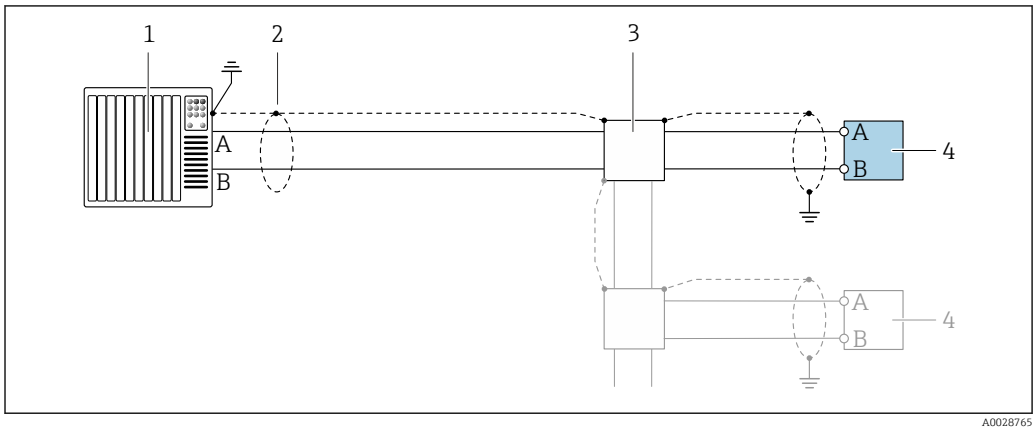


9 Connection example for PROFIBUS DP, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

If baud rates > 1.5 MBaud an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

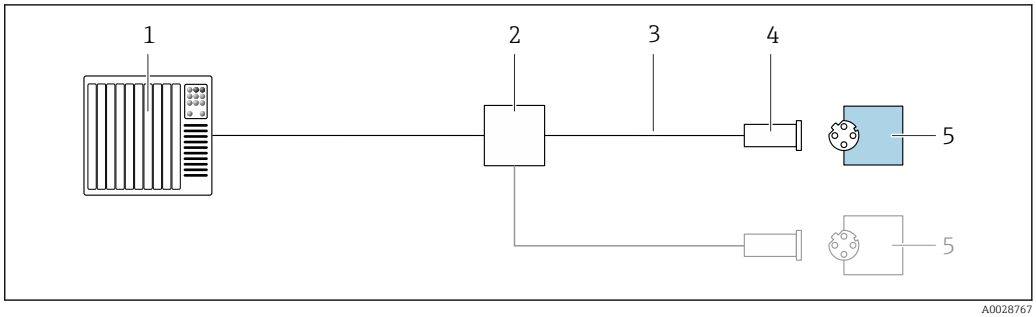
Modbus RS485



10 Connection example for Modbus RS485, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

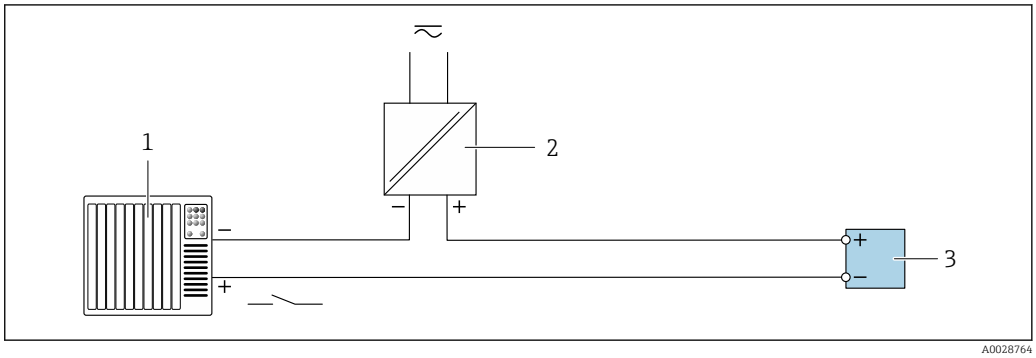
EtherNet/IP



11 Connection example for EtherNet/IP

1 Control system (e.g. PLC)
2 Ethernet switch
3 Observe cable specifications
4 Device plug
5 Transmitter

Status input



12 Connection example for status input

1 Automation system with status output (e.g. PLC)
2 Power supply
3 Transmitter

Potential equalization

Introduction

Correct potential equalization (equipotential bonding) is a prerequisite for stable and reliable flow measurement. Inadequate or incorrect potential equalization can result in device failure and present a safety hazard.

The following requirements must be observed to ensure correct, trouble-free measurement:
- The principle that the medium, the sensor and the transmitter must be at the same electrical potential applies.
- Take in-company grounding guidelines, materials and the grounding conditions and potential conditions of the pipe into consideration.
- Any necessary potential equalization connections must be established by ground cables with a minimum cross-section of 6 mm^2 (0.0093 in^2).
- For remote device versions, the ground terminal in the example always refers to the sensor and not to the transmitter.

You can order accessories like ground cables and ground disks from Endress+Hauser → 103

For devices intended for use in hazardous locations, observe the instructions in the Ex documentation (XA).

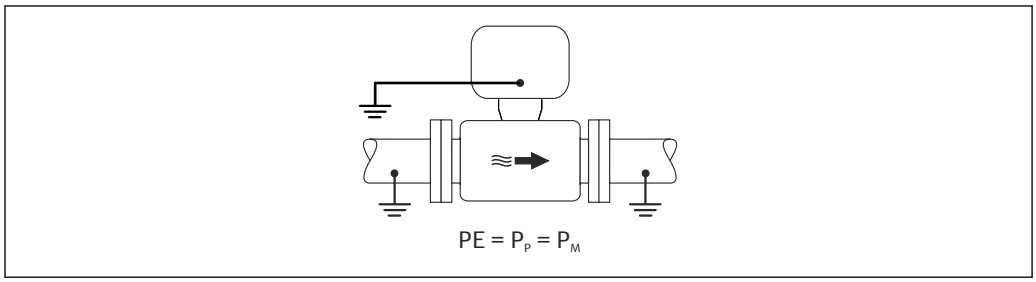
Abbreviations used
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

Connection examples for standard situations

Unlined and grounded metal pipe

- Potential equalization is via the measuring pipe.
- The medium is set to ground potential.

Starting conditions:
- Pipes are correctly grounded on both sides.
- Pipes are conductive and at the same electrical potential as the medium



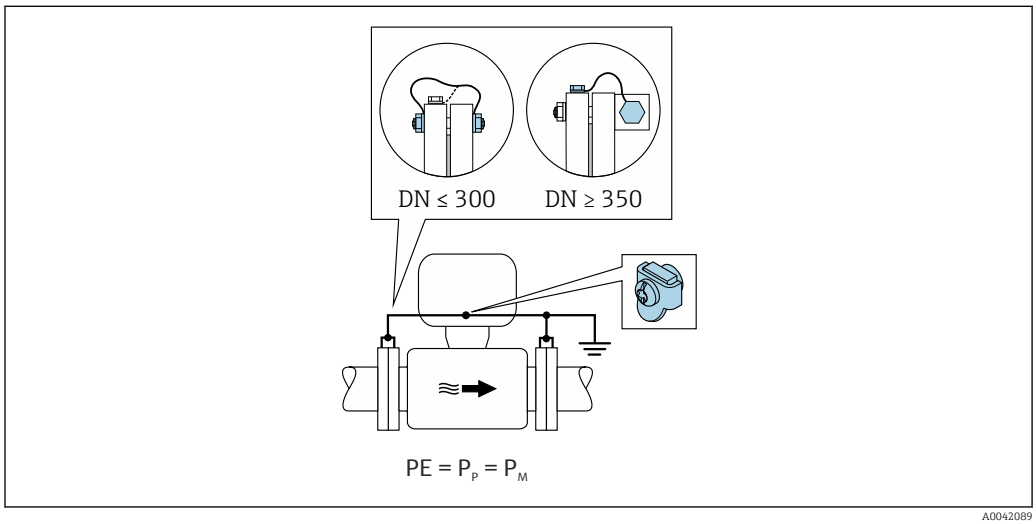
A0044854

▶ Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Unlined metal pipe

- Potential equalization is via the ground terminal and pipe flanges.
- The medium is set to ground potential.

Starting conditions:
- Pipes are not sufficiently grounded.
- Pipes are conductive and at the same electrical potential as the medium



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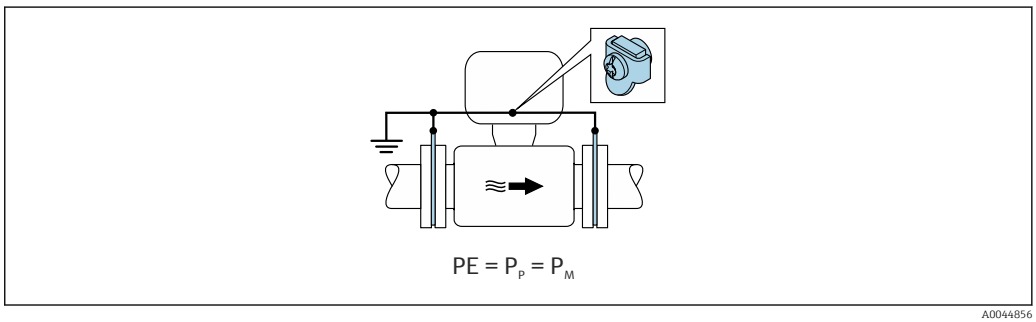
1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

- For DN ≤ 300 (12"): Mount the ground cable directly on the conductive flange coating of the sensor with the flange screws.
- For DN ≥ 350 (14"): Mount the ground cable directly on the metal transport bracket. Observe screw tightening torques: see the Brief Operating Instructions for the sensor.

Plastic pipe or pipe with insulating liner

- Potential equalization is via the ground terminal and ground disks.
- The medium is set to ground potential.

Starting conditions:
- The pipe has an insulating effect.
- Low-impedance medium grounding close to the sensor is not guaranteed.
- Equalizing currents through the medium cannot be ruled out.



A0044856

1. Connect the ground disks to the ground terminal of the connection housing of the transmitter or sensor via the ground cable.
2. Connect the connection to ground potential.

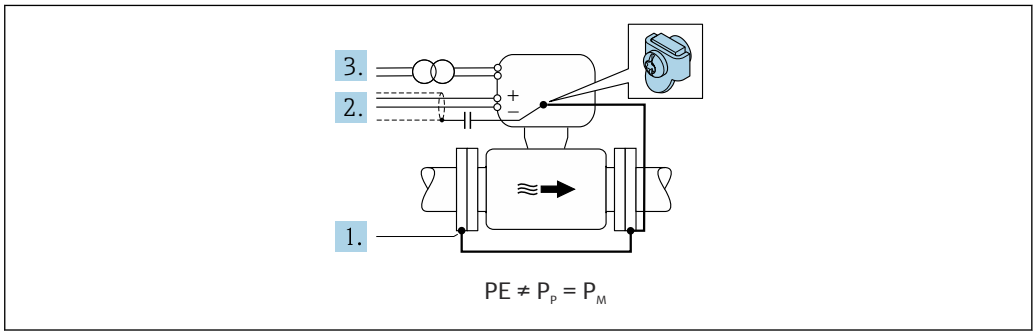
Connection example with the potential of the medium not equal to the protective ground

In these cases, the medium potential can differ from the potential of the device.

Metal, ungrounded pipe

The sensor and transmitter are installed in a way that provides electrical insulation from PE, e.g. applications for electrolytic processes or systems with cathodic protection.

Starting conditions:
- Unlined metal pipe
- Pipes with an electrically conductive liner



A0042253

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal lines via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).

Connection examples with the potential of medium not equal to protective earth with the "Measurement isolated from ground" option

In these cases, the medium potential can differ from the potential of the device.

Introduction

The "Measurement isolated from ground" option enables the galvanic isolation of the measuring system from the device potential. This minimizes harmful equalizing currents caused by differences

in potential between the medium and the device. The "Measurement isolated from ground" option is optionally available: order code for "Sensor option", option CV

Operating conditions for the use of the "Measurement isolated from ground" option

Device version	Compact version and remote version (length of connecting cable ≤ 10 m)
Differences in voltage between medium potential and device potential	As small as possible, usually in the mV range
Alternating voltage frequencies in the medium or at ground potential (PE)	Below typical power line frequency in the country

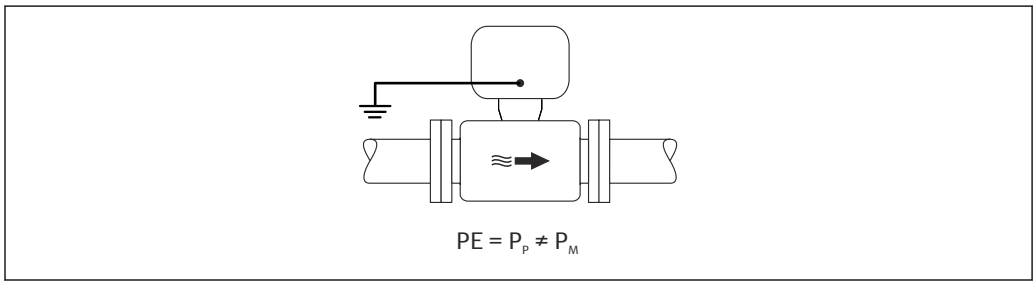
To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.

A full pipe adjustment is recommended when the device is installed.

Plastic pipe

Sensor and transmitter are correctly grounded. A difference in potential can occur between the medium and protective earth. Potential equalization between P_M and PE via the reference electrode is minimized with the "Measurement isolated from ground" option.

Starting conditions:
- The pipe has an insulating effect.
- Equalizing currents through the medium cannot be ruled out.



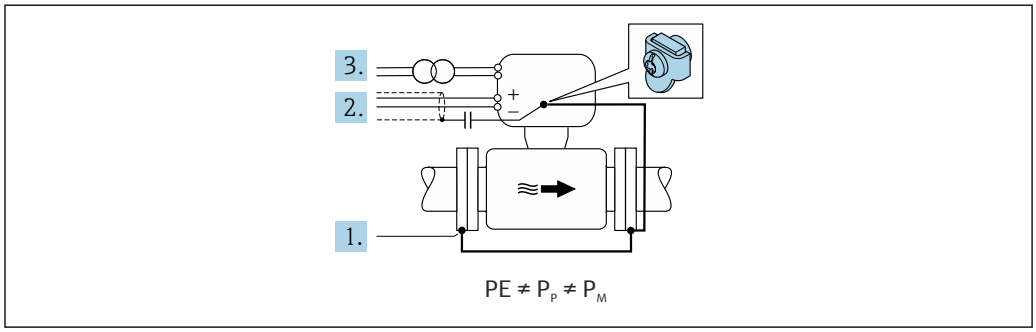
A0044855

1. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Metal, ungrounded pipe with insulating liner

The sensor and transmitter are installed in a way that provides electrical insulation from PE. The medium and pipe have different potentials. The "Measurement isolated from ground" option minimizes harmful equalizing currents between P_M and P_P via the reference electrode.

Starting conditions:
- Metal pipe with insulating liner
- Equalizing currents through the medium cannot be ruled out.



A0044857

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal cables via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).
4. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.

Terminals

Transmitter
- Supply voltage cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Signal cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Electrode cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Coil current cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Sensor connection housing
Spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Cable entries

Cable entry thread
- M20 x 1.5
- Via adapter:
  - NPT ½"
  - G ½"

Cable gland
- For standard cable: M20 × 1.5 with cable Φ 6 to 12 mm (0.24 to 0.47 in)
- For armored cable: M20 × 1.5 with cable Φ 9.5 to 16 mm (0.37 to 0.63 in)

If metal cable entries are used, use a grounding plate.

Cable specification

Permitted temperature range
- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Signal cable

Current output 0/4 to 20 mA

Standard installation cable is sufficient.

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Status input

Standard installation cable is sufficient.

PROFIBUS DP

The IEC 61158 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)

Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

For further information on planning and installing PROFIBUS networks see:
Operating Instructions "PROFIBUS DP/PA: Guidelines for planning and commissioning" (BA00034S)

Modbus RS485

The EIA/TIA-485 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)
Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

EtherNet/IP

The standard ANSI/TIA/EIA-568-B.2 Annex specifies CAT 5 as the minimum category for a cable used for EtherNet/IP. CAT 5e and CAT 6 are recommended.

For more information on planning and installing EtherNet/IP networks, please refer to the "Media Planning and Installation Manual. EtherNet/IP" of ODVA Organization

Connecting cable for remote version

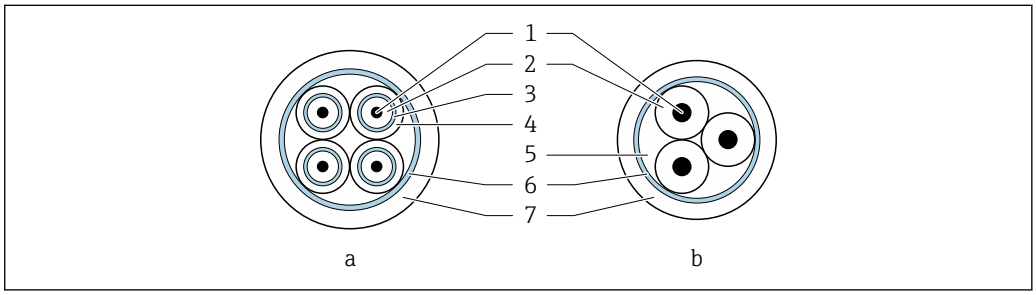
Electrode cable

Standard cable	3 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Cable for empty pipe detection (EPD)	4 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Conductor resistance	≤50 Ω/km (0.015 Ω/ft)
Capacitance: core/shield	≤420 pF/m (128 pF/ft)
Operating temperature	–20 to +80 °C (–4 to +176 °F)

Coil current cable

Standard cable	3 ×0.75 mm² (18 AWG) with common, braided copper shield (ϕ ~9 mm (0.35 in))
Conductor resistance	≤37 Ω/km (0.011 Ω/ft)
Capacitance: core/core, shield grounded	≤120 pF/m (37 pF/ft)

Operating temperature	–20 to +80 °C (–4 to +176 °F)
Test voltage for cable insulation	≤ AC 1433 V rms 50/60 Hz or ≥ DC 2026 V



13 *Cable cross-section*

a Electrode cable
b Coil current cable
1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

A connecting cable can be ordered from Endress+Hauser for IP68:
- Pre-terminated cables that are already connected to the sensor
- Pre-terminated cables, where the cables are connected by the customer onsite (incl. tools for sealing the connection compartment)

Armored connecting cable

Armored connecting cables with an additional, reinforcing metal braid should be used:
- When laying the cable directly in the ground
- Where there is a risk of damage from rodents
- Use as per IP68 degree of protection

Armored connecting cables with an additional, reinforcing metal braid can be ordered from Endress+Hauser → 103.

Operation in environments with strong electrical interference

The measuring system meets the general safety requirements → 102 and EMC specifications → 48.

Grounding is by means of the ground terminal provided for the purpose inside the connection housing. The stripped and twisted lengths of cable shield to the ground terminal must be as short as possible.

Performance characteristics

Reference operating conditions

- Error limits following DIN EN 29104, in future ISO 20456
- Water, typically +15 to +45 °C (+59 to +113 °F); 0.5 to 7 bar (73 to 101 psi)
- Data as indicated in the calibration protocol
- Accuracy based on accredited calibration rigs according to ISO 17025

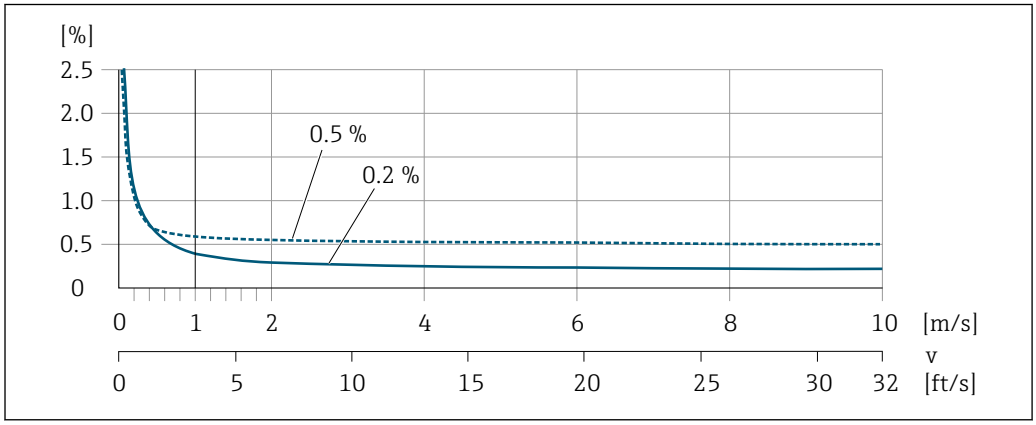
Maximum measured error

Error limits under reference operating conditions

Volume flow

- ±0.5 % o.r. ± 1 mm/s (0.04 in/s)
- Optional: ±0.2 % o.r. ± 2 mm/s (0.08 in/s)

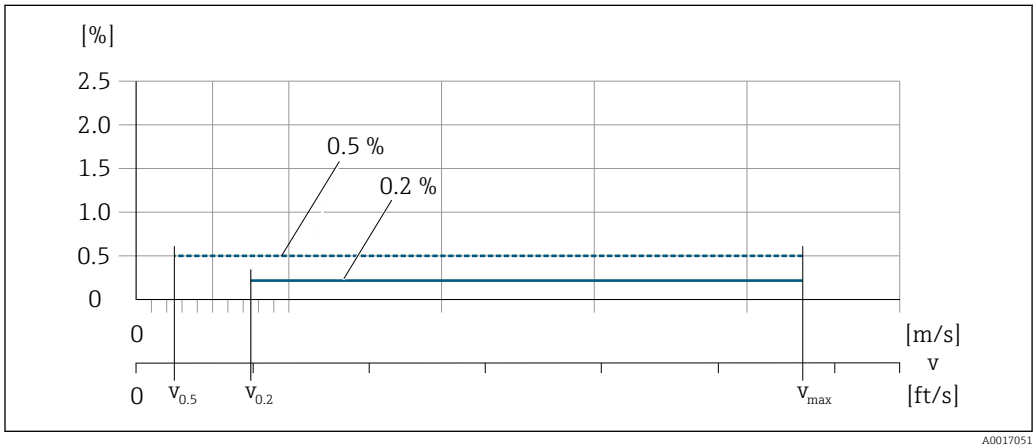
Fluctuations in the supply voltage do not have any effect within the specified range.



14 *Maximum measured error in % o.r.*

Flat Spec

For Flat Spec in the range $v_{0.5}$ ($v_{0.2}$) up to v_{max} the measured error is constant.



15 *Flat Spec in % o.r.*

Flat Spec flow values 0.5 %

Nominal diameter		$v_{0.5}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	0.5	1.64	10	32
50 to 300 [1)]	2 to 12	0.25	0.82	5	16

1) Order code for "Design", option C

Flat Spec flow values 0.2 %

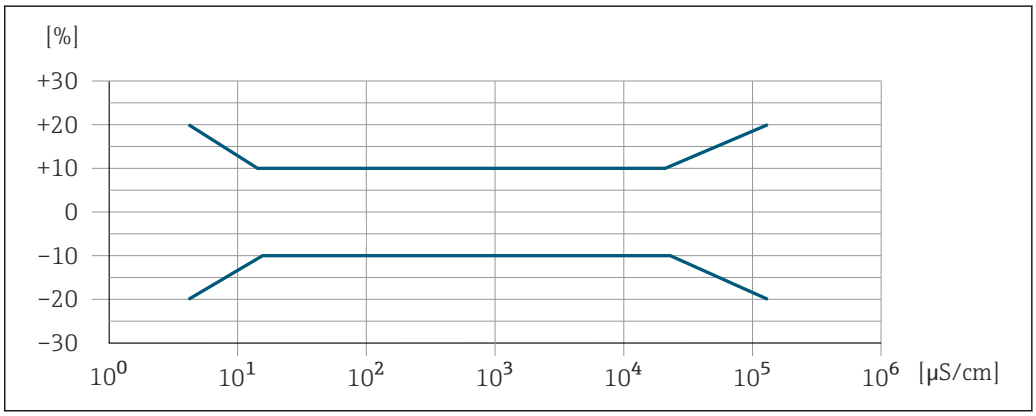
Nominal diameter		$v_{0.2}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	1.5	4.92	10	32
50 to 300 [1)]	2 to 12	0.6	1.97	4	13

1) Order code for "Design", option C

Electrical conductivity

The values apply for:
- Measurements at a reference temperature of 25 °C (77 °F)
  At different temperatures, attention must be paid to the temperature coefficient of the medium (typically 2.1 %/K)
- Device version: compact version - transmitter and sensor form a mechanical unit
- Devices installed in a metal pipe or in a non-metal pipe with ground disks
- Devices whose potential equalization was performed according to the instructions in the associated Operating Instructions

Conductivity [µS/cm]	Measured error [%] o. r.
5 to 20	± 20%
20 to 20 000	± 10%
20 000 to 100 000	± 20%



16 Measured error

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	Max. ±5 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±50 ppm o.r. (over the entire ambient temperature range)

Repeatability

o.r. = of reading

Volume flow
max. ±0.1 % o.r. ± 0.5 mm/s (0.02 in/s)

Electrical conductivity
Max. ±5 % o.r.

Influence of ambient temperature

Current output

o.r. = of reading

Temperature coefficient	Max. ±0.005 % o.r./°C

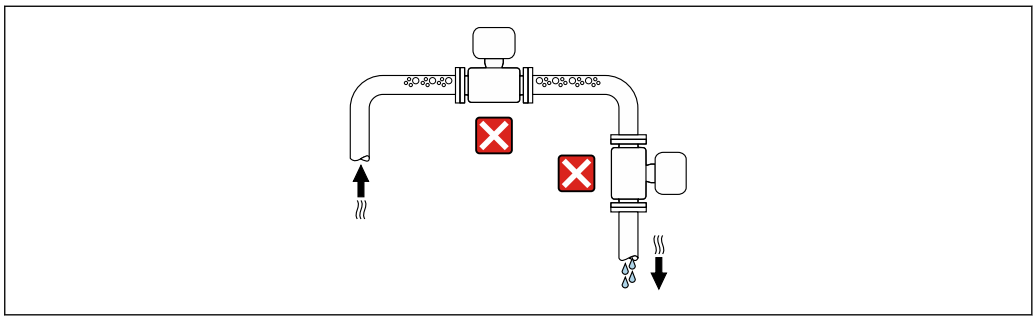
Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

Installation

Mounting location

- Do not install the device at the highest point of the pipe.
- Do not install the device upstream from a free pipe outlet in a down pipe.



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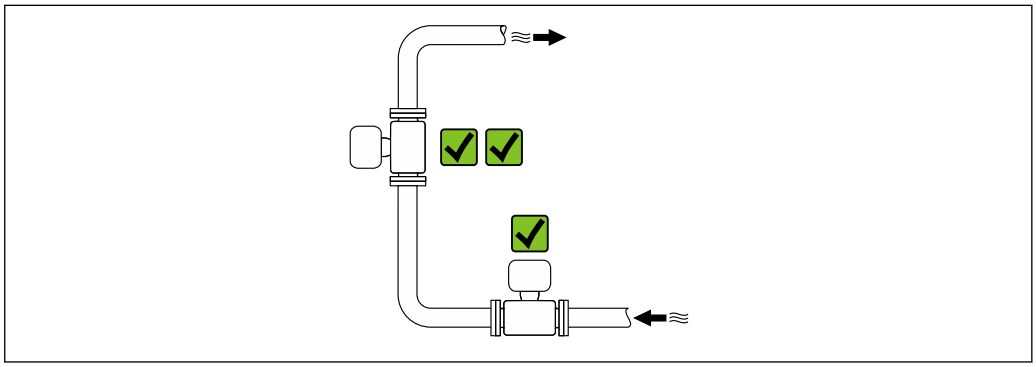
The device should ideally be installed in an ascending pipe.



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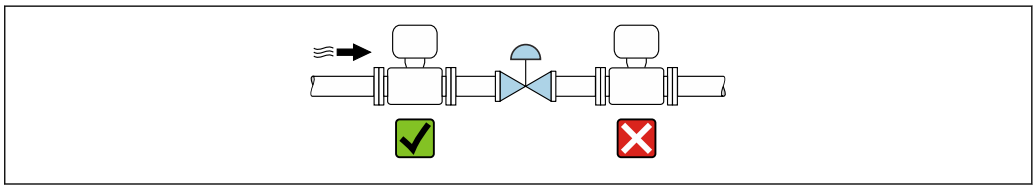
Installation near valves

Install the device in the direction of flow upstream from the valve.



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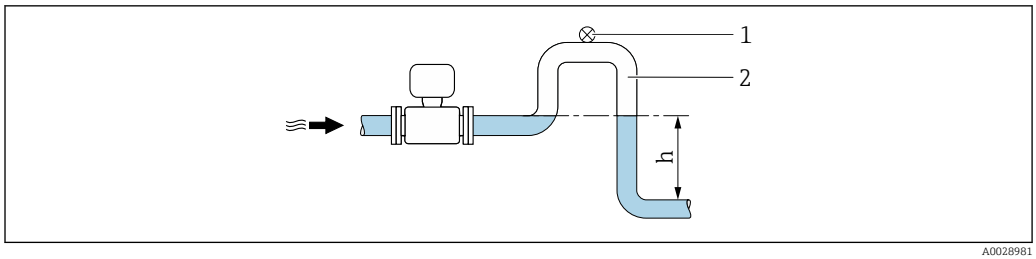
Installation upstream from a down pipe

NOTICE

Negative pressure in the measuring pipe can damage the liner!

▶ If installing upstream from down pipes with a length h ≥ 5 m (16.4 ft), install a siphon with a vent valve downstream from the device.

This arrangement prevents the stoppage of liquid flow and the formation of air pockets.

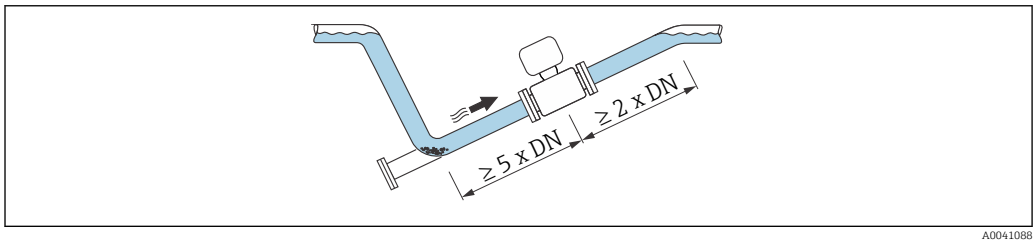


A0028981

1 Vent valve
2 Pipe siphon
h Length of down pipe

Installation with partially filled pipes

- Partially filled pipes with a gradient require a drain-type configuration.
- The installation of a cleaning valve is recommended.



A0041088

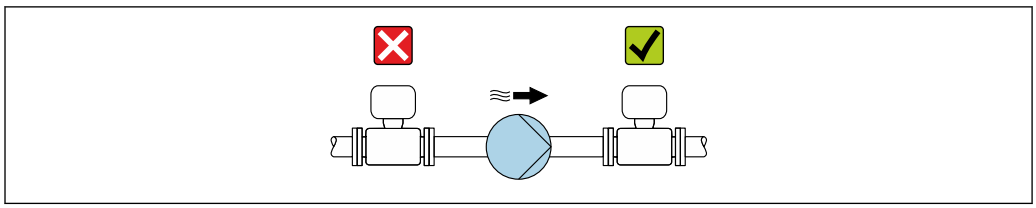
No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

Installation near pumps

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- ▶ In order to maintain the system pressure, install the device in the flow direction downstream from the pump.
- ▶ Install pulsation dampers if reciprocating, diaphragm or peristaltic pumps are used.



A0041083

- Information on the liner's resistance to partial vacuum → 51
- Information on the measuring system's resistance to vibration and shock → 47

Installation of very heavy devices

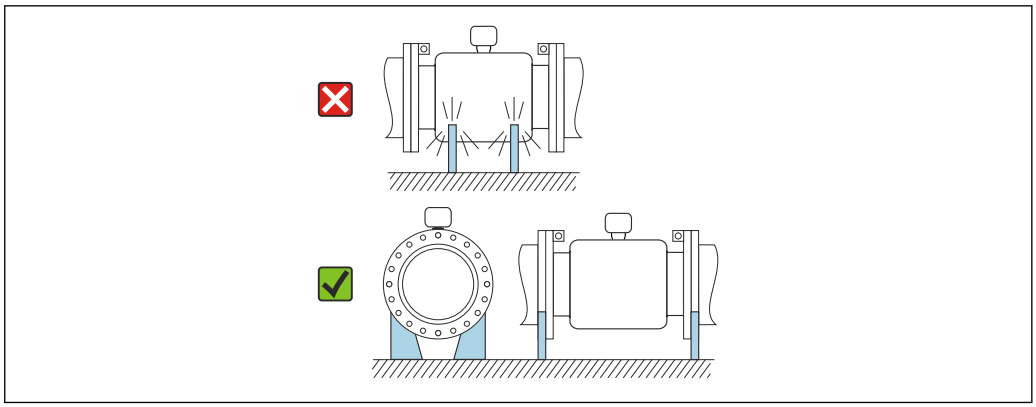
Support required for nominal diameters of DN ≥ 350 mm (14 in).

NOTICE

Damage to the device!

If incorrect support is provided, the sensor housing could buckle and the internal magnetic coils could be damaged.

- ▶ Only provide supports at the pipe flanges.



A0041087

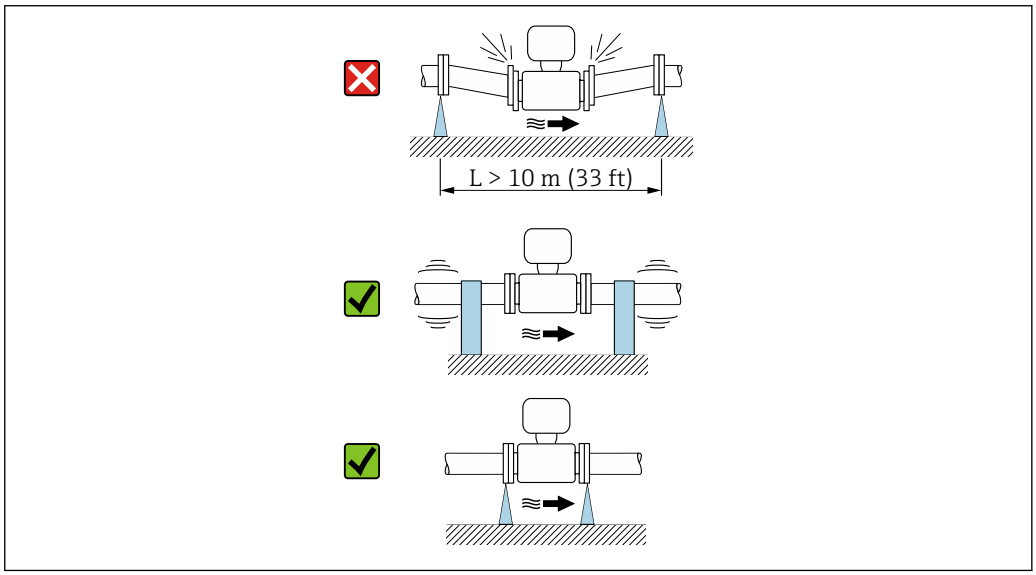
Installation in event of pipe vibrations

A remote version is recommended in the event of strong pipe vibrations.

NOTICE

Pipe vibrations can damage the device!

- Do not expose the device to strong vibrations.
- Support the pipe and fix it in place.
- Support the device and fix it in place.
- Mount the sensor and transmitter separately.

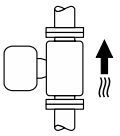
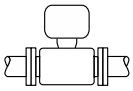
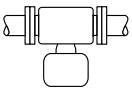
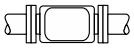


A0041092

Information on the measuring system's resistance to vibration and shock → 47

Orientation

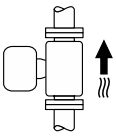
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

Orientation		Recommendation
Vertical orientation	 A0015591	✓✓
Horizontal orientation, transmitter at top	 A0015589	✓✓ 1)
Horizontal orientation, transmitter at bottom	 A0015590	✓✓ 2) 3) ✗ 4)
Horizontal orientation, transmitter at side	 A0015592	✗

1) Applications with low process temperatures may decrease the ambient temperature. To maintain the minimum ambient temperature for the transmitter, this orientation is recommended.
2) Applications with high process temperatures may increase the ambient temperature. To maintain the maximum ambient temperature for the transmitter, this orientation is recommended.
3) To prevent the electronics module from overheating in the case of a sharp rise in temperature (e.g. CIP or SIP processes), install the device with the transmitter component pointing downwards.
4) With the empty pipe detection function switched on: empty pipe detection only works if the transmitter housing is pointing upwards.

Vertical

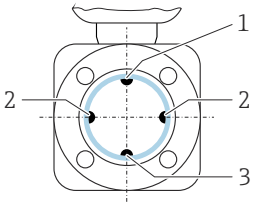
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



A0015591

Horizontal

- Ideally, the measuring electrode plane should be horizontal. This prevents brief insulation of the measuring electrodes by entrained air bubbles.
- Empty pipe detection only works if the transmitter housing is pointing upwards as otherwise there is no guarantee that the empty pipe detection function will actually respond to a partially filled or empty measuring tube.



A0029344

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Inlet and outlet runs

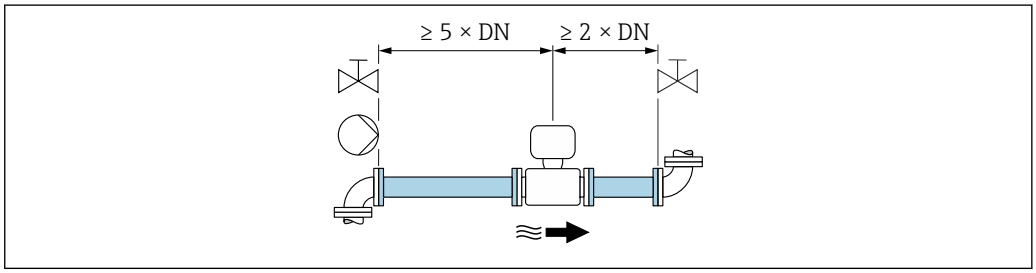
Installation with inlet and outlet runs

Installation requires inlet and outlet runs: devices with the order code for "Design", option D, E, F and G.

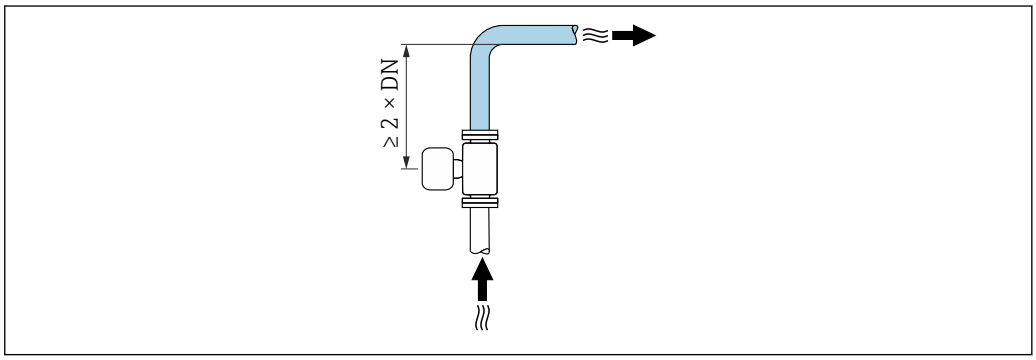
Installation with elbows, pumps or valves

To avoid a vacuum and to maintain the specified level of accuracy, install the device upstream from assemblies that produce turbulence (e.g. valves, T-sections) and downstream from pumps, wherever possible.

Maintain straight, unimpeded inlet and outlet runs.



A0028997



A0042132

Installation without inlet and outlet runs

Depending on the device design and installation location, the inlet and outlet runs can be reduced or omitted entirely.

Maximum measured error
When the device is installed with the inlet and outlet runs described, a maximum measured error of ±0.5 % of the reading ±1 mm/s (0.04 in/s) can be guaranteed.

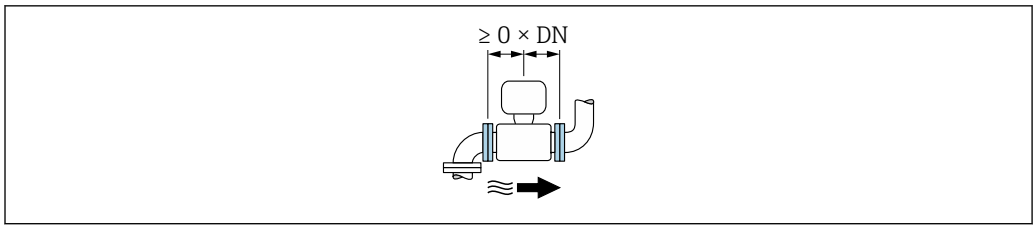
Devices and possible order options

Order code for "Design"		
Option	**Description**	**Design**
C	Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs	Constricted measuring tube [1]
H	Lap joint flange, 0 x DN inlet/outlet runs	Full Bore [2]
I	Fixed flange, 0 x DN inlet/outlet runs	
J	Fixed flange, short installed length, 0 x DN inlet/ outlet runs	
K	Fixed flange, long installed length, 0 x DN inlet/ outlet runs	

1) "Constricted measuring tube" stands for a reduction of the internal diameter of the measuring tube. The reduced internal diameter causes a higher flow velocity inside the measuring tube.
2) "Full Bore" stands for the full diameter of the measuring tube. There is no pressure loss with a full diameter.

Installation before or after bends

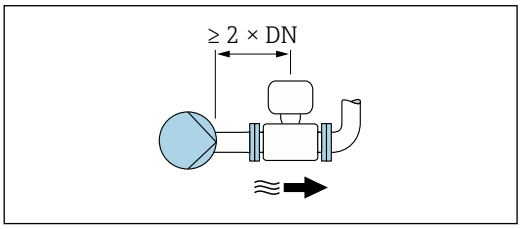
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

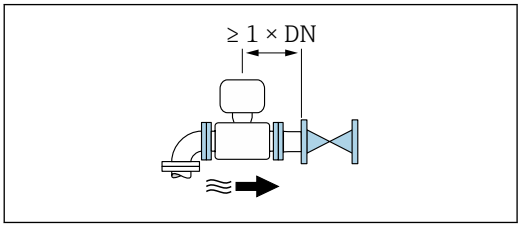
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

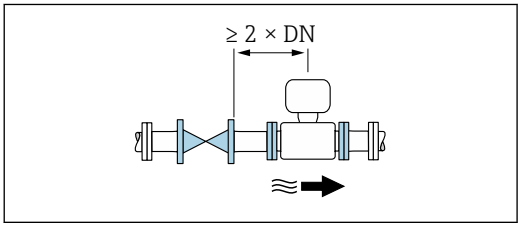
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



Installation downstream of valves

Installation without inlet and outlet runs is possible if the valve is 100% open during operation: devices with the order code for "Design", option C, H and I.

In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration if the valve is 100% open during operation.



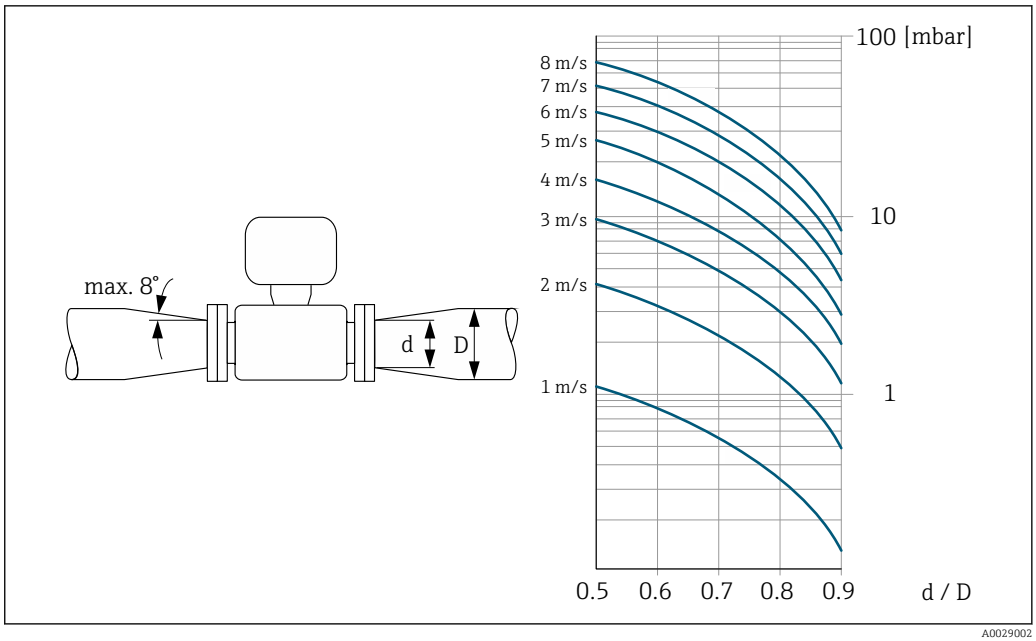
Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids.

The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders:

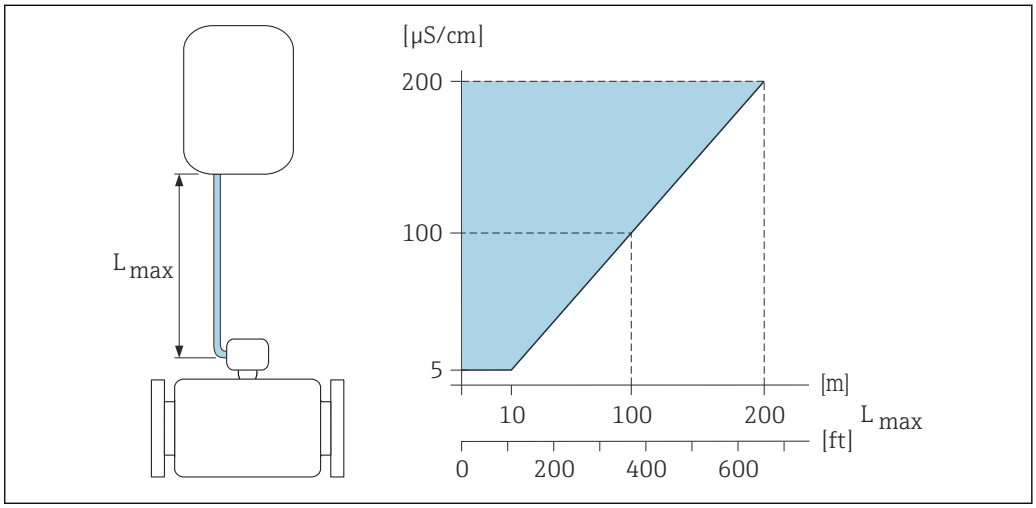
- Calculate the ratio of the diameters d/D.
- From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

The nomogram only applies to liquids with a viscosity similar to that of water.



Length of connecting cable

To obtain correct measurement results, observe the permitted connecting cable length of L_{max}. This length is determined by the conductivity of the fluid. If measuring liquids in general: 5 µS/cm



17 *Permitted length of connecting cable*

Colored area = permitted range
L_{max} = length of connecting cable in [m] ([ft])
[µS/cm] = fluid conductivity

Special mounting instructions

Display guard

To ensure that the optional display guard can be easily opened, maintain the following minimum head clearance: 350 mm (13.8 in)

Immersion in water

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

▶ Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

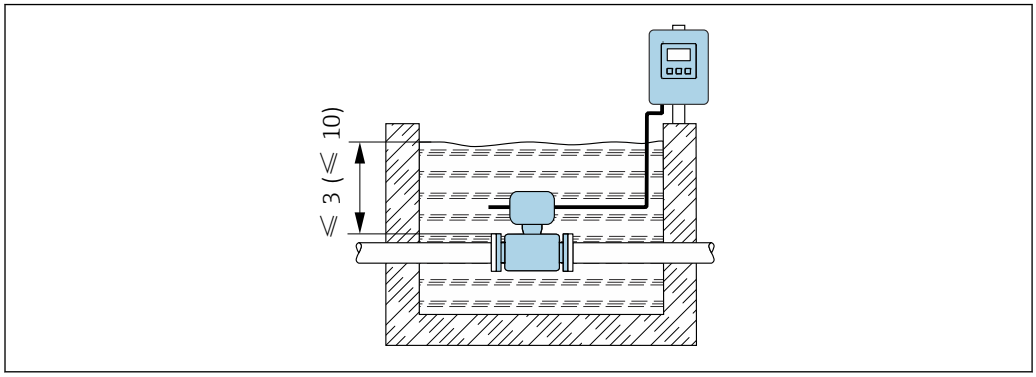
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof "

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



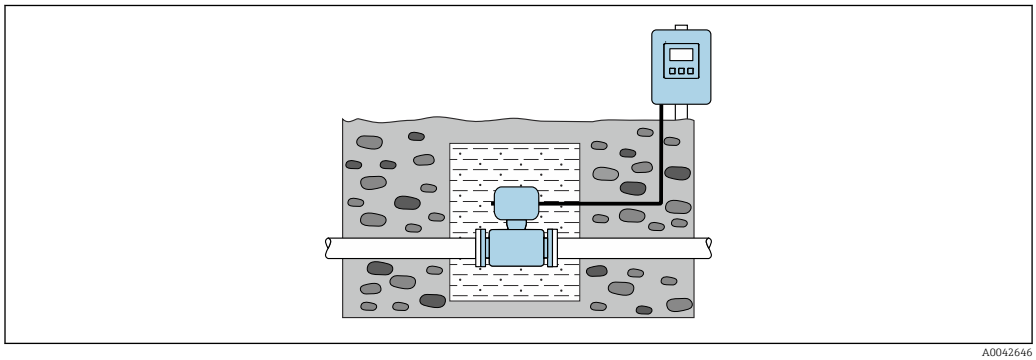
A0042412

Use in buried applications

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

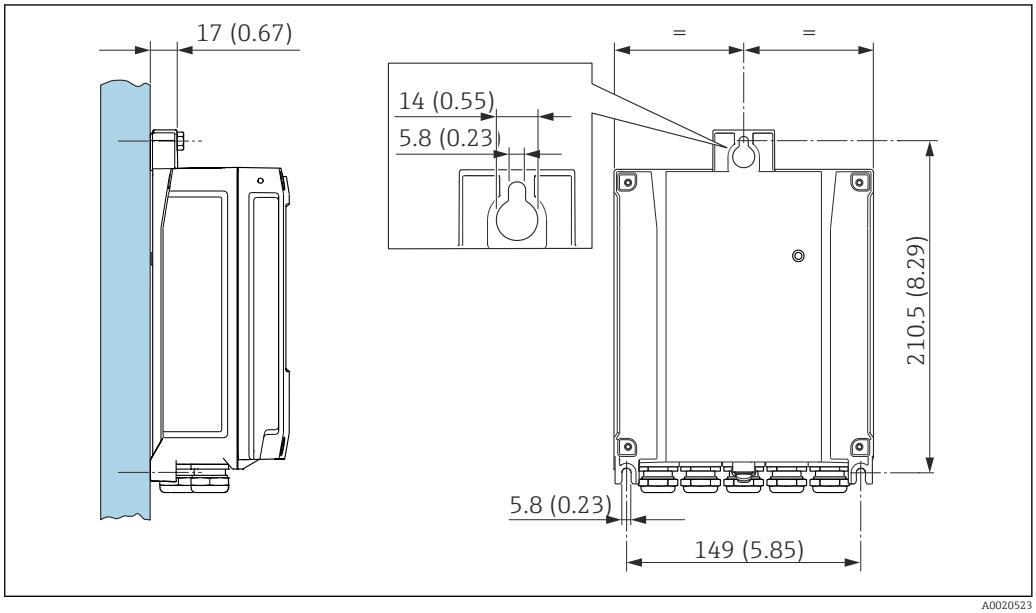
For the use of the device in buried applications.



A0042646

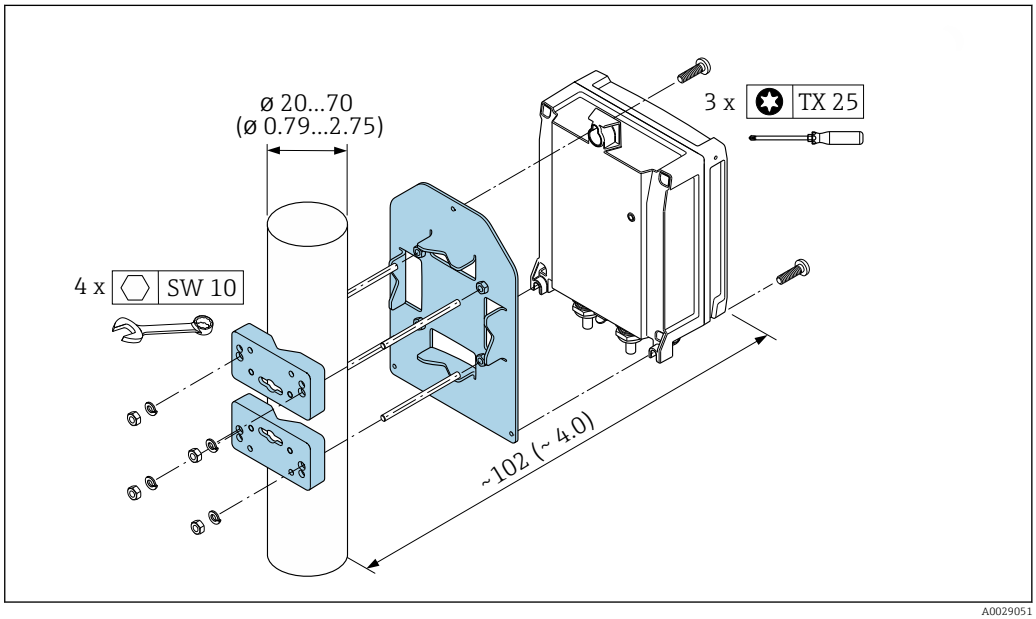
Mounting the transmitter housing

Wall mounting



18 *Engineering unit mm (in)*

Post mounting



19 *Engineering unit mm (in)*

Environment

Ambient temperature range

Transmitter	−40 to +60 °C (−40 to +140 °F)
Local display	−20 to +60 °C (−4 to +140 °F), the legibility of the local display may be impaired at temperatures outside the temperature range.

Sensor	▪ Process connection material, carbon steel: −10 to +60 °C (+14 to +140 °F) ▪ Process connection material, stainless steel: −40 to +60 °C (−40 to +140 °F) If both the ambient and the medium temperatures are high, mount the sensor separately from the transmitter.
Liner	Do not exceed or fall below the permitted temperature range of the liner → 🖹 48.

If operating outdoors:
- Install the measuring device in a shady location.
- Avoid direct sunlight, particularly in warm climatic regions.
- Avoid direct exposure to weather conditions.
- If the compact version of the device is insulated at low temperatures, the insulation must also include the device neck.
- Protect the display against impact.
- Protect the display from abrasion, e.g. caused by sand in desert areas.

Display guard available as an accessory → 🖹 103.

Temperature tables

Observe the interdependencies between the permitted ambient and fluid temperatures when operating the device in hazardous areas.

For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.

Storage temperature

The storage temperature corresponds to the operating temperature range of the transmitter and the sensor → 🖹 45.

- Protect the measuring device against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Select a storage location where moisture cannot collect in the measuring device as fungus or bacteria infestation can damage the liner.
- If protection caps or protective covers are mounted these should never be removed before installing the measuring device.

Atmosphere

If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing.

In cases of doubt, please contact the Sales Center.

Degree of protection

Transmitter

- IP66/67, type 4X enclosure
- When housing is open: IP20, type 1 enclosure
- Display module: IP20, type 1 enclosure

Sensor

Compact and remote version

IP66/67, type 4X enclosure

Optionally available for compact and remote version:

Order code for "Sensor option", option CA, C3
- IP66/67, type 4X enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M
- For the operation of the device in corrosive environments

Optionally available for remote version:

Order code for "Sensor option", option CB, CC
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M/Im1 and EN 60529
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ
- IP68, type 6P, temporarily waterproof
- Sensor with aluminum half-shell housing
- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", option CD, CE
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 Im2/Im3 and EN 60529
- For the operation of the device in buried applications
- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Vibration- and shock-resistance

Sinusoidal vibration according to IEC 60068-2-6

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 2 to 8.4 Hz, 3.5 mm peak
- 8.4 to 2 000 Hz, 1 g peak

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 10 to 200 Hz, 0.003 g^2/Hz
- 200 to 2 000 Hz, 0.001 g^2/Hz
- Total: 1.54 g rms

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Shock half-sine, according to IEC 60068-2-27

- Compact version; order code for "Housing", option A "Compact, aluminum, coated"
  6 ms 30 g
- Compact version; order code for "Housing", option M "Compact, polycarbonate"
  6 ms 50 g
- Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
  6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Mechanical load

- Protect the transmitter housing against mechanical effects, such as shock or impact; the use of the remote version is sometimes preferable.
- Never use the transmitter housing as a ladder or climbing aid.

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)
- Complies with emission limits for industry as per EN 55011 (Class A)
- Device version with PROFIBUS DP: Complies with emission limits for industry as per EN 50170 Volume 2, IEC 61784

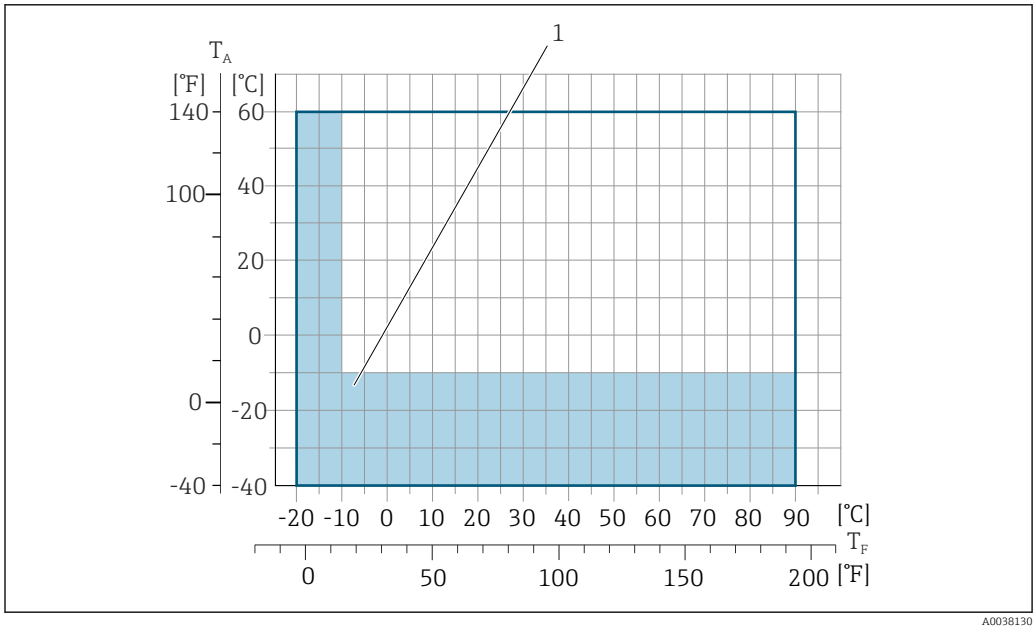
The following applies for PROFIBUS DP: If baud rates > 1.5 MBaud, an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

Details are provided in the Declaration of Conformity.

Process

Medium temperature range

- 0 to +80 °C (+32 to +176 °F) for hard rubber, DN 50 to 3000 (2 to 120")
- −20 to +50 °C (−4 to +122 °F) for polyurethane, DN 25 to 1200 (1 to 48")
- −20 to +90 °C (−4 to +194 °F) for PTFE, DN 25 to 300 (1 to 12")



T_A *Ambient temperature*
T_F *Medium temperature*
1 *Colored area: The ambient temperature range of −10 to −40 °C (+14 to −40 °F) and the medium temperature range of −10 to −20 °C (+14 to −4 °F) only apply for stainless flanges*

The permitted fluid temperature in custody transfer is 0 to +50 °C (+32 to +122 °F).

Conductivity

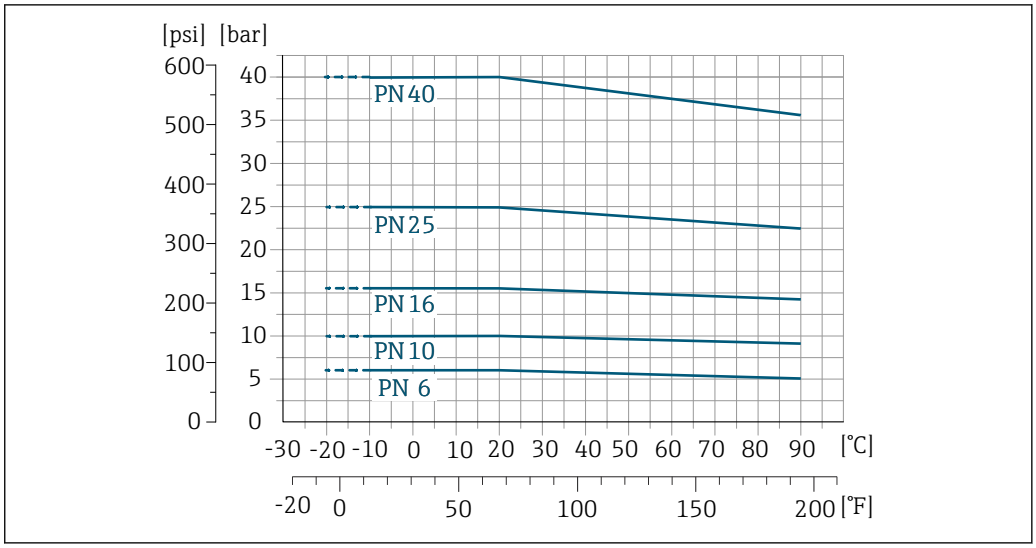
≥5 µS/cm for liquids in general.

- Note that in the case of the remote version, the requisite minimum conductivity additionally depends on the length of the connecting cable → 43.
- Maximum measured error for electrical conductivity → 35.

Pressure/temperature ratings

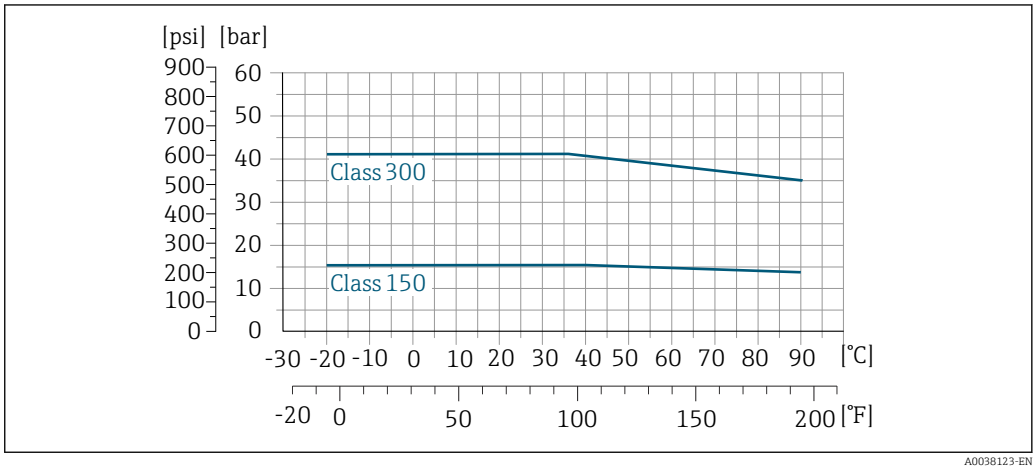
The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

Process connection: fixed flange according to EN 1092-1 (DIN 2501)

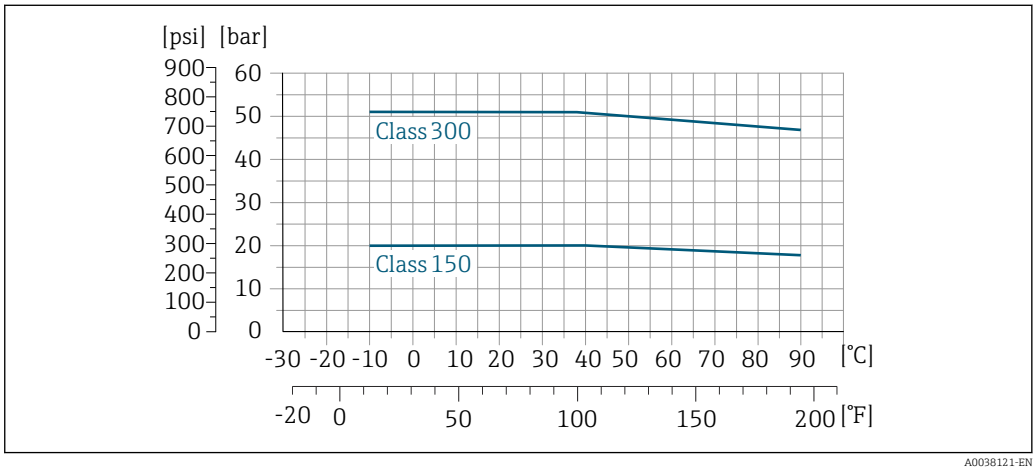


20 *Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))*

Process connection: fixed flange according to ASME B16.5

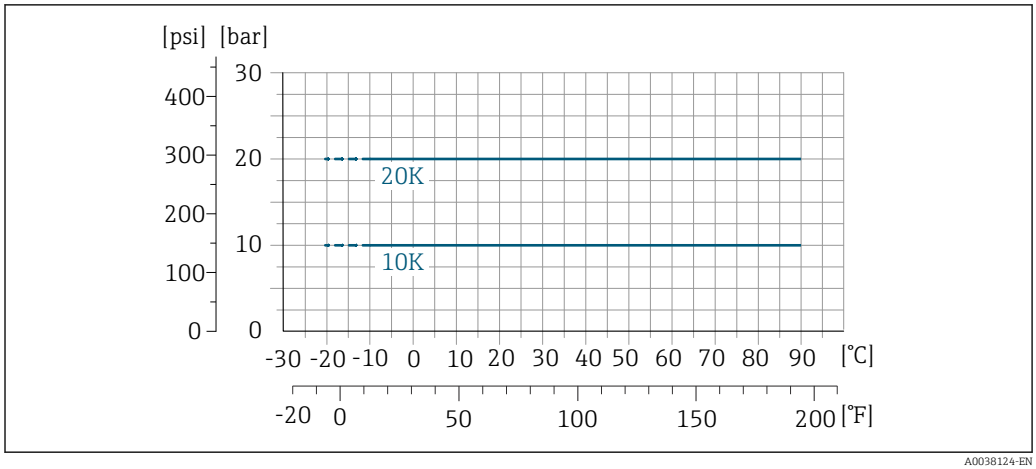


21 *Process connection material: stainless steel*



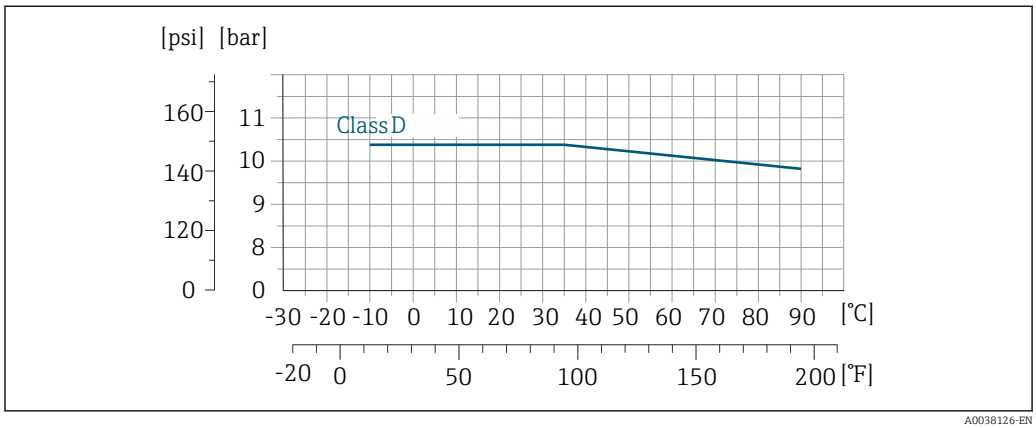
22 *Process connection material: carbon steel*

Process connection: fixed flange according to JIS B2220



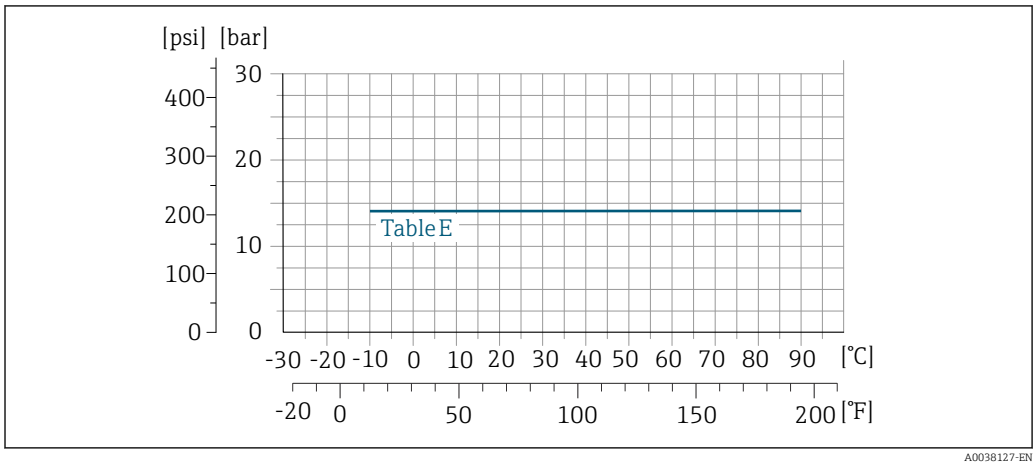
23 Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))

Process connection: fixed flange according to AWWA C207



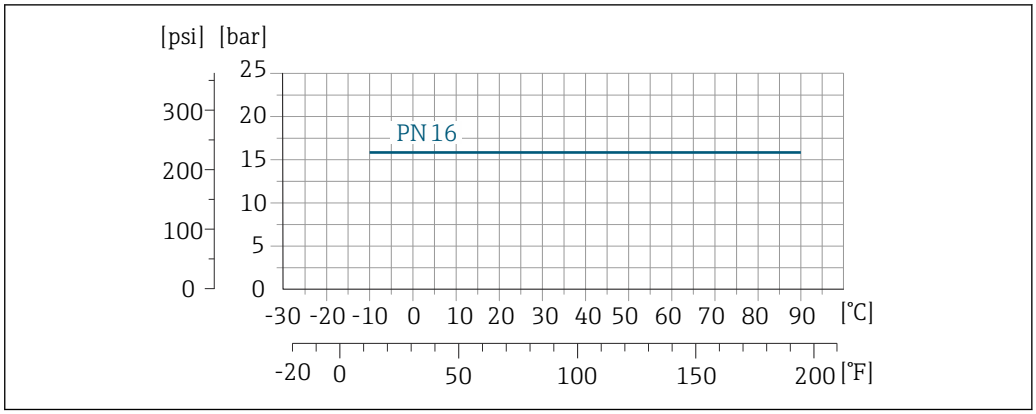
24 Process connection material: carbon steel

Process connection: fixed flange according to AS 2129



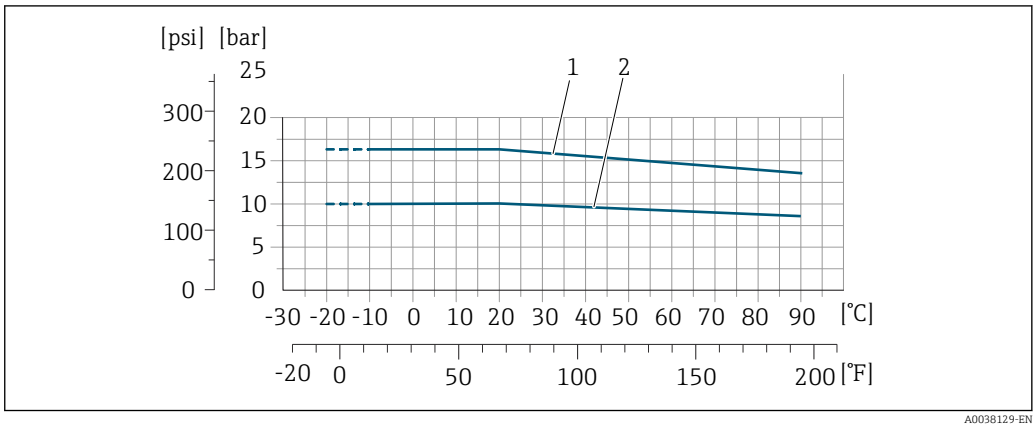
25 Process connection material: carbon steel

Process connection: fixed flange according to AS 4087



26 Process connection material: carbon steel

Process connection: lap joint flange/lap joint flange, stamped plate according to EN 1092-1 (DIN 2501) and ASME B16.5; DN 25 to 300 (1 to 12")



27 Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))

1 Lap joint flange PN16/ Class150
2 Lap joint flange, stamped plate PN10, lap joint flange PN10

Pressure tightness

Liner: hard rubber

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:		
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)	+80 °C (+176 °F)
50 … 3000	2 … 120	0 (0)	0 (0)	0 (0)

Liner: polyurethane

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)
25 … 1200	1 … 48	0 (0)	0 (0)

Liner: PTFE

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
25	1	0 (0)	0 (0)
40	2	0 (0)	0 (0)

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
50	2	0 (0)	0 (0)
65	2 ½	0 (0)	40 (0.58)
80	3	0 (0)	40 (0.58)
100	4	0 (0)	135 (2.0)
125	5	135 (2.0)	240 (3.5)
150	6	135 (2.0)	240 (3.5)
200	8	200 (2.9)	290 (4.2)
250	10	330 (4.8)	400 (5.8)
300	12	400 (5.8)	500 (7.3)

Flow limit

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 to 3 m/s (6.56 to 9.84 ft/s). Also match the velocity of flow (v) to the physical properties of the medium:
- v < 2 m/s (6.56 ft/s): for abrasive media (e.g. potter's clay, lime milk, ore slurry)
- v > 2 m/s (6.56 ft/s): for media producing buildup (e.g. wastewater sludge)

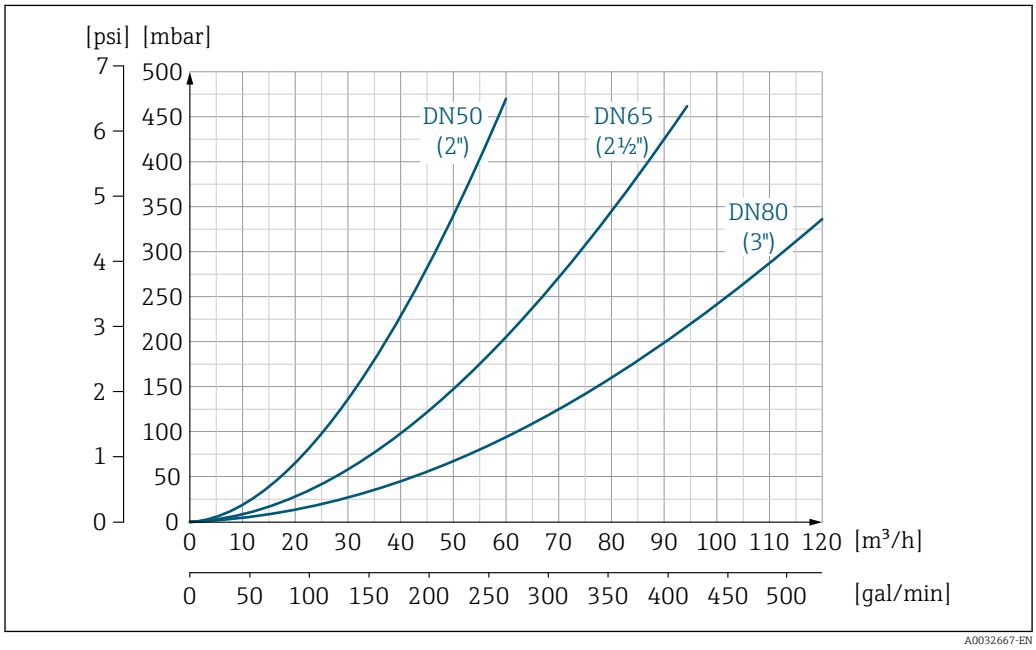
A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter.

For an overview of the full scale values for the measuring range, see the "Measuring range" section → 🖹 8

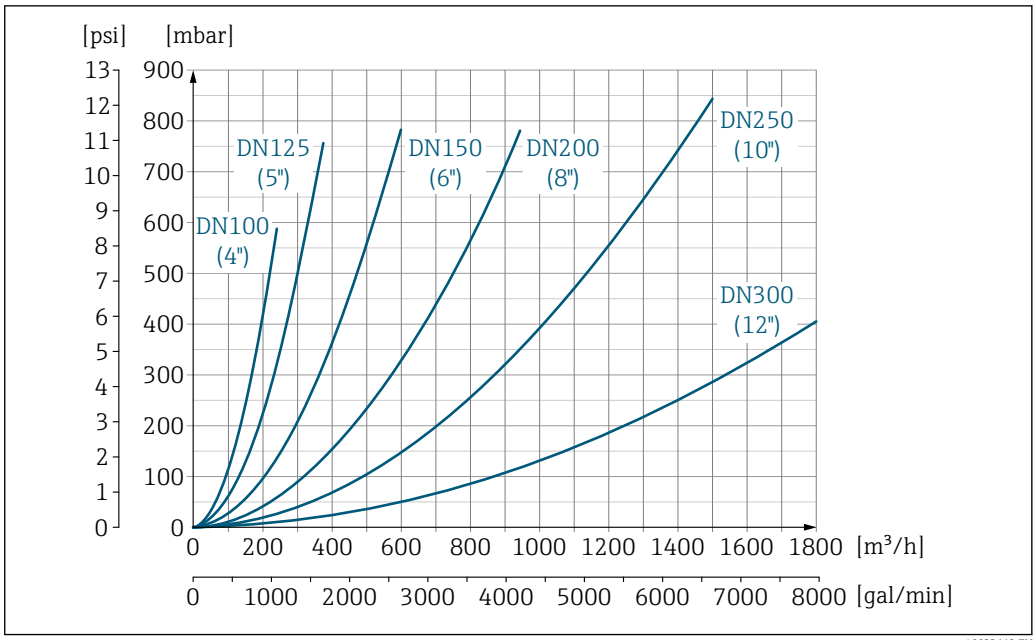
For custody transfer, the applicable approval determines the permitted measuring range.

Pressure loss

- No pressure loss occurs if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → 🖹 42



28 *Pressure loss DN 50 to 80 (2 to 3") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*



29 *Pressure loss DN 100 to 300 (4 to 12") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*

System pressure	Installation near pumps → 38
Vibrations	Installation in event of pipe vibrations → 39

Custody transfer mode

The measuring device is optionally tested in accordance with OIML R49 and has an EU type-examination certificate according to Measuring Instruments Directive 2014/32/EU for service subject to legal metrological control ("custody transfer") for cold water (Annex III).

The permitted medium temperature in these applications is 0 to +50 °C (+32 to +122 °F).

The device is used with a legally controlled totalizer on the local display and optionally with legally controlled outputs.

Measuring devices subject to legal metrological control totalize in both directions, i.e. all the outputs consider flow components in the positive (forward) and negative (reverse) flow direction.

Generally a measuring device subject to legal metrological control is secured against tampering by seals on the transmitter or sensor. These seals may normally only be opened by a representative of the competent authority for legal metrology controls.

After putting the device into circulation or after sealing the device, operation is only possible to a limited extent.

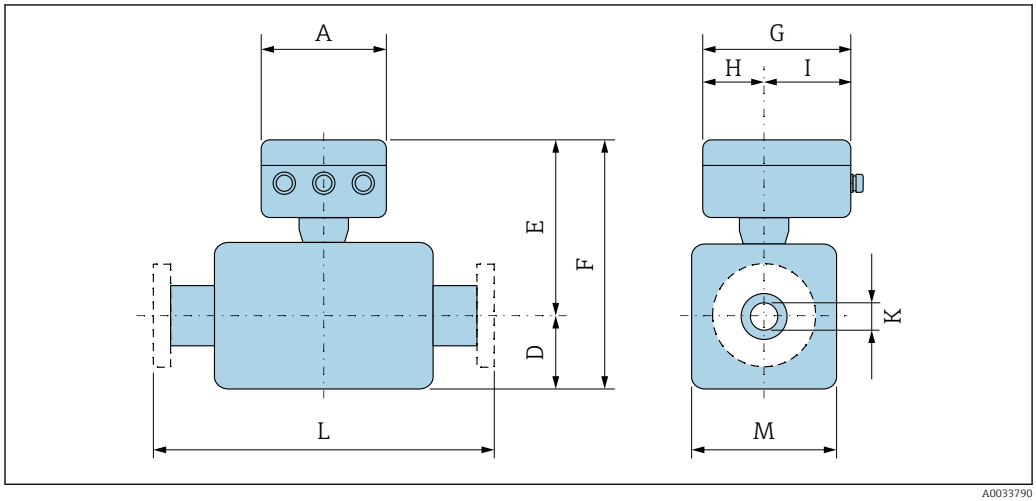
Detailed ordering information is available from your local Endress+Hauser sales center for national approvals (outside Europe) as cold water meters based on OIML R49.

Mechanical construction

Dimensions in SI units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



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A [mm]	G [1] [mm]	H [mm]	I [1] [mm]
167	193	90	103

1) Depending on the cable gland used: values up to + 30 mm

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"								K	L
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	201	285	120	–	–	–	–	[2]	200
32	–	84	201	285	120	–	–	–	–	[2]	200
40	1 ½	84	201	285	120	–	–	–	–	[2]	200
50	2	84	201	285	120	84	201	285	120	[2]	200
65	–	109	226	335	180	84	201	285	120	[2]	200
80	3	109	226	335	180	84	201	285	120	[2]	200
100	4	109	226	335	180	109	226	335	180	[2]	250
125	–	150	266	416	260	109	226	335	180	[2]	250
150	6	150	266	416	260	109	226	335	180	[2]	300
200	8	180	291	471	324	150	266	416	260	[2]	350
250	10	205	316	521	400	150	266	416	260	[2]	450
300	12	230	341	571	460	180	291	471	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	600
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design"				K	L	
		Options F, G, J, K						
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

DN		Order code for "Design"				K	L
		Option F, J					
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

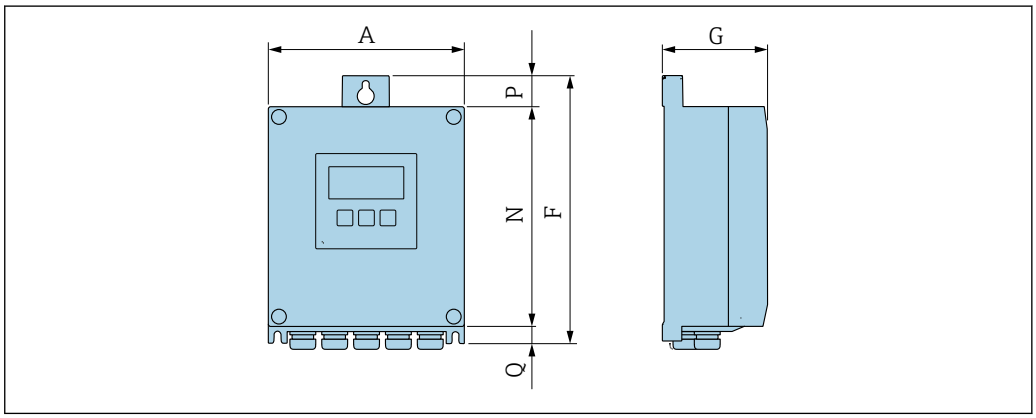
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



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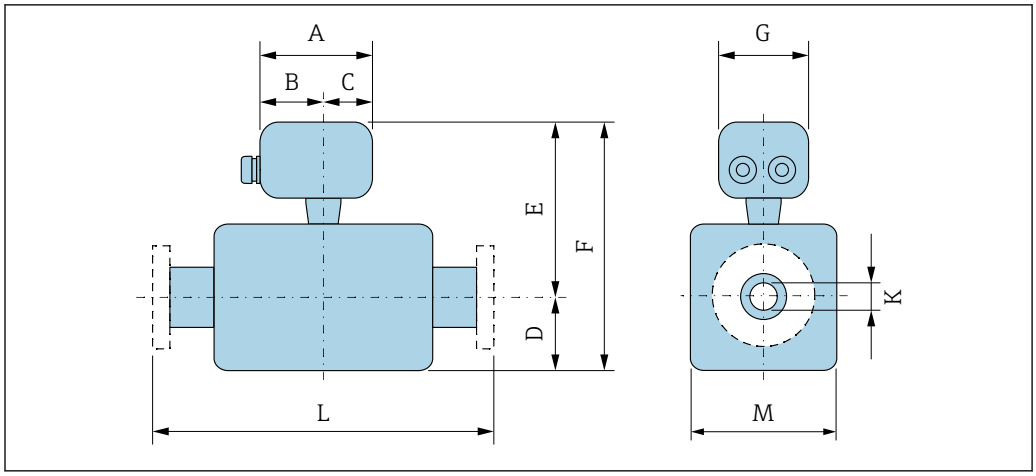
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
167	232	80	187	24	21

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
177	234	90	197	17	22

Sensor connection housing



Aluminum, coated

A [mm]	B [mm]	C [mm]	G [mm]
148	94	54	136

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [mm]	B [mm]	C [mm]	G [mm]
113	62	51	112

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	200	284	120	–	–	–	–	[2]	200
32	–	84	200	284	120	–	–	–	–	[2]	200
40	1 ½	84	200	284	120	–	–	–	–	[2]	200
50	2	84	200	284	120	84	200	284	120	[2]	200
65	–	109	225	334	180	84	200	284	120	[2]	200
80	3	109	225	334	180	84	200	284	120	[2]	200
100	4	109	225	334	180	109	225	334	180	[2]	250
125	–	150	265	415	260	109	225	334	180	[2]	250
150	6	150	265	415	260	109	225	334	180	[2]	300
200	8	180	290	470	324	150	265	415	260	[2]	350
250	10	205	315	520	400	150	265	415	260	[2]	450
300	12	230	340	570	460	180	290	470	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 25 to 300 mm (1 to 12 in): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	70	200	270	140	–	–	–	–	[2]	200
32	–	70	200	270	140	–	–	–	–	[2]	200
40	1 ½	70	200	270	140	–	–	–	–	[2]	200
50	2	70	200	270	140	70	200	270	140	[2]	200
65	–	82	225	307	165	70	200	270	140	[2]	200
80	3	87	225	312	175	70	200	270	140	[2]	200
100	4	100	225	325	200	82	225	307	165	[2]	250
125	–	113	265	378	226	87	225	312	175	[2]	250
150	6	134	265	399	269	100	225	325	200	[2]	300
200	8	160	290	450	320	113	265	378	226	[2]	350
250	10	193	315	508	387	134	265	399	269	[2]	450
300	12	218	340	558	437	160	290	450	320	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	550
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

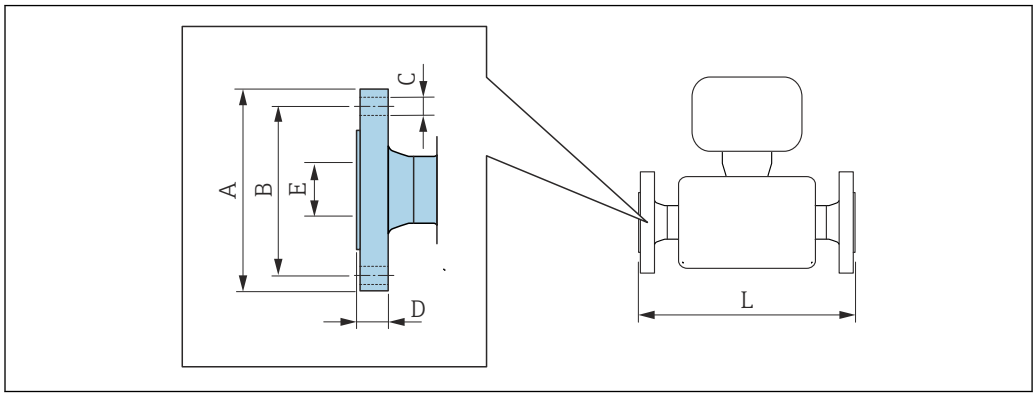
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 90

Flange connections

Fixed flange



A0015621

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 6 **Carbon steel:** *order code for "Process connection", option* **D1K** **Stainless steel:** *order code for "Process connection", option* **D1S**						
DN **[mm]**	**A** **[mm]**	**B** **[mm]**	**C** **[mm]**	**D** **[mm]**	**E** **[mm]**	**L** **[mm]**
350	490	445	12 × Ø22	22	1)	2)
400	540	495	16 × Ø22	22		
450	595	565	20 × Ø26	26		
500	645	600	20 × Ø22	24		
600	755	705	20 × Ø26	30		
700	860	810	24 × Ø26	30		
800	975	920	24 × Ø30	30		
900	1075	1020	24 × Ø30	34		
1000	1175	1120	28 × Ø30	38		
1200	1405	1340	32 × Ø33	42		
1400	1630	1560	36 × Ø36	56		
1600	1830	1760	40 × Ø36	63		
1800	2045	1970	44 × Ø39	69		
2000	2265	2180	48 × Ø42	74		
2200	2475	2390	52 × Ø42	81		
2400	2685	2600	56 × Ø42	87		
2600	2905	2810	60 × Ø48	91		
2800	3115	3020	64 × Ø48	101		
3000	3315	3220	68 × Ø48	102		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10
Carbon steel: *order code for "Process connection", option* **D2K**
Stainless steel: *order code for "Process connection", option* **D2S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
200	340	295	8 × Ø22	26	1)	2)
250	395	350	12 × Ø22	28		
300	445	400	12 × Ø22	28		
350	505	460	16 × Ø22	26		
400	565	515	16 × Ø26	26		
450	615	565	20 × Ø26	26		
500	670	620	20 × Ø26	28		
600	780	725	20 × Ø30	30		
700	895	840	24 × Ø30	35		
800	1015	950	24 × Ø33	38		
900	1115	1050	28 × Ø33	38		
1000	1230	1160	28 × Ø36	44		
1200	1455	1380	32 × Ø39	55		
1400	1675	1590	36 × Ø42	65		
1600	1915	1820	40 × Ø48	75		
1800	2115	2020	44 × Ø48	85		
2000	2325	2230	48 × Ø48	90		
2200	2550	2440	52 × Ø56	100		
2400	2760	2650	56 × Ø56	110		
2600	2960	2850	60 × Ø56	110		
2800	3180	3070	64 × Ø56	124		
3000	3405	3290	68 × Ø62	132		

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D3K**
Stainless steel: *order code for "Process connection", option* **D3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
65	185	145	8 × Ø18	20	1)	2)
80	200	160	8 × Ø18	20		
100	220	180	8 × Ø18	22		
125	250	210	8 × Ø18	24		
150	285	240	8 × Ø22	24		
200	340	295	12 × Ø22	26		
250	405	355	12 × Ø26	32		
300	460	410	12 × Ø26	32		

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D3K** **Stainless steel:** *order code for "Process connection", option* **D3S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
350	520	470	16 × Ø26	30		
400	580	525	16 × Ø30	32		
450	640	585	20 × Ø30	34		
500	715	650	20 × Ø33	36		
600	840	770	20 × Ø36	40		
700	910	840	24 × Ø36	40		
800	1025	950	24 × Ø39	41		
900	1125	1050	28 × Ø39	48		
1000	1255	1170	28 × Ø42	59		
1200	1485	1390	32 × Ø48	78		
1400	1685	1590	36 × Ø48	84		
1600	1930	1820	40 × Ø56	102		
1800	2130	2020	44 × Ø56	110		
2000	2345	2230	48 × Ø62	124		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 25 **Carbon steel:** *order code for "Process connection", option* **D4K** **Stainless steel:** *order code for "Process connection", option* **D4S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
200	360	310	12 × Ø26	32	1)	2)
250	425	370	12 × Ø30	36		
300	485	430	16 × Ø30	40		
350	555	490	16 × Ø33	38		
400	620	550	16 × Ø36	40		
450	670	600	20 × Ø36	46		
500	730	660	20 × Ø36	48		
600	845	770	20 × Ø39	48		
700	960	875	24 × Ø42	50		
800	1085	990	24 × Ø48	53		
900	1185	1090	28 × Ø48	57		
1000	1320	1210	28 × Ø56	63		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 40
Carbon steel: *order code for "Process connection", option* **D5K**
Stainless steel: *order code for "Process connection", option* **D5S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	115	85	4 × Ø14	16	1)	2)
32	140	100	4 × Ø18	18		
40	150	110	4 × Ø18	18		
50	165	125	4 × Ø18	20		
65	185	145	8 × Ø18	24		
80	200	160	8 × Ø18	26		
100	235	190	8 × Ø22	26		
125	270	220	8 × Ø26	28		
150	300	250	8 × Ø26	30		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A1K**
Stainless steel: *order code for "Process connection", option* **A1S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	108	79.2	4 × Ø16	12.6	1)	2)
40	1 ½	127	98.6	4 × Ø16	15.9		
50	2	152.4	120.7	4 × Ø19.1	17.5		
80	3	190.5	152.4	4 × Ø19.1	22.3		
100	4	228.6	190.5	8 × Ø19.1	22.3		
150	6	279.4	241.3	8 × Ø22.4	23.8		
200	8	342.9	298.5	8 × Ø22.4	26.8		
250	10	406.4	362	12 × Ø25.4	29.6		
300	12	482.6	431.8	12 × Ø25.4	30.2		
350	14	535	476.3	12 × Ø28.6	35.4		
400	16	595	539.8	16 × Ø28.6	37		
450	18	635	577.9	16 × Ø31.8	40.1		
500	20	700	635	20 × Ø31.8	43.3		
600	24	815	749.3	20 × Ø34.9	48.1		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	123.9	88.9	4 × Ø19.1	15.9	1)	2)
40	1 ½	155.4	114.3	4 × Ø22.4	19		
50	2	165.1	127	8 × Ø19.1	20.8		
80	3	209.6	168.1	8 × Ø22.4	26.8		
100	4	254	200.2	8 × Ø22.4	30.2		
150	6	317.5	269.7	12 × Ø22.4	35		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 10K
Carbon steel: *order code for "Process connection", option* **N3K**
Stainless steel: *order code for "Process connection", option* **N3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
50	155	120	4 × Ø19	16	1)	2)
65	175	140	4 × Ø19	18		
80	185	150	8 × Ø19	18		
100	210	175	8 × Ø19	18		
125	250	210	8 × Ø23	20		
150	280	240	8 × Ø23	22		
200	330	290	12 × Ø23	22		
250	400	355	12 × Ø25	24		
300	445	400	16 × Ø25	24		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	125	90	4 × Ø19	16	1)	2)
32	135	100	4 × Ø19	18		
40	140	105	4 × Ø19	18		
50	155	120	8 × Ø19	18		
65	175	140	8 × Ø19	20		
80	200	160	8 × Ø23	22		
100	225	185	8 × Ø23	24		

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
125	270	225	8 × Ø25	26		
150	305	260	12 × Ø25	28		
200	350	305	12 × Ø25	30		
250	430	380	12 × Ø27	34		
300	480	430	16 × Ø27	36		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AWWA, Class D
Order code for "Process connection", option **W1K**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
700	28	927	863.6	28 × Ø35	33.4	1)	2)
750	30	984	914.4	28 × Ø35	35.0		
800	32	1060	977.9	28 × Ø42	38.1		
900	36	1168	1085.9	32 × Ø42	41.3		
1000	40	1289	1200.2	36 × Ø42	41.3		
–	42	1346	1257.3	36 × Ø42	44.5		
1200	48	1511	1422.4	44 × Ø42	47.7		
–	54	1683	1593.9	44 × Ø48	54.0		
–	60	1855	1759.0	52 × Ø48	57.2		
–	66	2032	1930.4	52 × Ø48	63.5		
1800	72	2197	2095.5	60 × Ø48	66.7		
–	78	2362	2260.6	64 × Ø54	69.9		
–	84	2535	2425.7	64 × Ø54	73.1		
–	90	2705	2717.8	68 × Ø60	76.2		
–	96	2877	2755.9	68 × Ø60.3	82.55		
–	102	3048	2908.3	68 × Ø66.7	82.55		
–	108	3219	3067.0	68 × Ø66.7	85.73		
–	114	3391	3219.5	68 × Ø73	88.90		
–	120	3562	3371.8	68 × Ø73	88.90		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AS 2129, Tab. E
Order code for "Process connection", option **M2K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	8 × Ø18	13		
150	280	235	8 × Ø22	17		
200	335	292	8 × Ø22	19		
250	405	356	12 × Ø22	22		
300	455	406	12 × Ø26	25		
350	525	470	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	16 × Ø26	35		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø33	48		
700	910	845	20 × Ø33	51		
750	995	927	20 × Ø36	54		
800	1060	984	20 × Ø36	54		
900	1175	1092	24 × Ø36	64		
1000	1255	1175	24 × Ø39	67		
1200	1490	1410	32 × Ø39	79		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

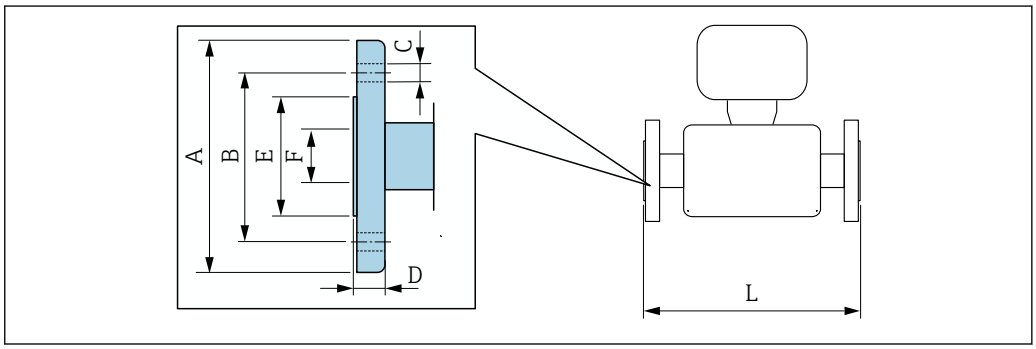
Flange according to AS 4087, PN 16
Order code for "Process connection", option **M3K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	4 × Ø18	13		
150	280	235	8 × Ø18	13		
200	335	292	8 × Ø18	19		
250	405	356	8 × Ø22	19		
300	455	406	12 × Ø22	23		
350	525	470	12 × Ø26	30		
375	550	495	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	12 × Ø26	30		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø30	48		
700	910	845	20 × Ø30	56		
750	995	927	20 × Ø33	56		
800	1060	984	20 × Ø36	56		

Flange according to AS 4087, PN 16 *Order code for "Process connection", option* **M3K**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
900	1175	1092	24 × Ø36	66		
1000	1255	1175	24 × Ø36	66		
1200	1490	1410	32 × Ø36	76		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange



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Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D22** **Stainless steel:** *order code for "Process connection", option* **D24**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
200	8	340	295	8 × Ø22	24	264	1)	2)
250	10	395	350	12 × Ø22	26	317		
300	12	445	400	12 × Ø22	26	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D32** **Stainless steel:** *order code for "Process connection", option* **D34**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
25	1	115	85	4 × Ø14	16	49	1)	2)
32	-	140	100	4 × Ø18	18	65		
40	1 ½	150	110	4 × Ø18	18	71		
50	2	165	125	4 × Ø18	20	88		
65	-	185	145	8 × Ø18	20	103		
80	3	200	160	8 × Ø18	20	120		

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D32**
Stainless steel: *order code for "Process connection", option* **D34**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
100	4	220	180	8 × Ø18	22	148		
125	-	250	210	8 × Ø18	22	177		
150	6	285	240	8 × Ø22	24	209		
200	8	340	295	12 × Ø22	26	264		
250	10	405	355	12 × Ø26	29	317		
300	12	460	410	12 × Ø26	32	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

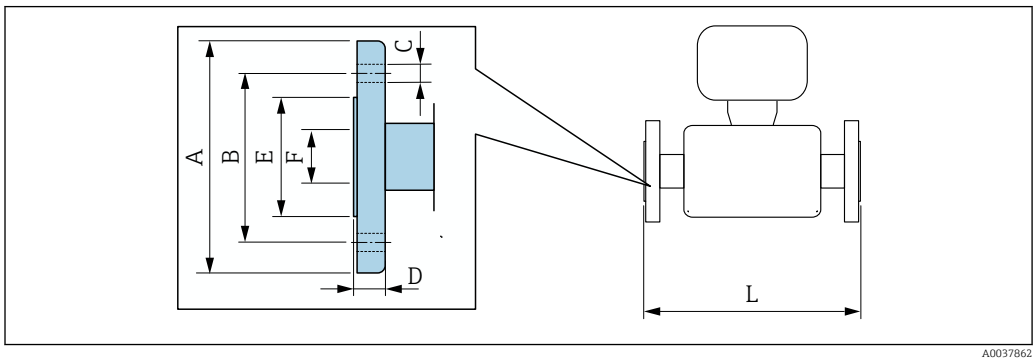
1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A12**
Stainless steel: *order code for "Process connection", option* **A14**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	110	80	4 × Ø16	14	49	1)	2)
40	1 ½	125	98	4 × Ø16	17.5	71		
50	2	150	121	4 × Ø19	19	88		
80	3	190	152	4 × Ø19	24	120		
100	4	230	190	8 × Ø19	24	148		
150	6	280	241	8 × Ø23	25	209		
200	8	345	298	8 × Ø23	29	264		
250	10	405	362	12 × Ø25	30	317		
300	12	485	432	12 × Ø25	32	378		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange, stamped plate



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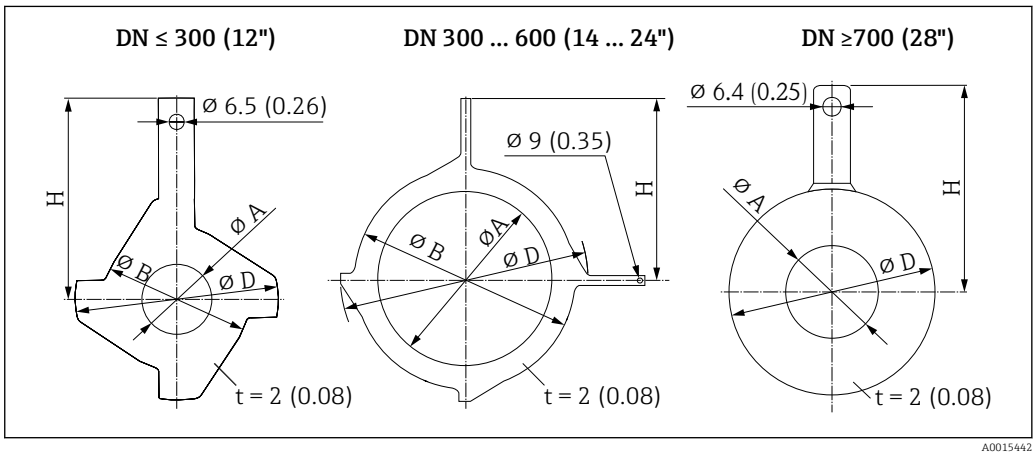
Lap joint flange, stamped plate in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D21** **Stainless steel:** *order code for "Process connection", option* **D23**							
DN [mm]	**A** [mm]	**B** [mm]	**C** [mm]	**D** [mm]	**E** [mm]	**F** [mm]	**L** [mm]
25	115	85	4 x Ø13.5	16.5	49	1)	2)
32	140	100	4 x Ø17.5	17	65		
40	150	110	4 x Ø17.5	16.5	71		
50	165	125	4 x Ø17.5	18.5	88		
65	185	145	4 x Ø17.5	20	103		
80	200	160	8 x Ø17.5	23.5	120		
100	220	180	8 x Ø17.5	24.5	148		
125	250	210	8 x Ø17.5	24	177		
150	285	240	8 x Ø21.5	25	209		
200	340	295	8 x Ø21.5	27.5	264		
250	405	350	12 x Ø21.5	30.5	317		
300	445	400	12 x Ø21.5	34.5	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Accessories

Ground disks for flange connections



DN		**Pressure rating**	**A**		**B**		**D**		**H**	
[mm]	**[inch]**		**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
100	4"	1)	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	1)	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	1)	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	1)	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	1)	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98

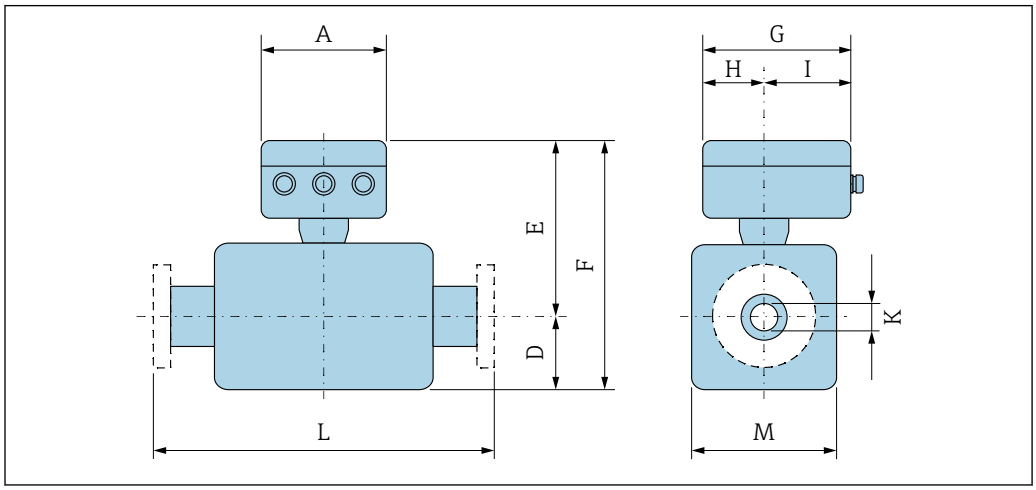
DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Dimensions in US units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



A [in]	G [1] [in]	H [in]	I [1] [in]
6.57	7.60	3.54	4.06

1) Depending on the cable gland used: values up to + 1.18 in

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.91	11.22	4.72	3.31	7.91	11.22	4.72	[2]	7.87
65	–	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
80	3	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
100	4	4.29	8.9	13.19	7.09	4.29	8.9	13.19	7.09	[2]	9.84
125	–	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	9.84
150	6	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	11.81
200	8	7.09	11.46	18.54	12.76	5.91	10.47	16.38	10.24	[2]	13.78
250	10	8.07	12.44	20.51	15.75	5.91	10.47	16.38	10.24	[2]	17.72
300	12	9.06	13.43	22.48	18.11	7.09	11.46	18.54	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design" Options F, J				Options G, K				K	L	
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [2]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [2]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [2]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [2]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [2]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [2]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	[2]	39.37 [3]	51.18 [4]
–	42	24.33	28.86	53.19	48.66	[2]	41.34 [3]	53.74 [4]
1200	48	27.40	31.93	59.33	54.80	[2]	47.24 [3]	61.42 [4]
–	54	31.85	36.38	68.23	63.66	[2]	53.15 [3]	69.09 [4]
1400	–	31.85	36.38	68.23	63.66	[2]	55.12 [3]	71.65 [4]
–	60	35.79	40.31	76.10	71.54	[2]	59.06 [3]	76.77 [4]
1600	–	35.79	40.31	76.10	71.54	[2]	62.99 [3]	81.89 [4]
–	66	37.80	42.32	80.12	75.55	[2]	64.96 [3]	84.45 [4]
1800	72	40.00	44.53	84.53	80.00	[2]	70.87 [3]	92.13 [4]

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
–	78	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]
2000	–	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 84 to 120 in (2200 to 3000 mm)

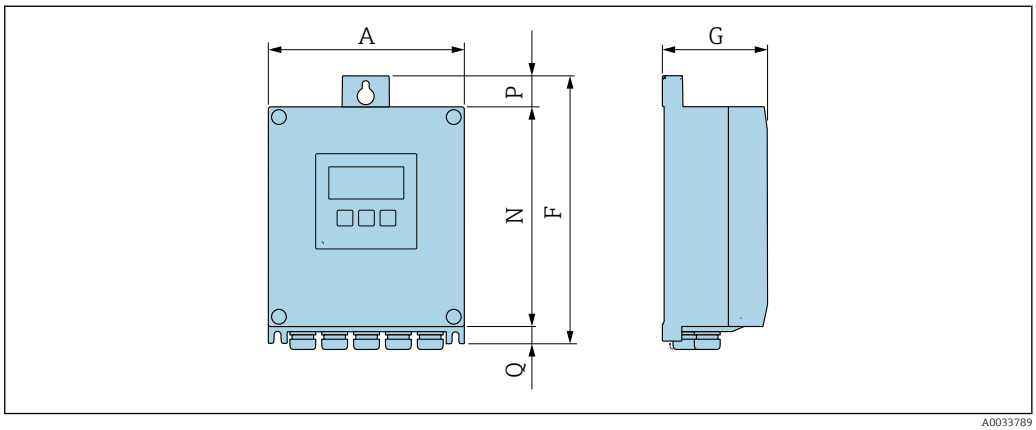
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	[2]	86.61
2200	–	48.31	52.83	101.14	96.61	[2]	86.61
–	90	52.44	56.97	109.41	104.88	[2]	94.49
2400	–	52.44	56.97	109.57	104.88	[2]	94.49
–	96	56.34	60.87	117.20	112.64	[2]	96.46
–	102	59.69	64.21	123.90	119.37	[2]	102.36
2600	–	56.77	61.30	118.07	113.50	[2]	102.36
–	108	63.07	67.64	130.71	126.14	[2]	108.27
2800	–	60.91	65.43	126.34	121.77	[2]	110.24
–	114	66.46	70.98	137.44	132.87	[2]	114.17
3000	–	64.84	69.37	134.21	129.65	[2]	118.11
–	120	69.84	74.37	144.21	139.65	[2]	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



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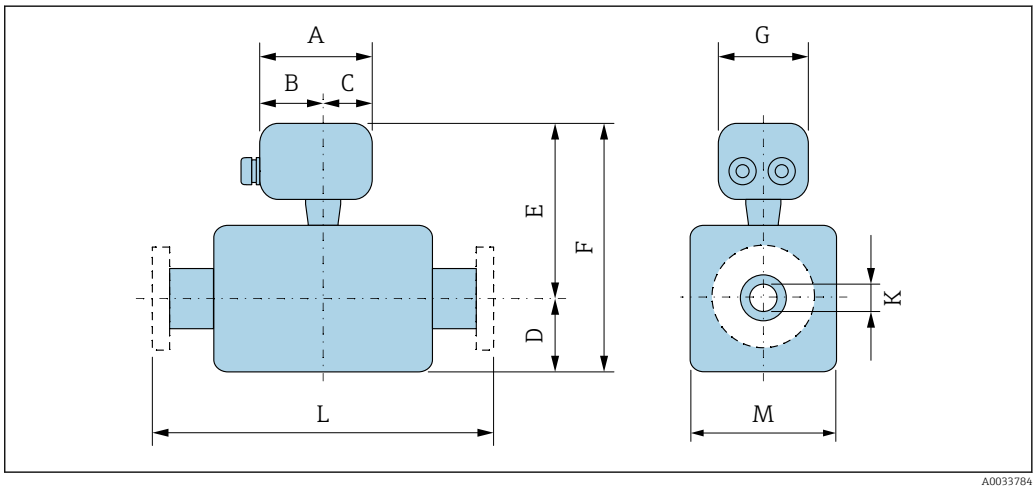
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.57	9.13	3.15	7.36	0.94	0.83

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.97	9.21	3.54	7.76	0.67	0.87

Sensor connection housing



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Aluminum, coated

A [in]	B [in]	C [in]	G [in]
5.83	3.7	2.13	5.35

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [in]	B [in]	C [in]	G [in]
4.45	2.44	2.01	4.41

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.87	11.18	4.72	3.31	7.87	11.18	4.72	[2]	7.87
65	–	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
80	3	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
100	4	4.29	8.86	13.15	7.09	4.29	8.86	13.15	7.09	[2]	9.84
125	–	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	9.84
150	6	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	11.81
200	8	7.09	11.42	18.5	12.76	5.91	10.43	16.34	10.24	[2]	13.78
250	10	8.07	12.4	20.47	15.75	5.91	10.43	16.34	10.24	[2]	17.72
300	12	9.06	13.39	22.44	18.11	7.09	11.42	18.5	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 1 to 12 in (25 to 300 mm): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
32	–	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
40	1 ½	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
50	2	2.76	7.87	10.63	5.51	2.76	7.87	10.63	5.51	[2]	7.87
65	–	3.23	8.86	12.09	6.5	2.76	7.87	10.63	5.51	[2]	7.87
80	3	3.43	8.86	12.28	6.89	2.76	7.87	10.63	5.51	[2]	7.87
100	4	3.94	8.86	12.8	7.87	3.23	8.86	12.09	6.5	[2]	9.84
125	–	4.45	10.43	14.88	8.9	3.43	8.86	12.28	6.89	[2]	9.84
150	6	5.28	10.43	15.71	10.59	3.94	8.86	12.8	7.87	[2]	11.81
200	8	6.3	11.42	17.72	12.6	4.45	10.43	14.88	8.9	[2]	13.78

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
250	10	7.6	12.4	20	15.24	5.28	10.43	15.71	10.59	[2]	17.72
300	12	8.58	13.39	21.97	17.2	6.3	11.42	17.72	12.6	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [3]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [3]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [3]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [3]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [3]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [3]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	[2]	39.37 [3]	51.18 [4]
–	42	24.33	28.86	53.19	48.66	[2]	41.34 [3]	53.74 [4]
1200	48	27.40	31.93	59.33	54.80	[2]	47.24 [3]	61.42 [4]
–	54	31.85	36.38	68.23	63.66	[2]	53.15 [3]	69.09 [4]
1400	–	31.85	36.38	68.23	63.66	[2]	55.12 [3]	71.65 [4]
–	60	35.79	40.31	76.10	71.54	[2]	59.06 [3]	76.77 [4]
1600	–	35.79	40.31	76.10	71.54	[2]	62.99 [3]	81.89 [4]
–	66	37.80	42.32	80.12	75.55	[2]	64.96 [3]	84.45 [4]
1800	72	40.00	44.53	84.53	80.00	[2]	70.87 [3]	92.13 [4]
–	78	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]
2000	–	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

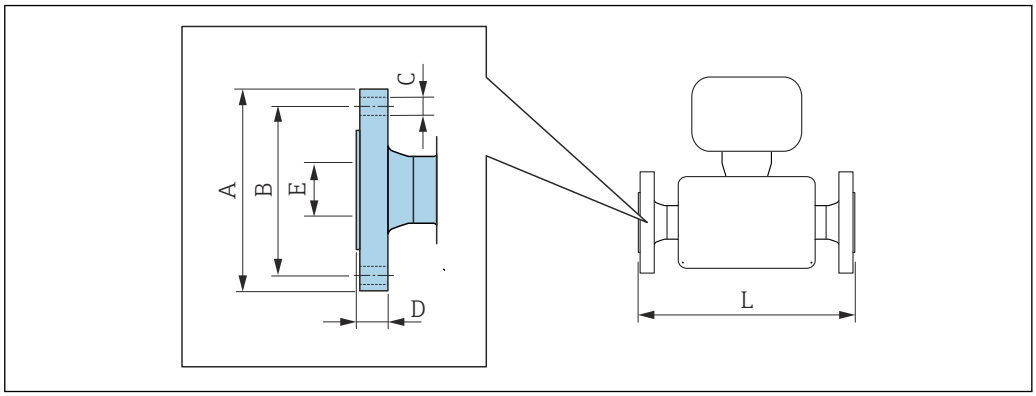
DN 84 to 120 in (2200 to 3000 mm)

DN		Order code for "Design" Option F, J				K	L
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	[2]	86.61
2200	–	48.31	52.83	101.14	96.61	[2]	86.61
–	90	52.44	56.97	109.41	104.88	[2]	94.49
2400	–	52.44	56.97	109.57	104.88	[2]	94.49
–	96	56.34	60.87	117.20	112.64	[2]	96.46
–	102	59.69	64.21	123.90	119.37	[2]	102.36
2600	–	56.77	61.30	118.07	113.50	[2]	102.36
–	108	63.07	67.64	130.71	126.14	[2]	108.27
2800	–	60.91	65.43	126.34	121.77	[2]	110.24
–	114	66.46	70.98	137.44	132.87	[2]	114.17
3000	–	64.84	69.37	134.21	129.65	[2]	118.11
–	120	69.84	74.37	144.21	139.65	[2]	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90

Flange connections

Fixed flange



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Flange according to ASME B16.5, Class 150 **Carbon steel:** *order code for "Process connection", option* **A1K** **Stainless steel:** *order code for "Process connection", option* **A1S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[mm]	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
25	1	4.25	3.12	4 × Ø0.63	0.5	1)	2)
40	1 ½	5	3.88	4 × Ø0.63	0.63		
50	2	6	4.75	4 × Ø0.75	0.69		
80	3	7.5	6	4 × Ø0.75	0.88		
100	4	9	7.5	8 × Ø0.75	0.88		
150	6	11	9.5	8 × Ø0.88	0.94		
200	8	13.5	11.75	8 × Ø0.88	1.06		
250	10	16	14.25	12 × Ø1	1.17		
300	12	19	17	12 × Ø1	1.19		
350	14	21.06	18.75	12 × Ø1.13	1.39		
400	16	23.43	21.25	16 × Ø1.13	1.46		
450	18	25	22.75	16 × Ø1.25	1.58		
500	20	27.56	25	20 × Ø1.25	1.7		
600	24	32.09	29.5	20 × Ø1.37	1.89		
Surface roughness (flange): Ra 250 to 492 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to ASME B16.5, Class 300 **Carbon steel:** *order code for "Process connection", option* **A2K** **Stainless steel:** *order code for "Process connection", option* **A2S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[in]	**[mm]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
1	25	4.88	3.5	4 × Ø0.75	0.63	1)	2)
1 ½	40	6.12	4.5	4 × Ø0.88	0.75		
2	50	6.5	5	8 × Ø0.75	0.82		

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
3	80	8.25	6.62	8 × Ø0.88	1.06		
4	100	10	7.88	8 × Ø0.88	1.19		
6	150	12.5	10.62	12 × Ø0.88	1.38		
Surface roughness (flange): Ra 250 to 492 µm							

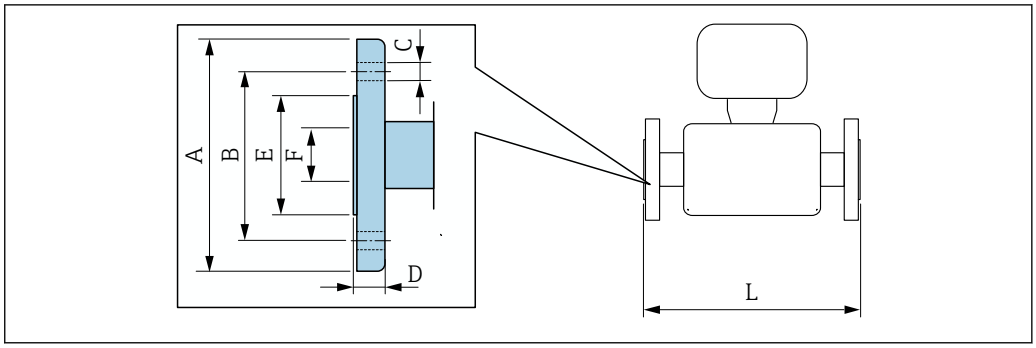
1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to AWWA, Cl. D
Order code for "Process connection", option **W1K**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
28	700	36.50	34.00	28 × Ø1.38	1.31	1)	2)
30	–	38.74	36.00	28 × Ø1.38	1.38		
32	800	41.73	38.50	28 × Ø1.65	1.50		
36	900	45.98	42.75	32 × Ø1.65	1.63		
40	1000	50.75	47.25	36 × Ø1.65	1.63		
42	–	52.99	49.50	36 × Ø1.65	1.75		
48	1200	59.49	56.00	44 × Ø1.65	1.88		
54	–	66.26	62.75	44 × Ø1.89	2.13		
60	–	73.03	69.25	52 × Ø1.89	2.25		
66	–	80.00	76.00	52 × Ø1.89	2.50		
72	1800	86.50	82.50	60 × Ø1.89	2.63		
78	–	92.99	89.00	64 × Ø2.13	2.75		
84	–	99.80	95.50	64 × Ø2.13	2.88		
90	–	106.50	107.00	68 × Ø2.36	3.00		
96	–	113.27	108.50	68 × Ø2.37	3.25		
102	–	120.00	114.50	68 × Ø2.63	3.25		
108	–	126.73	120.75	68 × Ø2.63	3.38		
114	–	133.50	126.75	68 × Ø2.87	3.50		
120	–	140.24	132.75	68 × Ø2.87	3.50		
Surface roughness (flange): Ra 250 to 492 µin							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 74 (compact version) → 🖹 77 (remote version)

Lap joint flange



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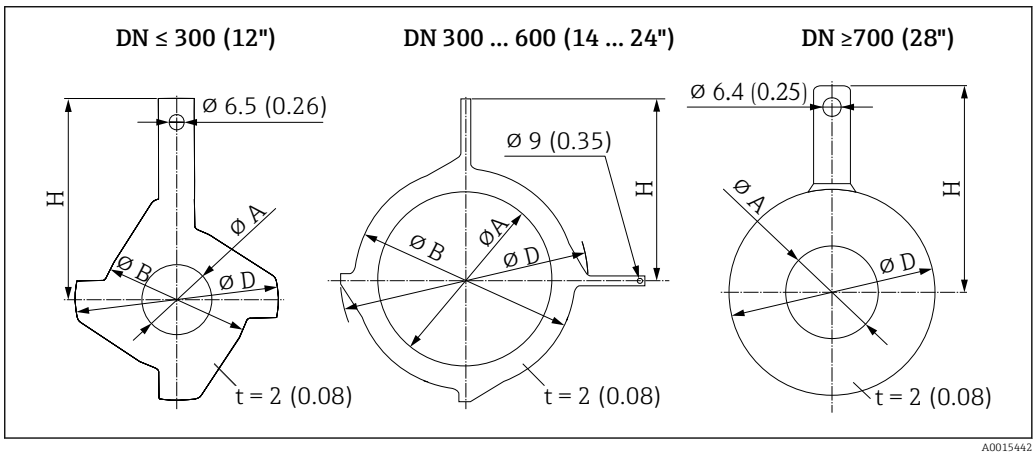
Lap joint flange according to ASME B16.5, Class 150 **Carbon steel:** *order code for "Process connection", option* **A12** **Stainless steel:** *order code for "Process connection", option* **A14**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
25	1	4.33	3.15	4 × Ø0.63	0.55	1.93	1)	2)
40	1 ½	4.92	3.86	4 × Ø0.63	0.69	2.8		
50	2	5.91	4.76	4 × Ø0.75	0.75	3.46		
80	3	7.48	5.98	4 × Ø0.75	0.94	4.72		
100	4	9.06	7.48	8 × Ø0.75	0.94	5.83		
150	6	11.02	9.49	8 × Ø0.91	0.98	8.23		
200	8	13.58	11.73	8 × Ø0.91	1.14	10.39		
250	10	15.94	14.25	12 × Ø0.98	1.18	12.48		
300	12	19.09	17.01	12 × Ø0.98	1.26	14.88		
Surface roughness (flange): Ra 248 to 492 µin								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Accessories

Ground disks for flange connections



A0015442

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31
100	4"	1)	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	1)	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	1)	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	1)	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	1)	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Weight

All values (weight exclusive of packaging material) refer to devices with flanges of the standard pressure rating.
The weight may be lower than indicated depending on the pressure rating and design.

Weight in SI units

Order code for "Design", option C, D, E, H, I : DN 25 to 400 mm (1 to 16 in)			
Nominal diameter		Reference values EN (DIN), AS, JIS	
[mm]	[in]	Pressure rating	[kg]
25	1	PN 40	10
32	–	PN 40	11
40	1 ½	PN 40	12
50	2	PN 40	13
65	–	PN 16	13
80	3	PN 16	15
100	4	PN 16	18
125	–	PN 16	25
150	6	PN 16	31
200	8	PN 10	52
250	10	PN 10	81
300	12	PN 10	95
350	14	PN 6	106
375	15	PN 6	121
400	16	PN 6	121

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
		Reference values	
Nominal diameter		EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
450	18	142	138
500	20	182	186
600	24	227	266
700	28	291	369
–	30	–	447
800	32	353	524
900	36	444	704
1000	40	566	785
–	42	–	–
1200	48	843	1 229
–	54	–	–
1400	–	1 204	–
–	60	–	–
1600	–	1 845	–
–	66	–	–

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
		Reference values	
Nominal diameter		EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
1800	72	2 357	–
–	78	2 929	–
2000	–	2 929	–

Order code for "Design", option F, J: DN 2 200 to 3 000 mm (84 to 120 in)		
		Reference values
Nominal diameter		EN (DIN) (PN6)
[mm]	[in]	[kg]
–	84	–
2200	–	3 422
–	90	–
2400	–	4 094
–	96	–
–	102	–
2600	–	7 601.5
–	108	–
2800	–	9 466.5
–	114	–
3000	–	11 911
–	120	–

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
		Reference values
Nominal diameter		EN (DIN) (PN 6)
[mm]	[in]	[kg]
450	18	161
500	20	156
600	24	208
700	28	304
–	30	–
800	32	357
900	36	485
1000	40	589
–	42	–
1200	48	850
–	54	850
1400	–	1 300
–	60	–
1600	–	1 845

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values EN (DIN) (PN 6)
[mm]	[in]	[kg]
–	66	–
1800	72	2 357
–	78	2 929
2000	–	2 929

Weight in US units

Order code for "Design", option C, D, E, H, I: DN 1 to 16 in (25 to 400 mm)		
Nominal diameter		Reference values ASME (Class 150)
[mm]	[in]	[lb]
25	1	11
32	–	–
40	1 ½	15
50	2	20
65	–	–
80	3	31
100	4	42
125	–	–
150	6	73
200	8	115
250	10	198
300	12	284
350	14	379
375	15	–
400	16	448

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	421
500	20	503
600	24	666
700	28	587
–	30	701
800	32	845
900	36	1036
1000	40	1294
–	42	1477
1200	48	1987

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
–	54	2 807
1400	–	–
–	60	3 515
1600	–	–
–	66	4 699
1800	72	5 662
–	78	6 864
2000	–	6 864
–	84	8 280
2200	–	–
–	90	10 577
2400	–	–
–	96	15 574.6
–	102	18 023.9
2600	–	–
–	108	20 783.0
2800	–	–
–	114	24 060.2
3000	–	–
–	120	27 724.3

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	562
500	20	628
600	24	893
700	28	882
–	30	1 014
800	32	1 213
900	36	1 764
1000	40	1 984
–	42	2 426
1200	48	3 087
–	54	4 851
1400	–	–
–	60	5 954
1600	–	–
–	66	8 158

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
1800	72	9040
–	78	10143
2000	–	–

Measuring tube specification

The values are reference values and can vary depending on the pressure rating, design and order option.

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
25	1	PN 40	Class 150	–	20K	–	–	24	0.93	25	1.00
32	–	PN 40	–	–	20K	–	–	32	1.28	34	1.34
40	1 ½	PN 40	Class 150	–	20K	–	–	38	1.51	40	1.57
50	2	PN 40	Class 150	Table E, PN 16	10K	50	1.98	50	1.98	52	2.04
50 [1]	2	PN 40	Class 150	Table E, PN 16	10K	32	1.26	–	–	–	–
65	–	PN 16	–	–	10K	66	2.60	66	2.60	68	2.67
65 [1]	–	PN 16	–	–	10K	38	1.50	–	–	–	–
80	3	PN 16	Class 150	Table E, PN 16	10K	79	3.11	79	3.11	80	3.15
80 [1]	3	PN 16	Class 150	Table E, PN 16	10K	50	1.97	–	–	–	–
100	4	PN 16	Class 150	Table E, PN 16	10K	101	3.99	104	4.11	104	4.09
100 [1]	4	PN 16	Class 150	Table E, PN 16	10K	66	2.60	–	–	–	–
125	–	PN 16	–	–	10K	127	4.99	130	5.11	129	5.08
125 [1]	–	PN 16	–	–	10K	79	3.11	–	–	–	–
150	6	PN 16	Class 150	Table E, PN 16	10K	155	6.11	158	6.23	156	6.15
150 [1]	6	PN 16	Class 150	Table E, PN 16	10K	102	4.02	–	–	–	–
200	8	PN 10	Class 150	Table E, PN 16	10K	204	8.02	207	8.14	202	7.96
200 [1]	8	PN 16	Class 150	Table E, PN 16	10K	127	5.00	–	–	–	–
250	10	PN 10	Class 150	Table E, PN 16	10K	258	10.14	261	10.26	256	10.09
250 [1]	10	PN 16	Class 150	Table E, PN 16	10K	156	6.14	–	–	–	–
300	12	PN 10	Class 150	Table E, PN 16	10K	309	12.15	312	12.26	306	12.03
300 [1]	12	PN 16	Class 150	Table E, PN 16	10K	204	8.03	–	–	–	–
350	14	PN 10	Class 150	Table E, PN 16	10K	337	13.3	340	13.4	–	–
375	15	–	–	PN 16	10K	389	15.3	392	15.4	–	–
400	16	PN 10	Class 150	Table E, PN 16	10K	387	15.2	390	15.4	–	–
450	18	PN 10	Class 150	–	10K	436	17.2	439	17.3	–	–
500	20	PN 10	Class 150	Table E, PN 16	10K	487	19.2	490	19.3	–	–
600	24	PN 10	Class 150	Table E, PN 16	10K	585	23.0	588	23.1	–	–
700	28	PN 10	Class D	Table E, PN 16	10K	694	27.3	697	27.4	–	–
750	30	–	Class D	Table E, PN 16	10K	743	29.3	746	29.4	–	–
800	32	PN 10	Class D	Table E, PN 16	–	794	31.3	797	31.4	–	–

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
900	36	PN 10	Class D	Table E, PN 16	–	895	35.2	898	35.4	–	–
1000	40	PN 6	Class D	Table E, PN 16	–	991	39.0	994	39.1	–	–
–	42	–	Class D	–	–	1043	41.1	1043	41.1	–	–
1200	48	PN 6	Class D	Table E, PN 16	–	1191	46.9	1197	47.1	–	–
–	54	–	Class D	–	–	1339	52.7	–	–	–	–
1400	–	PN 6	–	–	–	1402	55.2	–	–	–	–
–	60	–	Class D	–	–	1492	58.7	–	–	–	–
1600	–	PN 6	–	–	–	1600	63.0	–	–	–	–
–	66	–	Class D	–	–	1638	64.5	–	–	–	–
1800	72	PN 6	–	–	–	1786	70.3	–	–	–	–
–	78	–	Class D	–	–	1989	78.3	–	–	–	–
2000	–	PN 6	–	–	–	1989	78.3	–	–	–	–
–	84	–	Class D	–	–	2099	84.0	–	–	–	–
2200	–	PN 6	–	–	–	2194	87.8	–	–	–	–
–	90	–	Class D	–	–	2246	89.8	–	–	–	–
2400	–	PN 6	–	–	–	2391	94.1	–	–	–	–
–	96	–	Class D	–		2382	93.8	–	–	–	–
–	102	–	Class D	–		2533	99.7	–	–	–	–
2600	–	PN 6	–	–		2580	101.6	–	–	–	–
–	108	–	Class D	–		2683	105.6	–	–	–	–
2800	–	PN 6	–	–		2780	109.5	–	–	–	–
–	114	–	Class D	–		2832	111.5	–	–	–	–
3000	–	PN 6	–	–		2976	117.2	–	–	–	–
–	120	–	Class D	–		2980	117.3	–	–	–	–

1) Order code for "Design", option C

Materials

Transmitter housing

Compact version

- Order code for "Housing", option **A** "Compact, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **M**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **A**: glass
  - For order code for "Housing", option **M**: plastic

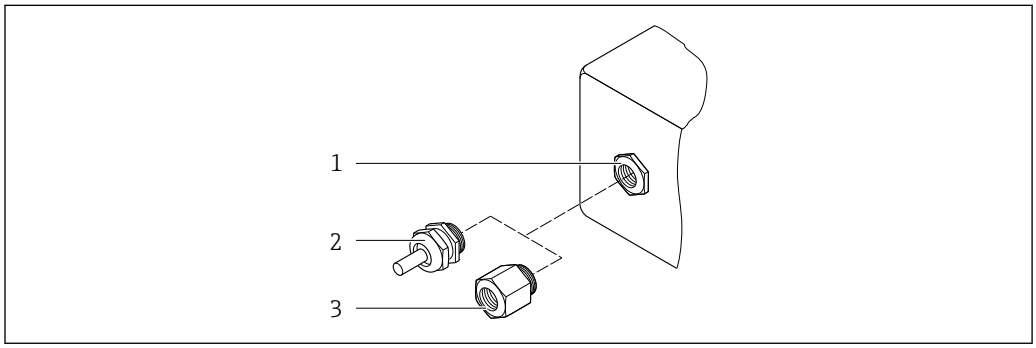
Remote version (wall-mount housing)

- Order code for "Housing", option **P** "Remote, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **N**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **P**: glass
  - For order code for "Housing", option **N**: plastic

Sensor connection housing

- Aluminum, AlSi10Mg, coated
- Polycarbonate plastic (only in conjunction with order code for "Sensor option", options CA, C3, CB, CC, CD, CD)

Cable entries/cable glands



30 Possible cable entries/cable glands

1 Female thread M20 × 1.5
2 Cable gland M20 × 1.5
3 Adapter for cable entry with female thread G ½" or NPT ½"

Compact and remote versions and sensor connection housing

Cable entry/cable gland	Material
Cable gland M20 × 1.5	▪ Plastic ▪ Nickel-plated brass
Remote version: cable gland M20 × 1.5 Option of armored connecting cable	▪ Sensor connection housing: Nickel-plated brass ▪ Transmitter wall-mount housing: Plastic
Adapter for cable entry with female thread G ½" or NPT ½"	Nickel-plated brass

Device plug

Electrical connection	Material
Plug M12x1	▪ Socket: Stainless steel, 1.4404 (316L) ▪ Contact housing: Polyamide ▪ Contacts: Gold-plated brass

Remote version connecting cable

UV rays can impair the cable outer sheath. Protect the cable from exposure to sun as much as possible.

Electrode and coil current cable:
- Standard cable: PVC cable with copper shield
- Armored cable: PVC cable with copper shield and additional steel wire braided jacket

Sensor housing

- DN 25 to 300 (1 to 12")
  - Aluminum half-shell housing, aluminum, AlSi10Mg, coated
  - Fully welded carbon steel housing with protective varnish
- DN 350 to 3000 (14 to 120")
  Fully welded carbon steel housing with protective varnish

Measuring tubes

- DN 25 to 600 (1 to 24")
  Stainless steel: 1.4301, 1.4306, 304, 304L
- DN 700 to 3000 (28 to 120")
  Stainless steel: 1.4301, 304

Liner

- DN 25 to 300 (1 to 12"): PTFE
- DN 25 to 1200 (1 to 48"): polyurethane
- DN 50 to 3000 (2 to 120"): hard rubber

Electrodes

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

For flanges made of carbon steel:
- DN ≤ 300 (12"): with Al/Zn protective coating or protective varnish
- DN ≥ 350 (14"): protective varnish

All carbon steel lap joint flanges are supplied with a hot-dip galvanized finish.

EN 1092-1 (DIN 2501)

Fixed flange
- Carbon steel:
  - DN ≤ 300: S235JRG2, S235JR+N, P245GH, A105, E250C
  - DN 350 to 3000: P245GH, S235JRG2, A105, E250C
- Stainless steel:
  - DN ≤ 300: 1.4404, 1.4571, F316L
  - DN 350 to 600: 1.4571, F316L, 1.4404
  - DN 700 to 1000: 1.4404, F316L

Lap joint flange
- Carbon steel DN ≤ 300: S235JRG2, A105, E250C
- Stainless steel DN ≤ 300: 1.4306,1.4404, 1.4571, F316L

Lap joint flange, stamped plate
- Carbon steel DN ≤ 300: S235JRG2 similar to S235JR+AR or 1.0038
- Stainless steel DN ≤ 300: 1.4301 similar to 304

ASME B16.5

Fixed flange, lap joint flange
- Carbon steel: A105
- Stainless steel: F316L

JIS B2220

- Carbon steel: A105, A350 LF2
- Stainless steel: F316L

AWWA C207

Carbon steel: A105, P265GH, A181 Class 70, E250C, S275JR

AS 2129

Carbon steel: A105, E250C, P235GH, P265GH, S235JRG2

AS 4087

Carbon steel: A105, P265GH, S275JR

Seals

As per DIN EN 1514-1, form IBC

Accessories

Display guard

Stainless steel, 1.4301 (304L)

Ground disks

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Fitted electrodes

Measurement, reference and empty pipe detection electrodes available as standard with:
- 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

- EN 1092-1 (DIN 2501)
- ASME B16.5
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16
- AWWA C207 Class D

For information on the different materials used in the process connections → 93

Surface roughness

Electrodes with 1.4435 (316L); Alloy C22, 2.4602 (UNS N06022); tantalum: < 0.5 µm (19.7 µin)

(All data relate to parts in contact with medium)

Human interface

Operating concept

Operator-oriented menu structure for user-specific tasks
- Commissioning
- Operation
- Diagnostics
- Expert level

Fast and safe commissioning
- Guided menus ("Make-it-run" wizards) for applications
- Menu guidance with brief descriptions of the individual parameter functions
- Access to the device via Web server
- WLAN access to the device via mobile handheld terminal, tablet or smart phone

Reliable operation
- Operation in local language
- Uniform operating philosophy applied to device and operating tools
- If replacing electronic modules, transfer the device configuration via the integrated memory (HistoROM backup) which contains the process and measuring device data and the event logbook. No need to reconfigure.

Efficient diagnostic behavior increases measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

Languages

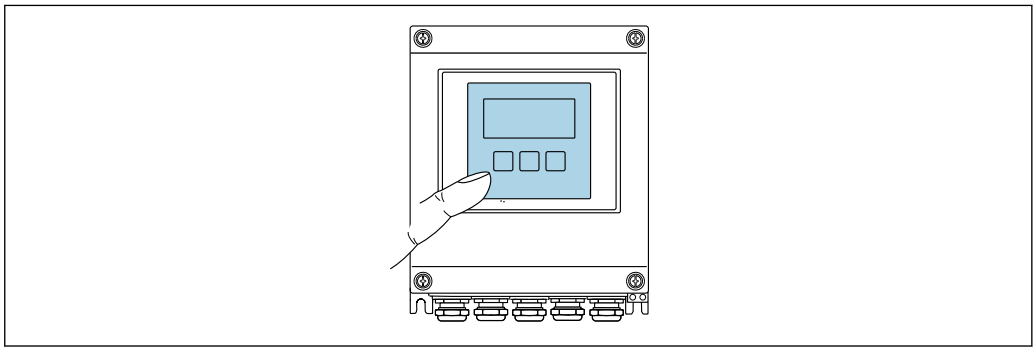
Can be operated in the following languages:
- Via local operation:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool:
  English, German, French, Spanish, Italian, Chinese, Japanese
- Via Web browser (only available for device versions with HART, PROFIBUS DP and EtherNet/IP):
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish

Local operation

Via display module

Equipment:
- Standard features 4-line, illuminated, graphic display; touch control
- Order code for "Display; operation", option BA "WLAN" offers standard equipment features in addition to access via Web browser

Information about WLAN interface → 98



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31 *Operation with touch control*

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- Format for displaying measured variables and status variables can be individually configured
- Permitted ambient temperature for the display: −20 to +60 °C (−4 to +140 °F)
  The readability of the display may be impaired at temperatures outside the temperature range.

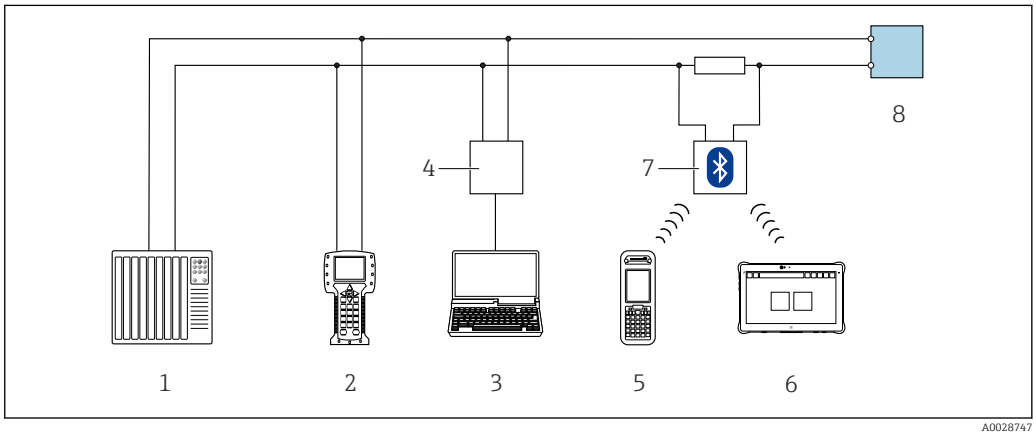
Operating elements

- External operation via touch control (3 optical keys) without opening the housing: ⊞, ⊟, Ⓔ
- Operating elements also accessible in the various zones of the hazardous area

Remote operation

Via HART protocol

This communication interface is available in device versions with a HART output.



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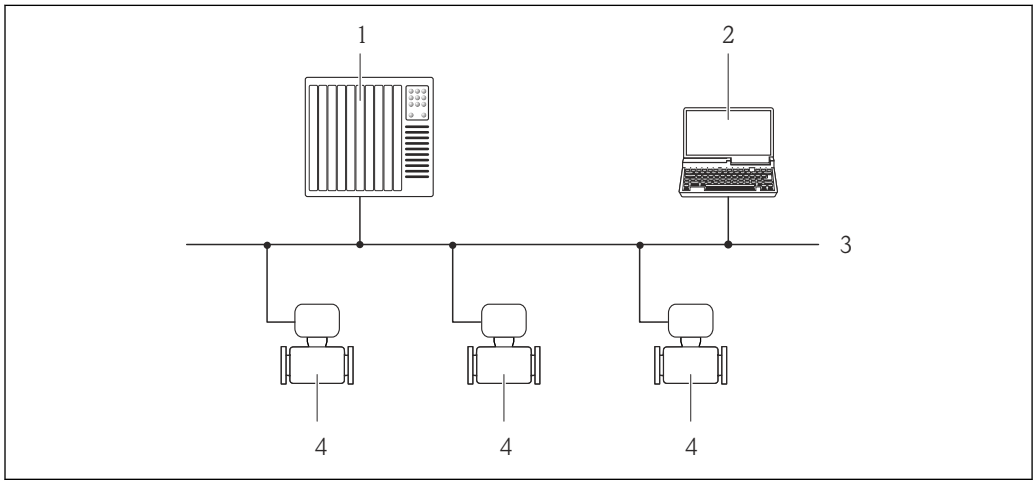
32 *Options for remote operation via HART protocol*

1 *Control system (e.g. PLC)*
2 *Field Communicator 475*
3 *Computer with operating tool (e.g. FieldCare, AMS Device Manager, SIMATIC PDM)*
4 *Commubox FXA195 (USB)*
5 *Field Xpert SFX350 or SFX370*
6 *Field Xpert SMT70*
7 *VIATOR Bluetooth modem with connecting cable*
8 *Transmitter*

Via PROFIBUS DP network

This communication interface is available in device versions with PROFIBUS DP.

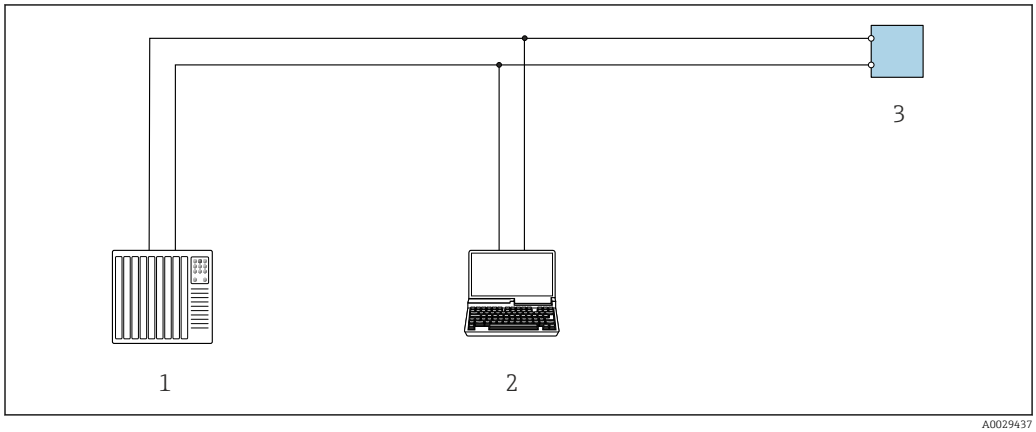


33 *Options for remote operation via PROFIBUS DP network*

1 *Automation system*
2 *Computer with PROFIBUS network card*
3 *PROFIBUS DP network*
4 *Measuring device*

Via Modbus RS485 protocol

This communication interface is available in device versions with a Modbus-RS485 output.



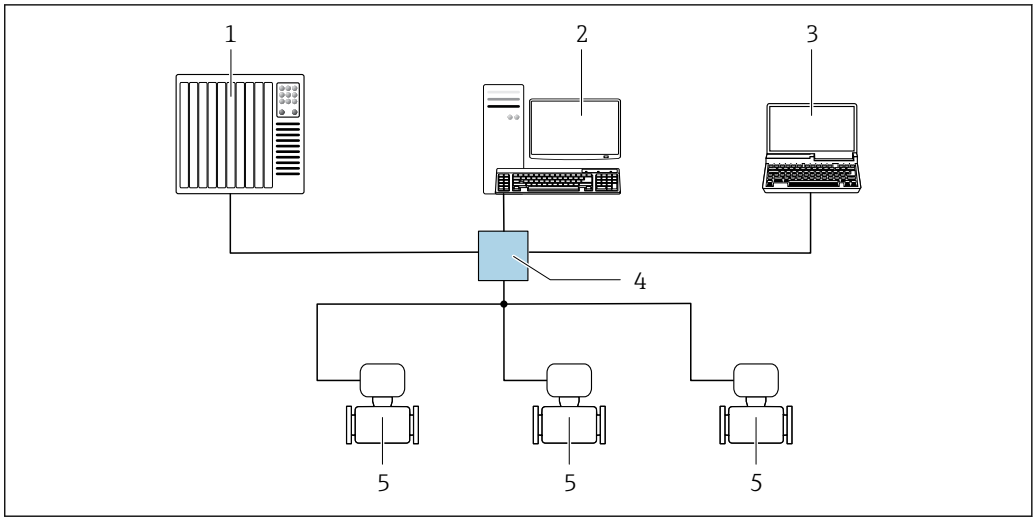
34 *Options for remote operation via Modbus-RS485 protocol (active)*

1 *Control system (e.g. PLC)*
2 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
3 *Transmitter*

Via EtherNet/IP network

This communication interface is available in device versions with EtherNet/IP.

Star topology



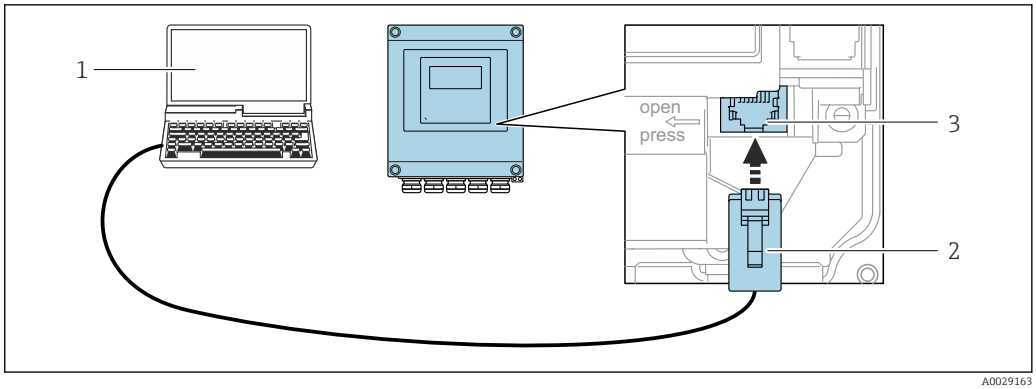
35 *Options for remote operation via EtherNet/IP network: star topology*

1 *Automation system, e.g. "RSLogix" (Rockwell Automation)*
2 *Workstation for measuring device operation: with Custom Add-On Profile for "RSLogix 5000" (Rockwell Automation) or with Electronic Data Sheet (EDS)*
3 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or computer with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP"*
4 *Ethernet switch*
5 *Measuring device*

Service interface

Via service interface (CDI-RJ45)

This communication interface is present in the following device version:
- Order code for "Output", option **H**: 4 to 20 mA HART, pulse/frequency output, switch output
- Order code for "Output", option **I**: 4 to 20 mA HART, 2 x pulse/frequency/switch output, status input
- Order code for "Output", option **J**: 4 to 20 mA HART, certified pulse output, switch output; status input
- Order code for "Output", option **L**: PROFIBUS DP
- Order code for "Output", option **M**: Modbus RS485
- Order code for "Output", option **O**: Modbus RS485, 4 to 20 mA, 2 x pulse/frequency/switch output
- Order code for "Output", option **P**: Modbus RS485, 4 to 20 mA, certified pulse output, pulse/frequency/switch output
- Order code for "Output", option **N**: EtherNet/IP

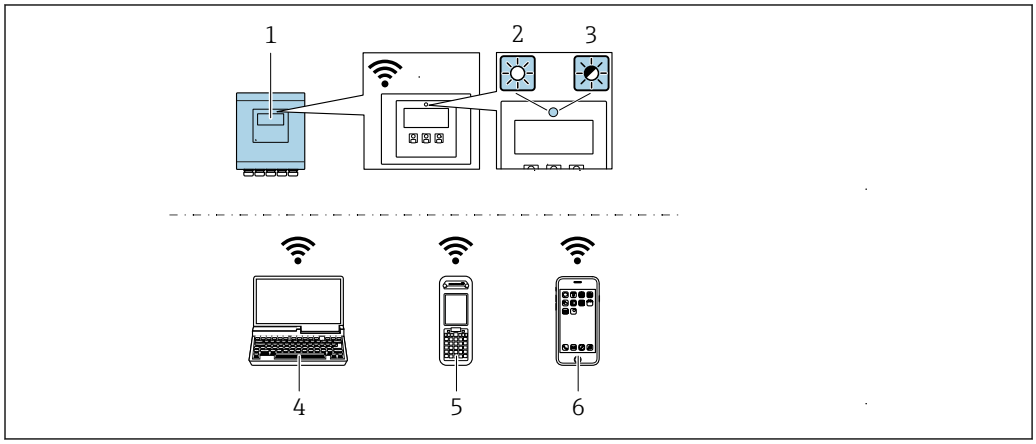


36 *Connection via service interface (CDI-RJ45)*

1 *Computer with Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with "FieldCare", "DeviceCare" operating tool with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
2 *Standard Ethernet connecting cable with RJ45 plug*
3 *Service interface (CDI-RJ45) of the measuring device with access to the integrated Web server*

Via WLAN interface

The optional WLAN interface is available on the following device version:
Order code for "Display", option BA "WLAN":
4-line, illuminated, graphic display; touch control + WLAN



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1 *Transmitter with integrated WLAN antenna*
2 *LED lit constantly: WLAN reception is enabled on measuring device*
3 *LED flashing: WLAN connection established between operating unit and measuring device*
4 *Computer with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare)*
5 *Mobile handheld terminal with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or operating tool (e.g. FieldCare, DeviceCare)*
6 *Smart phone or tablet (e.g. Field Xpert SMT70)*

Function	WLAN: IEEE 802.11 b/g (2.4 GHz) ▪ Access point with DHCP server (default setting) ▪ Network
Encryption	WPA2-PSK AES-128 (in accordance with IEEE 802.11i)
Configurable WLAN channels	1 to 11
Degree of protection	IP67
Available antenna	Internal antenna
Range	Typically 10 m (32 ft)

Supported operating tools

Different operating tools can be used for local or remote access to the measuring device. Depending on the operating tool used, access is possible with different operating units and via a variety of interfaces.

Supported operating tools	Operating unit	Interface	Additional information
Web browser	Notebook, PC or tablet with Web browser	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Ethernet-based fieldbus (EtherNet/IP)	Special Documentation for the device
DeviceCare SFE100	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 📄 105

Supported operating tools	Operating unit	Interface	Additional information
FieldCare SFE500	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 🖹 105
Device Xpert	Field Xpert SFX 100/350/370	Fieldbus protocol HART	Operating Instructions BA01202S Device description files: Use update function of handheld terminal

Other operating tools based on FDT technology with a device driver such as DTM/iDTM or DD/EDD can be used for device operation. These operating tools are available from the individual manufacturers. Integration into the following operating tools, among others, is supported:

- FactoryTalk AssetCentre (FTAC) from Rockwell Automation → www.rockwellautomation.com
- Process Device Manager (PDM) from Siemens → www.siemens.com
- Asset Management Solutions (AMS) from Emerson → www.emersonprocess.com
- FieldCommunicator 375/475 from Emerson → www.emersonprocess.com
- Field Device Manager (FDM) from Honeywell → www.honeywellprocess.com
- FieldMate from Yokogawa → www.yokogawa.com
- PACTWare → www.pactware.com

The related device description files are available: www.endress.com → Downloads

Web server

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

Supported functions
Data exchange between the operating unit (such as a notebook for example) and the measuring device:
- Upload the configuration from the measuring device (XML format, configuration backup)
- Save the configuration to the measuring device (XML format, restore configuration)
- Export event list (.csv file)
- Export parameter settings (.csv file or PDF file, document the measuring point configuration)
- Export the Heartbeat verification log (PDF file, only available with the "Heartbeat Verification" application package)
- Flash firmware version for device firmware upgrade, for instance
- Download driver for system integration
- Visualize up to 1000 saved measured values (only available with the **Extended HistoROM** application package → 🖹 103)

Web server special documentation → 🖹 106

HistoROM data management

The measuring device features HistoROM data management. HistoROM data management comprises both the storage and import/export of key device and process data, making operation and servicing far more reliable, secure and efficient.

Additional information on the data storage concept

There are different types of data storage units in which device data are stored and used by the device:

	HistoROM backup	T-DAT	S-DAT

Available data	▪ Event logbook such as diagnostic events for example
	▪ Device firmware package
	▪ Driver for system integration for exporting via Web server, e.g:
	  ▪ GSD for PROFIBUS DP
	  ▪ EDS for EtherNet/IP
		▪ Measured value logging ("Extended HistoROM" order option)
		▪ Current parameter data record (used by firmware at run time)
		▪ Peakhold indicator (min/max values)
		▪ Totalizer values
			▪ Sensor data: nominal diameter etc.
			▪ Serial number
			▪ Calibration data
			▪ Device configuration (e.g. SW options, fixed I/O or multi I/O)

Storage location	Fixed on the user interface board in the connection compartment	Attachable to the user interface board in the connection compartment	In the sensor plug in the transmitter neck part

Data backup

Automatic
- The most important device data (sensor and transmitter) are automatically saved in the DAT modules
- If the transmitter or measuring device is replaced: once the T-DAT containing the previous device data has been exchanged, the new measuring device is ready for operation again immediately without any errors
- If the sensor is replaced: once the sensor has been replaced, new sensor data are transferred from the S-DAT in the measuring device and the measuring device is ready for operation again immediately without any errors

Data transmission

Manual
- Transfer of a device configuration to another device using the export function of the specific operating tool, e.g. with FieldCare, DeviceCare or Web server: to duplicate the configuration or to store in an archive (e.g. for backup purposes)
- Transmission of the drivers for system integration via Web server, e.g.:
  - GSD for PROFIBUS DP
  - EDS for EtherNet/IP

Event list

Automatic
- Chronological display of up to 20 event messages in the events list
- If the **Extended HistoROM** application package (order option) is enabled: up to 100 event messages are displayed in the events list along with a time stamp, plain text description and remedial measures
- The events list can be exported and displayed via a variety of interfaces and operating tools e.g. DeviceCare, FieldCare or Web server

Data logging

Manual
If the **Extended HistoROM** application package (order option) is enabled:
- Record up to 1 000 measured values via 1 to 4 channels
- User configurable recording interval
- Record up to 250 measured values via each of the 4 memory channels
- Export the measured value log via a variety of interfaces and operating tools e.g. FieldCare, DeviceCare or web server

Certificates and approvals

Current certificates and approvals for the product are available via the Product Configurator at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.

The **Configuration** button opens the Product Configurator.

CE mark

The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

UKCA marking

The device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards. By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

RCM mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex approval

The devices are certified for use in hazardous areas and the relevant safety instructions are provided in the separate "Control Drawing" document. Reference is made to this document on the nameplate.

Drinking water approval

- ACS
- KTW/W270
- NSF 61
- WRAS BS 6920

HART certification

HART interface

The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications:
- Certified according to HART 7
- The device can also be operated with certified devices of other manufacturers (interoperability)

PROFIBUS conformity

PROFIBUS interface

The measuring device is registered with PI (PROFIBUS and PROFINET International). It meets all the requirements of PROFIBUS PA Profile 3.02 specifications and can also be operated with certified devices of other manufacturers (interoperability).

Modbus RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out.

EtherNet/IP certification

The measuring device is certified and registered by the ODVA (Open Device Vendor Association). The measuring system meets all the requirements of the following specifications:
- Certified in accordance with the ODVA Conformance Test
- EtherNet/IP Performance Test
- EtherNet/IP PlugFest compliance
- The device can also be operated with certified devices of other manufacturers (interoperability)

Radio approval

The measuring device has radio approval.

For detailed information regarding radio approval, see the Special Documentation → 106

Measuring instrument approval

The measuring device is (optionally) approved as a cold water meter (MI-001) for volume measurement in service subject to legal metrological control in accordance with the European Measuring Instruments Directive 2014/32/EU (MID).

The measuring device is qualified to OIML R49: 2013.

Other standards and guidelines

- EN 60529
  Degrees of protection provided by enclosures (IP code)
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements
- IEC/EN 61326-3-2
  Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements).
- ANSI/ISA-61010-1 (82.02.01)
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- CAN/CSA-C22.2 No. 61010-1-12
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment
- NAMUR NE 32
  Data retention in the event of a power failure in field and control instruments with microprocessors
- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics
- NAMUR NE 105
  Specifications for integrating fieldbus devices in engineering tools for field devices
- NAMUR NE 107
  Self-monitoring and diagnosis of field devices
- NAMUR NE 131
  Requirements for field devices for standard applications

Ordering information

Detailed ordering information is available for your nearest sales organization www.addresses.endress.com or in the Product Configurator under www.endress.com :

1. Click Corporate
2. Select the country
3. Click Products
4. Select the product using the filters and search field
5. Open the product page

The Configuration button to the right of the product image opens the Product Configurator.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Application packages

Many different application packages are available to enhance the functionality of the device. Such packages might be needed to address safety aspects or specific application requirements.

The application packages can be ordered with the device or subsequently from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Cleaning

Package	Description
Electrode cleaning circuit (ECC)	The electrode cleaning circuit (ECC) function has been developed to have a solution for applications where magnetite (Fe_3O_4) deposits frequently occur (e.g. hot water). Since magnetite is highly conductive this build up leads to measuring errors and ultimately to the loss of signal. The application package is designed to avoid build-up of very conductive matter and thin layers (typical of magnetite).

Diagnostics functions

Package	Description
Extended HistoROM	Comprises extended functions concerning the event log and the activation of the measured value memory. Event log: Memory volume is extended from 20 message entries (standard version) to up to 100 entries. Data logging (line recorder): ▪ Memory capacity for up to 1000 measured values is activated. ▪ 250 measured values can be output via each of the 4 memory channels. The recording interval can be defined and configured by the user. ▪ Measured value logs can be accessed via the local display or operating tool e.g. FieldCare, DeviceCare or Web server.

Heartbeat Technology

Package	Description
Heartbeat Verification +Monitoring	**Heartbeat Verification** Meets the requirement for traceable verification to DIN ISO 9001:2008 Chapter 7.6 a) "Control of monitoring and measuring equipment". ▪ Functional testing in the installed state without interrupting the process. ▪ Traceable verification results on request, including a report. ▪ Simple testing process via local operation or other operating interfaces. ▪ Clear measuring point assessment (pass/fail) with high test coverage within the framework of manufacturer specifications. ▪ Extension of calibration intervals according to operator's risk assessment. **Heartbeat Monitoring** Continuously supplies data, which are characteristic of the measuring principle, to an external condition monitoring system for the purpose of preventive maintenance or process analysis. These data enable the operator to: ▪ Draw conclusions - using these data and other information - about the impact process influences (such as corrosion, abrasion, buildup etc.) have on the measuring performance over time. ▪ Schedule servicing in time. ▪ Monitor the process or product quality, e.g. gas pockets.

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Device-specific accessories

For the transmitter

Accessories	Description
Promag 400 transmitter	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Output/input ▪ Display/operation ▪ Housing ▪ Software For details, see Installation Instructions EA00104D

Display guard	Is used to protect the display against impact or scoring, for example from sand in desert areas. Order number: 71228792 Installation Instructions EA01093D
Connecting cable for remote version	Coil current and electrode cables, various lengths, reinforced cables available on request.
Ground cable	Set, consisting of two ground cables for potential equalization.
Post mounting kit	Post mounting kit for transmitter.
Compact → Remote conversion kit	For converting a compact device version to a remote device version.
Conversion kit Promag 50/53 → Promag 400	For converting a Promag with transmitter 50/53 to a Promag 400.

For the sensor

Accessory	Description
Ground disks	Are used to ground the medium in lined measuring tubes to ensure proper measurement. For details, see Installation Instructions EA00070D

Communication-specific accessories

Accessories	Description
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB interface. Technical Information TI00404F
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI405C/07
HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. ▪ Technical Information TI00429F ▪ Operating Instructions BA00371F
Wireless HART adapter SWA70	Is used for the wireless connection of field devices. The WirelessHART adapter can be easily integrated into field devices and existing infrastructures, offers data protection and transmission safety and can be operated in parallel with other wireless networks with minimum cabling complexity. Operating Instructions BA00061S
Fieldgate FXA42	Is used to transmit the measured values of connected 4 to 20 mA analog measuring devices, as well as digital measuring devices ▪ Technical Information TI01297S ▪ Operating Instructions BA01778S ▪ Product page: www.endress.com/fxa42

Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt70
Field Xpert SMT77	The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1. ▪ Technical Information TI01418S ▪ Operating Instructions BA01923S ▪ Product page: www.endress.com/smt77

Service-specific accessories

Accessory	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Choice of measuring devices with industrial requirements ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, flow velocity and accuracy. ▪ Graphic illustration of the calculation results ▪ Determination of the partial order code, administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://portal.endress.com/webapp/applicator ▪ As a downloadable DVD for local PC installation.
W@M	W@M Life Cycle Management Improved productivity with information at your fingertips. Data relevant to a plant and its components is generated from the first stages of planning and during the asset's complete life cycle. W@M Life Cycle Management is an open and flexible information platform with online and on-site tools. Instant access for your staff to current, in-depth data shortens your plant's engineering time, speeds up procurement processes and increases plant uptime. Combined with the right services, W@M Life Cycle Management boosts productivity in every phase. For more information, see: www.endress.com/lifecyclemanagement
FieldCare	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Operating Instructions BA00027S and BA00059S
DeviceCare	Tool for connecting and configuring Endress+Hauser field devices. Innovation brochure IN01047S
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress +Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI00405C

System components

Accessories	Description
Memograph M graphic data manager	The Memograph M graphic data manager provides information on all the relevant measured variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a SD card or USB stick. ▪ Technical Information TI00133R ▪ Operating Instructions BA00247R

Supplementary documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Standard documentation

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
Proline Promag W	KA01266D

Transmitter Brief Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Proline 400	KA01263D	KA01420D	KA01419D	KA01418D

Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag W 400	BA01063D	BA01234D	BA01231D	BA01214D

Description of device parameters

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag 400	GP01043D	GP01044D	GP01045D	GP01046D

Supplementary device-dependent documentation

Special Documentation

Content	Documentation code
Display modules A309/A310	SD01793D
Information on Custody Transfer Measurement	SD02038D
Information on Custody Transfer Measurement	SD02561D

Content	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Web server	SD01811D	SD01813D	SD01812D	SD01814D
Heartbeat Verification + Monitoring	SD01847D	SD02569D	SD02568D	SD02570D

Installation Instructions

Content	Comment
Installation instructions for spare part sets and accessories	Documentation code: specified for each individual accessory → 🖹 103.

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.

EtherNet/IP™
Trademark of ODVA, Inc.

www.addresses.endress.com

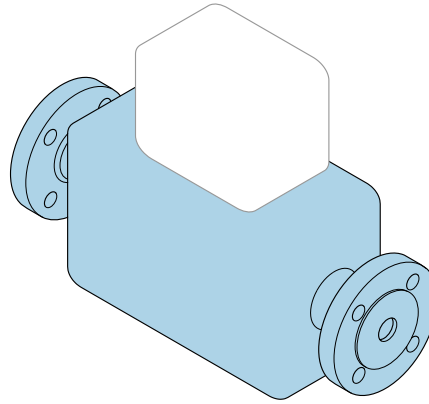
Endress+Hauser

People for Process Automation

KA01266D/06/EN/11.22-00
71574710
2022-08-01

Brief Operating Instructions **Flowmeter Proline Promag W**

Electromagnetic sensor

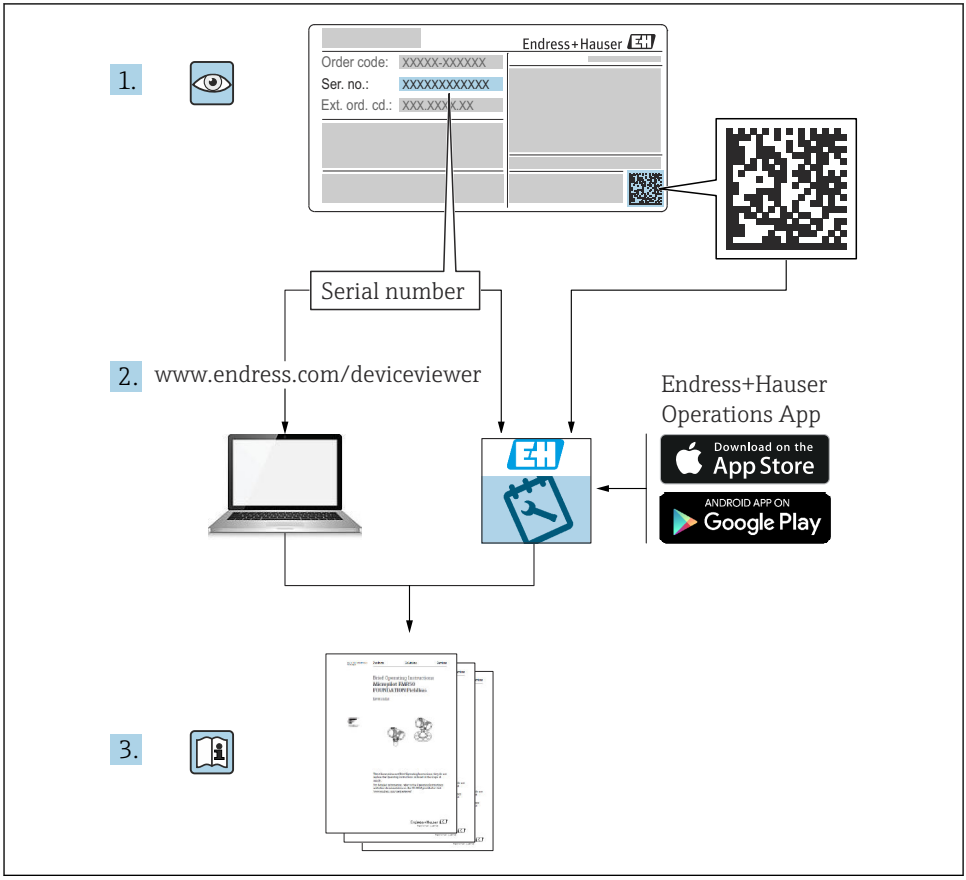


These Brief Operating Instructions are **not** a substitute for the Operating Instructions pertaining to the device.

Brief Operating Instructions Part 1 of 2: Sensor
Contain information about the sensor.

Brief Operating Instructions Part 2 of 2: Transmitter
→ 3.

Endress+Hauser
People for Process Automation


1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXXX
Ext. ord. cd.: XXX.XXX-XXX
Serial number
2.
www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the
App Store
ANDROID APP ON
Google Play
3.

A0023555

Brief Operating Instructions for flowmeter

The device consists of a transmitter and a sensor.

The process of commissioning these two components is described in two separate manuals that together form the Brief Operating Instructions for the flowmeter:
- Brief Operating Instructions Part 1: Sensor
- Brief Operating Instructions Part 2: Transmitter

Please refer to both parts of the Brief Operating Instructions when commissioning the device, as the contents of the manuals complement one another:

Brief Operating Instructions Part 1: Sensor
The Sensor Brief Operating Instructions are aimed at specialists with responsibility for installing the measuring device.
- Incoming acceptance and product identification
- Storage and transport
- Installation

Brief Operating Instructions Part 2: Transmitter
The Transmitter Brief Operating Instructions are aimed at specialists with responsibility for commissioning, configuring and parameterizing the measuring device (until the first measured value).
- Product description
- Installation
- Electrical connection
- Operation options
- System integration
- Commissioning
- Diagnostic information

Additional device documentation

These Brief Operating Instructions are the **Brief Operating Instructionspart 1: Sensor**.

The "Brief Operating Instructions part 2: Transmitter" are available via:
- Internet: www.endress.com/deviceviewer
- Smart phone/tablet: *Endress+Hauser Operations App*

Detailed information about the device can be found in the Operating Instructions and the other documentation:
- Internet: www.endress.com/deviceviewer
- Smart phone/tablet: *Endress+Hauser Operations App*

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1 About this document

1.1 Symbols

1.1.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.1.2 Symbols for certain types of information

Symbol	Meaning	Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.		**Preferred** Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.		**Tip** Indicates additional information.
	Reference to documentation		Reference to page
	Reference to graphic	1., 2., 3...	Series of steps
	Result of a step		Visual inspection

1.1.3 Electrical symbols

Symbol	Meaning	Symbol	Meaning
	Direct current		Alternating current
	Direct current and alternating current		**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.

Symbol	Meaning
	Potential equalization connection (PE: protective earth) Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: ▪ Interior ground terminal: potential equalization is connected to the supply network. ▪ Exterior ground terminal: device is connected to the plant grounding system.

1.1.4 Tool symbols

Symbol	Meaning	Symbol	Meaning
	Torx screwdriver		Flat-blade screwdriver
	Phillips head screwdriver		Allen key
	Open-ended wrench		

1.1.5 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3,...	Item numbers	1., 2., 3...	Series of steps
A, B, C, ...	Views	**A-A, B-B, C-C, ...**	Sections
	Hazardous area		Safe area (non-hazardous area)
	Flow direction		

2 Basic safety instructions

2.1 Requirements for the personnel

The personnel must fulfill the following requirements for its tasks:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

2.2 Intended use

Application and media
The measuring device is intended only for the flow measurement of liquids with a minimum conductivity of 5 µS/cm.

Depending on the version ordered, the measuring device can also measure potentially explosive, flammable, poisonous and oxidizing media.

Measuring devices for use in hazardous areas, in hygienic applications or in applications where there is an increased risk due to process pressure, are marked accordingly on the nameplate.

To ensure that the measuring device remains in proper condition for the operation time:
- Keep within the specified pressure and temperature range.
- Only use the measuring device in full compliance with the data on the nameplate and the general conditions listed in the Operating Instructions and supplementary documentation.
- Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area (e.g. explosion protection, pressure vessel safety).
- Use the measuring device only for media to which the process-wetted materials are sufficiently resistant.
- If the ambient temperature of the measuring device is outside the atmospheric temperature, it is absolutely essential to comply with the relevant basic conditions as specified in the device documentation.

- Protect the measuring device permanently against corrosion from environmental influences.

Promag 400

The measuring device is optionally tested in accordance with OIML R49: 2006 and has an EC type-examination certificate according to Measuring Instruments Directive 2004/22/EC (MID) for service subject to legal metrological control ("custody transfer") for cold water (Annex MI-001).

The permitted medium temperature in these applications is 0 to 50 °C (32 to 122 °F).

Promag 800

The measuring device is optionally tested in accordance with OIML R49: 2013 and has an EC type-examination certificate according to Measuring Instruments Directive 2004/22/EC (MID) for service subject to legal metrological control ("custody transfer") for cold water (Annex MI-001).

Incorrect use

Non-designated use can compromise safety. The manufacturer is not liable for damage caused by improper or non-designated use.

WARNING

Danger of breakage due to corrosive or abrasive fluids and ambient conditions!

- Verify the compatibility of the process fluid with the sensor material.
- Ensure the resistance of all fluid-wetted materials in the process.
- Keep within the specified pressure and temperature range.

NOTICE

Verification for borderline cases:

- For special fluids and fluids for cleaning, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of fluid-wetted materials, but does not accept any warranty or liability as minute changes in the temperature, concentration or level of contamination in the process can alter the corrosion resistance properties.

Residual risks

WARNING

If the temperature of the media or electronics unit is high or low, this may cause the surfaces of the device to become hot or cold. This poses a risk of burns or frostbite!

- In the case of hot or cold medium temperatures, install appropriate protection against contact.

2.3 Workplace safety

When working on and with the device:

- Wear the required personal protective equipment as per national regulations.

2.4 Operational safety

Risk of injury!
- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Ambient requirements for transmitter housing made of plastic

If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing.
- If you are unsure, please contact your Endress+Hauser Sales Center for clarification.
- If used in an approval-related area, observe the information on the nameplate.

2.5 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

Furthermore, the device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards.

By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

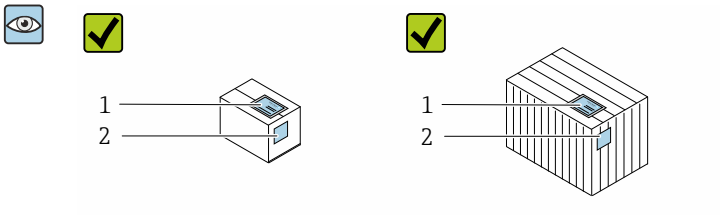
2.6 IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

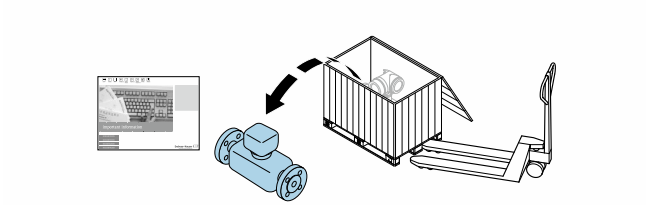
IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Incoming acceptance and product identification

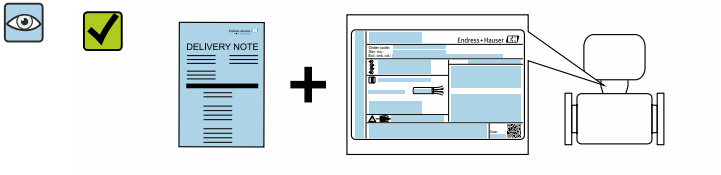
3.1 Incoming acceptance



Are the order codes on the delivery note (1) and the product sticker (2) identical?



Are the goods undamaged?



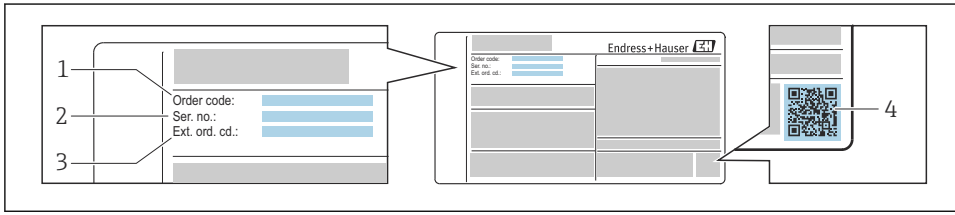
Do the data on the nameplate match the ordering information on the delivery note?

Is the envelope present with accompanying documents?

- If one of the conditions is not satisfied, contact your Endress+Hauser Sales Center.
- The Technical Documentation is available via the Internet or via the *Endress+Hauser Operations App*.

3.2 Product identification

The following options are available for identification of the device:
- Nameplate specifications
- Order code with breakdown of the device features on the delivery note
- Enter the serial numbers from the nameplates in the *Device Viewer* (www.endress.com/deviceviewer): all the information about the device is displayed.
- Enter the serial numbers from the nameplates into the *Endress+Hauser Operations App* or scan the DataMatrix code on the nameplate with the *Endress+Hauser Operations App*: all the information about the device is displayed.



A0030196

1 Example of a nameplate

1 Order code
2 Serial number (Ser. no.)
3 Extended order code (Ext. ord. cd.)
4 2-D matrix code (QR code)

For detailed information on the breakdown of the specifications on the nameplate, see the Operating Instructions for the device .

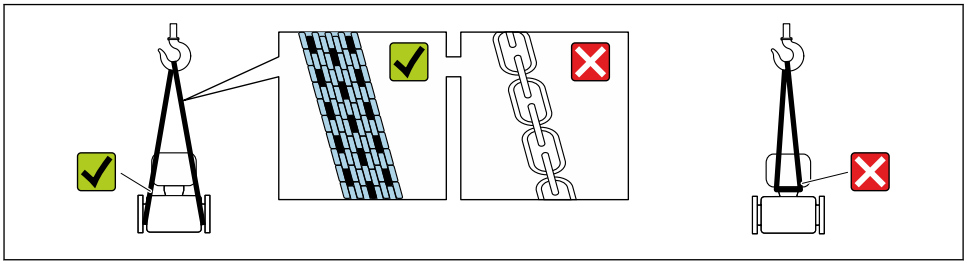
4 Storage and transport

4.1 Storage conditions

Observe the following notes for storage:
- Store in the original packaging to ensure protection from shock.
- Do not remove protective covers or protective caps installed on process connections. They prevent mechanical damage to the sealing surfaces and contamination in the measuring pipe.
- Protect from direct sunlight to avoid unacceptably high surface temperatures.
- Select a storage location where moisture cannot collect in the measuring device as fungus and bacteria infestation can damage the liner.
- Store in a dry and dust-free place.
- Do not store outdoors.

4.2 Transporting the product

Transport the measuring device to the measuring point in the original packaging.



A0029252

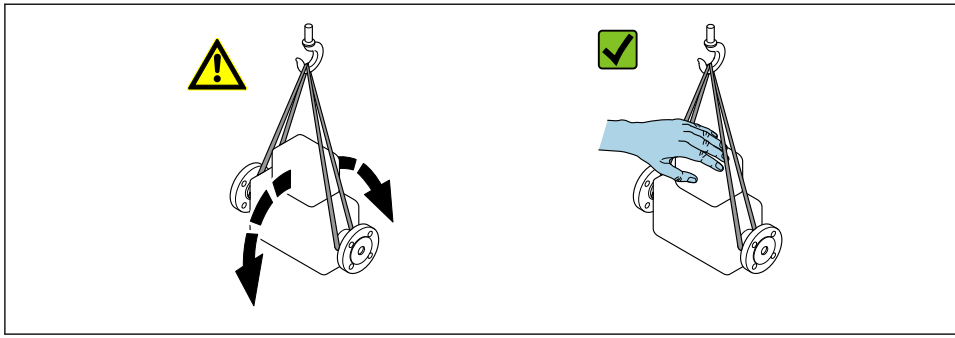
Do not remove protective covers or caps installed on process connections. They prevent mechanical damage to the sealing surfaces and contamination in the measuring tube.

4.2.1 Measuring devices without lifting lugs

WARNING

Center of gravity of the measuring device is higher than the suspension points of the webbing slings.

Risk of injury if the measuring device slips.
- Secure the measuring device against slipping or turning.
- Observe the weight specified on the packaging (stick-on label).



A0029214

4.2.2 Measuring devices with lifting lugs

⚠ CAUTION

Special transportation instructions for devices with lifting lugs

- ▶ Only use the lifting lugs fitted on the device or flanges to transport the device.
- ▶ The device must always be secured at two lifting lugs at least.

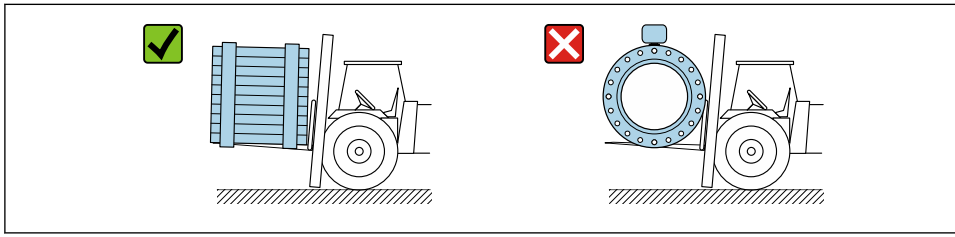
4.2.3 Transporting with a fork lift

If transporting in wood crates, the floor structure enables the crates to be lifted lengthwise or at both sides using a forklift.

⚠ CAUTION

Risk of damaging the magnetic coil

- ▶ If transporting by forklift, do not lift the sensor by the metal casing.
- ▶ This would buckle the casing and damage the internal magnetic coils.



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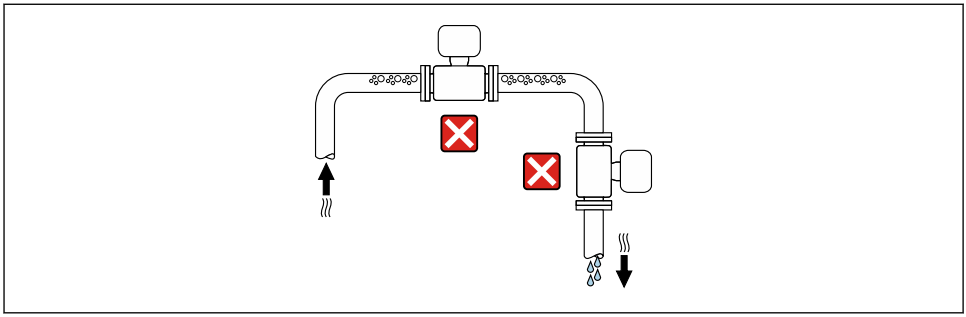
5 Mounting

5.1 Mounting requirements

5.1.1 Mounting position

Mounting location

- Do not install the device at the highest point of the pipe.
- Do not install the device upstream from a free pipe outlet in a down pipe.



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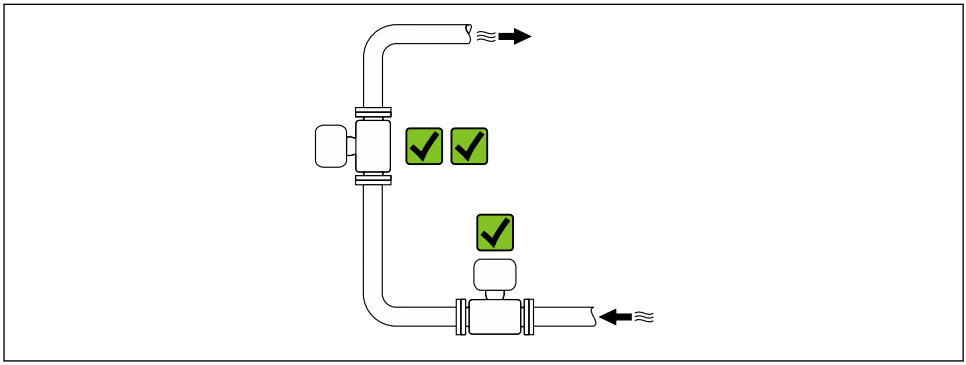
The device should ideally be installed in an ascending pipe.



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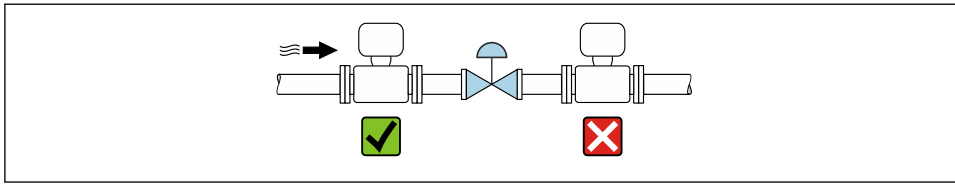
Installation near valves

Install the device in the direction of flow upstream from the valve.



A0041091

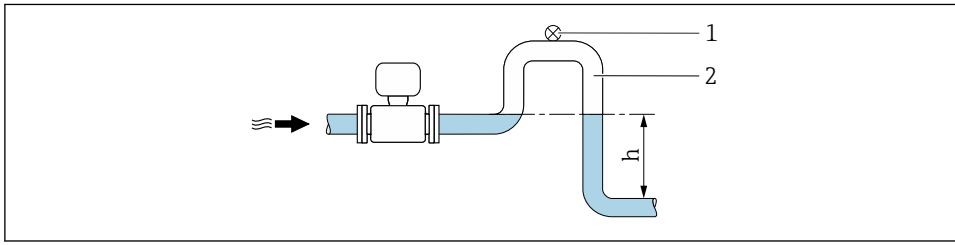
Installation upstream from a down pipe

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- ▶ If installing upstream of down pipes whose length h ≥ 5 m (16.4 ft): install a siphon with a vent valve downstream of the device.

This arrangement prevents the flow of liquid stopping in the pipe and air entrainment.



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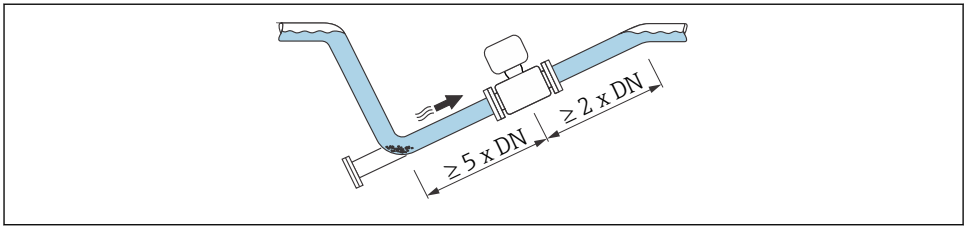
1 Vent valve
2 Pipe siphon
h Length of down pipe

Installation with partially filled pipes

- Partially filled pipes with a gradient require a drain-type configuration.
- The installation of a cleaning valve is recommended.



A0041088

No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

No inlet and outlet runs for devices with the order code for "Design": Option C, H or I.

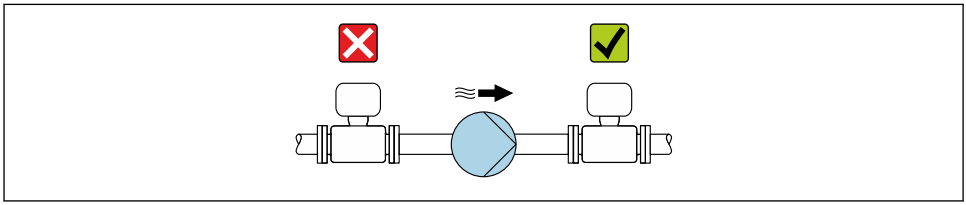
No inlet and outlet runs for devices with the order code for "Design": Option C.

Installation near pumps

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- In order to maintain the system pressure, install the device in the flow direction downstream from the pump.
- Install pulsation dampers if reciprocating, diaphragm or peristaltic pumps are used.



A0041083

Installation of very heavy devices

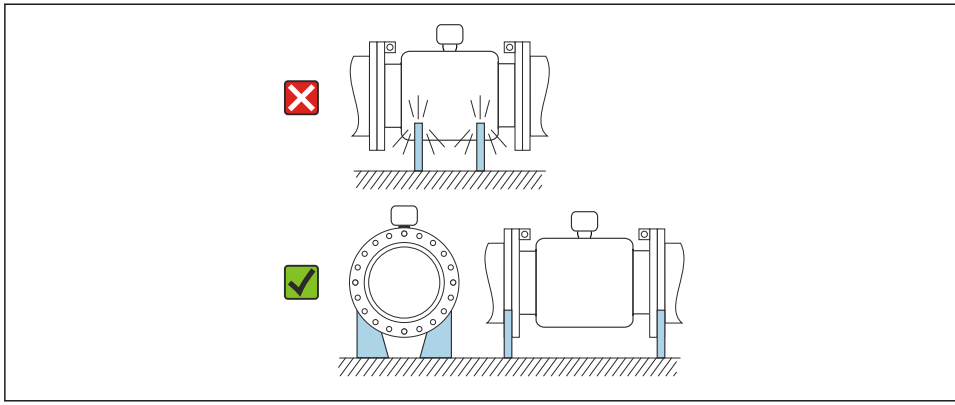
Support required for nominal diameters of DN ≥ 350 mm (14 in).

NOTICE

Damage to the device!

If incorrect support is provided, the sensor housing could buckle and the internal magnetic coils could be damaged.

- Only provide supports at the pipe flanges.



A0041087

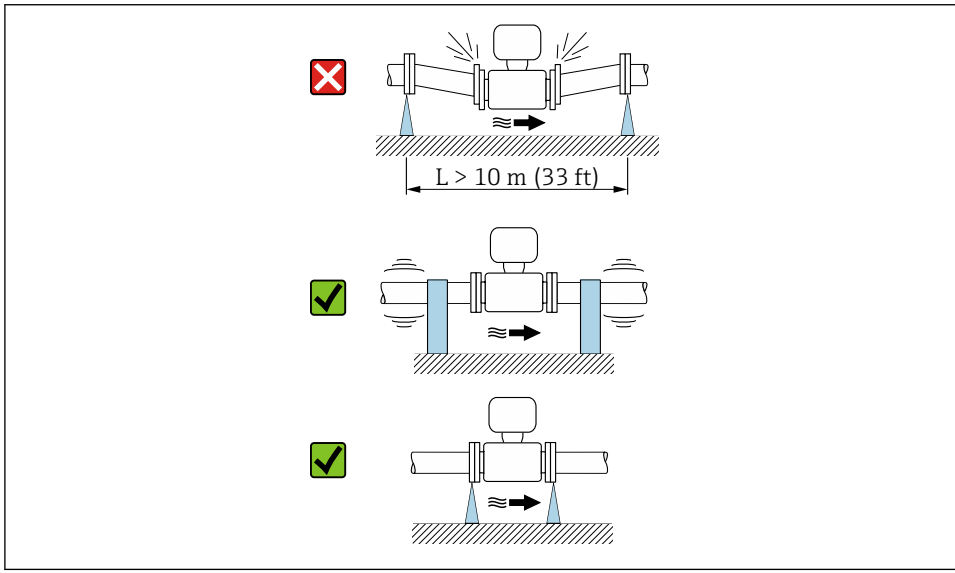
Installation in event of pipe vibrations

A remote version is recommended in the event of strong pipe vibrations.

NOTICE

Pipe vibrations can damage the device!

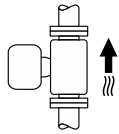
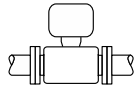
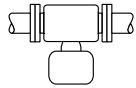
- ▶ Do not expose the device to strong vibrations.
- ▶ Support the pipe and fix it in place.
- ▶ Support the device and fix it in place.
- ▶ Mount the sensor and transmitter separately.



A0041092

Orientation

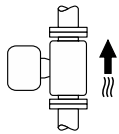
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction.

Orientation		Recommendation
Vertical orientation	 A0015591	✓✓
Horizontal orientation, transmitter at top	 A0015589	✓✓ 1)
Horizontal orientation, transmitter at bottom	 A0015590	✓✓ 2) 3) ✗ 4)
Horizontal orientation, transmitter at side	A0015592	✗

1) Applications with low process temperatures may reduce the ambient temperature. To maintain the minimum ambient temperature for the transmitter, this orientation is recommended.
2) Applications with high process temperatures may increase the ambient temperature. To maintain the maximum ambient temperature for the transmitter, this orientation is recommended.
3) To prevent the electronics from overheating in the event of strong heat formation (e.g. CIP or SIP cleaning process), install the device with the transmitter part pointing downwards.
4) When the empty pipe detection function is switched on, empty pipe detection only works if the transmitter housing is pointing upwards.

Vertical

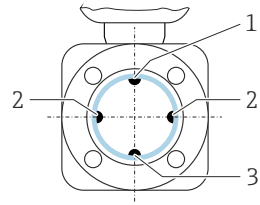
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



A0015591

Horizontal

- Ideally, the measuring electrode plane should be horizontal. This prevents brief insulation of the measuring electrodes by entrained air bubbles.
- Empty pipe detection only works if the transmitter housing is pointing upwards as otherwise there is no guarantee that the empty pipe detection function will actually respond to a partially filled or empty measuring tube.



A0029344

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Inlet and outlet runs

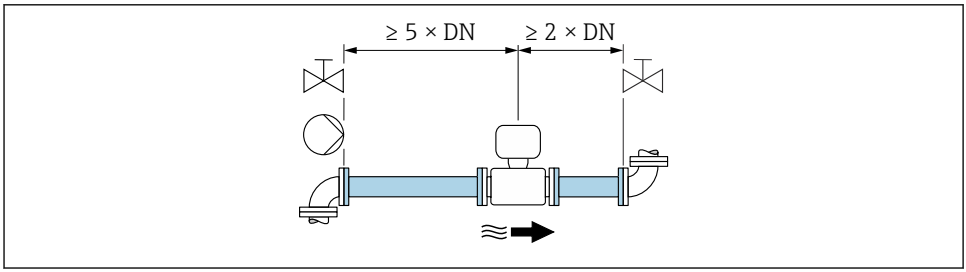
Installation with inlet and outlet runs

Installation requires inlet and outlet runs: devices with the order code for "Design", option D, E, F and G.

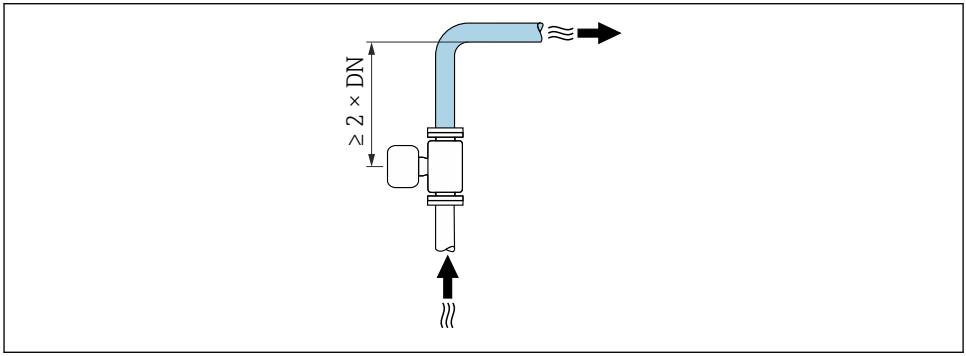
Installation with elbows, pumps or valves

To avoid a vacuum and to maintain the specified level of accuracy, if possible install the device upstream from assemblies that produce turbulence (e.g. valves, T-sections) and downstream from pumps.

Maintain straight, unimpeded inlet and outlet runs.



A0028997



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Installation without inlet and outlet runs

Depending on the device design and installation location, the inlet and outlet runs can be reduced or omitted entirely.

Maximum measured error
When the device is installed with the inlet and outlet runs described, a maximum measured error of ±0.5 % of the reading ±1 mm/s (0.04 in/s) ±2 mm/s (0.08 in/s) can be guaranteed.

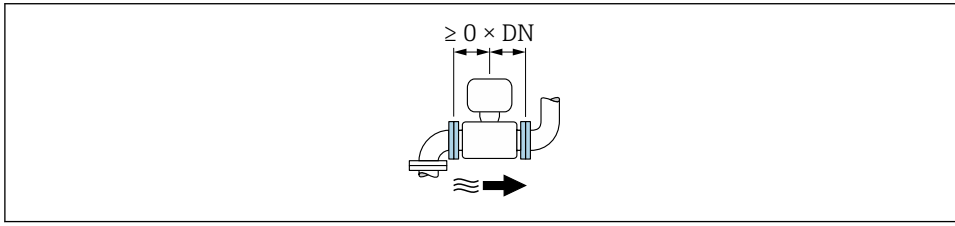
Devices and possible order options

Order code for "Design"		
Option	**Description**	**Design**
C	Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs	Constricted measuring tube [1]
H	Lap joint flange, 0 x DN inlet/outlet runs	Full Bore [2]
I	Fixed flange, 0 x DN inlet/outlet runs	
J	Fixed flange, short installed length, 0 x DN inlet/outlet runs	
K	Fixed flange, long installed length, 0 x DN inlet/outlet runs	

1) "Constricted measuring tube" stands for a reduction of the internal diameter of the measuring tube. The reduced internal diameter causes a higher flow velocity inside the measuring tube.
2) "Full Bore" stands for the full diameter of the measuring tube. There is no pressure loss with a full diameter.

Installation before or after bends

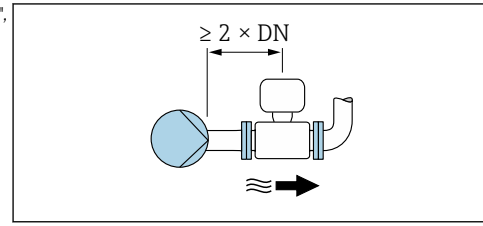
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

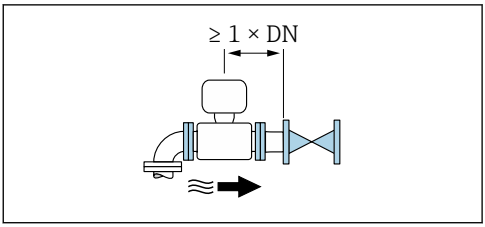
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

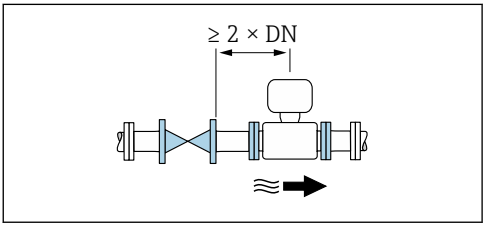
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



Installation downstream of valves

Installation without inlet and outlet runs is possible if the valve is 100% open during operation: devices with the order code for "Design", option C, H and I.

In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration if the valve is 100% open during operation.



5.1.2 Environmental and process-specific requirements

Ambient temperature range

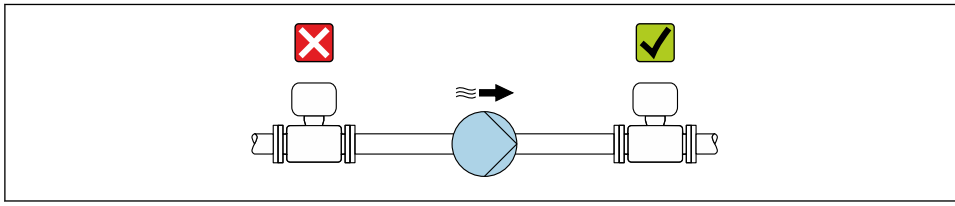
For detailed information on the ambient temperature range, see the Operating Instructions for the device.

If operating outdoors:
- Install the measuring device in a shady location.
- Avoid direct sunlight, particularly in warm climatic regions.
- Avoid direct exposure to weather conditions.

Temperature tables

For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.

System pressure



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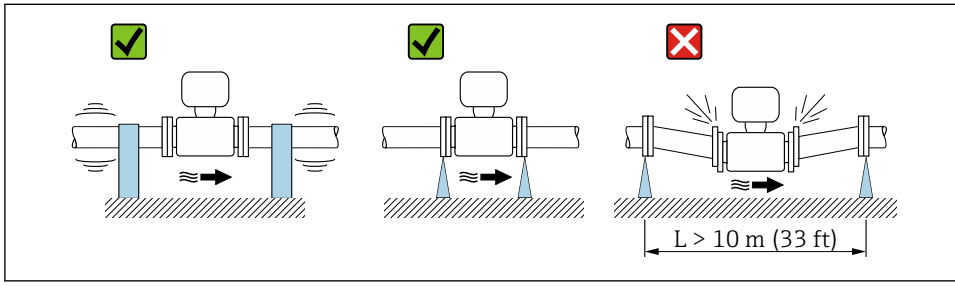
Furthermore, install pulse dampers if reciprocating, diaphragm or peristaltic pumps are used.

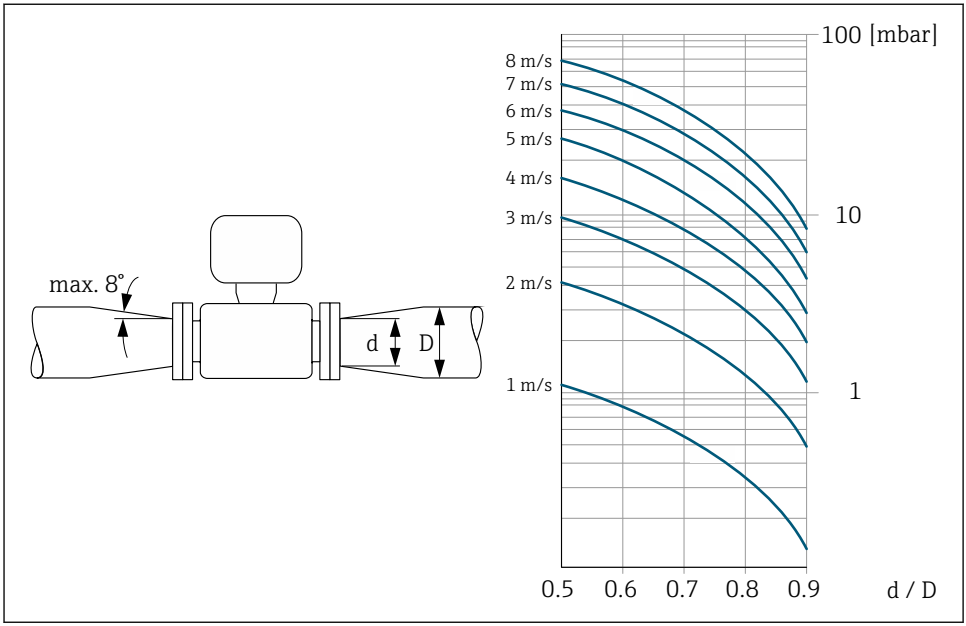
Vibrations



A0029004

2 *Measures to prevent vibration of the device*

Adapters



A0029002

5.1.3 Special mounting instructions

Display guard

▶ To ensure that the optional display guard can be easily opened, maintain the following minimum head clearance: 350 mm (13.8 in)

Degree of protection IP68, Type 6P enclosure, with "Cust-potted" option

Depending on the version, the sensor fulfills all the requirements for the IP68 degree of protection, Type 6P enclosure and can be used as a remote version.

The degree of protection of the transmitter is always only IP66/67, Type 4X enclosure and the transmitter must therefore be treated accordingly.

To guarantee IP68 degree of protection, Type 6P enclosure for the "Cust-potted" options, carry out the following steps after the electrical connection:

1. Firmly tighten the cable glands (torque: 2 to 3.5 Nm) until there is no gap between the bottom of the cover and the housing support surface.
2. Firmly tighten the union nut of the cable glands.
3. Pot the field housing with a potting compound.
4. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
5. Tighten all housing screws and screw covers (torque: 20 to 30 Nm).

Promag W 10, 400, 500

Immersion in water

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

▶ Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

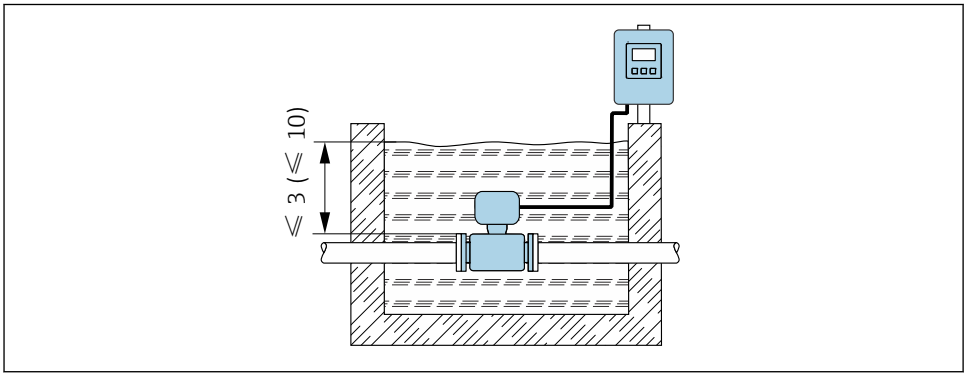
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof"

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



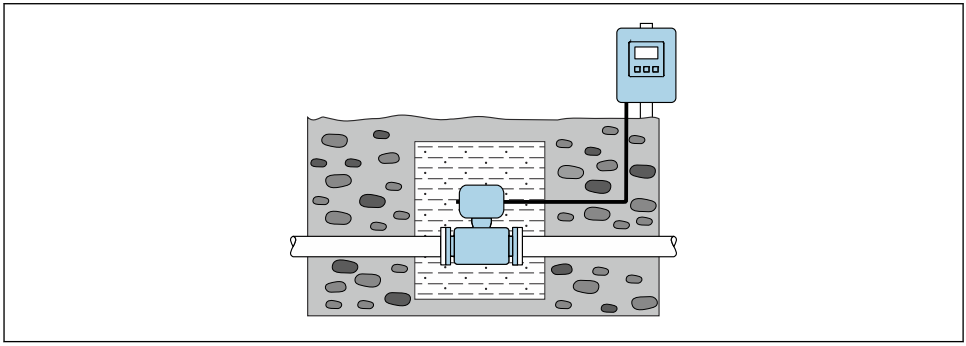
A0042412

Use in buried applications

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

For the use of the device in buried applications.



A0042646

Promag W 800

For immersion in water, Proline 800

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

► Observe the maximum water depth and operating duration.

Order code for "Sensor option", option CQ "Temporarily water-proof "

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

For immersion in water, Proline 800 - Advanced

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

► Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

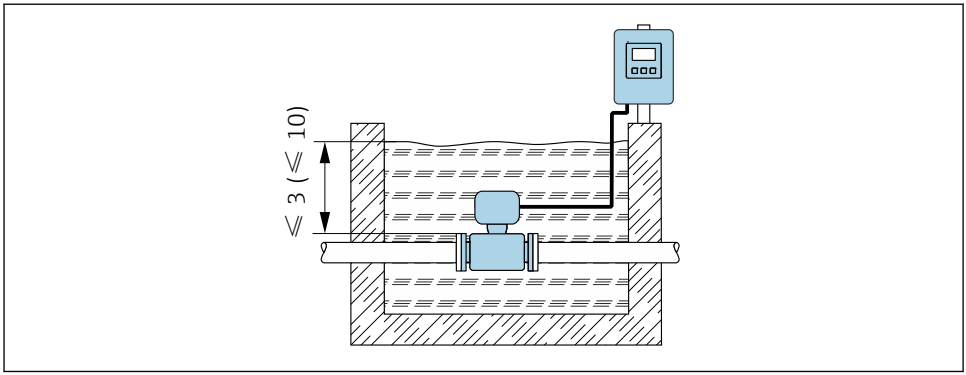
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof"

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



A0042412

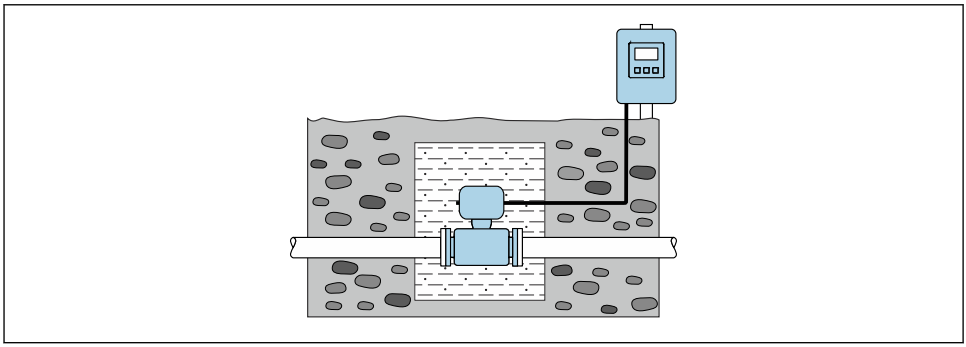
3 *Installation for permanent immersion in water*

For use in buried applications, Proline 800 - Advanced

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

For the use of the device in buried applications.



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5.2 Mounting the measuring device

5.2.1 Required tools

For flanges and other process connections, use an appropriate mounting tool

5.2.2 Preparing the measuring device

1. Remove all remaining transport packaging.
2. Remove any protective covers or protective caps present from the sensor.
3. Remove stick-on label on the electronics compartment cover.

5.2.3 Mounting the sensor

⚠ WARNING

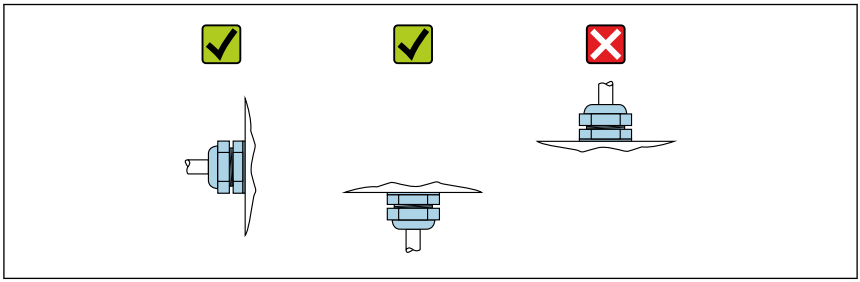
An electrically conductive layer could form on the inside of the measuring tube!
Risk of measuring signal short circuit.
- ▶ Ensure that the inside diameters of the gaskets are greater than or equal to that of the process connections and piping.
- ▶ Ensure that the gaskets are clean and undamaged.
- ▶ Install the gaskets correctly.
- ▶ Do not use electrically conductive sealing compounds such as graphite.

⚠ WARNING

Danger due to improper process sealing!
- ▶ Ensure that the inside diameters of the gaskets are greater than or equal to that of the process connections and piping.
- ▶ Ensure that the seals are clean and undamaged.
- ▶ Secure the seals correctly.

1. Ensure that the direction of the arrow on the sensor matches the flow direction of the medium.
2. To ensure compliance with device specifications, install the measuring device between the pipe flanges in a way that it is centered in the measurement section.
3. If using ground disks, comply with the Installation Instructions provided.
4. Observe required screw tightening torques .

5. Install the measuring device or turn the transmitter housing so that the cable entries do not point upwards.



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Mounting the seals

CAUTION

An electrically conductive layer could form on the inside of the measuring tube!
Risk of measuring signal short circuit.
► Do not use electrically conductive sealing compounds such as graphite.

Comply with the following instructions when installing seals:
- Make sure that the seals do not protrude into the piping cross-section.
- When mounting the process connections, make sure that the seals concerned are clean and centered correctly.
- For DIN flanges: only use seals according to DIN EN 1514-1.
- For "hard rubber" lining: additional seals are **always** required.
- For "polyurethane" lining: generally additional seals are **not** required.
- For "PTFE" lining: generally additional seals are **not** required.

Mounting the ground cable/ground disks

For information on potential equalization and detailed mounting instructions for the use of ground cables/ground disks, see the Transmitter Brief Operating Instructions.

Screw tightening torques

→ 33

5.3 Post-installation check

Is the device undamaged (visual inspection)?	❑
Does the measuring device conform to the measuring point specifications? For example: ▪ Process temperature ▪ Process pressure (refer to the "Pressure-temperature ratings" section of the "Technical Information" document) ▪ Ambient temperature ▪ Measuring range	❑
Has the correct orientation been selected for the sensor → 🖹 18 ? ▪ According to sensor type ▪ According to medium temperature ▪ According to medium properties (outgassing, with entrained solids)	❑
Does the arrow on the sensor nameplate match the actual direction of flow of the fluid through the piping → 🖹 18?	❑
Are the measuring point identification and labeling correct (visual inspection)?	❑
Is the device adequately protected from precipitation and direct sunlight?	❑
Have the fixing screws been tightened with the correct tightening torque?	❑

6 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

6.1 Removing the measuring device

1. Switch off the device.

⚠ WARNING

Danger to persons from process conditions!

- Beware of hazardous process conditions such as pressure in the measuring device, high temperatures or aggressive fluids.

2. Carry out the mounting and connection steps from the "Mounting the measuring device" and "Connecting the measuring device" sections in reverse order. Observe the safety instructions.

6.2 Disposing of the measuring device

⚠ WARNING

Danger to personnel and environment from fluids that are hazardous to health.

- Ensure that the measuring device and all cavities are free of fluid residues that are hazardous to health or the environment, e.g. substances that have permeated into crevices or diffused through plastic.

Observe the following notes during disposal:

- Observe valid federal/national regulations.
- Ensure proper separation and reuse of the device components.

7 Appendix

7.1 Screw tightening torques

For detailed information on the screw tightening torques, see the "Mounting the sensor" section of the Operating Instructions for the device

Please note the following:
- The torques listed only apply:
  - For lubricated threads.
  - For pipes that are free from tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Maximum screw tightening torques for EN 1092-1 (DIN 2501)

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
25	1	PN 40	4 × M12	18	–	15	26
32	–	PN 40	4 × M16	18	–	24	41
40	1 ½	PN 40	4 × M16	18	–	31	52
50	2	PN 40	4 × M16	20	48	40	65
65 [1)]	–	PN 16	8 × M16	18	32	27	44
65	–	PN 40	8 × M16	22	32	27	44
80	3	PN 16	8 × M16	20	40	34	53
		PN 40	8 × M16	24	40	34	53
100	4	PN 16	8 × M16	20	43	36	57
		PN 40	8 × M20	24	59	50	79
125	–	PN 16	8 × M16	22	56	48	75
		PN 40	8 × M24	26	83	71	112
150	6	PN 16	8 × M20	22	74	63	99
		PN 40	8 × M24	28	104	88	137
200	8	PN 10	8 × M20	24	106	91	141
		PN 16	12 × M20	24	70	61	94
		PN 25	12 × M24	30	104	92	139
250	10	PN 10	12 × M20	26	82	71	110
		PN 16	12 × M24	26	98	85	132
		PN 25	12 × M27	32	150	134	201

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
300	12	PN 10	12 × M20	26	94	81	126
		PN 16	12 × M24	28	134	118	179
		PN 25	16 × M27	34	153	138	204
350	14	PN 6	12 × M20	22	111	120	–
		PN 10	16 × M20	26	112	118	–
		PN 16	16 × M24	30	152	165	–
		PN 25	16 × M30	38	227	252	–
400	16	PN 6	16 × M20	22	90	98	–
		PN 10	16 × M24	26	151	167	–
		PN 16	16 × M27	32	193	215	–
		PN 25	16 × M33	40	289	326	–
450	18	PN 6	16 × M20	22	112	126	–
		PN 10	20 × M24	28	153	133	–
		PN 16	20 × M27	40	198	196	–
		PN 25	20 × M33	46	256	253	–
500	20	PN 6	20 × M20	24	119	123	–
		PN 10	20 × M24	28	155	171	–
		PN 16	20 × M30	34	275	300	–
		PN 25	20 × M33	48	317	360	–
600	24	PN 6	20 × M24	30	139	147	–
		PN 10	20 × M27	28	206	219	–
600	24	PN 16	20 × M33	36	415	443	–
600	24	PN 25	20 × M36	58	431	516	–
700	28	PN 6	24 × M24	24	148	139	–
		PN 10	24 × M27	30	246	246	–
		PN 16	24 × M33	36	278	318	–
		PN 25	24 × M39	46	449	507	–
800	32	PN 6	24 × M27	24	206	182	–
		PN 10	24 × M30	32	331	316	–
		PN 16	24 × M36	38	369	385	–
		PN 25	24 × M45	50	664	721	–

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
900	36	PN 6	24 × M27	26	230	637	–
		PN 10	28 × M30	34	316	307	–
		PN 16	28 × M36	40	353	398	–
		PN 25	28 × M45	54	690	716	–
1000	40	PN 6	28 × M27	26	218	208	–
		PN 10	28 × M33	34	402	405	–
		PN 16	28 × M39	42	502	518	–
		PN 25	28 × M52	58	970	971	–
1200	48	PN 6	32 × M30	28	319	299	–
		PN 10	32 × M36	38	564	568	–
		PN 16	32 × M45	48	701	753	–
1400	–	PN 6	36 × M33	32	430	–	–
		PN 10	36 × M39	42	654	–	–
		PN 16	36 × M45	52	729	–	–
1600	–	PN 6	40 × M33	34	440	–	–
		PN 10	40 × M45	46	946	–	–
		PN 16	40 × M52	58	1007	–	–
1800	72	PN 6	44 × M36	36	547	–	–
		PN 10	44 × M45	50	961	–	–
		PN 16	44 × M52	62	1108	–	–
2000	–	PN 6	48 × M39	38	629	–	–
		PN 10	48 × M45	54	1047	–	–
		PN 16	48 × M56	66	1324	–	–
2200	–	PN 6	52 × M39	42	698	–	–
		PN 10	52 × M52	58	1217	–	–
2400	–	PN 6	56 × M39	44	768	–	–
		PN 10	56 × M52	62	1229	–	–

1) Sizing as per EN 1092-1 (not DIN 2501)

Nominal screw tightening torques for EN 1092-1 (DIN 2501); calculated according to EN 1591-1:2014 for flanges according to EN 1092-1:2013

Nominal diameter		Pressure rating	Screws	Flange thickness	Nom. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
350	14	PN 6	12 × M20	22	60	75	–
		PN 10	16 × M20	26	70	80	–
		PN 16	16 × M24	30	125	135	–
		PN 25	16 × M30	38	230	235	–
400	16	PN 6	16 × M20	22	65	70	–
		PN 10	16 × M24	26	100	120	–
		PN 16	16 × M27	32	175	190	–
		PN 25	16 × M33	40	315	325	–
450	18	PN 6	16 × M20	22	70	90	–
		PN 10	20 × M24	28	100	110	–
		PN 16	20 × M27	34	175	190	–
		PN 25	20 × M33	46	300	310	–
500	20	PN 6	20 × M20	24	65	70	–
		PN 10	20 × M24	28	110	120	–
		PN 16	20 × M30	36	225	235	–
		PN 25	20 × M33	48	370	370	–
600	24	PN 6	20 × M24	30	105	105	–
		PN 10	20 × M27	30	165	160	–
600 [1)]	24	PN 16	20 × M33	40	340	340	–
600	24	PN 25	20 × M36	48	540	540	–
700	28	PN 6	24 × M24	30	110	110	–
		PN 10	24 × M27	35	190	190	–
		PN 16	24 × M33	40	340	340	–
		PN 25	24 × M39	50	615	595	–
800	32	PN 6	24 × M27	30	145	145	–
		PN 10	24 × M30	38	260	260	–
		PN 16	24 × M36	41	465	455	–
		PN 25	24 × M45	53	885	880	–
900	36	PN 6	24 × M27	34	170	180	–

Nominal diameter		Pressure rating	Screws	Flange thickness	Nom. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
		PN 10	28 × M30	38	265	275	–
		PN 16	28 × M36	48	475	475	–
		PN 25	28 × M45	57	930	915	–
1000	40	PN 6	28 × M27	38	175	185	–
		PN 10	28 × M33	44	350	360	–
		PN 16	28 × M39	59	630	620	–
		PN 25	28 × M52	63	1300	1290	–
1200	48	PN 6	32 × M30	42	235	250	–
		PN 10	32 × M36	55	470	480	–
		PN 16	32 × M45	78	890	900	–
1400	–	PN 6	36 × M33	56	300	–	–
		PN 10	36 × M39	65	600	–	–
		PN 16	36 × M45	84	1050	–	–
1600	–	PN 6	40 × M33	63	340	–	–
		PN 10	40 × M45	75	810	–	–
		PN 16	40 × M52	102	1420	–	–
1800	72	PN 6	44 × M36	69	430	–	–
		PN 10	44 × M45	85	920	–	–
		PN 16	44 × M52	110	1600	–	–
2000	–	PN 6	48 × M39	74	530	–	–
		PN 10	48 × M45	90	1040	–	–
		PN 16	48 × M56	124	1900	–	–
2200	–	PN 6	52 × M39	81	580	–	–
		PN 10	52 × M52	100	1290	–	–
2400	–	PN 6	56 × M39	87	650	–	–
		PN 10	56 × M52	110	1410	–	–

1) Sizing as per EN 1092-1 (not DIN 2501)

Maximum screw tightening torques for ASME B16.5

Nominal diameter		Pressure rating	Screws	Max. screw tightening torque			
				HG		PUR	
[mm]	[in]	[psi]	[in]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
25	1	Class 150	4 × ½	–	–	7	5
25	1	Class 300	4 × 5/8	–	–	8	6
40	1 ½	Class 150	4 × ½	–	–	10	7
40	1 ½	Class 300	4 × ¾	–	–	15	11
50	2	Class 150	4 × 5/8	35	26	22	16
50	2	Class 300	8 × 5/8	18	13	11	8
80	3	Class 150	4 × 5/8	60	44	43	32
80	3	Class 300	8 × ¾	38	28	26	19
100	4	Class 150	8 × 5/8	42	31	31	23
100	4	Class 300	8 × ¾	58	43	40	30
150	6	Class 150	8 × ¾	79	58	59	44
150	6	Class 300	12 × ¾	70	52	51	38
200	8	Class 150	8 × ¾	107	79	80	59
250	10	Class 150	12 × 7/8	101	74	75	55
300	12	Class 150	12 × 7/8	133	98	103	76
350	14	Class 150	12 × 1	135	100	158	117
400	16	Class 150	16 × 1	128	94	150	111
450	18	Class 150	16 × 1 1/8	204	150	234	173
500	20	Class 150	20 × 1 1/8	183	135	217	160
600	24	Class 150	20 × 1 ¼	268	198	307	226

Maximum screw tightening torques for AWWA C207, Class D

Nominal diameter		Screws	Max. screw tightening torque			
			HG		PUR	
[mm]	[in]	[in]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
700	28	28 × 1 ¼	247	182	292	215
750	30	28 × 1 ¼	287	212	302	223
800	32	28 × 1 ½	394	291	422	311
900	36	32 × 1 ½	419	309	430	317

Nominal diameter		Screws	Max. screw tightening torque			
[mm]	[in]	[in]	HG		PUR	
			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
1000	40	36 × 1 ½	420	310	477	352
–	42	36 × 1 ½	528	389	518	382
–	48	44 × 1 ½	552	407	531	392
–	54	44 × 1 ¾	730	538	–	–
–	60	52 × 1 ¾	758	559	–	–
–	66	52 × 1 ¾	946	698	–	–
–	72	60 × 1 ¾	975	719	–	–
–	78	64 × 2	853	629	–	–
–	84	64 x 2	931	687	–	–
–	90	64 x 2 ¼	1048	773	–	–

Maximum screw tightening torques for AS 2129, Table E

Nominal diameter	Screws	Max. screw tightening torque [Nm]	
[mm]	[mm]	HG	PUR
50	4 × M16	32	–
80	4 × M16	49	–
100	8 × M16	38	–
150	8 × M20	64	–
200	8 × M20	96	–
250	12 × M20	98	–
300	12 × M24	123	–
350	12 × M24	203	–
400	12 × M24	226	–
450	16 × M24	226	–
500	16 × M24	271	–
600	16 × M30	439	–
700	20 × M30	355	–
750	20 × M30	559	–
800	20 × M30	631	–
900	24 × M30	627	–

Nominal diameter [mm]	Screws [mm]	Max. screw tightening torque [Nm]	
		HG	PUR
1000	24 × M30	634	–
1200	32 × M30	727	–

Maximum screw tightening torques for AS 4087, PN 16

Nominal diameter [mm]	Screws [mm]	Max. screw tightening torque [Nm]	
		HG	PUR
50	4 × M16	32	–
80	4 × M16	49	–
100	4 × M16	76	–
150	8 × M20	52	–
200	8 × M20	77	–
250	8 × M20	147	–
300	12 × M24	103	–
350	12 × M24	203	–
375	12 × M24	137	–
400	12 × M24	226	–
450	12 × M24	301	–
500	16 × M24	271	–
600	16 × M27	393	–
700	20 × M27	330	–
750	20 × M30	529	–
800	20 × M33	631	–
900	24 × M33	627	–
1000	24 × M33	595	–
1200	32 × M33	703	–

Maximum screw tightening torques for JIS B2220

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Max. screw tightening torque [Nm]	
			HG	PUR
25	10K	4 × M16	–	19
25	20K	4 × M16	–	19
32	10K	4 × M16	–	22

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Max. screw tightening torque [Nm]	
			HG	PUR
32	20K	4 × M16	–	22
40	10K	4 × M16	–	24
40	20K	4 × M16	–	24
50	10K	4 × M16	40	33
50	20K	8 × M16	20	17
65	10K	4 × M16	55	45
65	20K	8 × M16	28	23
80	10K	8 × M16	29	23
80	20K	8 × M20	42	35
100	10K	8 × M16	35	29
100	20K	8 × M20	56	48
125	10K	8 × M20	60	51
125	20K	8 × M22	91	79
150	10K	8 × M20	75	63
150	20K	12 × M22	81	72
200	10K	12 × M20	61	52
200	20K	12 × M22	91	80
250	10K	12 × M22	100	87
250	20K	12 × M24	159	144
300	10K	16 × M22	74	63
300	20K	16 × M24	138	124

Nominal screw tightening torques for JIS B2220

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Nom. screw tightening torque [Nm]	
			HG	PUR
350	10K	16 × M22	109	109
	20K	16 × M30×3	217	217
400	10K	16 × M24	163	163
	20K	16 × M30×3	258	258
450	10K	16 × M24	155	155
	20K	16 × M30×3	272	272
500	10K	16 × M24	183	183

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Nom. screw tightening torque [Nm]	
			HG	PUR
	20K	16 × M30×3	315	315
600	10K	16 × M30	235	235
	20K	16 × M36×3	381	381
700	10K	16 × M30	300	300
750	10K	16 × M30	339	339

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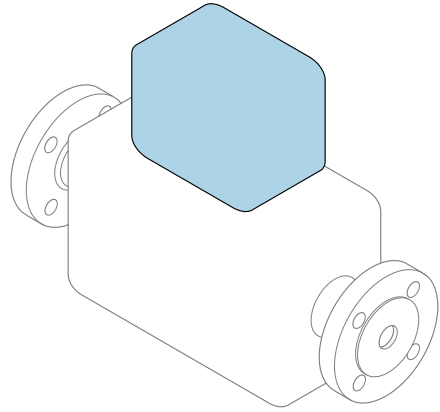
Brief Operating Instructions **Flowmeter Proline 400**

HART transmitter
with electromagnetic sensor



These instructions are Brief Operating Instructions; they are **not** a substitute for the Operating Instructions pertaining to the device.

Brief Operating Instructions part 2 of 2: Transmitter
Contain information about the transmitter.

Brief Operating Instructions part 1 of 2: Sensor → 3

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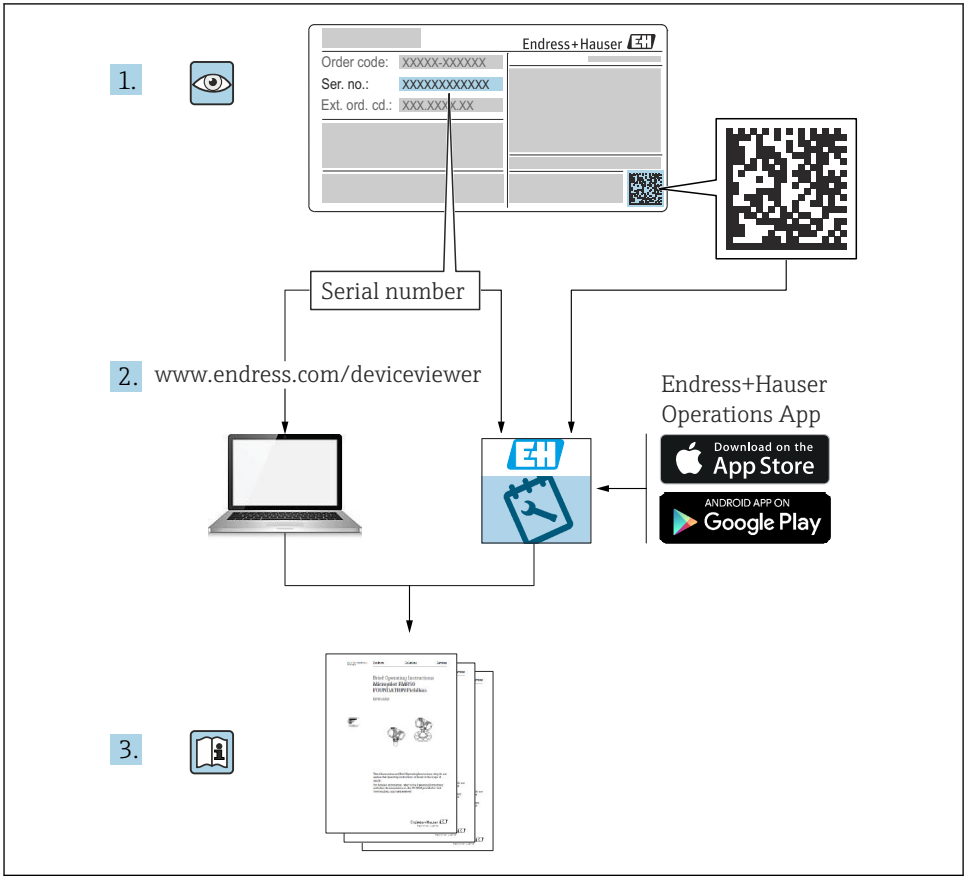
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A0023555

Brief Operating Instructions for flowmeter

The device consists of a transmitter and a sensor.

The process of commissioning these two components is described in two separate manuals that together form the Brief Operating Instructions for the flowmeter:
- Brief Operating Instructions Part 1: Sensor
- Brief Operating Instructions Part 2: Transmitter

Please refer to both parts of the Brief Operating Instructions when commissioning the device, as the contents of the manuals complement one another:

Brief Operating Instructions Part 1: Sensor
The Sensor Brief Operating Instructions are aimed at specialists with responsibility for installing the measuring device.
- Incoming acceptance and product identification
- Storage and transport
- Installation

Brief Operating Instructions Part 2: Transmitter
The Transmitter Brief Operating Instructions are aimed at specialists with responsibility for commissioning, configuring and parameterizing the measuring device (until the first measured value).
- Product description
- Installation
- Electrical connection
- Operation options
- System integration
- Commissioning
- Diagnostic information

Additional device documentation

These Brief Operating Instructions are **Brief Operating Instructions Part 2: Transmitter**.

The "Brief Operating Instructions Part 1: Sensor" are available via:
- Internet: www.endress.com/deviceviewer
- Smart phone/tablet: *Endress+Hauser Operations App*

Detailed information about the device can be found in the Operating Instructions and the other documentation:
- Internet: www.endress.com/deviceviewer
- Smart phone/tablet: *Endress+Hauser Operations App*

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1 About this document

1.1 Symbols used

1.1.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.1.2 Symbols for certain types of information

Symbol	Meaning	Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.		**Preferred** Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.		**Tip** Indicates additional information.
	Reference to documentation		Reference to page
	Reference to graphic	1., 2., 3...	Series of steps
	Result of a step		Visual inspection

1.1.3 Electrical symbols

Symbol	Meaning	Symbol	Meaning
	Direct current		Alternating current
	Direct current and alternating current		**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.

Symbol	Meaning
	Protective Earth (PE) A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: ▪ Inner ground terminal: Connects the protectiv earth to the mains supply. ▪ Outer ground terminal: Connects the device to the plant grounding system.

1.1.4 Communication symbols

Symbol	Meaning	Symbol	Meaning
	Wireless Local Area Network (WLAN) Communication via a wireless, local network.		Promag 10, 400, 800 **Bluetooth** Wireless data transmission between devices over a short distance.
	Promag 800 **Cellular radio** Bidirectional data exchange via cellular network.		**LED** Light emitting diode is off.
	LED Light emitting diode is on.		**LED** Light emitting diode is flashing.

1.1.5 Tool symbols

Symbol	Meaning	Symbol	Meaning
	Torx screwdriver		Flat blade screwdriver
	Cross-head screwdriver		Allen key
	Open-ended wrench		

1.1.6 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3,...	Item numbers	1., 2., 3...	Series of steps
A, B, C, ...	Views	A-A, B-B, C-C, ...	Sections
	Hazardous area		Safe area (non-hazardous area)
	Flow direction		

2 Safety instructions

2.1 Requirements for the personnel

The personnel must fulfill the following requirements for its tasks:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

2.2 Designated use

Application and media
The measuring device described in this manual is intended only for the flow measurement of liquids with a minimum conductivity of 5 µS/cm.

Depending on the version ordered, the measuring device can also measure potentially explosive, flammable, poisonous and oxidizing media.

Measuring devices for use in hazardous areas, in hygienic applications or where there is an increased risk due to process pressure, are labeled accordingly on the nameplate.

To ensure that the measuring device remains in proper condition for the operation time:
- Keep within the specified pressure and temperature range.
- Only use the measuring device in full compliance with the data on the nameplate and the general conditions listed in the Operating Instructions and supplementary documentation.
- Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area (e.g. explosion protection, pressure vessel safety).
- Use the measuring device only for media to which the process-wetted materials are sufficiently resistant.
- If the ambient temperature of the measuring device is outside the atmospheric temperature, it is absolutely essential to comply with the relevant basic conditions as specified in the device documentation.
- Protect the measuring device permanently against corrosion from environmental influences.

The measuring device is optionally tested in accordance with OIML R49: 2006 and has an EC type-examination certificate according to Measuring Instruments Directive 2004/22/EC (MID) for service subject to legal metrological control ("custody transfer") for cold water (Annex MI-001).

The permitted medium temperature in these applications is 0 to +50 °C (+32 to +122 °F).

Incorrect use
Non-designated use can compromise safety. The manufacturer is not liable for damage caused by improper or non-designated use.

⚠ WARNING

Danger of breakage due to corrosive or abrasive fluids and ambient conditions!
- ▶ Verify the compatibility of the process fluid with the sensor material.
- ▶ Ensure the resistance of all fluid-wetted materials in the process.
- ▶ Keep within the specified pressure and temperature range.

NOTICE

Verification for borderline cases:
- ▶ For special fluids and fluids for cleaning, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of fluid-wetted materials, but does not accept any warranty or liability as minute changes in the temperature, concentration or level of contamination in the process can alter the corrosion resistance properties.

Residual risks

⚠ WARNING

If the temperature of the media or electronics unit is high or low, this may cause the surfaces of the device to become hot or cold. This poses a risk of burns or frostbite!
- ▶ In the case of hot or cold medium temperatures, install appropriate protection against contact.

2.3 Workplace safety

For work on and with the device:
- ▶ Wear the required personal protective equipment according to national regulations.

For welding work on the piping:
- ▶ Do not ground the welding unit via the measuring device.

If working on and with the device with wet hands:
- ▶ Due to the increased risk of electric shock, wear suitable gloves.

2.4 Operational safety

Risk of injury.
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for interference-free operation of the device.

2.5 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

Furthermore, the device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards.

By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

2.6 IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

2.7 Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly.

For detailed information on device-specific IT security, see the Operating Instructions for the device.

3 Product description

The device consists of a transmitter and a sensor.

Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

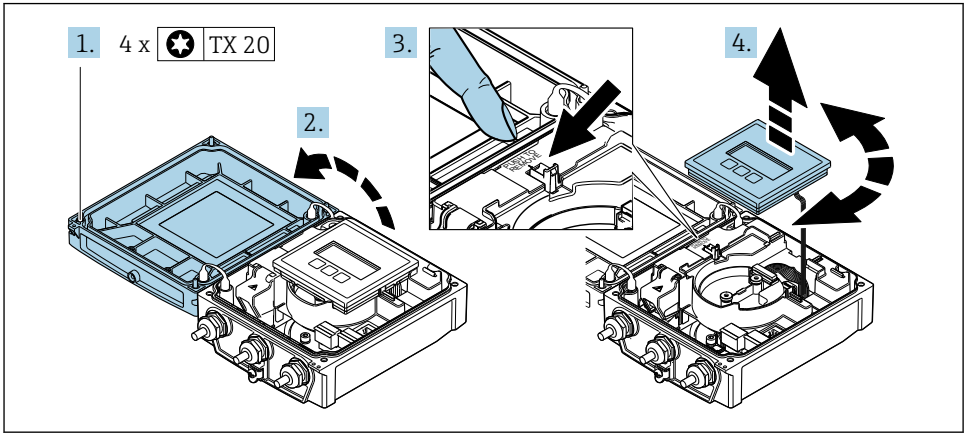
For detailed information on the product description, see the Operating Instructions for the device → 3

4 Installation

For detailed information about mounting the sensor, see the Sensor Brief Operating Instructions → 3

4.1 Turning the display module

4.1.1 Opening the transmitter housing and turning the display module



1. Loosen the fixing screws of the housing cover.
2. Open the housing cover.
3. Unlock the display module.
4. Pull out the display module and turn it to the desired position in increments of 90°.

4.1.2 Mounting the transmitter housing

WARNING

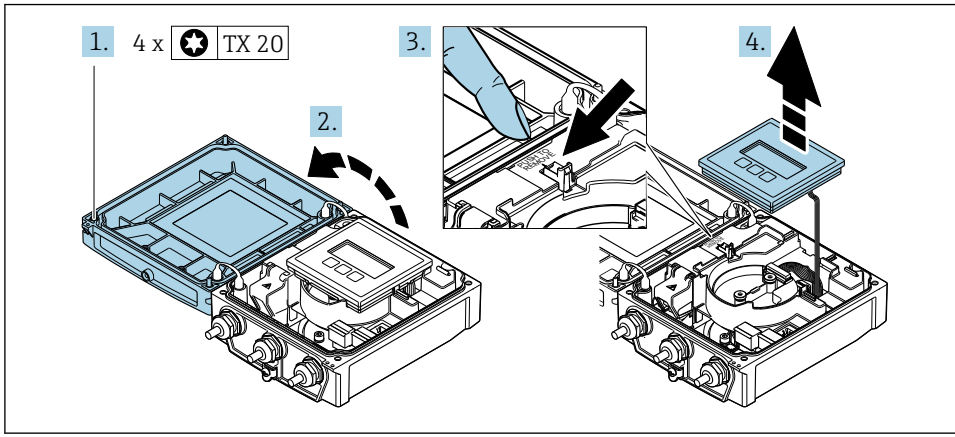
Excessive tightening torque applied to the fixing screws!
Damage to the transmitter.
► Tighten the fixing screws with the specified torques.

1. Insert the display module and lock it when doing so.
2. Close the housing cover.
3. Tighten the fixing screws of the housing cover: tightening torque for aluminum housing 2.5 Nm (1.8 lbf ft) – plastic housing 1 Nm (0.7 lbf ft).

4.2 Turning the transmitter housing: Promag D

To provide easier access to the connection compartment or display module, the transmitter housing can be turned.

4.2.1 Disassembling and turning the transmitter housing



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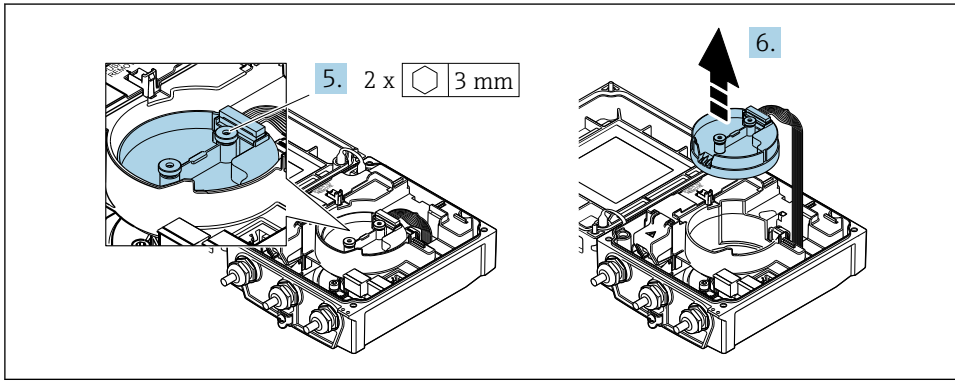
1. Loosen the fixing screws of the housing cover.
2. Open the housing cover.
3. Unlock the display module.
4. Remove the display module.



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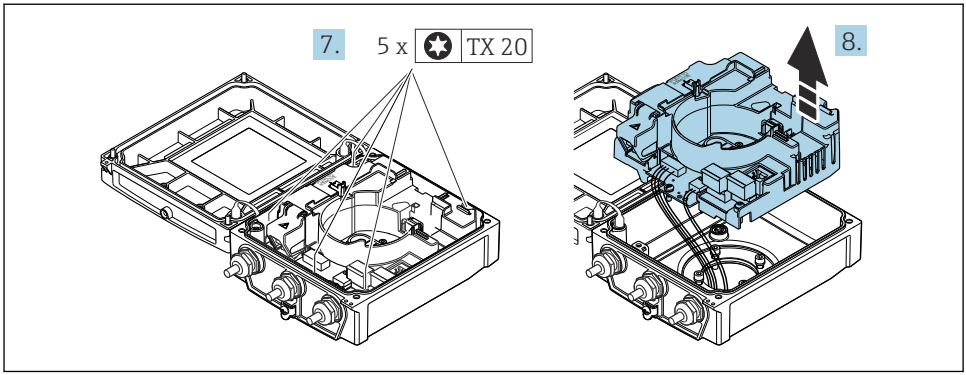
5. Loosen the fixing screws of the intelligent sensor electronics module.
6. Remove the intelligent sensor electronics module.



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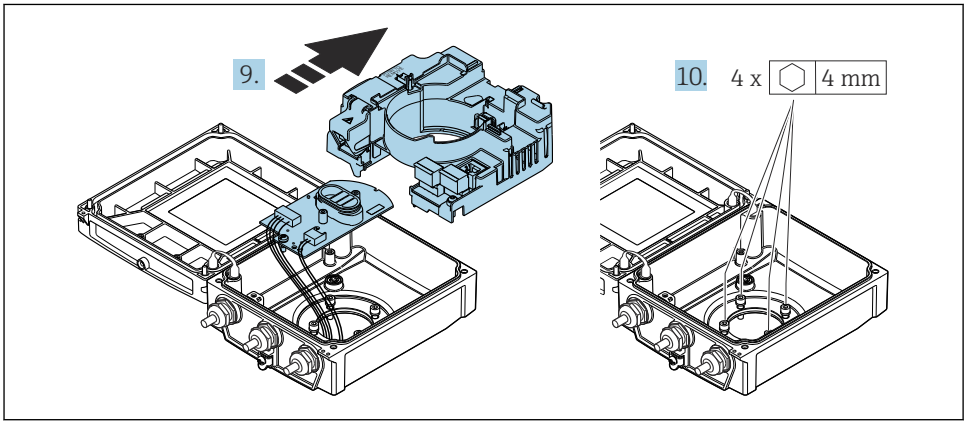
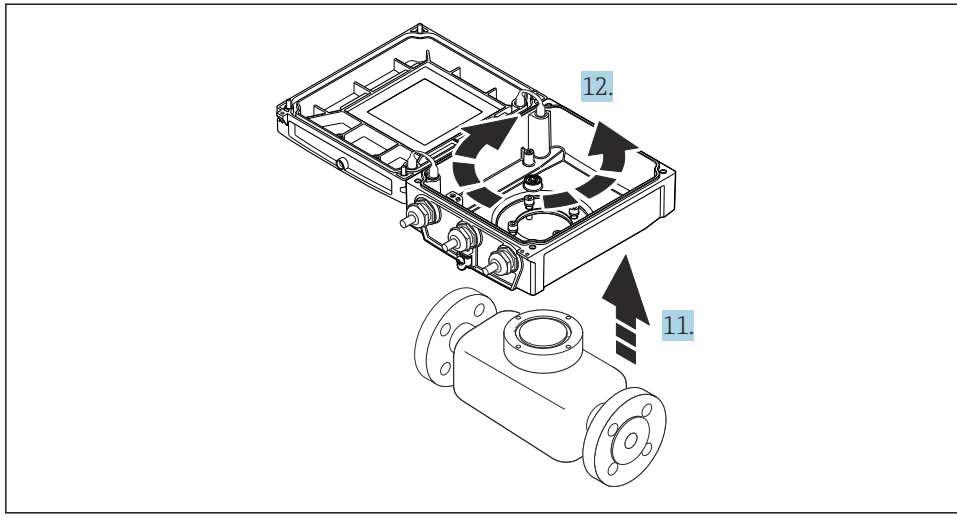
7. Loosen the fixing screws of the main electronics module.
8. Remove the main electronics module.



A0032131

9. Remove the electronics module from the main electronics module.
10. Loosen the fixing screws of the transmitter housing (when reassembling, pay attention to the tightening torque.



A0032132

11. Lift the transmitter housing.
12. Turn the housing to the desired position in increments of 90°.

4.2.2 Mounting the sensor housing

NOTICE

Incorrect routing of the connecting cables between the sensor and transmitter in the transmitter housing!
This can interfere with the measuring signal.
► Route the connecting cables directly at the level of the plugs.

⚠ WARNING

Excessive tightening torque applied to the fixing screws!
Damage to the transmitter.
► Tighten the fixing screws with the specified tightening torques.

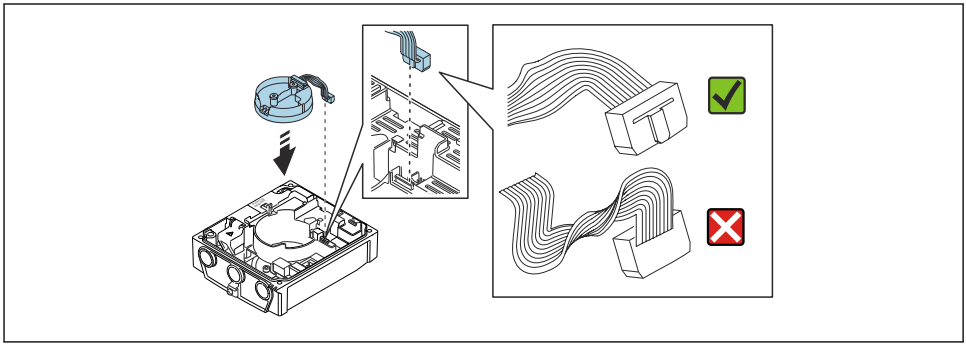
1. Fit the transmitter housing.
2. Tighten the fixing screws of the transmitter housing: tightening torque 5.5 Nm (4.1 lbf ft).
3. Slide the electronics module into the main electronics module.
4. Insert the main electronics module.
5. Tighten the fixing screws of the main electronics module: tightening torque 1.5 Nm (1.1 lbf ft).

NOTICE

Plug of the smart sensor electronics module connected incorrectly!

No measuring signal is output.

► Plug in the plug of the smart sensor electronics module as per the coding.



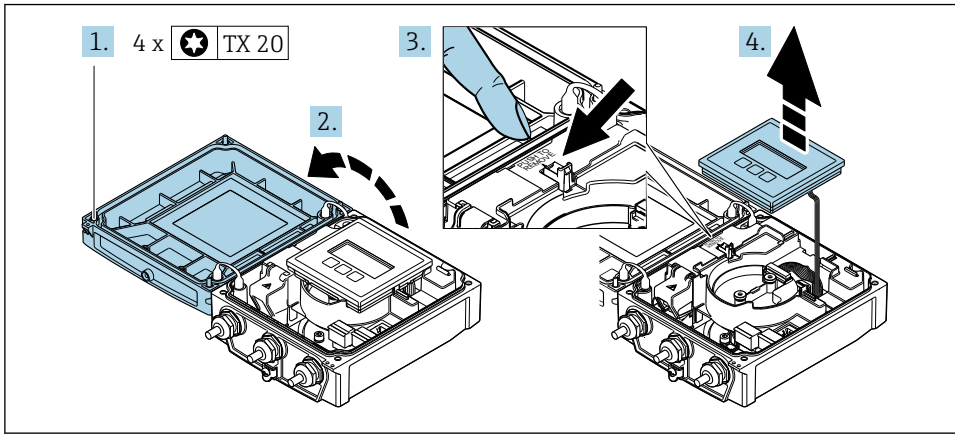
A0021585

6. Plug in the intelligent sensor electronics module: pay attention to the coding!
7. Tighten the fixing screws of the intelligent sensor electronics module: tightening torque 0.6 Nm (0.4 lbf ft).
8. Insert the display module and lock it when doing so.
9. Close the housing cover.
10. Tighten the fixing screws of the main electronics module: tightening torque for aluminum housing 2.5 Nm (1.8 lbf ft) – tightening torque for plastic housing 1 Nm (0.7 lbf ft).

4.3 Turning the transmitter housing: Promag L and W

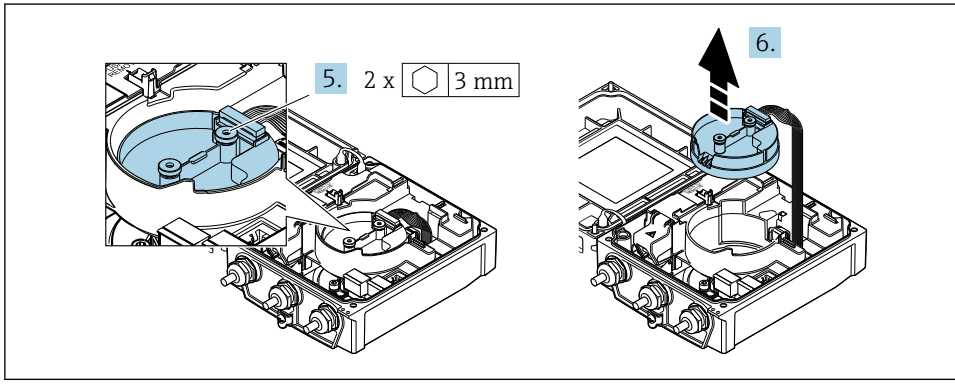
To provide easier access to the connection compartment or display module, the transmitter housing can be turned.

4.3.1 Disassembling and turning the transmitter housing



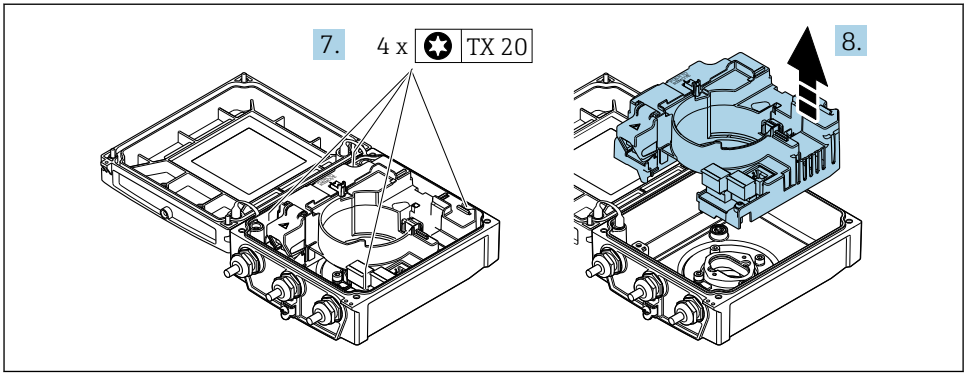
A0032086

1. Loosen the fixing screws of the housing cover.
2. Open the housing cover.
3. Unlock the display module.
4. Remove the display module.



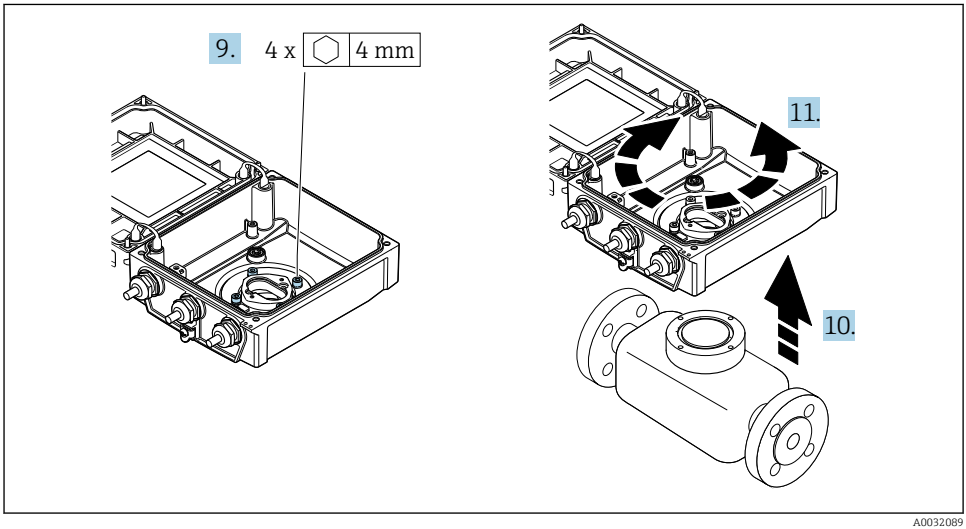
A0032087

5. Loosen the fixing screws of the intelligent sensor electronics module.
6. Remove the intelligent sensor electronics module.



A0032088

7. Loosen the fixing screws of the main electronics module.
8. Remove the main electronics module.



A0032089

9. Loosen the fixing screws of the transmitter housing (when reassembling, pay attention to the tightening torque.
10. Lift the transmitter housing.
11. Turn the housing to the desired position in increments of 90°.

4.3.2 Mounting the sensor housing

⚠ WARNING

Excessive tightening torque applied to the fixing screws!

Damage to the transmitter.

► Tighten the fixing screws with the specified tightening torques.

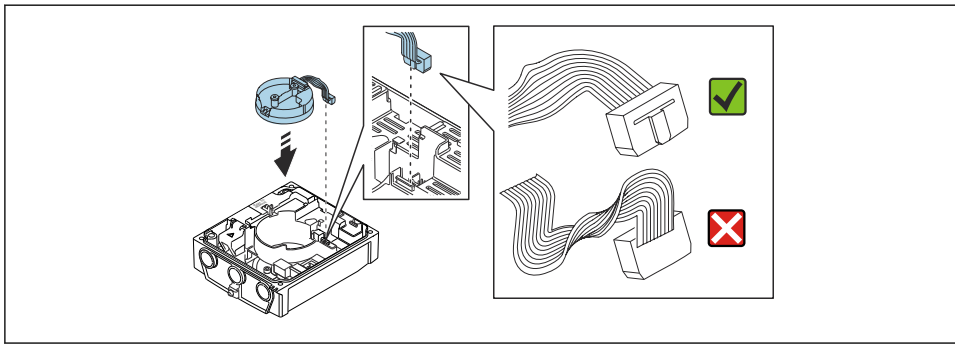
1. Fit the transmitter housing.
2. Tighten the fixing screws of the transmitter housing: tightening torque 5.5 Nm (4.1 lbf ft).
3. Insert the main electronics module.
4. Tighten the fixing screws of the main electronics module: tightening torque 1.5 Nm (1.1 lbf ft).

NOTICE

Plug of the smart sensor electronics module connected incorrectly!

No measuring signal is output.

► Plug in the plug of the smart sensor electronics module as per the coding.



A0021585

5. Plug in the intelligent sensor electronics module: pay attention to the coding!
6. Tighten the fixing screws of the intelligent sensor electronics module: tightening torque 0.6 Nm (0.4 lbf ft).
7. Insert the display module and lock it when doing so.
8. Close the housing cover.
9. Tighten the fixing screws of the main electronics module: tightening torque for aluminum housing 2.5 Nm (1.8 lbf ft) – for plastic housing 1 Nm (0.7 lbf ft).

4.4 Transmitter post-installation check

The post-installation check must always be performed after the following tasks:
- Turning the transmitter housing
- Turning the display module

Is the device undamaged (visual inspection)?	❑
Turning the transmitter housing: ▪ Is the fixing screw firmly tightened? ▪ Is the connection compartment cover screwed on tightly? ▪ Is the securing clamp firmly tightened?	❑
Turning the display module: ▪ Is the connection compartment cover screwed on tightly? ▪ Is the securing clamp firmly tightened?	❑

5 Electrical connection

NOTICE

The measuring device does not have an internal circuit breaker.

- ▶ For this reason, assign the measuring device a switch or power-circuit breaker so that the power supply line can be easily disconnected from the mains.
- ▶ Although the measuring device is equipped with a fuse, additional overcurrent protection (maximum 16 A) should be integrated into the system installation.

5.1 Electrical safety

In accordance with applicable national regulations.

5.2 Connection conditions

5.2.1 Required tools

- Torque wrench
- For cable entries: Use corresponding tools
- Wire stripper
- When using stranded cables: Crimper for wire end ferrule

5.2.2 Requirements for connecting cable

The connecting cables provided by the customer must fulfill the following requirements.

Permitted temperature range

- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Signal cable

Current output 0/4 to 20 mA

Standard installation cable is sufficient.

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Status input

Standard installation cable is sufficient.

Connecting cable for remote version

In the case of the remote version, the sensor is connected to the transmitter via an electrode cable and a coil current cable.

For detailed information about the specification of the connecting cables, see the Operating Instructions for the device → 3

Operation in environments with strong electrical interference

Grounding is by means of the ground terminal provided for the purpose inside the connection housing. The stripped and twisted lengths of cable shield to the ground terminal must be as short as possible.

Cable diameter

- Cable glands supplied:
  - For standard cable: M20 × 1.5 with cable ϕ 6 to 12 mm (0.24 to 0.47 in)
  - For reinforced cable: M20 × 1.5 with cable ϕ 9.5 to 16 mm (0.37 to 0.63 in)
- (Plug-in) spring terminals for wire cross-sections 0.5 to 2.5 mm^2 (20 to 14 AWG)

5.2.3 Terminal assignment

In addition to the inputs and outputs available, information on the terminal assignment for the electrical connection can be found on the connection nameplate on the main electronics module.

For detailed information on the terminal assignment, see the Operating Instructions for the device → 3

5.2.4 Preparing the measuring device

Carry out the steps in the following order:

1. Mount the sensor and transmitter.
2. Connection housing, sensor: Connect connecting cable.
3. Transmitter: Connect connecting cable.
4. Transmitter: Connect signal cable and cable for supply voltage.

NOTICE

Insufficient sealing of the housing!

Operational reliability of the measuring device could be compromised.

► Use suitable cable glands corresponding to the degree of protection.

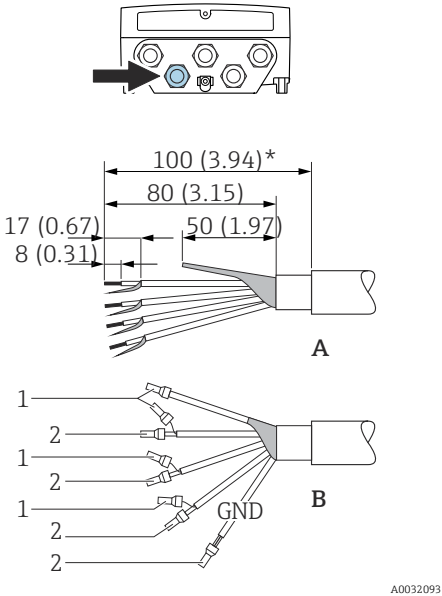
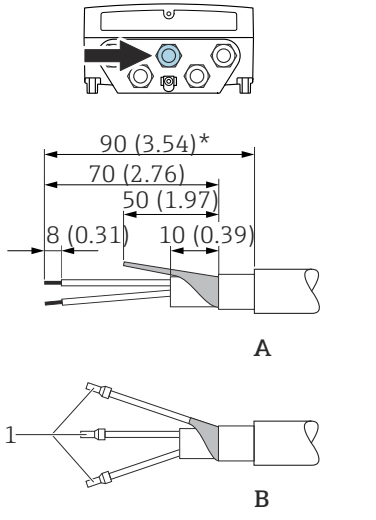
1. Remove dummy plug if present.
2. If the measuring device is supplied without cable glands:
   Provide suitable cable gland for corresponding connecting cable.
3. If the measuring device is supplied with cable glands:
   Observe requirements for connecting cables → 19.

5.2.5 Preparing the connecting cable for the remote version

When terminating the connecting cable, pay attention to the following points:

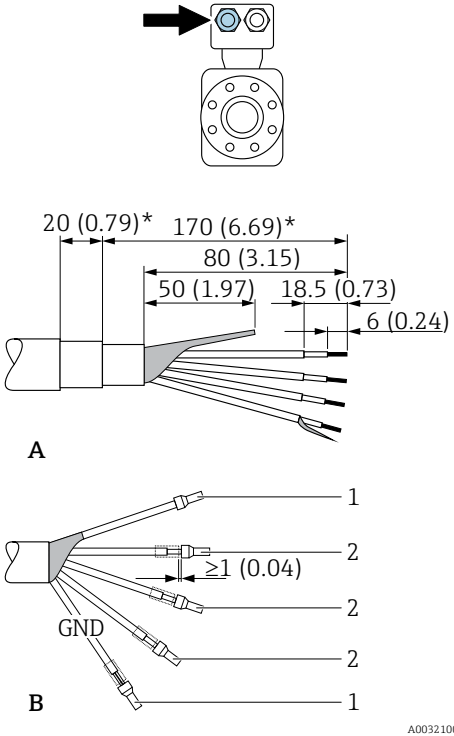
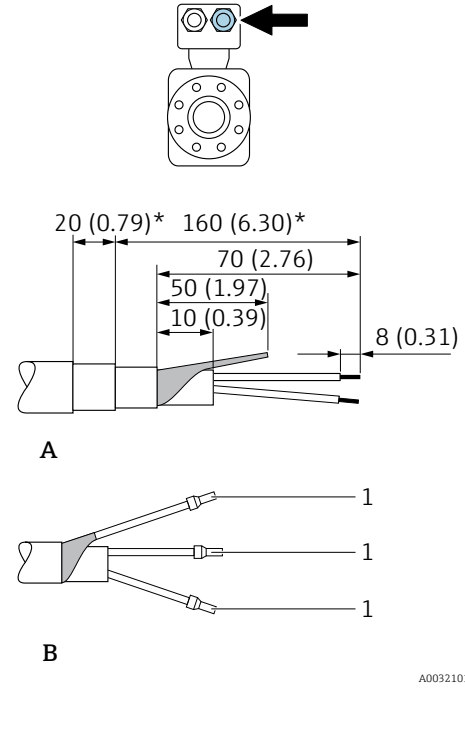
1. In the case of the electrode cable:
   Make sure that the ferrules do not touch the core shields on the sensor side. Minimum distance = 1 mm (exception: green “GND” cable)
2. In the case of the coil current cable:
   Insulate one core of the three-core cable at the level of the core reinforcement. You only require two cores for the connection.
3. For cables with fine-wire cores (stranded cables):
   Fit the cores with ferrules.

Transmitter

Electrode cable	Coil current cable
	
1 *Engineering unit mm (in)*	2 *Engineering unit mm (in)*

A = Termination of the cables
B = Termination of the fine-wire cores with ferrules
1 = Red ferrules, ϕ 1.0 mm (0.04 in)
2 = White ferrules, ϕ 0.5 mm (0.02 in)
* = Stripping only for reinforced cables

Sensor

Electrode cable	Coil current cable
	

A = Termination of the cables
B = Termination of the fine-wire cores with ferrules
1 = Red ferrules, ⌀ 1.0 mm (0.04 in)
2 = White ferrules, ⌀ 0.5 mm (0.02 in)
* = Stripping only for reinforced cables

5.3 Connecting the measuring device

⚠ WARNING

Risk of electric shock! Components carry dangerous voltages!

- Have electrical connection work carried out by correspondingly trained specialists only.
- Observe applicable federal/national installation codes and regulations.
- Comply with local workplace safety regulations.
- Observe grounding concept of the plant.
- Never mount or wire the measuring device while it is connected to the supply voltage.
- Before the supply voltage is applied, connect the protective ground to the measuring device.

5.3.1 Connecting the remote version

⚠ WARNING

Risk of damaging the electronic components!

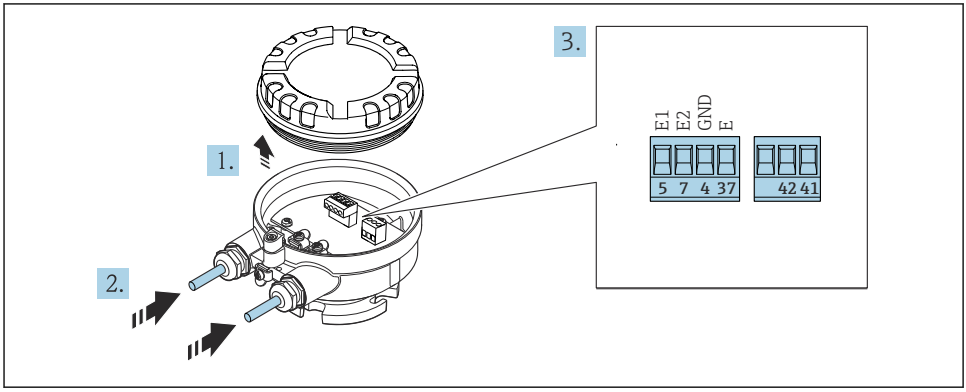
- Connect the sensor and transmitter to the same potential equalization.
- Only connect the sensor to a transmitter with the same serial number.
- Ground the connection housing of the sensor via the external screw terminal.

The following procedure (in the action sequence given) is recommended for the remote version:

1. Mount the sensor and transmitter.
2. Connect the connecting cable for the remote version.
3. Connect the transmitter.

Connecting the connecting cable to the sensor connection housing

Promag D



3 Sensor: connection module

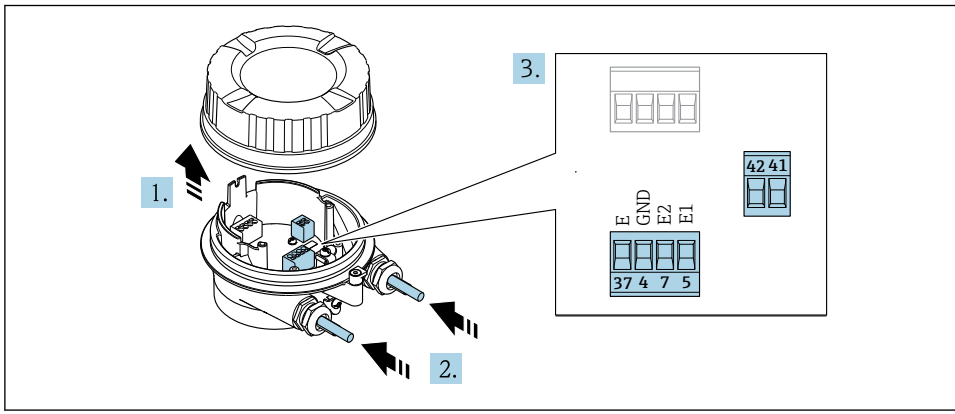
1. Loosen the securing clamp of the housing cover.

2. Unscrew and lift off the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules → 21.
5. Connect the cable in accordance with the terminal assignment .
6. Firmly tighten the cable glands.
7. **WARNING**

   Housing degree of protection may be voided due to insufficient sealing of the housing.
   - Screw in the screw without using any lubricant. The threads on the cover are coated with a dry lubricant.

   Reverse the procedure to reassemble the sensor.

Promag L and W



4 *Sensor: connection module*

1. Loosen the securing clamp of the housing cover.
2. Unscrew and lift off the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. **NOTICE**

   For conduit extensions:
   - Fit O-ring on cable and push it back sufficiently. When inserting the cable, the O-ring must be located outside the conduit extension.

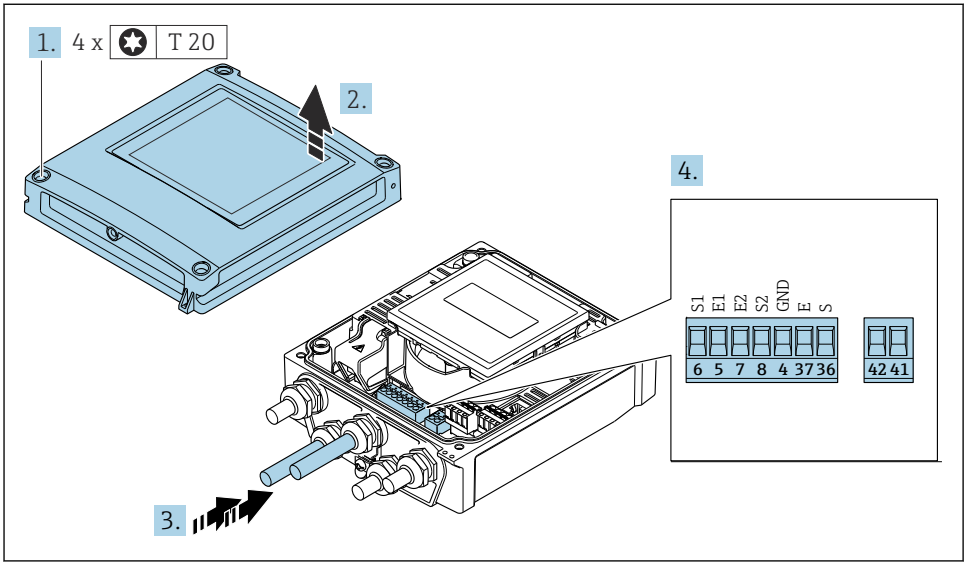
   Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.

5. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules → 21.
6. Connect the cable in accordance with the terminal assignment .
7. Firmly tighten the cable glands.
8. **WARNING**

   Housing degree of protection may be voided due to insufficient sealing of the housing.
   - Screw in the screw without using any lubricant. The threads on the cover are coated with a dry lubricant.

   Reverse the procedure to reassemble the sensor.

Connecting the connecting cable to the transmitter



5 *Transmitter: main electronics module with terminals*

1. Loosen the 4 fixing screws on the housing cover.
2. Open the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules → 21.
5. Connect the cable in accordance with the terminal assignment .
6. Firmly tighten the cable glands.

7. **⚠ WARNING**

Housing degree of protection may be voided due to insufficient sealing of the housing.

- ▶ Screw in the screw without using any lubricant.

Reverse the removal procedure to reassemble the transmitter.

5.3.2 Connecting the transmitter

WARNING

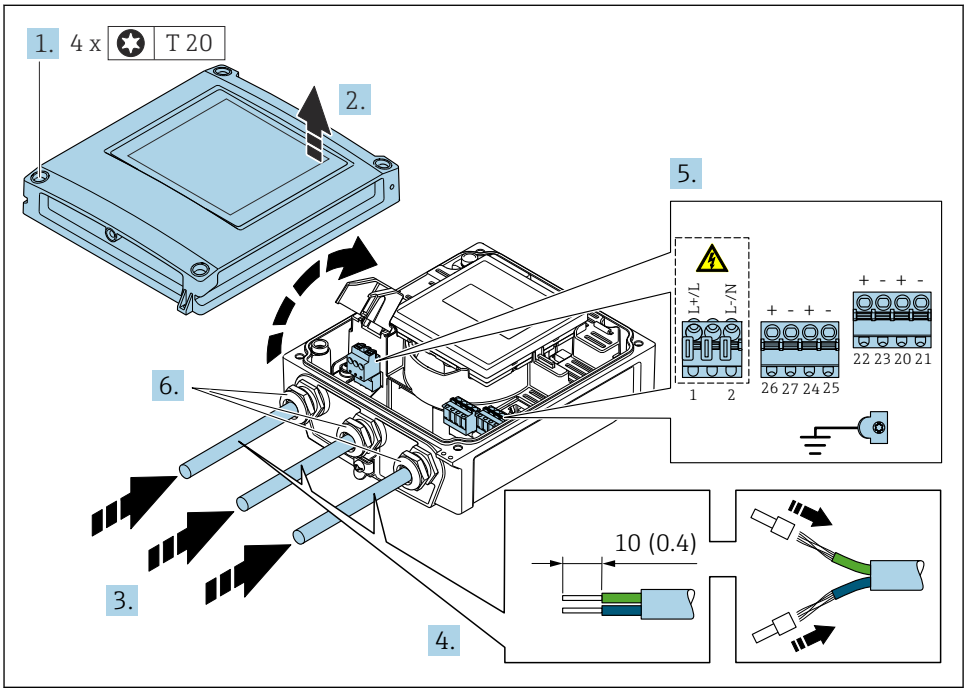
Housing degree of protection may be voided due to insufficient sealing of the housing.

- Screw in the screw without using any lubricant. The threads on the cover are coated with a dry lubricant.

Tightening torques for plastic housing

Housing cover fixing screw	1 Nm (0.7 lbf ft)
Cable entry	5 Nm (3.7 lbf ft)
Ground terminal	2.5 Nm (1.8 lbf ft)

For HART communication: when connecting the cable shield to the ground terminal, observe the grounding concept of the facility.



6 *Connecting the supply voltage and 0-20 mA/4-20 mA HART with additional outputs and inputs*

1. Loosen the 4 fixing screws on the housing cover.
2. Open the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.

4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules.
5. Connect the cables according to the connection nameplate on the main electronics module, for supply voltage: open the shock protection cover.
6. Firmly tighten the cable glands.

Reassembling the transmitter

1. Close the shock protection cover.
2. Close the housing cover.
3. **⚠ WARNING**

   Housing degree of protection may be voided due to insufficient sealing of the housing.
   ▶ Screw in the screw without using any lubricant.

   Tighten the 4 fixing screws on the housing cover.

5.4 Ensuring potential equalization

5.4.1 Introduction

Correct potential equalization (equipotential bonding) is a prerequisite for stable and reliable flow measurement. Inadequate or incorrect potential equalization can result in device failure and present a safety hazard.

The following requirements must be observed to ensure correct, trouble-free measurement:
- The principle that the medium, the sensor and the transmitter must be at the same electrical potential applies.
- Take in-company grounding guidelines, materials and the grounding conditions and potential conditions of the pipe into consideration.
- Any necessary potential equalization connections must be established by ground cables with a minimum cross-section of 6 mm^2 (0.0093 in^2).
- In the case of remote device versions, the ground terminal in the example always refers to the sensor and not to the transmitter.

You can order accessories like the ground cable and ground disks from Endress+Hauser: Operating Instructions for the device → 3

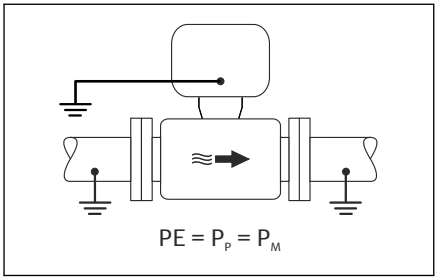
For devices intended for use in hazardous locations, please observe the instructions in the Ex documentation (XA) → 3

Abbreviations used
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

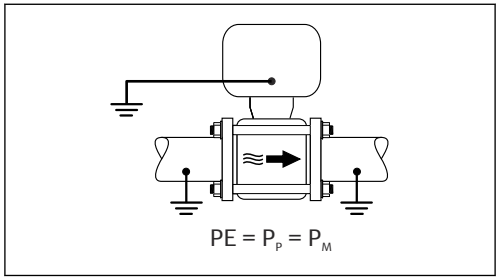
5.4.2 Connection examples for standard situations

Unlined and grounded metal pipe
- Potential equalization is via the measuring pipe.
- The medium is set to ground potential.

Starting conditions:
- Pipes are correctly grounded on both sides.
- Pipes are conductive and at the same electrical potential as the medium



7 *Promag L, W*



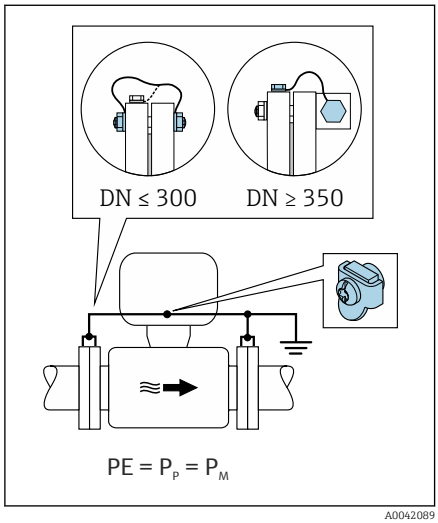
8 *Promag D*

▶ Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Promag L, W: Metal pipe without liner

- Potential equalization is via the ground terminal and pipe flanges.
- The medium is set to ground potential.

Starting conditions:
- Pipes are not sufficiently grounded.
- Pipes are conductive and at the same electrical potential as the medium



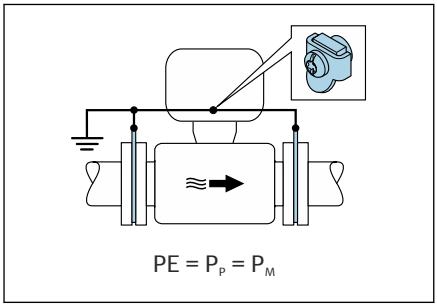
9 *Promag L, W*

1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.
3. If DN ≤ 300 (12"): Mount the ground cable directly on the conductive flange coating of the sensor with the flange screws.
4. If DN ≥ 350 (14"): Mount the ground cable directly on the metal transport bracket. Observe the screw tightening torques: see the Brief Operating Instructions for the sensor.

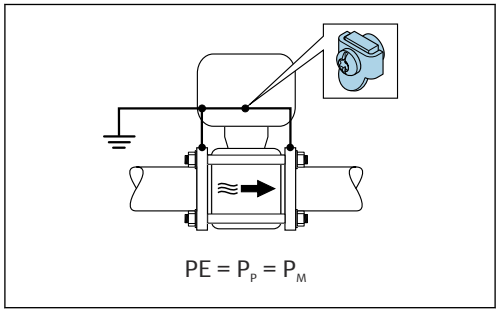
Plastic pipe or pipe with insulating liner

- Potential equalization is established via:
  - Promag D: Ground terminal and flanges
  - Promag L, W: Ground terminal and ground disks
- The medium is set to ground potential.

Starting conditions:
- The pipe has an insulating effect.
- Low-impedance medium grounding close to the sensor is not guaranteed.
- Equalizing currents through the medium cannot be ruled out.



10 *Promag L, W*



11 *Promag D*

Promag D

1. Connect flanges to the ground terminal of the transmitter's or sensor's connection housing via the ground cable.
2. Connect the connection to ground potential.

Promag L and W

1. Connect ground disks to the ground terminal of the transmitter's or sensor's connection housing via the ground cable.
2. Connect the connection to ground potential.

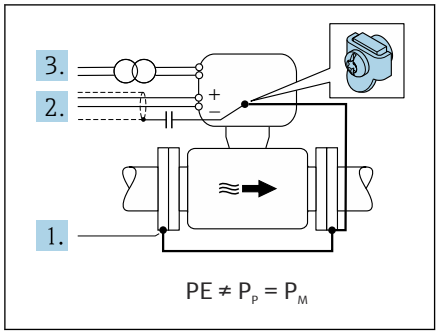
5.4.3 Connection example with the potential of the medium not equal to the protective ground

In these cases, the medium potential can differ from the potential of the device.

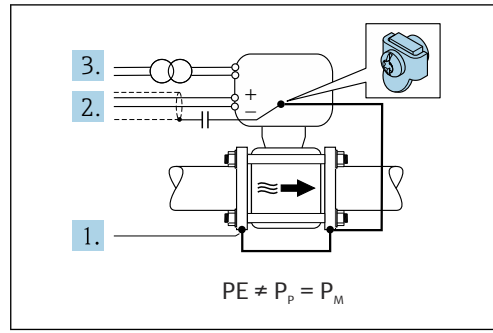
Metal, ungrounded pipe

The sensor and transmitter are installed in a way that provides electrical insulation from PE, e.g. applications for electrolytic processes or systems with cathodic protection.

Starting conditions:
- Unlined metal pipe
- Pipes with an electrically conductive liner



12 *Promag L, W*



13 *Promag D*

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal lines via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).

5.4.4 Promag W: Connection examples with the potential of the medium not equal to the protective ground with the "Measurement isolated from ground" option

In these cases, the medium potential can differ from the potential of the device.

Introduction

The "Measurement isolated from ground" option enables the galvanic isolation of the measuring system from the device potential. This minimizes harmful equalizing currents caused by differences in potential between the medium and the device. The "Measurement isolated from ground" option is optionally available: order code for "Sensor option", option CV

Operating conditions for the use of the "Measurement isolated from ground" option

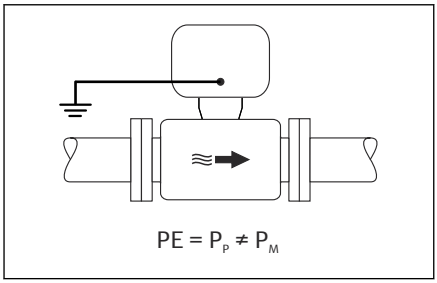
Device version	Compact version and remote version (Length of connecting cable ≤ 10 m)
Differences in voltage between medium potential and device potential	As small as possible, usually in the mV range
Alternating voltage frequencies in the medium or at ground potential (PE)	Below typical power line frequency in the country

- To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.
- A full pipe adjustment is recommended when the device is installed.

Plastic pipe

Sensor and transmitter are correctly grounded. A difference in potential can occur between the medium and protective earth. Potential equalization between P_M and PE via the reference electrode is minimized with the "Measurement isolated from ground" option.

Starting conditions:
- The pipe has an insulating effect.
- Equalizing currents through the medium cannot be ruled out.



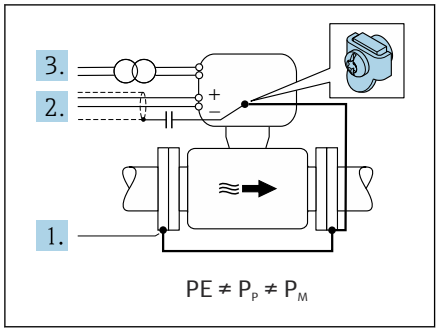
14 Promag W

1. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Metal, ungrounded pipe with insulating liner

The sensor and transmitter are installed in a way that provides electrical insulation from PE. The medium and pipe have different potentials. The "Measurement isolated from ground" option minimizes harmful equalizing currents between P_M and P_P via the reference electrode.

Starting conditions:
- Metal pipe with insulating liner
- Equalizing currents through the medium cannot be ruled out.



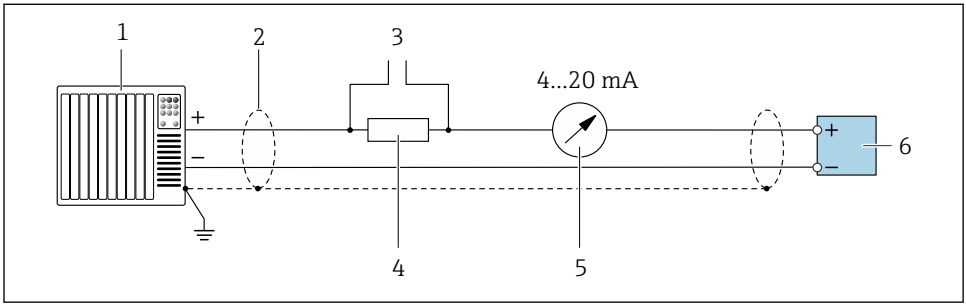
15 *Promag W*

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal cables via a capacitor (recommended value 1.5µF/ 50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).
4. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.

5.5 Special connection instructions

5.5.1 Connection examples

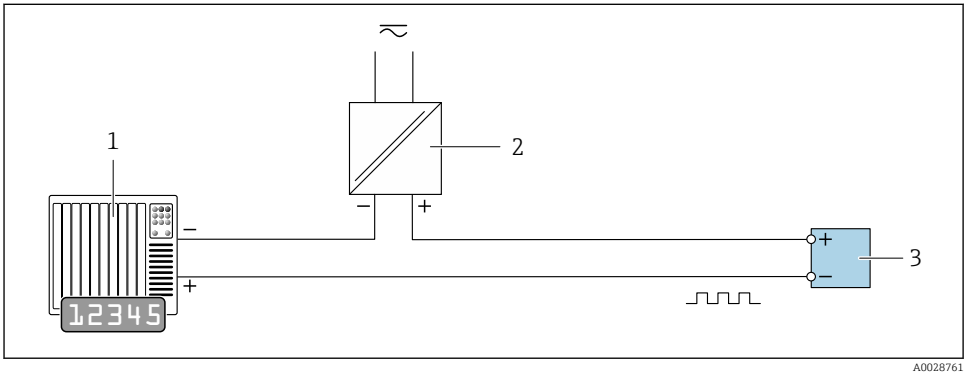
Current output 4 to 20 mA HART



16 *Connection example for 4 to 20 mA HART current output (active)*

1 *Automation system with current input (e.g. PLC)*
2 *Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications*
3 *Connection for HART operating devices*
4 *Resistor for HART communication (≥ 250 Ω): observe maximum load*
5 *Analog display unit: observe maximum load*
6 *Transmitter*

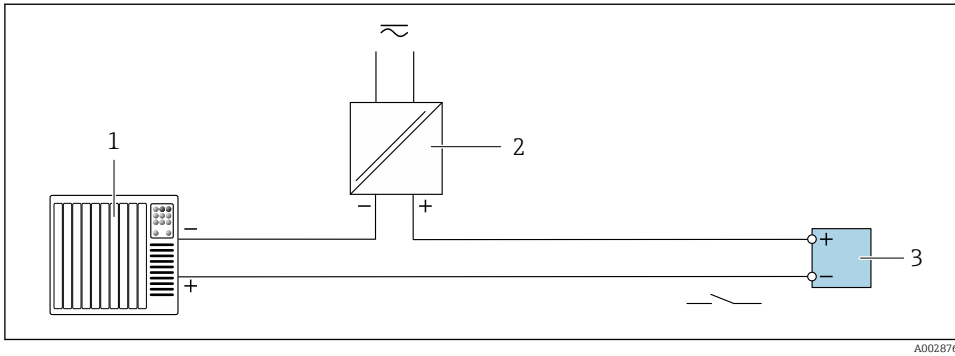
Pulse/frequency output



17 *Connection example for pulse/frequency output (passive)*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values*

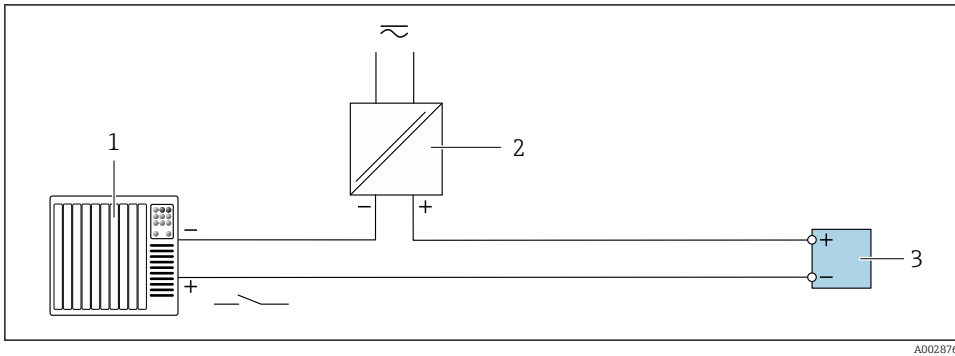
Switch output



18 *Connection example for switch output (passive)*

1 *Automation system with switch input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values*

Status input



19 *Connection example for status input*

1 *Automation system with status output (e.g. PLC)*
2 *Power supply*
3 *Transmitter*

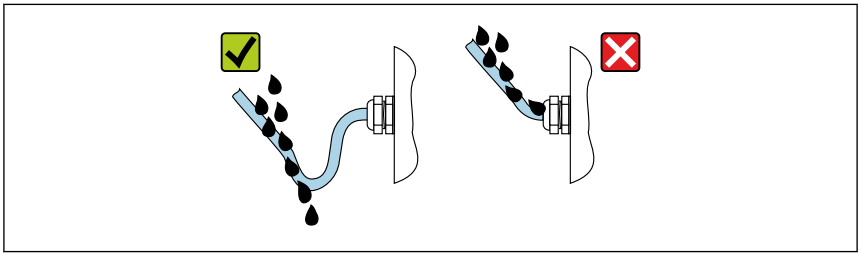
5.6 Ensuring the degree of protection

5.6.1 Degree of protection IP66/67, Type 4X enclosure

The measuring device fulfills all the requirements for the IP66/67 degree of protection, Type 4X enclosure.

To guarantee IP66/67 degree of protection, Type 4X enclosure, carry out the following steps after the electrical connection:

1. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
2. Tighten all housing screws and screw covers.
3. Firmly tighten the cable glands.
4. To ensure that moisture does not enter the cable entry, route the cable so that it loops down before the cable entry ("water trap").



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5. Insert dummy plugs (corresponding to the housing degree of protection) into unused cable entries.

NOTICE

Standard dummy plugs used for transportation do not have the appropriate degree of protection and can result in damage to the device!

▶ Use suitable dummy plugs corresponding to the degree of protection.

5.6.2 Degree of protection IP68, Type 6P enclosure, with "Cust-potted" option

Depending on the version, the sensor meets all the requirements of IP68 degree of protection, Type 6P enclosure and can be used as a remote version .

The degree of protection of the transmitter is always only IP66/67, Type 4X enclosure and the transmitter must therefore be treated accordingly → 38.

To guarantee IP68 degree of protection, Type 6P enclosure for the "Cust-potted" options, carry out the following steps after the electrical connection:

1. Firmly tighten the cable glands (torque: 2 to 3.5 Nm) until there is no gap between the bottom of the cover and the housing support surface.
2. Firmly tighten the union nut of the cable glands.
3. Pot the field housing with a potting compound.

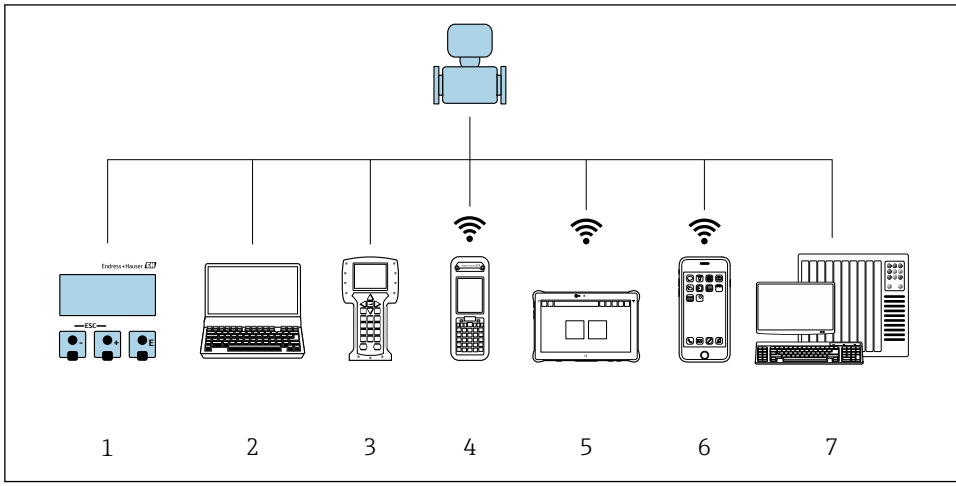
4. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
5. Tighten all housing screws and screw covers (torque: 20 to 30 Nm).

5.7 Post-connection check

Are cables or the device undamaged (visual inspection)?	❑
Do the cables used meet the requirements → 🖹 19?	❑
Do the cables have adequate strain relief?	❑
Are all the cable glands installed, firmly tightened and leak-tight? Cable run with "water trap" → 🖹 38?	❑
Only for remote version: is the sensor connected to the right transmitter? Check the serial number on the nameplate of the sensor and transmitter.	❑
Does the supply voltage match the specifications on the transmitter nameplate ?	❑
Is the terminal assignment correct → 🖹 20?	❑
If supply voltage is present, do values appear on the display module?	❑
Is the potential equalization established correctly ?	❑
Are all housing covers installed and the screws tightened with the correct tightening torque?	❑

6 Operation options

6.1 Overview of operation methods



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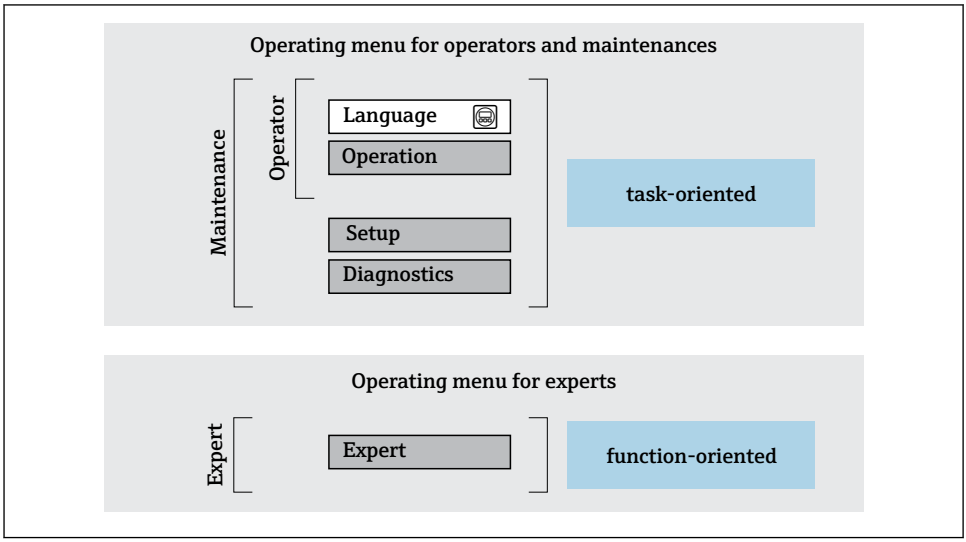
1 *Local operation via display module*
2 *Computer with Web browser (e.g. Internet Explorer) or with operating tool (e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM)*
3 *Field Communicator 475*
4 *Field Xpert SFX350 or SFX370*
5 *Field Xpert SMT70*
6 *Mobile handheld terminal*
7 *Control system (e.g. PLC)*

For custody transfer, once the device has been put into circulation or sealed, its operation is restricted.

6.2 Structure and function of the operating menu

6.2.1 Structure of the operating menu



20 *Schematic structure of the operating menu*

6.2.2 Operating philosophy

The individual parts of the operating menu are assigned to certain user roles (operator, maintenance etc.). Each user role contains typical tasks within the device lifecycle.

For detailed information on the operating philosophy, see the Operating Instructions for the device.

For custody transfer, once the device has been put into circulation or sealed, its operation is restricted.

6.3 Access to the operating menu via the Web browser

6.3.1 Function scope

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

For additional information on the Web server, refer to the Special Documentation for the device

6.3.2 Prerequisites

Computer hardware

Hardware	Interface	
	CDI-RJ45	**WLAN**
Interface	The computer must have an RJ45 interface.	The operating unit must have a WLAN interface.
Connection	Standard Ethernet cable with RJ45 connector.	Connection via Wireless LAN.
Screen	Recommended size: ≥12" (depends on the screen resolution)	

Computer software

Software	Interface	
	CDI-RJ45	**WLAN**

Recommended operating systems	▪ Microsoft Windows 8 or higher.
	▪ Mobile operating systems:
	  ▪ iOS
	  ▪ Android
	Microsoft Windows XP is supported.
	Microsoft Windows 7 is supported.	

Web browsers supported	▪ Microsoft Internet Explorer 8 or higher ▪ Microsoft Edge ▪ Mozilla Firefox ▪ Google Chrome ▪ Safari	

Computer settings

Settings	Interface	
	CDI-RJ45	WLAN
User rights	Appropriate user rights (e.g. administrator rights) for TCP/IP and proxy server settings are necessary (for adjusting the IP address, subnet mask etc.).	
Proxy server settings of the Web browser	The Web browser setting *Use a Proxy Server for Your LAN* must be **deselected** .	
JavaScript	JavaScript must be enabled. If JavaScript cannot be enabled: enter http://192.168.1.212/basic.html in the address line of the Web browser. A fully functional but simplified version of the operating menu structure starts in the Web browser.	
Network connections	Only the active network connections to the measuring device should be used.	
	Switch off all other network connections such as WLAN.	Switch off all other network connections.

In the event of connection problems:

Measuring device: Via CDI-RJ45 service interface

Device	CDI-RJ45 service interface
Measuring device	The measuring device has an RJ45 interface.
Web server	Web server must be enabled; factory setting: ON

Measuring device: via WLAN interface

Device	WLAN interface
Measuring device	The measuring device has a WLAN antenna: Transmitter with integrated WLAN antenna
Web server	Web server and WLAN must be enabled; factory setting: ON

6.3.3 Establishing a connection

Via service interface (CDI-RJ45)

Preparing the measuring device

Configuring the Internet protocol of the computer

The following information refers to the default Ethernet settings of the device.

IP address of the device: 192.168.1.212 (factory setting)

1. Switch on the measuring device.
2. Connect to the computer using a cable .

3. If a 2nd network card is not used, close all the applications on the notebook.
   ↳ Applications requiring Internet or a network, such as e-mail, SAP applications, Internet or Windows Explorer.
4. Close any open Internet browsers.
5. Configure the properties of the Internet protocol (TCP/IP) as defined in the table:

IP address	192.168.1.XXX; for XXX all numerical sequences except: 0, 212 and 255 → e.g. 192.168.1.213
Subnet mask	255.255.255.0
Default gateway	192.168.1.212 or leave cells empty

Via WLAN interface

Configuring the Internet protocol of the mobile terminal

NOTICE

If the WLAN connection is lost during the configuration, settings made may be lost.

- ▶ Make sure that the WLAN connection is not disconnected while configuring the device.

NOTICE

In principle, avoid simultaneous access to the measuring device via the service interface (CDI-RJ45) and the WLAN interface from the same mobile terminal. This could cause a network conflict.

- ▶ Only activate one service interface (CDI-RJ45 service interface or WLAN interface).
- ▶ If simultaneous communication is necessary: configure different IP address ranges, e.g. 192.168.0.1 (WLAN interface) and 192.168.1.212 (CDI-RJ45 service interface).

Preparing the mobile terminal

- ▶ Enable WLAN reception on the mobile terminal.

Establishing a connection from the mobile terminal to the measuring device

1. In the WLAN settings of the mobile terminal:
   Select the measuring device using the SSID (e.g. EH_Promag__A802000).
2. If necessary, select the WPA2 encryption method.
3. Enter the password: serial number of the measuring device ex-works (e.g. L100A802000).
   ↳ LED on display module flashes: it is now possible to operate the measuring device with the Web browser, FieldCare or DeviceCare.

The serial number can be found on the nameplate.

To ensure the safe and swift assignment of the WLAN network to the measuring point, it is advisable to change the SSID name. It should be possible to clearly assign the SSID name to the measuring point (e.g. tag name) as it is displayed as the WLAN network.

Disconnecting

▶ After configuring the device:
Terminate the WLAN connection between the operating unit and measuring device.

Starting the Web browser

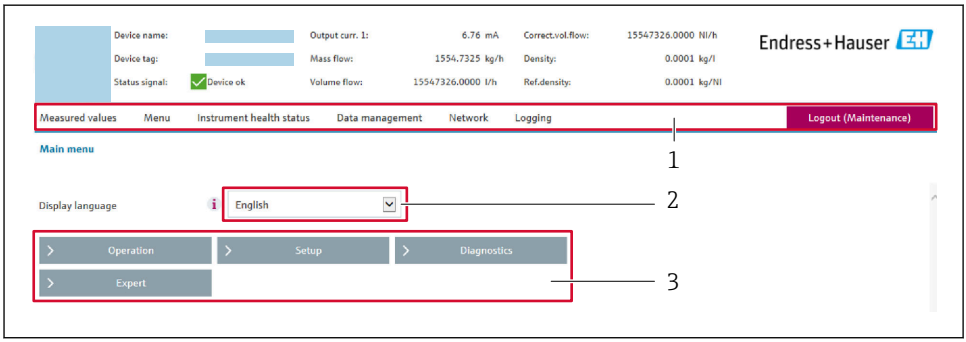
1. Start the Web browser on the computer.
2. Enter the IP address of the Web server in the address line of the Web browser: 192.168.1.212
   ↳ The login page appears.

If a login page does not appear, or if the page is incomplete, see the Special Documentation for the Web server

6.3.4 Logging on

Access code	0000 (factory setting); can be changed by customer

6.3.5 User interface



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1 *Function row*
2 *Local display language*
3 *Navigation area*

Header

The following information appears in the header:
- Device name
- Device tag
- Device status with status signal
- Current measured values

Function row

Functions	Meaning
Measured values	Displays the measured values of the device
Menu	▪ Access to the operating menu from the measuring device ▪ The structure of the operating menu is the same as for the local display For detailed information on the structure of the operating menu, see the Operating Instructions for the measuring device
Device status	Displays the diagnostic messages currently pending, listed in order of priority

Data management	Data exchange between PC and measuring device:
	▪ Device configuration:
	  ▪ Load settings from the device (XML format, save configuration)
	  ▪ Save settings to the device (XML format, restore configuration)
	▪ Logbook - Export Event logbook (.csv file)
	▪ Documents - Export documents:
	  ▪ Export backup data record (.csv file, create documentation of the measuring point configuration)
	  ▪ Verification report (PDF file, only available with the "Heartbeat Verification" application package)

Network configuration	Configuration and checking of all the parameters required for establishing the connection to the measuring device: ▪ Network settings (e.g. IP address, MAC address) ▪ Device information (e.g. serial number, firmware version)
Logout	End the operation and call up the login page

Navigation area

If a function is selected in the function bar, the submenus of the function open in the navigation area. The user can now navigate through the menu structure.

Working area

Depending on the selected function and the related submenus, various actions can be performed in this area:
- Configuring parameters
- Reading measured values
- Calling up help text
- Starting an upload/download

6.3.6 Disabling the Web server

The Web server of the measuring device can be switched on and off as required using the **Web server functionality** parameter.

Navigation

"Expert" menu → Communication → Web server

Parameter overview with brief description

Parameter	Description	Selection
Web server functionality	Switch the Web server on and off.	▪ Off ▪ On

Function scope of the "Web server functionality" parameter

Option	Description
Off	▪ The web server is completely disabled. ▪ Port 80 is locked.
On	▪ The complete functionality of the web server is available. ▪ JavaScript is used. ▪ The password is transferred in an encrypted state. ▪ Any change to the password is also transferred in an encrypted state.

Enabling the Web server

If the Web server is disabled it can only be re-enabled with the **Web server functionality** parameter via the following operating options:
- Via local display
- Via Bedientool "FieldCare"
- Via "DeviceCare" operating tool

6.3.7 Logging out

Before logging out, perform a data backup via the **Data management** function (upload configuration from device) if necessary.

1. Select the **Logout** entry in the function row.
   ↳ The home page with the Login box appears.
2. Close the Web browser.
3. If no longer needed:
   Reset modified properties of the Internet protocol (TCP/IP) → 44.

6.4 Access to the operating menu via the operating tool

For detailed information on access via FieldCare and DeviceCare, see the Operating Instructions for the device → 3

7 System integration

For detailed information on system integration, see the Operating Instructions for the device → 3

- Overview of device description files:
  - Current version data for the device
  - Operating tools
- Measured variables via HART protocol
- Burst mode functionality in accordance with HART 7 Specification

8 Commissioning

8.1 Function check

Before commissioning the measuring device:

▶ Make sure that the post-installation and post-connection checks have been performed.

- "Post-installation check" checklist → 18
- "Post-connection check" checklist → 40

8.2 Switching on the measuring device

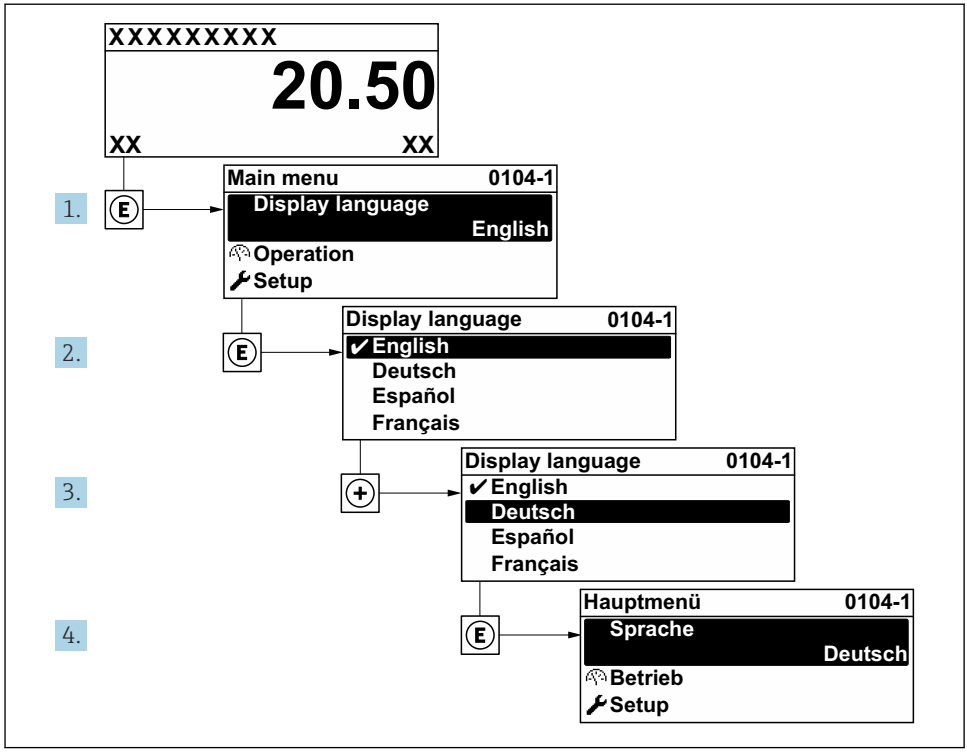
▶ After a successful function check, switch on the measuring device.

↳ After a successful startup, the local display switches automatically from the startup display to the operational display.

If nothing appears on the local display or a diagnostic message is displayed, refer to the Operating Instructions for the device → 3

8.3 Setting the operating language

Factory setting: English or ordered local language



21 *Taking the example of the local display*

8.4 Configuring the measuring device

The **Setup** menu with its submenus is used to commission the measuring device quickly. The submenus contain all the parameters required for configuration, such as parameters for measurement or communication.

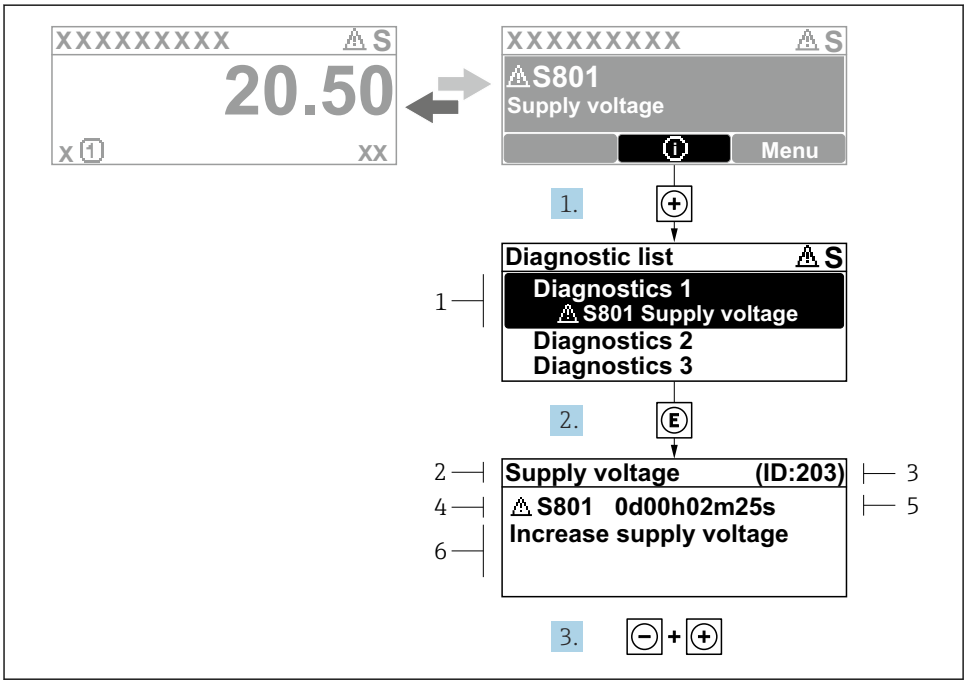
For detailed information on the parameters of the device, see the Description of Device Parameters → 3

Submenu	Configuration
System	Display, diagnostic settings, administration
Sensor	Measured values, system units, process parameters, external compensation, sensor adjustment, calibration
Input	Status input
Output	Current output, pulse/frequency/switch output
Communication	HART input, HART output, web server, diagnostic configuration, WLAN settings

Submenu	Configuration
Application	Totalizer, custody transfer mode
Diagnostics	Diagnostics list, event logbook, device information, simulation

9 Diagnostic information

Faults detected by the self-monitoring system of the measuring device are displayed as a diagnostic message in alternation with the operational display. The message about remedial measures can be called up from the diagnostic message, and contains important information on the fault.



22 *Message about remedial measures*

1 *Diagnostic information*
2 *Short text*
3 *Service ID*
4 *Diagnostic behavior with diagnostic code*
5 *Operation time of occurrence*
6 *Remedial measures*

1. The user is in the diagnostic message.
   Press ⊞ (ⓘ symbol).
   ↳ The **Diagnostic list** submenu opens.
2. Select the desired diagnostic event with ⊞ or ⊟ and press Ⓔ .
   ↳ The message about the remedial measures opens.
3. Press ⊟ + ⊞ simultaneously.
   ↳ The message about the remedial measures closes.

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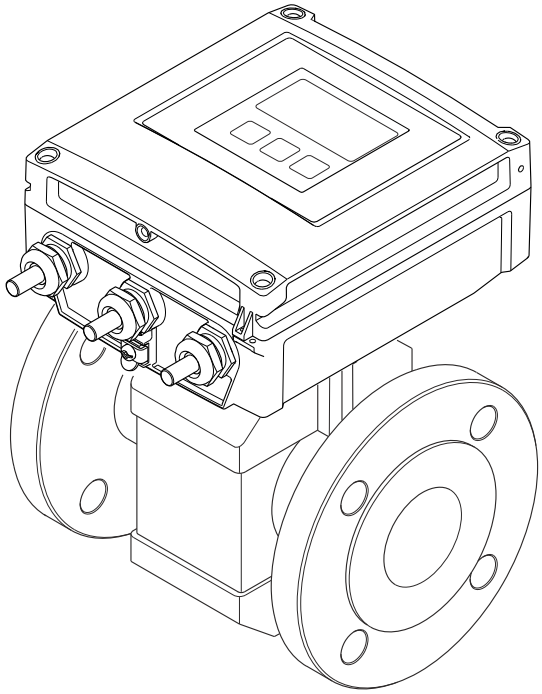
People for Process Automation

BA01063D/06/EN/09.21
71535806
2021-09-01

Valid as of version
02.01.zz (Device firmware)

Operating Instructions
Proline Promag W 400 HART

Electromagnetic flowmeter



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- Make sure the document is stored in a safe place such that it is always available when working on or with the device.
- To avoid danger to individuals or the facility, read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser Sales Center will supply you with current information and updates to these instructions.

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1 About this document

1.1 Document function

These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

1.2 Symbols

1.2.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.2.2 Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓ ~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⊕	**Protective Earth (PE)** A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: ▪ Inner ground terminal: Connects the protectiv earth to the mains supply. ▪ Outer ground terminal: Connects the device to the plant grounding system.

1.2.3 Communication symbols

Symbol	Meaning
	Wireless Local Area Network (WLAN) Communication via a wireless, local network.
	Bluetooth Wireless data transmission between devices over a short distance.
	LED Light emitting diode is off.

Symbol	Meaning
	LED Light emitting diode is on.
	LED Light emitting diode is flashing.

1.2.4 Tool symbols

Symbol	Meaning
	Torx screwdriver
	Phillips head screwdriver
	Open-ended wrench

1.2.5 Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Notice or individual step to be observed
1., 2., 3....	Series of steps
	Result of a step
	Help in the event of a problem
	Visual inspection

1.2.6 Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
	Hazardous area

Symbol	Meaning
	Safe area (non-hazardous area)
	Flow direction

1.3 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Detailed list of the individual documents along with the documentation code
→ 192

1.3.1 Standard documentation

Document type	Purpose and content of the document
Technical Information	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Sensor Brief Operating Instructions	**Getting the 1st measured value quickly - Part 1** The Sensor Brief Operating Instructions are aimed at specialists with responsibility for installing the measuring device. ▪ Incoming acceptance and product identification ▪ Storage and transport ▪ Installation
Transmitter Brief Operating Instructions	**Getting the 1st measured value quickly - Part 2** The Transmitter Brief Operating Instructions are aimed at specialists with responsibility for commissioning, configuring and parameterizing the measuring device (until the first measured value). ▪ Product description ▪ Installation ▪ Electrical connection ▪ Operation options ▪ System integration ▪ Commissioning ▪ Diagnostic information
Description of Device Parameters	**Reference for your parameters** The document provides a detailed explanation of each individual parameter in the Expert operating menu. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.

1.3.2 Supplementary device-dependent documentation

Additional documents are supplied depending on the device version ordered: Always comply strictly with the instructions in the supplementary documentation. The supplementary documentation is an integral part of the device documentation.

1.4 Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, USA

2 Safety instructions

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

The operating personnel must fulfill the following requirements:
- Are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Follow the instructions in this manual.

2.2 Designated use

Application and media
The measuring device described in this manual is intended only for the flow measurement of liquids with a minimum conductivity of 5 µS/cm.

Depending on the version ordered, the measuring device can also measure potentially explosive, flammable, poisonous and oxidizing media.

Measuring devices for use in hazardous areas, in hygienic applications or where there is an increased risk due to process pressure, are labeled accordingly on the nameplate.

To ensure that the measuring device remains in proper condition for the operation time:
- Keep within the specified pressure and temperature range.
- Only use the measuring device in full compliance with the data on the nameplate and the general conditions listed in the Operating Instructions and supplementary documentation.
- Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area (e.g. explosion protection, pressure vessel safety).
- Use the measuring device only for media to which the process-wetted materials are sufficiently resistant.
- If the ambient temperature of the measuring device is outside the atmospheric temperature, it is absolutely essential to comply with the relevant basic conditions as specified in the device documentation.→ 8
- Protect the measuring device permanently against corrosion from environmental influences.

The measuring device is optionally tested in accordance with OIML R49: 2006 and has an EC type-examination certificate according to Measuring Instruments Directive 2004/22/EC (MID) for service subject to legal metrological control ("custody transfer") for cold water (Annex MI-001).

The permitted medium temperature in these applications is 0 to +50 °C (+32 to +122 °F).

Incorrect use
Non-designated use can compromise safety. The manufacturer is not liable for damage caused by improper or non-designated use.

⚠ WARNING

Danger of breakage due to corrosive or abrasive fluids and ambient conditions!

- ▶ Verify the compatibility of the process fluid with the sensor material.
- ▶ Ensure the resistance of all fluid-wetted materials in the process.
- ▶ Keep within the specified pressure and temperature range.

NOTICE

Verification for borderline cases:

- ▶ For special fluids and fluids for cleaning, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of fluid-wetted materials, but does not accept any warranty or liability as minute changes in the temperature, concentration or level of contamination in the process can alter the corrosion resistance properties.

Residual risks

⚠ WARNING

If the temperature of the media or electronics unit is high or low, this may cause the surfaces of the device to become hot or cold. This poses a risk of burns or frostbite!

- ▶ In the case of hot or cold medium temperatures, install appropriate protection against contact.

2.3 Workplace safety

For work on and with the device:

- ▶ Wear the required personal protective equipment according to national regulations.

For welding work on the piping:

- ▶ Do not ground the welding unit via the measuring device.

If working on and with the device with wet hands:

- ▶ Due to the increased risk of electric shock, wear suitable gloves.

2.4 Operational safety

Risk of injury.

- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for interference-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.

- ▶ If, despite this, modifications are required, consult with Endress+Hauser.

Repair

To ensure continued operational safety and reliability,

- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to repair of an electrical device.
- ▶ Use original spare parts and accessories from Endress+Hauser only.

2.5 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

Furthermore, the device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards.

By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

2.6 IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

2.7 Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section.

2.7.1 Protecting access via a password

Different passwords are available to protect write access to the device parameters or access to the device via the WLAN interface.

- User-specific access code
  Protect write access to the device parameters via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.
- WLAN passphrase
  The network key protects a connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface which can be ordered as an option.

User-specific access code

Write access to the device parameters via the local display or operating tool (e.g. FieldCare, DeviceCare) can be protected by the modifiable, user-specific access code (→ 🖹 122).

When the device is delivered, the device does not have an access code and is equivalent to *0000* (open).

WLAN passphrase: Operation as WLAN access point

A connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface (→ 🖹 80), which can be ordered as an optional extra, is protected by

the network key. The WLAN authentication of the network key complies with the IEEE 802.11 standard.

When the device is delivered, the network key is pre-defined depending on the device. It can be changed via the **WLAN settings** submenu in the **WLAN passphrase** parameter (→ 118).

General notes on the use of passwords

- The access code and network key supplied with the device should be changed during commissioning.
- Follow the general rules for generating a secure password when defining and managing the access code or network key.
- The user is responsible for the management and careful handling of the access code and network key.
- For information on configuring the access code or on what to do if you lose the password, for example, see the "Write protection via access code" section → 122

2.7.2 Access via Web server

The device can be operated and configured via a Web browser with the integrated Web server (→ 73). The connection is via the service interface (CDI-RJ45) or the WLAN interface.

The Web server is enabled when the device is delivered. The Web server can be disabled if necessary (e.g. after commissioning) via the **Web server functionality** parameter.

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

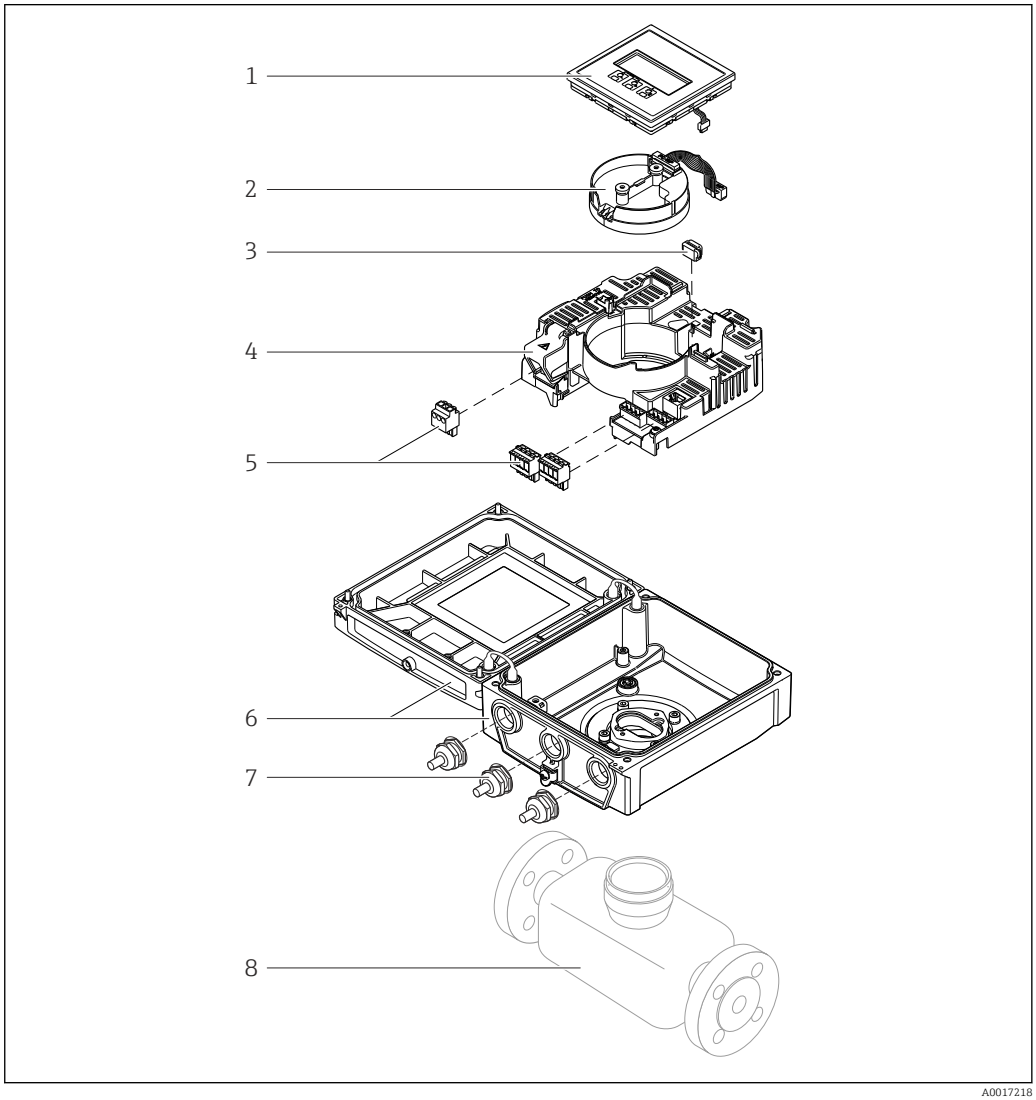
For detailed information on device parameters, see:
The "Description of Device Parameters" document → 193.

3 Product description

The device consists of a transmitter and a sensor.

Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

3.1 Product design

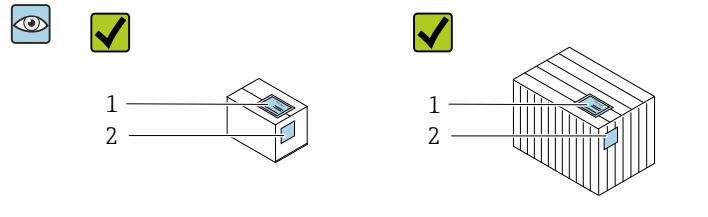


1 *Important components of the compact version*

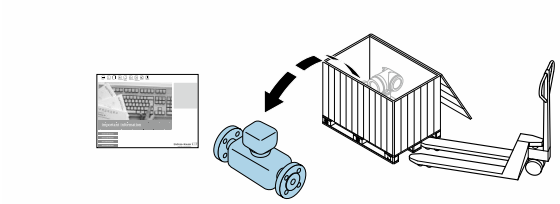
1 *Display module*
2 *Smart sensor electronics module*
3 *HistoROM DAT (plug-in memory)*
4 *Main electronics module*
5 *Terminals (screw terminals, some available as plug-in terminals) or fieldbus connectors*
6 *Transmitter housing, compact version*
7 *Cable glands*
8 *Sensor, compact version*

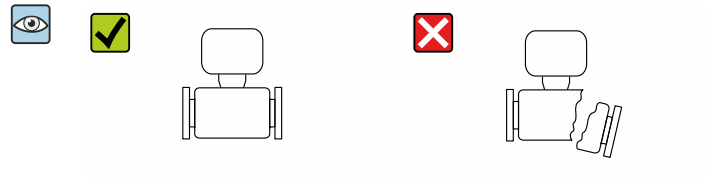
4 Incoming acceptance and product identification

4.1 Incoming acceptance

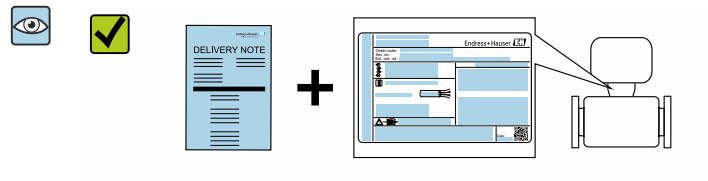


Are the order codes on the delivery note (1) and the product sticker (2) identical?





Are the goods undamaged?



Do the nameplate data match the ordering information on the delivery note?

Is the envelope present with accompanying documents?

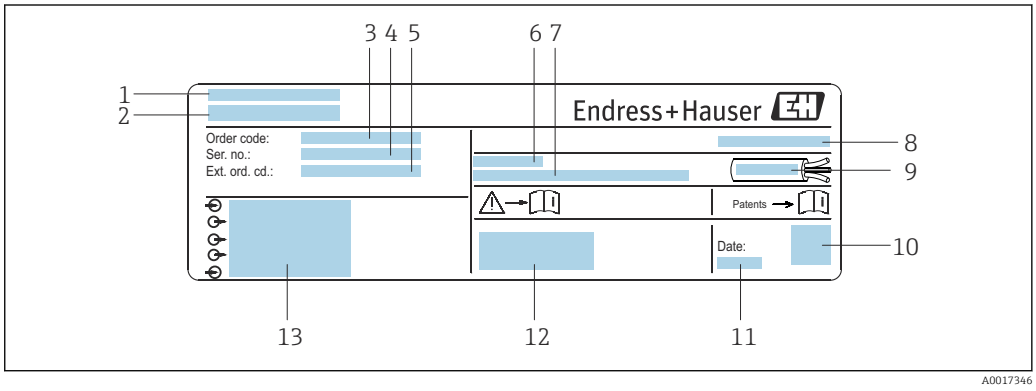
- If one of the conditions is not satisfied, contact your Endress+Hauser Sales Center.
- The Technical Documentation is available via the Internet or via the *Endress+Hauser Operations App*, see the "Product identification" section → 15.

4.2 Product identification

The following options are available for identification of the device:
- Nameplate specifications
- Order code with breakdown of the device features on the delivery note
- Enter the serial numbers from the nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer): all the information about the device is displayed.
- Enter the serial numbers from the nameplates into the *Endress+Hauser Operations App* or scan the DataMatrix code on the nameplate with the *Endress+Hauser Operations App*: all the information about the device is displayed.

For an overview of the scope of the associated Technical Documentation, refer to the following:
- The chapters "Additional standard documentation on the device" → 8 and "Supplementary device-dependent documentation" → 8
- The *W@M Device Viewer*: Enter the serial number from the nameplate (www.endress.com/deviceviewer)
- The *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the DataMatrix code on the nameplate.

4.2.1 Transmitter nameplate



2 *Example of a transmitter nameplate*

1 *Place of manufacture*
2 *Name of the transmitter*
3 *Order code*
4 *Serial number (Ser. no.)*
5 *Extended order code (Ext. ord. cd.)*
6 *Permitted ambient temperature (T_a)*
7 *Firmware version (FW) and device revision (Dev.Rev.) from the factory*
8 *Degree of protection*
9 *Permitted temperature range for cable*
10 *2-D matrix code*
11 *Date of manufacture: year-month*
12 *CE mark, RCM-Tick mark*
13 *Electrical connection data, e.g. available inputs and outputs, supply voltage*

4.2.2 Sensor nameplate

Order code
The measuring device is reordered using the order code.

Extended order code
- The device type (product root) and basic specifications (mandatory features) are always listed.
- Of the optional specifications (optional features), only the safety and approval-related specifications are listed (e.g. LA). If other optional specifications are also ordered, these are indicated collectively using the # placeholder symbol (e.g. #LA#).
- If the ordered optional specifications do not include any safety and approval-related specifications, they are indicated by the + placeholder symbol (e.g. XXXXXX-ABCDE +).

4.2.3 Symbols on measuring device

Symbol	Meaning
	WARNING! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury. To determine the nature of the potential hazard and the measures required to avoid it, consult the documentation accompanying the measuring device.
	Reference to documentation Refers to the corresponding device documentation.
	Protective ground connection A terminal which must be connected to ground prior to establishing any other connections.

5 Storage and transport

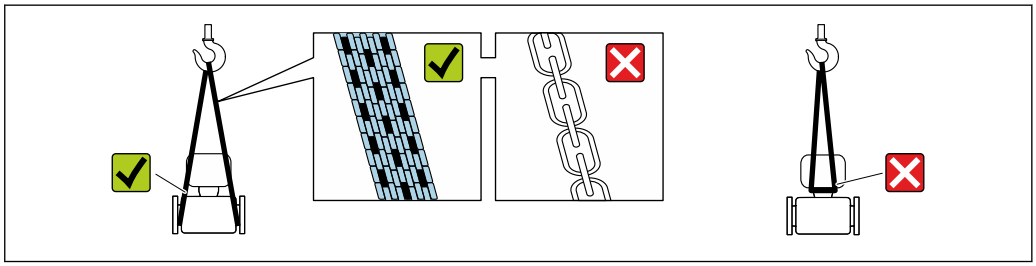
5.1 Storage conditions

Observe the following notes for storage:
- Store in the original packaging to ensure protection from shock.
- Do not remove protective covers or protective caps installed on process connections. They prevent mechanical damage to the sealing surfaces and contamination in the measuring tube.
- Protect from direct sunlight to avoid unacceptably high surface temperatures.
- Select a storage location where moisture cannot collect in the measuring device as fungus and bacteria infestation can damage the liner.
- Store in a dry and dust-free place.
- Do not store outdoors.

Storage temperature → 173

5.2 Transporting the product

Transport the measuring device to the measuring point in the original packaging.



A0029252

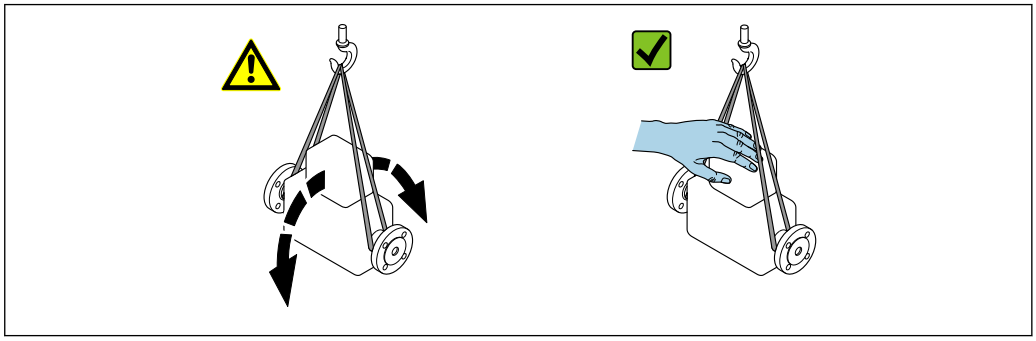
Do not remove protective covers or caps installed on process connections. They prevent mechanical damage to the sealing surfaces and contamination in the measuring tube.

5.2.1 Measuring devices without lifting lugs

WARNING

Center of gravity of the measuring device is higher than the suspension points of the webbing slings.

Risk of injury if the measuring device slips.
- Secure the measuring device against slipping or turning.
- Observe the weight specified on the packaging (stick-on label).



A0029214

5.2.2 Measuring devices with lifting lugs

⚠ CAUTION

Special transportation instructions for devices with lifting lugs

- ▶ Only use the lifting lugs fitted on the device or flanges to transport the device.
- ▶ The device must always be secured at two lifting lugs at least.

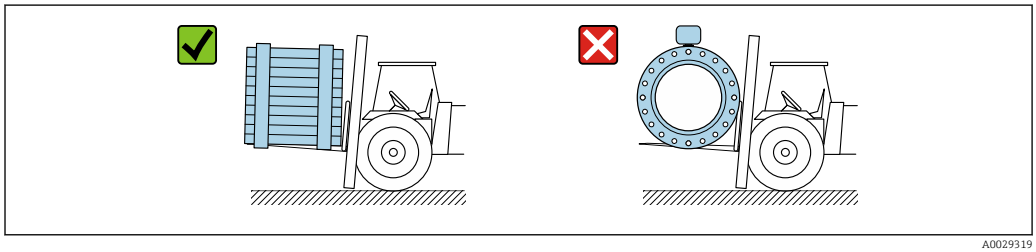
5.2.3 Transporting with a fork lift

If transporting in wood crates, the floor structure enables the crates to be lifted lengthwise or at both sides using a forklift.

⚠ CAUTION

Risk of damaging the magnetic coil

- ▶ If transporting by forklift, do not lift the sensor by the metal casing.
- ▶ This would buckle the casing and damage the internal magnetic coils.



A0029319

5.3 Packaging disposal

All packaging materials are environmentally friendly and 100 % recyclable:

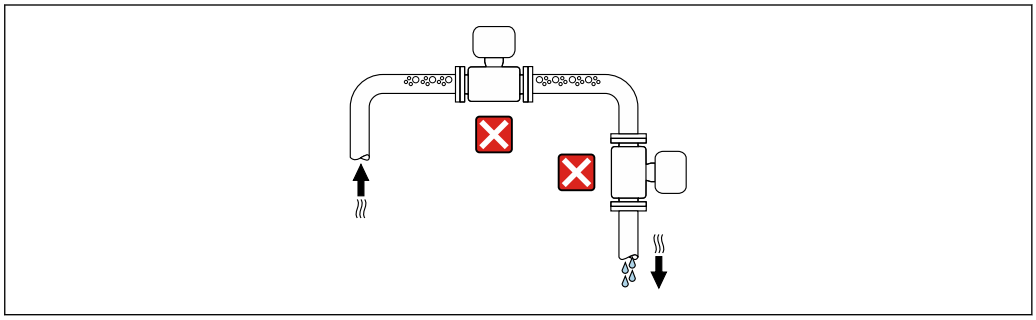
- Outer packaging of device
  Polymer stretch wrap, complying with EU Directive 2002/95/EC (RoHS)
- Packaging
  - Wooden crate treated in accordance with ISPM 15 standard, confirmed by IPPC logo
  - Cardboard box in accordance with European packaging guideline 94/62EC, recyclability confirmed by Resy symbol
- Carrying and securing materials
  - Disposable plastic pallet
  - Plastic straps
  - Plastic adhesive strips
- Filler material
  Paper pads

6 Installation

6.1 Installation conditions

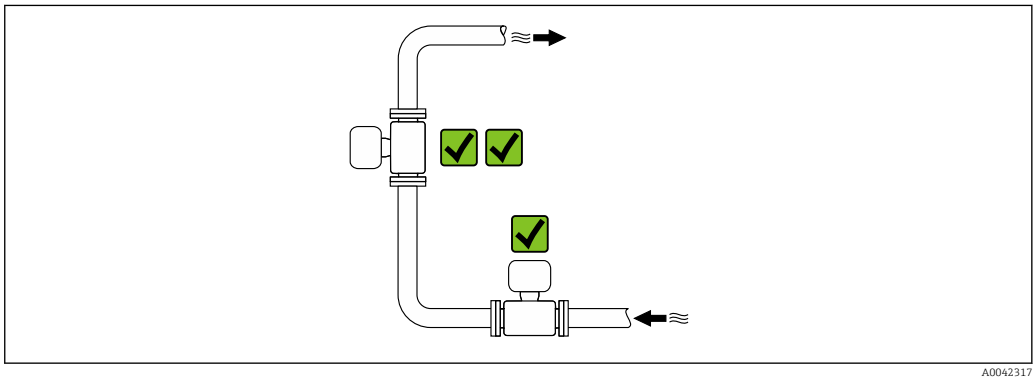
6.1.1 Mounting location

- Do not install the device at the highest point of the pipe.
- Do not install the device upstream from a free pipe outlet in a down pipe.



A0042131

The device should ideally be installed in an ascending pipe.



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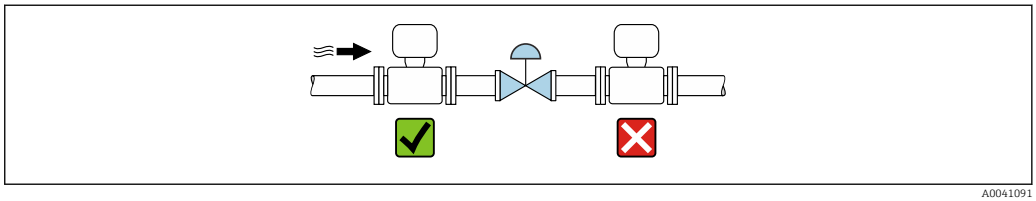
Installation near valves

Install the device in the direction of flow upstream from the valve.



A0041091

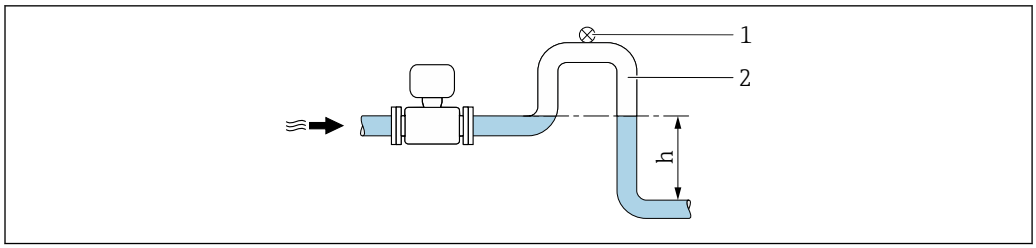
Installation upstream from a down pipe

NOTICE

Negative pressure in the measuring pipe can damage the liner!

▶ If installing upstream from down pipes with a length h ≥ 5 m (16.4 ft), install a siphon with a vent valve downstream from the device.

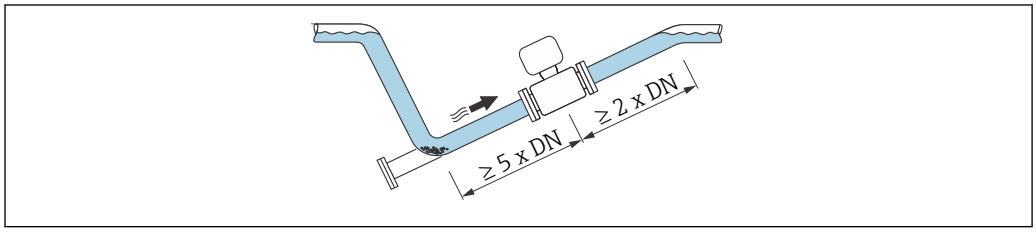
This arrangement prevents the stoppage of liquid flow and the formation of air pockets.



1 Vent valve
2 Pipe siphon
h Length of down pipe

Installation with partially filled pipes

- Partially filled pipes with a gradient require a drain-type configuration.
- The installation of a cleaning valve is recommended.



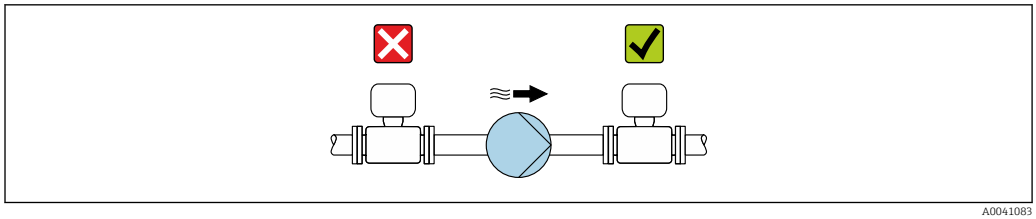
No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

Installation near pumps

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- ▶ In order to maintain the system pressure, install the device in the flow direction downstream from the pump.
- ▶ Install pulsation dampers if reciprocating, diaphragm or peristaltic pumps are used.



- Information on the liner's resistance to partial vacuum → 175
- Information on the measuring system's resistance to vibration and shock → 174

Installation of very heavy devices

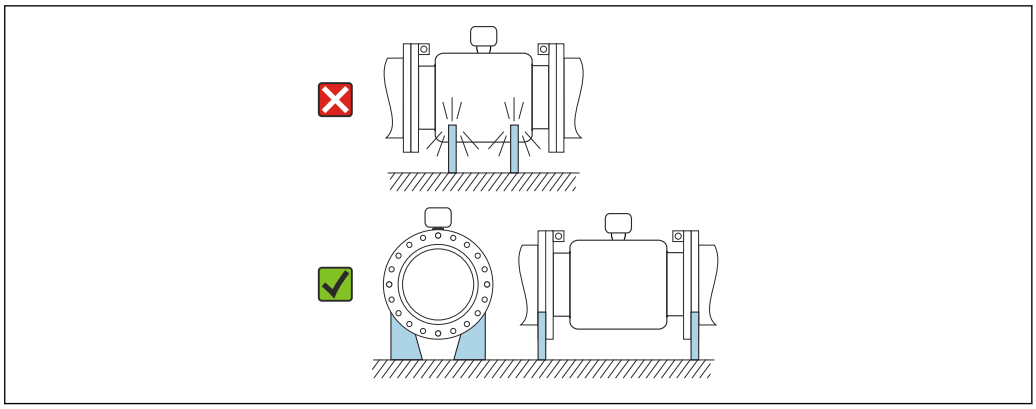
Support required for nominal diameters of DN ≥ 350 mm (14 in).

NOTICE

Damage to the device!

If incorrect support is provided, the sensor housing could buckle and the internal magnetic coils could be damaged.

- ▶ Only provide supports at the pipe flanges.



A0041087

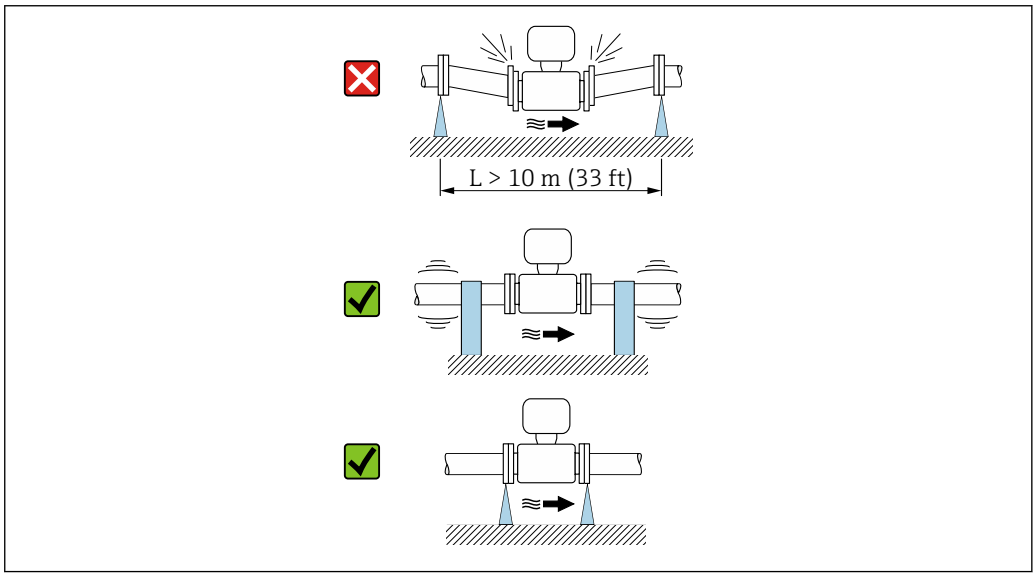
Installation in event of pipe vibrations

A remote version is recommended in the event of strong pipe vibrations.

NOTICE

Pipe vibrations can damage the device!

- Do not expose the device to strong vibrations.
- Support the pipe and fix it in place.
- Support the device and fix it in place.
- Mount the sensor and transmitter separately.

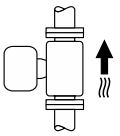
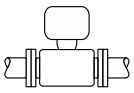
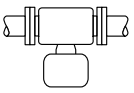
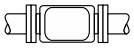


A0041092

Information on the measuring system's resistance to vibration and shock → 174

6.1.2 Orientation

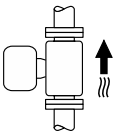
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

Orientation		Recommendation
Vertical orientation	 A0015591	✓✓
Horizontal orientation, transmitter at top	 A0015589	✓✓ 1)
Horizontal orientation, transmitter at bottom	 A0015590	✓✓ 2) 3) ✗ 4)
Horizontal orientation, transmitter at side	 A0015592	✗

1) Applications with low process temperatures may decrease the ambient temperature. To maintain the minimum ambient temperature for the transmitter, this orientation is recommended.
2) Applications with high process temperatures may increase the ambient temperature. To maintain the maximum ambient temperature for the transmitter, this orientation is recommended.
3) To prevent the electronics module from overheating in the case of a sharp rise in temperature (e.g. CIP or SIP processes), install the device with the transmitter component pointing downwards.
4) With the empty pipe detection function switched on: empty pipe detection only works if the transmitter housing is pointing upwards.

Vertical

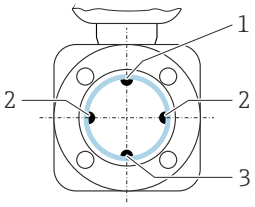
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



A0015591

Horizontal

- Ideally, the measuring electrode plane should be horizontal. This prevents brief insulation of the measuring electrodes by entrained air bubbles.
- Empty pipe detection only works if the transmitter housing is pointing upwards as otherwise there is no guarantee that the empty pipe detection function will actually respond to a partially filled or empty measuring tube.



A0029344

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

6.1.3 Inlet and outlet runs

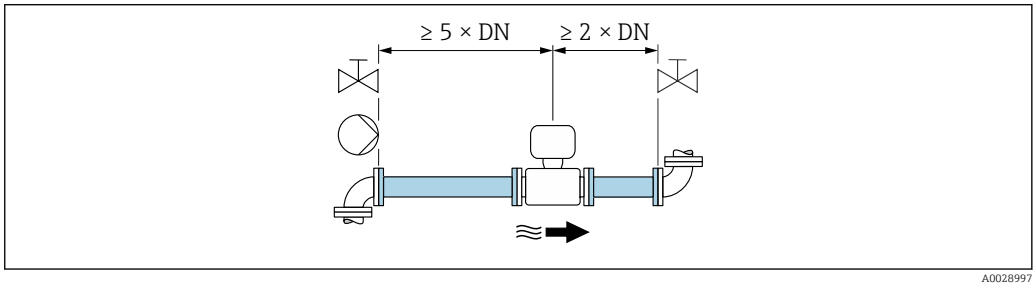
Installation with inlet and outlet runs

Installation requires inlet and outlet runs: devices with the order code for "Design", option D, E, F and G.

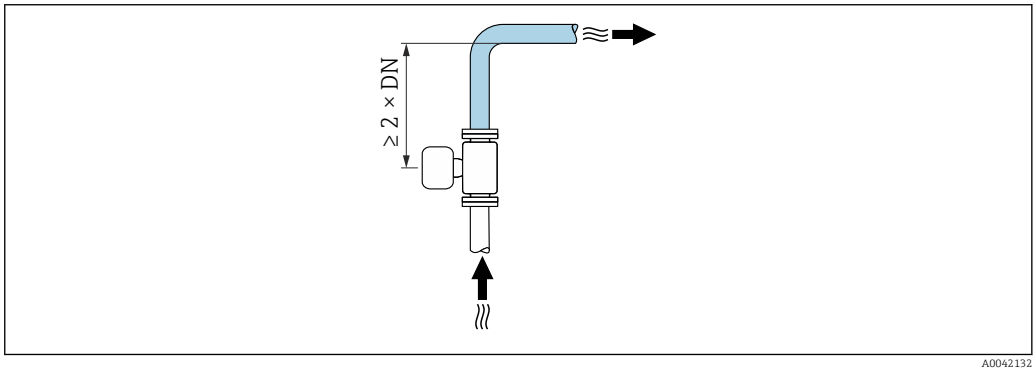
Installation with elbows, pumps or valves

To avoid a vacuum and to maintain the specified level of accuracy, install the device upstream from assemblies that produce turbulence (e.g. valves, T-sections) and downstream from pumps, wherever possible.

Maintain straight, unimpeded inlet and outlet runs.



A0028997



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Installation without inlet and outlet runs

Depending on the device design and installation location, the inlet and outlet runs can be reduced or omitted entirely.

Maximum measured error
When the device is installed with the inlet and outlet runs described, a maximum measured error of ±0.5 % of the reading ±1 mm/s (0.04 in/s) can be guaranteed.

Devices and possible order options

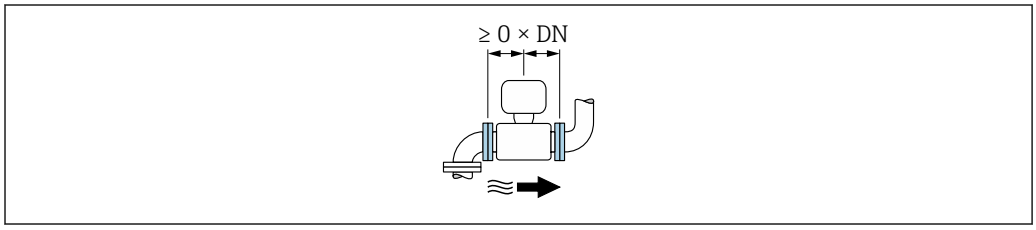
Order code for "Design"		
Option	**Description**	**Design**
C	Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs	Constricted measuring tube [1]
H	Lap joint flange, 0 x DN inlet/outlet runs	Full Bore [2]
I	Fixed flange, 0 x DN inlet/outlet runs	

Order code for "Design"		
Option	**Description**	**Design**
J	Fixed flange, short installed length, 0 x DN inlet/ outlet runs	
K	Fixed flange, long installed length, 0 x DN inlet/ outlet runs	

1) "Constricted measuring tube" stands for a reduction of the internal diameter of the measuring tube. The reduced internal diameter causes a higher flow velocity inside the measuring tube.
2) "Full Bore" stands for the full diameter of the measuring tube. There is no pressure loss with a full diameter.

Installation before or after bends

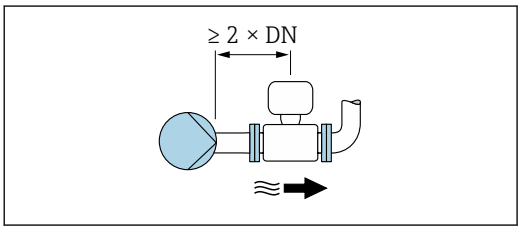
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

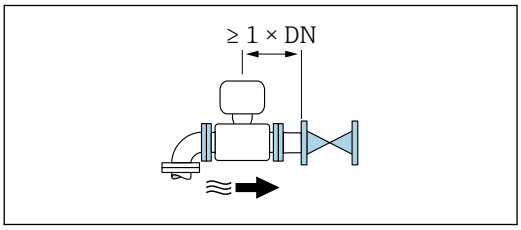
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

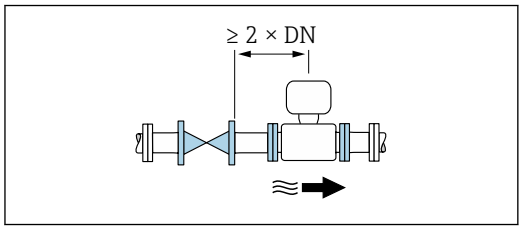
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



Installation downstream of valves

Installation without inlet and outlet runs is possible if the valve is 100% open during operation: devices with the order code for "Design", option C, H and I.

In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration if the valve is 100% open during operation.



6.1.4 Dimensions

For the dimensions and installed lengths of the device, see the "Technical Information" document, "Mechanical construction" section → 192

6.1.5 Environment and process requirements

Ambient temperature range

Transmitter	−40 to +60 °C (−40 to +140 °F)
Local display	−20 to +60 °C (−4 to +140 °F), the legibility of the local display may be impaired at temperatures outside the temperature range.
Sensor	▪ Process connection material, carbon steel: −10 to +60 °C (+14 to +140 °F) ▪ Process connection material, stainless steel: −40 to +60 °C (−40 to +140 °F) If both the ambient and the medium temperatures are high, mount the sensor separately from the transmitter.
Liner	Do not exceed or fall below the permitted temperature range of the liner → 175.

If operating outdoors:
- Install the measuring device in a shady location.
- Avoid direct sunlight, particularly in warm climatic regions.
- Avoid direct exposure to weather conditions.
- If the compact version of the device is insulated at low temperatures, the insulation must also include the device neck.
- Protect the display against impact.
- Protect the display from abrasion, e.g. caused by sand in desert areas.

Display guard available as an accessory → 157.

Temperature tables

Observe the interdependencies between the permitted ambient and fluid temperatures when operating the device in hazardous areas.

For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.

System pressure

Installation near pumps → 20

Vibrations

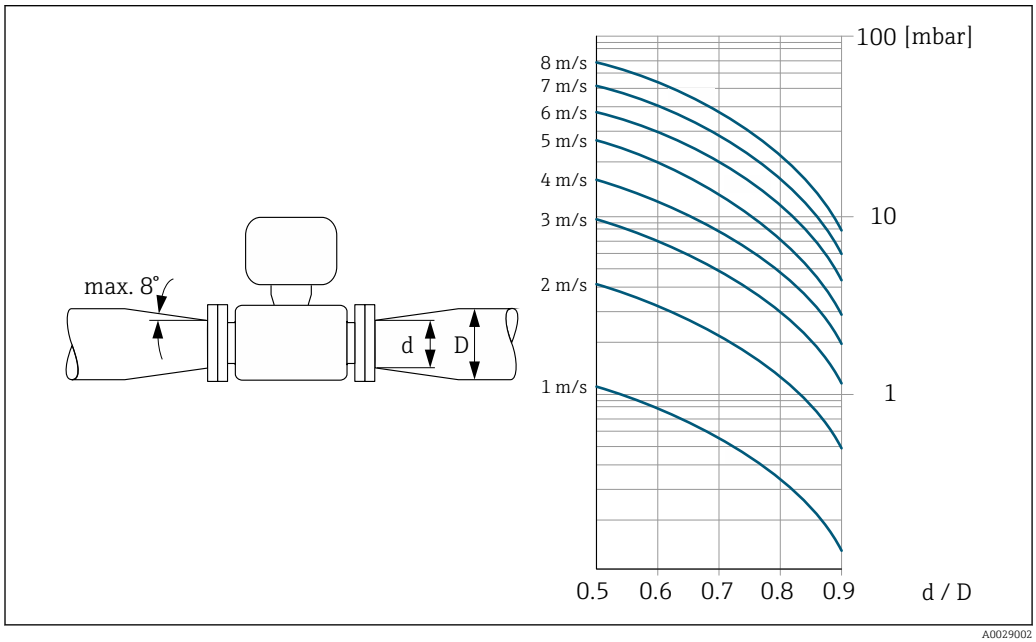
Installation in event of pipe vibrations → 21

Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids. The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders.

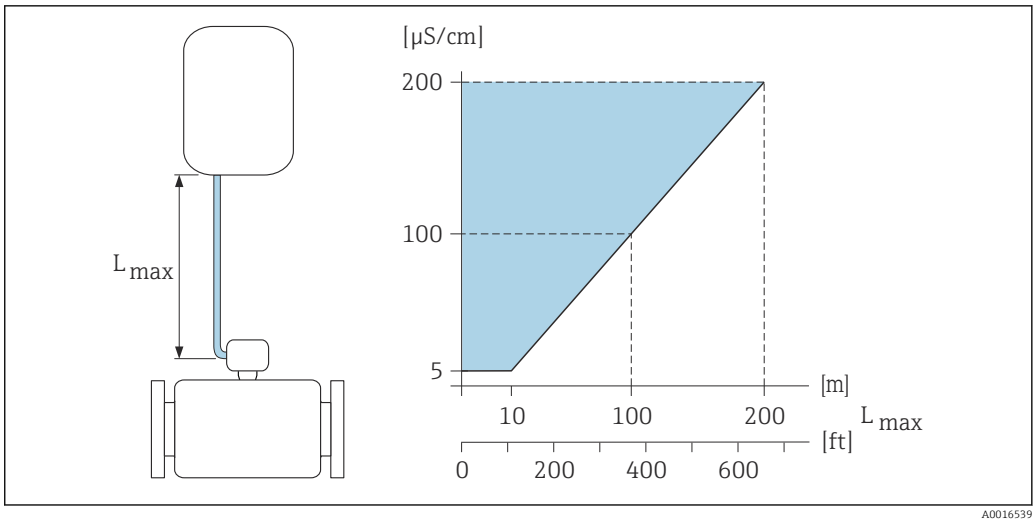
The nomogram only applies to liquids with a viscosity similar to that of water.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.



Length of connecting cable

To obtain correct measurement results, observe the permitted connecting cable length of L_{max}. This length is determined by the conductivity of the fluid. If measuring liquids in general: 5 µS/cm



3 *Permitted length of connecting cable*

Colored area = permitted range
L_{max} = length of connecting cable in [m] ([ft])
[µS/cm] = fluid conductivity

6.1.6 Special mounting instructions

Display guard

- To ensure that the optional display guard can be easily opened, maintain the following minimum head clearance: 350 mm (13.8 in)

Immersion in water

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

- Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

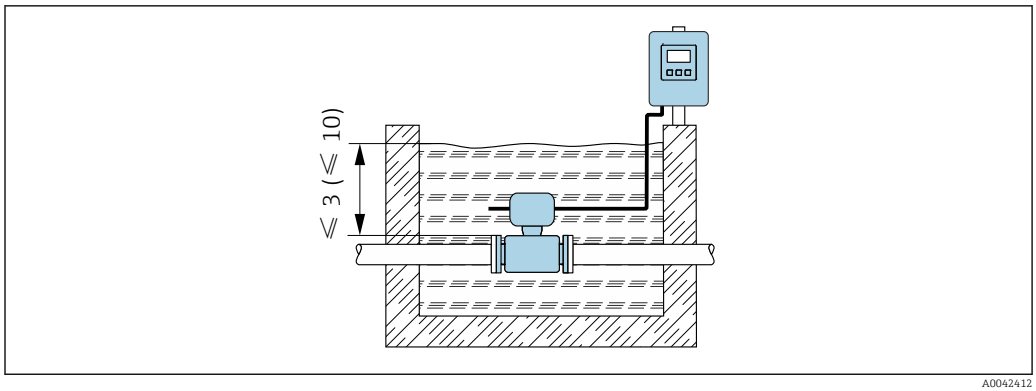
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof "

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



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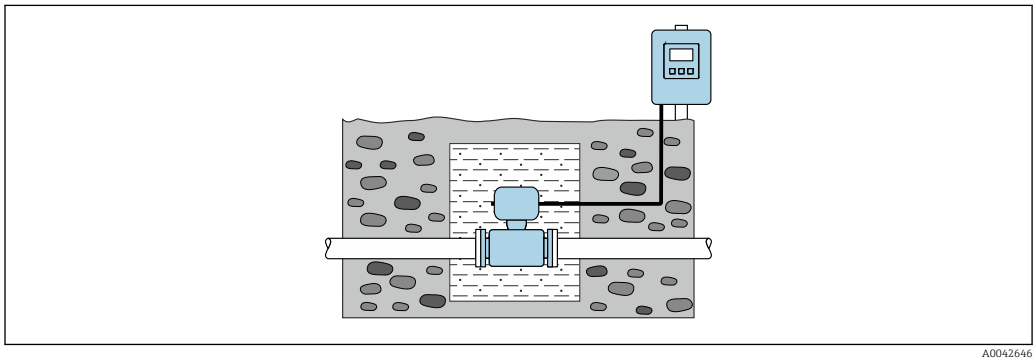
Use in buried applications

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

For the use of the device in buried applications.



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6.2 Mounting the measuring device

6.2.1 Required tool

For transmitter

- Torque wrench
- For wall mounting:
  Open-ended wrench for hexagonal screw max. M5
- For pipe mounting:
  - Open-ended wrench AF 8
  - Phillips head screwdriver PH 2
- For turning the transmitter housing (compact version):
  - Phillips head screwdriver PH 2
  - Torx screwdriver TX 20
  - Open-ended wrench AF 7

For sensor

For flanges and other process connections: use a suitable mounting tool

6.2.2 Preparing the measuring device

1. Remove all remaining transport packaging.
2. Remove any protective covers or protective caps present from the sensor.
3. Remove stick-on label on the electronics compartment cover.

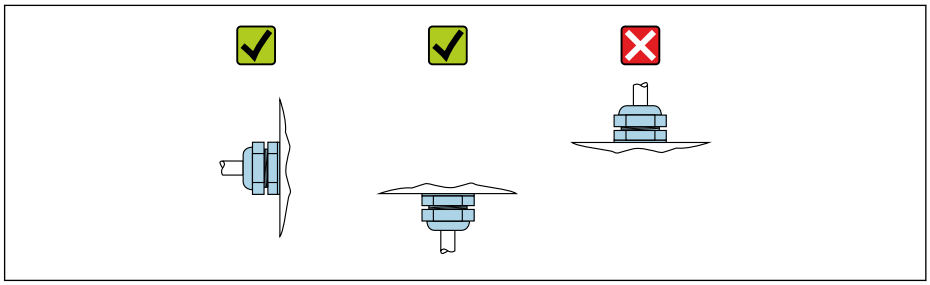
6.2.3 Mounting the sensor

⚠ WARNING

Danger due to improper process sealing!

- ▶ Ensure that the inside diameters of the gaskets are greater than or equal to that of the process connections and piping.
- ▶ Ensure that the seals are clean and undamaged.
- ▶ Secure the seals correctly.

1. Ensure that the direction of the arrow on the sensor matches the flow direction of the medium.
2. To ensure compliance with device specifications, install the measuring device between the pipe flanges in a way that it is centered in the measurement section.
3. If using ground disks, comply with the Installation Instructions provided.
4. Observe required screw tightening torques → 30.
5. Install the measuring device or turn the transmitter housing so that the cable entries do not point upwards.



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Mounting the seals

⚠ CAUTION

An electrically conductive layer could form on the inside of the measuring tube!
Risk of measuring signal short circuit.

- ▶ Do not use electrically conductive sealing compounds such as graphite.

Comply with the following instructions when installing seals:

1. Make sure that the seals do not protrude into the piping cross-section.
2. For DIN flanges: only use seals according to DIN EN 1514-1.
3. For a "hard rubber" liner: additional seals are **always** required.
4. For a "polyurethane" liner: additional seals are generally **not** required.

Mounting the ground cable/ground disks

Comply with the information on potential equalization and detailed mounting instructions for the use of ground cables/ground disks .

Screw tightening torques

Please note the following:
- The screw tightening torques listed below apply only to lubricated threads and to pipes not subjected to tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Nominal screw tightening torques → 35

Maximum screw tightening torques

Maximum screw tightening torques for EN 1092-1 (DIN 2501)

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
25	1	PN 40	4 × M12	18	–	15	26
32	–	PN 40	4 × M16	18	–	24	41
40	1 ½	PN 40	4 × M16	18	–	31	52
50	2	PN 40	4 × M16	20	48	40	65
65 [1)]	–	PN 16	8 × M16	18	32	27	44
65	–	PN 40	8 × M16	22	32	27	44
80	3	PN 16	8 × M16	20	40	34	53
		PN 40	8 × M16	24	40	34	53
100	4	PN 16	8 × M16	20	43	36	57
		PN 40	8 × M20	24	59	50	79
125	–	PN 16	8 × M16	22	56	48	75
		PN 40	8 × M24	26	83	71	112
150	6	PN 16	8 × M20	22	74	63	99
		PN 40	8 × M24	28	104	88	137
200	8	PN 10	8 × M20	24	106	91	141
		PN 16	12 × M20	24	70	61	94
		PN 25	12 × M24	30	104	92	139
250	10	PN 10	12 × M20	26	82	71	110
		PN 16	12 × M24	26	98	85	132
		PN 25	12 × M27	32	150	134	201
300	12	PN 10	12 × M20	26	94	81	126
		PN 16	12 × M24	28	134	118	179
		PN 25	16 × M27	34	153	138	204
350	14	PN 6	12 × M20	22	111	120	–
		PN 10	16 × M20	26	112	118	–
		PN 16	16 × M24	30	152	165	–
		PN 25	16 × M30	38	227	252	–
400	16	PN 6	16 × M20	22	90	98	–
		PN 10	16 × M24	26	151	167	–
		PN 16	16 × M27	32	193	215	–
		PN 25	16 × M33	40	289	326	–
450	18	PN 6	16 × M20	22	112	126	–

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
		PN 10	20 × M24	28	153	133	–
		PN 16	20 × M27	40	198	196	–
		PN 25	20 × M33	46	256	253	–
500	20	PN 6	20 × M20	24	119	123	–
		PN 10	20 × M24	28	155	171	–
		PN 16	20 × M30	34	275	300	–
		PN 25	20 × M33	48	317	360	–
600	24	PN 6	20 × M24	30	139	147	–
		PN 10	20 × M27	28	206	219	–
600	24	PN 16	20 × M33	36	415	443	–
600	24	PN 25	20 × M36	58	431	516	–
700	28	PN 6	24 × M24	24	148	139	–
		PN 10	24 × M27	30	246	246	–
		PN 16	24 × M33	36	278	318	–
		PN 25	24 × M39	46	449	507	–
800	32	PN 6	24 × M27	24	206	182	–
		PN 10	24 × M30	32	331	316	–
		PN 16	24 × M36	38	369	385	–
		PN 25	24 × M45	50	664	721	–
900	36	PN 6	24 × M27	26	230	637	–
		PN 10	28 × M30	34	316	307	–
		PN 16	28 × M36	40	353	398	–
		PN 25	28 × M45	54	690	716	–
1000	40	PN 6	28 × M27	26	218	208	–
		PN 10	28 × M33	34	402	405	–
		PN 16	28 × M39	42	502	518	–
		PN 25	28 × M52	58	970	971	–
1200	48	PN 6	32 × M30	28	319	299	–
		PN 10	32 × M36	38	564	568	–
		PN 16	32 × M45	48	701	753	–
1400	–	PN 6	36 × M33	32	430	–	–
		PN 10	36 × M39	42	654	–	–
		PN 16	36 × M45	52	729	–	–
1600	–	PN 6	40 × M33	34	440	–	–
		PN 10	40 × M45	46	946	–	–
		PN 16	40 × M52	58	1007	–	–
1800	72	PN 6	44 × M36	36	547	–	–
		PN 10	44 × M45	50	961	–	–
		PN 16	44 × M52	62	1108	–	–
2000	–	PN 6	48 × M39	38	629	–	–
		PN 10	48 × M45	54	1047	–	–

Nominal diameter		Pressure rating	Screws	Flange thickness	Max. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
		PN 16	48 × M56	66	1324	–	–
2200	–	PN 6	52 × M39	42	698	–	–
		PN 10	52 × M52	58	1217	–	–
2400	–	PN 6	56 × M39	44	768	–	–
		PN 10	56 × M52	62	1229	–	–

1) Sizing as per EN 1092-1 (not DIN 2501)

Maximum screw tightening torques for ASME B16.5

Nominal diameter		Pressure rating	Screws	Max. screw tightening torque			
				HG		PUR	
[mm]	[in]	[psi]	[in]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
25	1	Class 150	4 × ½	–	–	7	5
25	1	Class 300	4 × 5/8	–	–	8	6
40	1 ½	Class 150	4 × ½	–	–	10	7
40	1 ½	Class 300	4 × ¾	–	–	15	11
50	2	Class 150	4 × 5/8	35	26	22	16
50	2	Class 300	8 × 5/8	18	13	11	8
80	3	Class 150	4 × 5/8	60	44	43	32
80	3	Class 300	8 × ¾	38	28	26	19
100	4	Class 150	8 × 5/8	42	31	31	23
100	4	Class 300	8 × ¾	58	43	40	30
150	6	Class 150	8 × ¾	79	58	59	44
150	6	Class 300	12 × ¾	70	52	51	38
200	8	Class 150	8 × ¾	107	79	80	59
250	10	Class 150	12 × 7/8	101	74	75	55
300	12	Class 150	12 × 7/8	133	98	103	76
350	14	Class 150	12 × 1	135	100	158	117
400	16	Class 150	16 × 1	128	94	150	111
450	18	Class 150	16 × 1 1/8	204	150	234	173
500	20	Class 150	20 × 1 1/8	183	135	217	160
600	24	Class 150	20 × 1 ¼	268	198	307	226

Maximum screw tightening torques for JIS B2220

Nominal diameter	Pressure rating	Screws	Max. screw tightening torque [Nm]	
[mm]	[bar]	[mm]	HG	PUR
25	10K	4 × M16	–	19
25	20K	4 × M16	–	19
32	10K	4 × M16	–	22
32	20K	4 × M16	–	22
40	10K	4 × M16	–	24

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Max. screw tightening torque [Nm]	
			HG	PUR
40	20K	4 × M16	–	24
50	10K	4 × M16	40	33
50	20K	8 × M16	20	17
65	10K	4 × M16	55	45
65	20K	8 × M16	28	23
80	10K	8 × M16	29	23
80	20K	8 × M20	42	35
100	10K	8 × M16	35	29
100	20K	8 × M20	56	48
125	10K	8 × M20	60	51
125	20K	8 × M22	91	79
150	10K	8 × M20	75	63
150	20K	12 × M22	81	72
200	10K	12 × M20	61	52
200	20K	12 × M22	91	80
250	10K	12 × M22	100	87
250	20K	12 × M24	159	144
300	10K	16 × M22	74	63
300	20K	16 × M24	138	124

Maximum screw tightening torques for AWWA C207, Class D

Nominal diameter		Screws	Max. screw tightening torque			
[mm]	[in]	[in]	HG		PUR	
			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
700	28	28 × 1 ¼	247	182	292	215
750	30	28 × 1 ¼	287	212	302	223
800	32	28 × 1 ½	394	291	422	311
900	36	32 × 1 ½	419	309	430	317
1000	40	36 × 1 ½	420	310	477	352
–	42	36 × 1 ½	528	389	518	382
–	48	44 × 1 ½	552	407	531	392
–	54	44 × 1 ¾	730	538	–	–
–	60	52 × 1 ¾	758	559	–	–
–	66	52 × 1 ¾	946	698	–	–
–	72	60 × 1 ¾	975	719	–	–
–	78	64 × 2	853	629	–	–
–	84	64 x 2	931	687	–	–
–	90	64 x 2 ¼	1048	773	–	–

Maximum screw tightening torques for AS 2129, Table E

Nominal diameter [mm]	Screws [mm]	Max. screw tightening torque [Nm]	
		HG	PUR
50	4 × M16	32	–
80	4 × M16	49	–
100	8 × M16	38	–
150	8 × M20	64	–
200	8 × M20	96	–
250	12 × M20	98	–
300	12 × M24	123	–
350	12 × M24	203	–
400	12 × M24	226	–
450	16 × M24	226	–
500	16 × M24	271	–
600	16 × M30	439	–
700	20 × M30	355	–
750	20 × M30	559	–
800	20 × M30	631	–
900	24 × M30	627	–
1000	24 × M30	634	–
1200	32 × M30	727	–

Maximum screw tightening torques for AS 4087, PN 16

Nominal diameter [mm]	Screws [mm]	Max. screw tightening torque [Nm]	
		HG	PUR
50	4 × M16	32	–
80	4 × M16	49	–
100	4 × M16	76	–
150	8 × M20	52	–
200	8 × M20	77	–
250	8 × M20	147	–
300	12 × M24	103	–
350	12 × M24	203	–
375	12 × M24	137	–
400	12 × M24	226	–
450	12 × M24	301	–
500	16 × M24	271	–
600	16 × M27	393	–
700	20 × M27	330	–
750	20 × M30	529	–
800	20 × M33	631	–
900	24 × M33	627	–

Nominal diameter [mm]	Screws [mm]	Max. screw tightening torque [Nm]	
		HG	PUR
1000	24 × M33	595	–
1200	32 × M33	703	–

Nominal screw tightening torques

Nominal screw tightening torques for EN 1092-1 (DIN 2501); calculated according to EN 1591-1:2014 for flanges according to EN 1092-1:2013

Nominal diameter		Pressure rating	Screws	Flange thickness	Nom. screw tightening torque [Nm]		
[mm]	[in]	[bar]	[mm]	[mm]	HG	PUR	PTFE
1000	40	PN 6	28 × M27	38	175	185	–
		PN 10	28 × M33	44	350	360	–
		PN 16	28 × M39	59	630	620	–
		PN 25	28 × M52	63	1300	1290	–
1200	48	PN 6	32 × M30	42	235	250	–
		PN 10	32 × M36	55	470	480	–
		PN 16	32 × M45	78	890	900	–
1400	–	PN 6	36 × M33	56	300	–	–
		PN 10	36 × M39	65	600	–	–
		PN 16	36 × M45	84	1050	–	–
1600	–	PN 6	40 × M33	63	340	–	–
		PN 10	40 × M45	75	810	–	–
		PN 16	40 × M52	102	1420	–	–
1800	72	PN 6	44 × M36	69	430	–	–
		PN 10	44 × M45	85	920	–	–
		PN 16	44 × M52	110	1600	–	–
2000	–	PN 6	48 × M39	74	530	–	–
		PN 10	48 × M45	90	1040	–	–
		PN 16	48 × M56	124	1900	–	–
2200	–	PN 6	52 × M39	81	580	–	–
		PN 10	52 × M52	100	1290	–	–
2400	–	PN 6	56 × M39	87	650	–	–
		PN 10	56 × M52	110	1410	–	–

Nominal screw tightening torques for JIS B2220

Nominal diameter	Pressure rating	Screws	Nom. screw tightening torque [Nm]	
[mm]	[bar]	[mm]	HG	PUR
350	10K	16 × M22	109	109
	20K	16 × M30×3	217	217
400	10K	16 × M24	163	163
	20K	16 × M30×3	258	258
450	10K	16 × M24	155	155

Nominal diameter [mm]	Pressure rating [bar]	Screws [mm]	Nom. screw tightening torque [Nm]	
			HG	PUR
	20K	16 × M30×3	272	272
500	10K	16 × M24	183	183
	20K	16 × M30×3	315	315
600	10K	16 × M30	235	235
	20K	16 × M36×3	381	381
700	10K	16 × M30	300	300
750	10K	16 × M30	339	339

6.2.4 Mounting the transmitter of the remote version

⚠ CAUTION

Ambient temperature too high!

Danger of electronics overheating and housing deformation.

- ▶ Do not exceed the permitted maximum ambient temperature .
- ▶ If operating outdoors: Avoid direct sunlight and exposure to weathering, particularly in warm climatic regions.

⚠ CAUTION

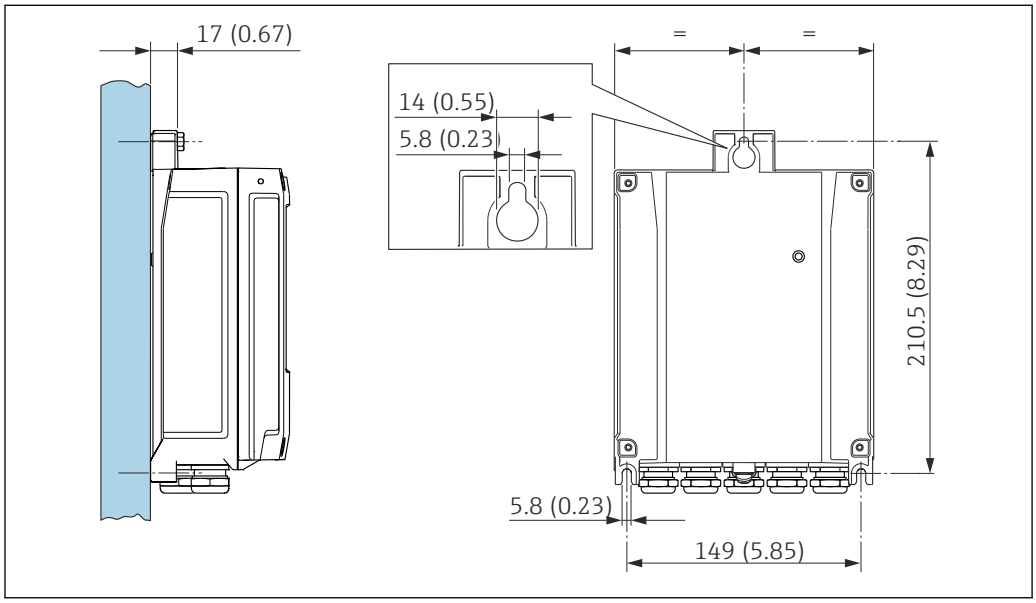
Excessive force can damage the housing!

- ▶ Avoid excessive mechanical stress.

The transmitter of the remote version can be mounted in the following ways:

- Wall mounting
- Pipe mounting

Wall mounting



4 *Engineering unit mm (in)*

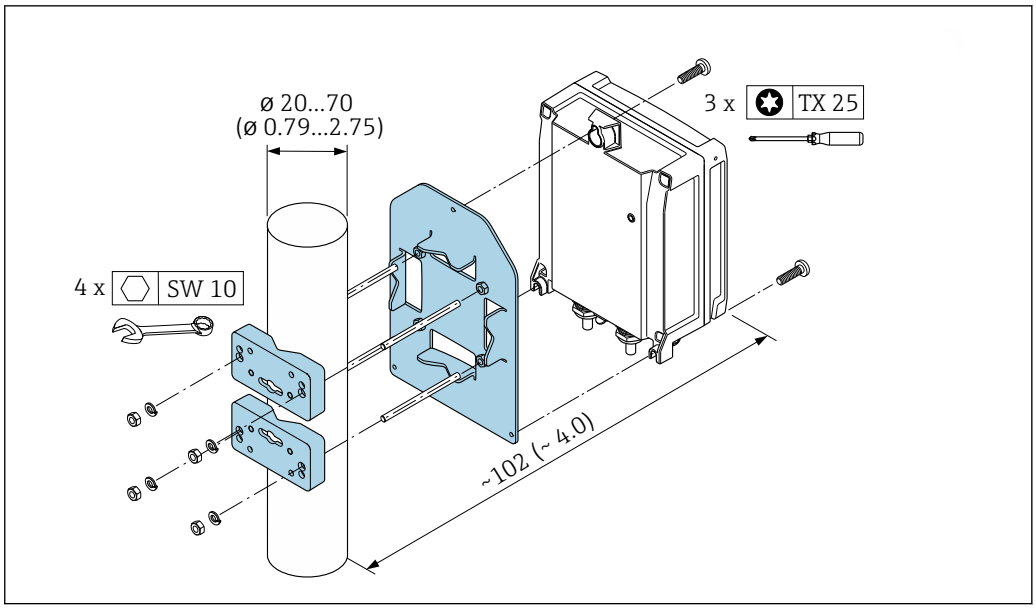
1. Drill the holes.
2. Insert wall plugs into the drilled holes.
3. Screw the securing screws in slightly.

4. Fit the transmitter housing over the securing screws and mount in place.
5. Tighten the securing screws.

Post mounting

WARNING

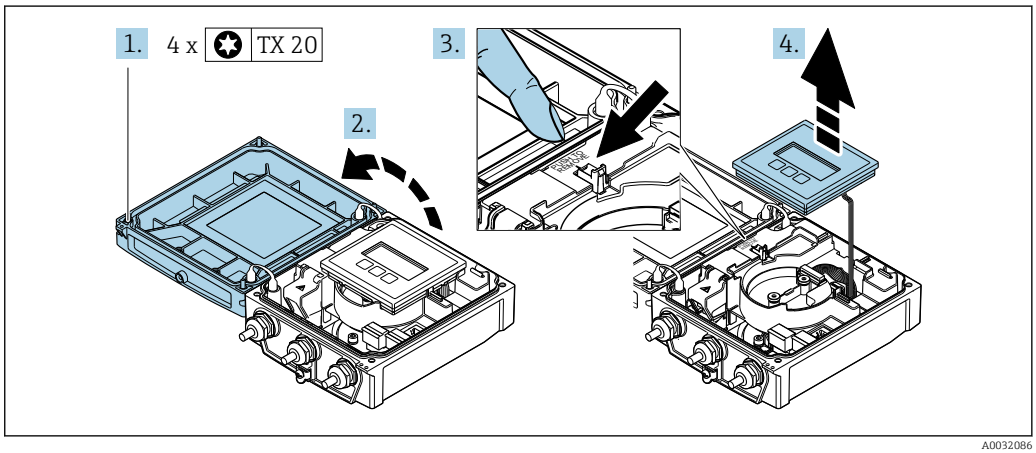
Excessive tightening torque applied to the fixing screws!
Risk of damaging the plastic transmitter.
▶ Tighten the fixing screws as per the tightening torque: 2 Nm (1.5 lbf ft)



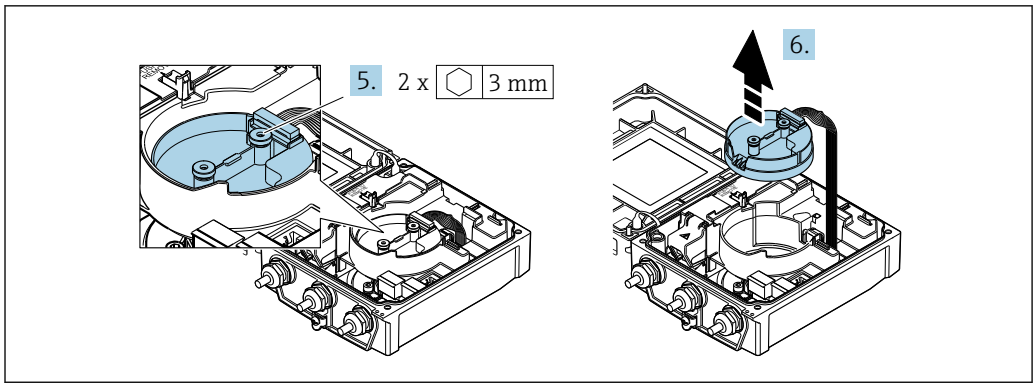
5 *Engineering unit mm (in)*

6.2.5 Turning the transmitter housing

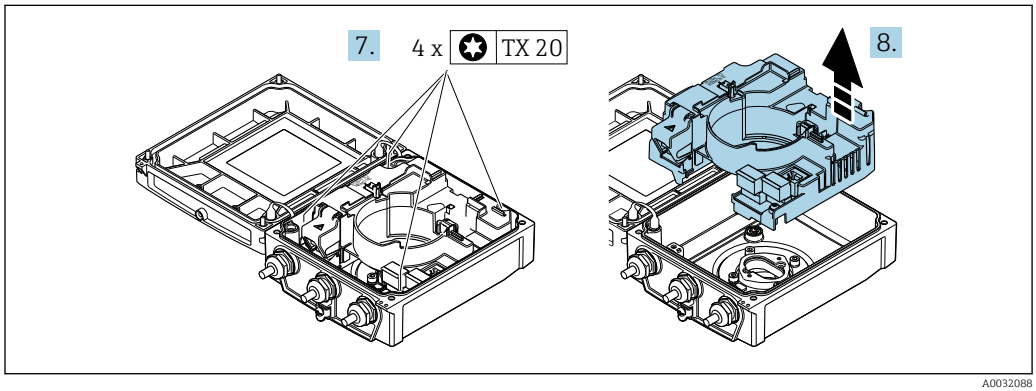
To provide easier access to the connection compartment or display module, the transmitter housing can be turned.



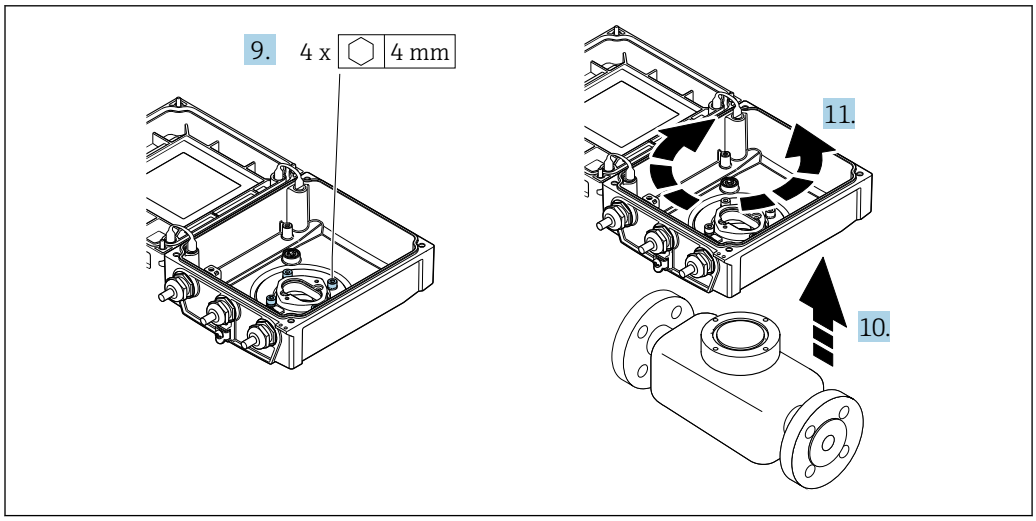
1. Loosen the fixing screws of the housing cover (when reassembling, pay attention to the tightening torque → 39).
2. Open the housing cover.
3. Unlock the display module.
4. Remove the display module.



5. Loosen the fixing screws of the smart sensor electronics module (when reassembling, pay attention to the tightening torque → 39).
6. Remove the smart sensor electronics module (when reassembling, pay attention to the coding of the plug → 39).



7. Loosen the fixing screws of the main electronics module (when reassembling, pay attention to the tightening torque → 39).
8. Remove the main electronics module.



9. Loosen the fixing screws of the transmitter housing (when reassembling, pay attention to the tightening torque → 39).
10. Lift the transmitter housing.
11. Turn the housing to the desired position in increments of 90°.

Reassembling the transmitter housing

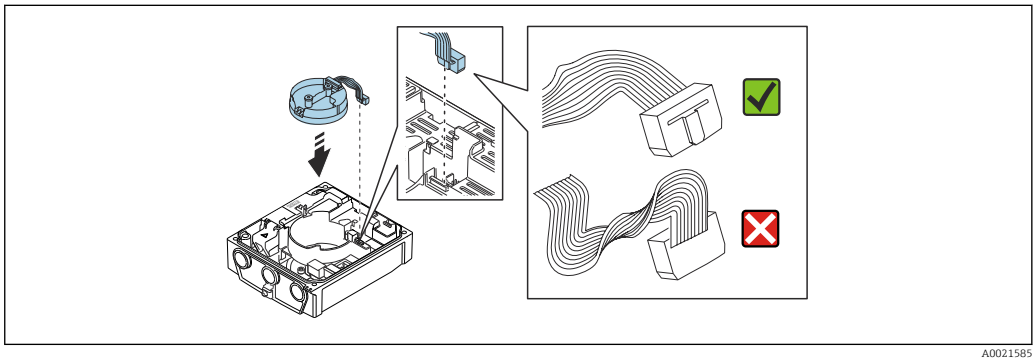
⚠ WARNING

Excessive tightening torque applied to the fixing screws!
Risk of damaging the plastic transmitter.
- ▶ Tighten the fixing screws as per the tightening torque: 2 Nm (1.5 lbf ft)

Step → 🖹 37	Fixing screw	Tightening torques for housing made of:	
		Aluminum	Plastic
1	Housing cover	2.5 Nm (1.8 lbf ft)	1 Nm (0.7 lbf ft)
5	Smart sensor electronics module	0.6 Nm (0.4 lbf ft)	
7	Main electronics module	1.5 Nm (1.1 lbf ft)	
9/10	Transmitter housing	5.5 Nm (4.1 lbf ft)	

NOTICE

Plug of the smart sensor electronics module connected incorrectly!
No measuring signal is output.
- ▶ Plug in the plug of the smart sensor electronics module as per the coding.



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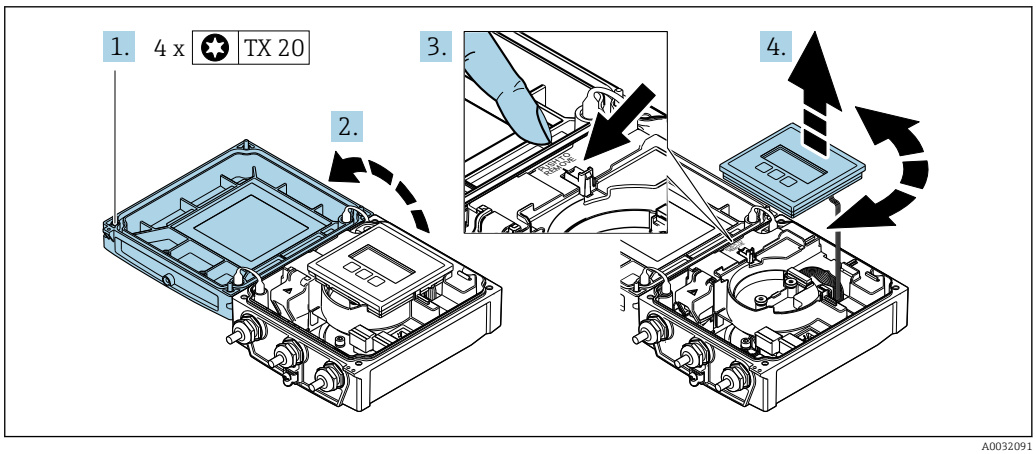
- ▶ Reverse the procedure to reassemble the measuring device.

6.2.6 Turning the display module

The display module can be turned to optimize display readability and operability.



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1. Loosen the fixing screws of the housing cover.
2. Open the housing cover.
3. Unlock the display module.
4. Pull out the display module and turn it to the desired position in increments of 90°.

Mounting the transmitter housing

⚠ WARNING

Excessive tightening torque applied to the fixing screws!
Damage to the transmitter.
▶ Tighten the fixing screws with the specified torques.

1. Insert the display module and lock it when doing so.
2. Close the housing cover.
3. Tighten the fixing screws of the housing cover: tightening torque for aluminum housing 2.5 Nm (1.8 lbf ft) – plastic housing 1 Nm (0.7 lbf ft).

6.3 Post-installation check

Is the device undamaged (visual inspection)?	❑
Does the measuring device conform to the measuring point specifications? For example: ▪ Process temperature → 🖹 175 ▪ Process pressure (refer to the section on "Pressure-temperature ratings" in the "Technical Information" document)→ 🖹 192 ▪ Ambient temperature → 🖹 25 ▪ Measuring range → 🖹 160	❑
Has the correct orientation been selected for the sensor → 🖹 21 ? ▪ According to sensor type ▪ According to medium temperature ▪ According to medium properties (outgassing, with entrained solids)	❑
Does the arrow on the sensor nameplate match the actual direction of flow of the fluid through the piping → 🖹 21?	❑
Are the measuring point identification and labeling correct (visual inspection)?	❑
Is the device adequately protected from precipitation and direct sunlight?	❑
Have the fixing screws been tightened with the correct tightening torque?	❑

7 Electrical connection

NOTICE

The measuring device does not have an internal circuit breaker.

- ▶ For this reason, assign the measuring device a switch or power-circuit breaker so that the power supply line can be easily disconnected from the mains.
- ▶ Although the measuring device is equipped with a fuse, additional overcurrent protection (maximum 16 A) should be integrated into the system installation.

7.1 Electrical safety

In accordance with applicable national regulations.

7.2 Connection conditions

7.2.1 Required tools

- Torque wrench
- For cable entries: Use corresponding tools
- Wire stripper
- When using stranded cables: Crimper for wire end ferrule

7.2.2 Requirements for connecting cable

The connecting cables provided by the customer must fulfill the following requirements.

Permitted temperature range

- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Signal cable

Current output 0/4 to 20 mA

Standard installation cable is sufficient.

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Status input

Standard installation cable is sufficient.

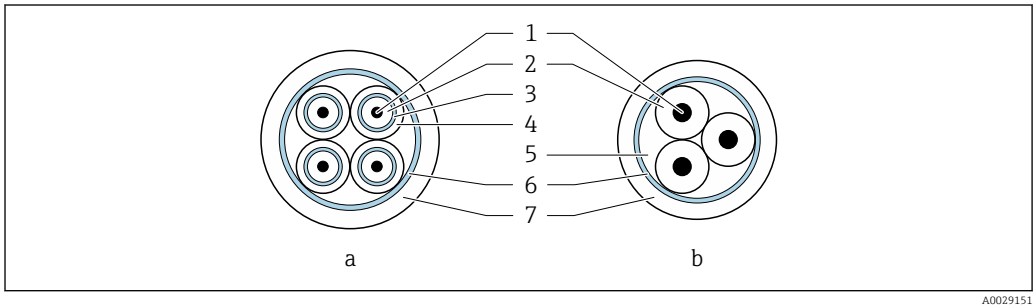
Connecting cable for remote version

Electrode cable

Standard cable	3 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Cable for empty pipe detection (EPD)	4 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Conductor resistance	≤50 Ω/km (0.015 Ω/ft)
Capacitance: core/shield	≤420 pF/m (128 pF/ft)
Operating temperature	–20 to +80 °C (–4 to +176 °F)

Coil current cable

Standard cable	3 ×0.75 mm² (18 AWG) with common, braided copper shield (ϕ ~9 mm (0.35 in))
Conductor resistance	≤37 Ω/km (0.011 Ω/ft)
Capacitance: core/core, shield grounded	≤120 pF/m (37 pF/ft)
Operating temperature	–20 to +80 °C (–4 to +176 °F)
Test voltage for cable insulation	≤ AC 1433 V rms 50/60 Hz or ≥ DC 2026 V



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6 Cable cross-section

a Electrode cable
b Coil current cable
1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

Armored connecting cable

Armored connecting cables with an additional, reinforcing metal braid should be used:
- When laying the cable directly in the ground
- Where there is a risk of damage from rodents
- Use as per IP68 degree of protection

Operation in environments with strong electrical interference

The measuring system meets the general safety requirements → 191 and EMC specifications → 175.

Grounding is by means of the ground terminal provided for the purpose inside the connection housing. The stripped and twisted lengths of cable shield to the ground terminal must be as short as possible.

Cable diameter

- Cable glands supplied:
  - For standard cable: M20 × 1.5 with cable Φ 6 to 12 mm (0.24 to 0.47 in)
  - For reinforced cable: M20 × 1.5 with cable Φ 9.5 to 16 mm (0.37 to 0.63 in)
- (Plug-in) spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

7.2.3 Terminal assignment

Transmitter

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

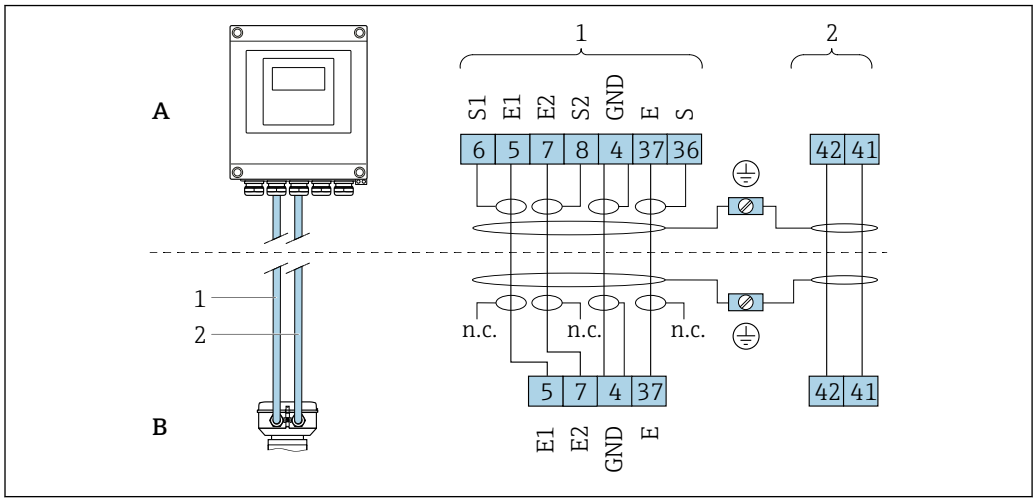
Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with current output 0 to 20 mA/4 to 20 mA HART and other outputs and inputs

Order code for "Output" and "Input"	Terminal numbers							
	Output 1		Output 2		Output 3		Input	
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **H**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency output (passive)		Switch output (passive)		-	
Option **I**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Status input	
Option **J**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Fixed assignment: Certified pulse output (passive)		Switch output		Status input	

Remote version



7 *Remote version terminal assignment*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable
n.c. Not connected, insulated cable shields

Terminal No. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

7.2.4 Preparing the measuring device

Carry out the steps in the following order:

1. Mount the sensor and transmitter.
2. Connection housing, sensor: Connect connecting cable.
3. Transmitter: Connect connecting cable.
4. Transmitter: Connect signal cable and cable for supply voltage.

NOTICE

Insufficient sealing of the housing!

Operational reliability of the measuring device could be compromised.

▶ Use suitable cable glands corresponding to the degree of protection.

1. Remove dummy plug if present.
2. If the measuring device is supplied without cable glands:
   Provide suitable cable gland for corresponding connecting cable.
3. If the measuring device is supplied with cable glands:
   Observe requirements for connecting cables → 41.

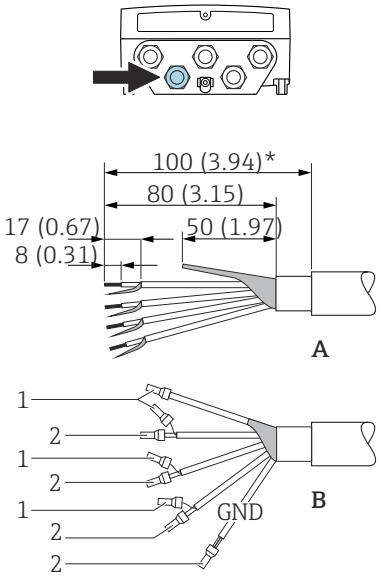
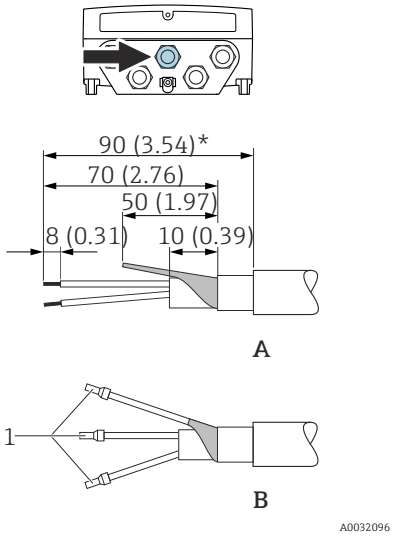
7.2.5 Preparing the connecting cable for the remote version

When terminating the connecting cable, pay attention to the following points:

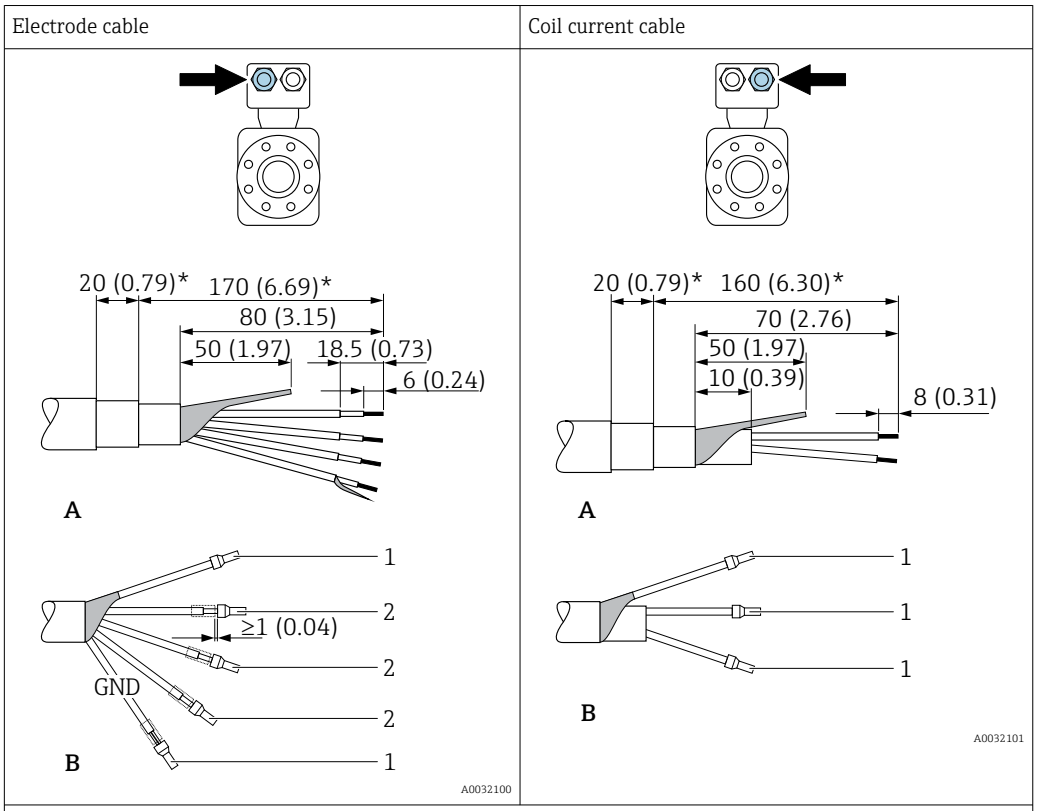
1. In the case of the electrode cable:
   Make sure that the ferrules do not touch the core shields on the sensor side.
   Minimum distance = 1 mm (exception: green “GND” cable)
2. In the case of the coil current cable:
   Insulate one core of the three-core cable at the level of the core reinforcement. You only require two cores for the connection.

3. For cables with fine-wire cores (stranded cables):
Fit the cores with ferrules.

Transmitter

Electrode cable	Coil current cable
 8 *Engineering unit mm (in)*	 9 *Engineering unit mm (in)*
A = Termination of the cables B = Termination of the fine-wire cores with ferrules 1 = Red ferrules, ϕ 1.0 mm (0.04 in) 2 = White ferrules, ϕ 0.5 mm (0.02 in) * = Stripping only for reinforced cables	

Sensor



A = Termination of the cables
B = Termination of the fine-wire cores with ferrules
1 = Red ferrules, ϕ 1.0 mm (0.04 in)
2 = White ferrules, ϕ 0.5 mm (0.02 in)
* = Stripping only for reinforced cables

7.3 Connecting the measuring device

⚠ WARNING

Risk of electric shock! Components carry dangerous voltages!

- ▶ Have electrical connection work carried out by correspondingly trained specialists only.
- ▶ Observe applicable federal/national installation codes and regulations.
- ▶ Comply with local workplace safety regulations.
- ▶ Observe grounding concept of the plant.
- ▶ Never mount or wire the measuring device while it is connected to the supply voltage.
- ▶ Before the supply voltage is applied, connect the protective ground to the measuring device.

7.3.1 Connecting the remote version

⚠ WARNING

Risk of damaging the electronic components!

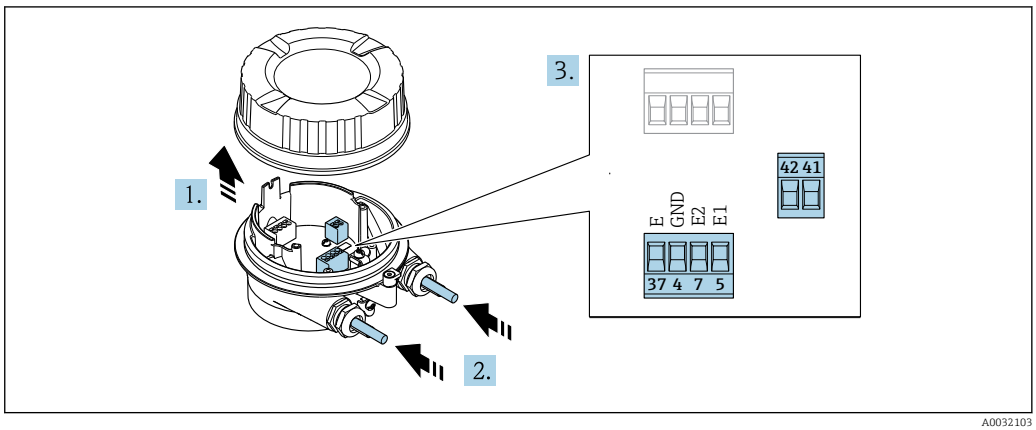
- ▶ Connect the sensor and transmitter to the same potential equalization.
- ▶ Only connect the sensor to a transmitter with the same serial number.
- ▶ Ground the connection housing of the sensor via the external screw terminal.

The following procedure (in the action sequence given) is recommended for the remote version:

1. Mount the sensor and transmitter.
2. Connect the connecting cable for the remote version.

3. Connect the transmitter.

Connecting the connecting cable to the sensor connection housing



10 *Sensor: connection module*

1. Loosen the securing clamp of the housing cover.
2. Unscrew and lift off the housing cover.
3. NOTICE

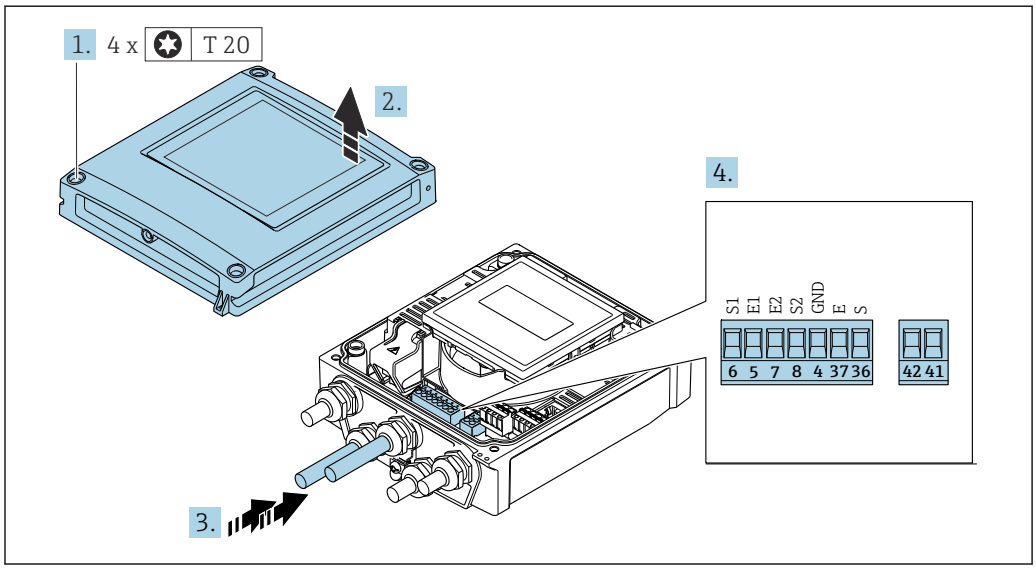
   For conduit extensions:
   - ▶ Fit O-ring on cable and push it back sufficiently. When inserting the cable, the O-ring must be located outside the conduit extension.

   Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules → 44.
5. Connect the cable in accordance with the terminal assignment → 44.
6. Firmly tighten the cable glands.
7. ⚠ WARNING

   Housing degree of protection may be voided due to insufficient sealing of the housing.
   - ▶ Screw in the screw without using any lubricant. The threads on the cover are coated with a dry lubricant.

   Reverse the procedure to reassemble the sensor.

Connecting the connecting cable to the transmitter



11 *Transmitter: main electronics module with terminals*

1. Loosen the 4 fixing screws on the housing cover.
2. Open the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules → 44.
5. Connect the cable in accordance with the terminal assignment → 44.
6. Firmly tighten the cable glands.
7. **WARNING**

   Housing degree of protection may be voided due to insufficient sealing of the housing.
   - Screw in the screw without using any lubricant.

   Reverse the removal procedure to reassemble the transmitter.

7.3.2 Connecting the transmitter

WARNING

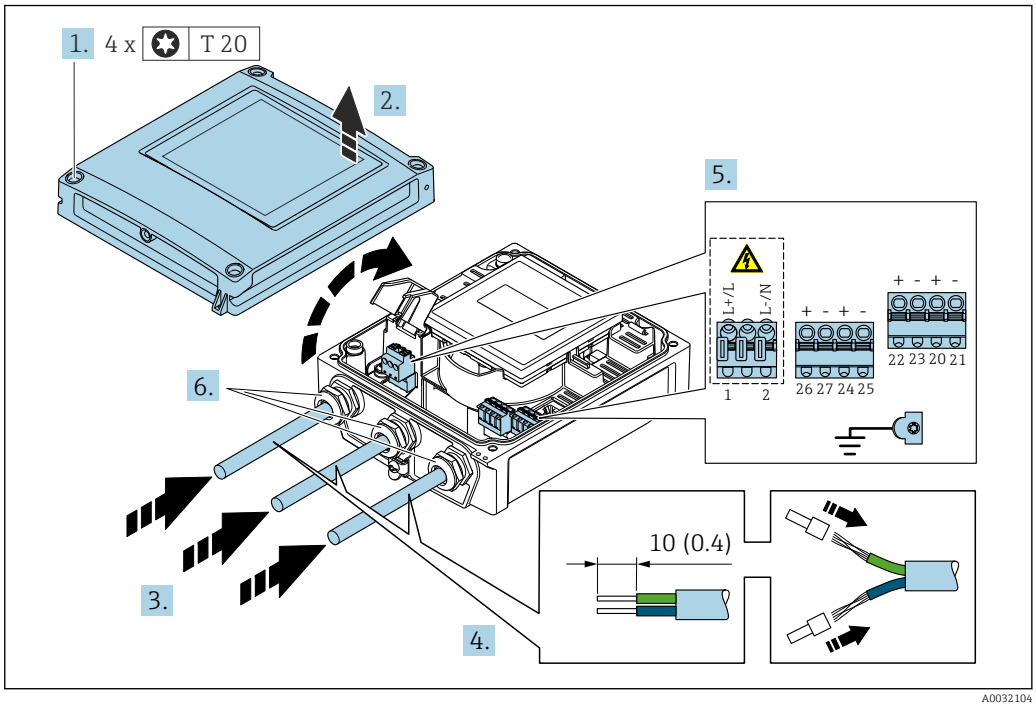
Housing degree of protection may be voided due to insufficient sealing of the housing.

- Screw in the screw without using any lubricant. The threads on the cover are coated with a dry lubricant.

Tightening torques for plastic housing

Housing cover fixing screw	1 Nm (0.7 lbf ft)
Cable entry	5 Nm (3.7 lbf ft)
Ground terminal	2.5 Nm (1.8 lbf ft)

For HART communication: when connecting the cable shield to the ground terminal, observe the grounding concept of the facility.



12 *Connecting the supply voltage and 0-20 mA/4-20 mA HART with additional outputs and inputs*

1. Loosen the 4 fixing screws on the housing cover.
2. Open the housing cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable and cable ends. In the case of stranded cables, also fit ferrules.
5. Connect the cables according to the terminal assignment → 43 . For supply voltage: open the shock protection cover.
6. Firmly tighten the cable glands.

Reassembling the transmitter

1. Close the shock protection cover.
2. Close the housing cover.

3. **⚠ WARNING**

Housing degree of protection may be voided due to insufficient sealing of the housing.

- ▶ Screw in the screw without using any lubricant.

Tighten the 4 fixing screws on the housing cover.

7.3.3 Ensuring potential equalization

Introduction

Correct potential equalization (equipotential bonding) is a prerequisite for stable and reliable flow measurement. Inadequate or incorrect potential equalization can result in device failure and present a safety hazard.

The following requirements must be observed to ensure correct, trouble-free measurement:
- The principle that the medium, the sensor and the transmitter must be at the same electrical potential applies.
- Take in-company grounding guidelines, materials and the grounding conditions and potential conditions of the pipe into consideration.
- Any necessary potential equalization connections must be established by ground cables with a minimum cross-section of 6 mm^2 (0.0093 in^2).
- For remote device versions, the ground terminal in the example always refers to the sensor and not to the transmitter.

You can order accessories like ground cables and ground disks from Endress+Hauser → 157

For devices intended for use in hazardous locations, observe the instructions in the Ex documentation (XA).

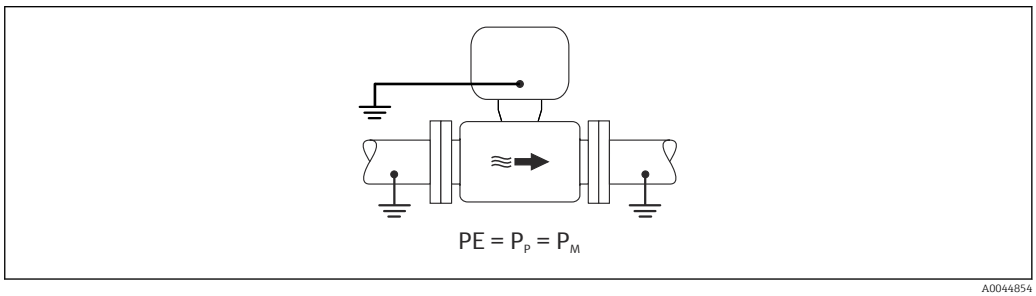
Abbreviations used
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

Connection examples for standard situations

Unlined and grounded metal pipe

- Potential equalization is via the measuring pipe.
- The medium is set to ground potential.

Starting conditions:
- Pipes are correctly grounded on both sides.
- Pipes are conductive and at the same electrical potential as the medium



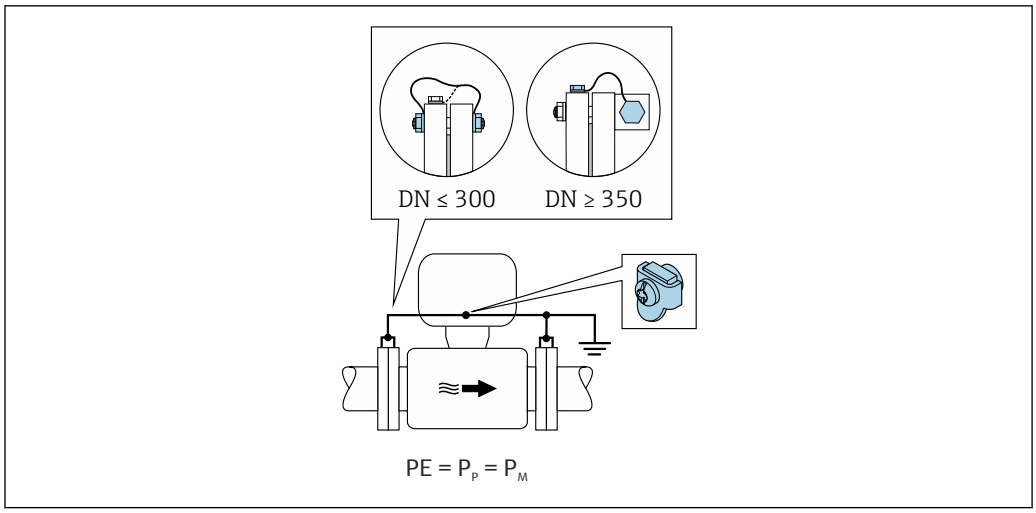
A0044854

▶ Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Unlined metal pipe

- Potential equalization is via the ground terminal and pipe flanges.
- The medium is set to ground potential.

Starting conditions:
- Pipes are not sufficiently grounded.
- Pipes are conductive and at the same electrical potential as the medium



A0042089

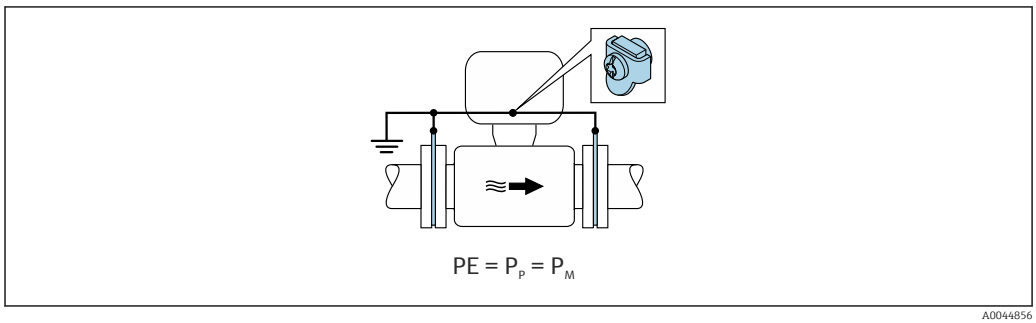
1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

- For DN ≤ 300 (12"): Mount the ground cable directly on the conductive flange coating of the sensor with the flange screws.
- For DN ≥ 350 (14"): Mount the ground cable directly on the metal transport bracket. Observe screw tightening torques: see the Brief Operating Instructions for the sensor.

Plastic pipe or pipe with insulating liner

- Potential equalization is via the ground terminal and ground disks.
- The medium is set to ground potential.

Starting conditions:
- The pipe has an insulating effect.
- Low-impedance medium grounding close to the sensor is not guaranteed.
- Equalizing currents through the medium cannot be ruled out.



A0044856

1. Connect the ground disks to the ground terminal of the connection housing of the transmitter or sensor via the ground cable.
2. Connect the connection to ground potential.

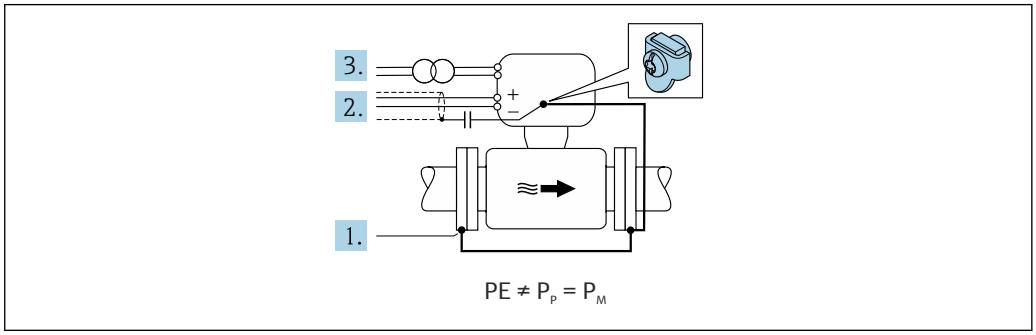
Connection example with the potential of the medium not equal to the protective ground

In these cases, the medium potential can differ from the potential of the device.

Metal, ungrounded pipe

The sensor and transmitter are installed in a way that provides electrical insulation from PE, e.g. applications for electrolytic processes or systems with cathodic protection.

Starting conditions:
- Unlined metal pipe
- Pipes with an electrically conductive liner



A0042253

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal lines via a capacitor (recommended value 1.5µF/ 50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).

Connection examples with the potential of medium not equal to protective earth with the "Measurement isolated from ground" option

In these cases, the medium potential can differ from the potential of the device.

Introduction

The "Measurement isolated from ground" option enables the galvanic isolation of the measuring system from the device potential. This minimizes harmful equalizing currents caused by differences in potential between the medium and the device. The "Measurement isolated from ground" option is optionally available: order code for "Sensor option", option CV

Operating conditions for the use of the "Measurement isolated from ground" option

Device version	Compact version and remote version (length of connecting cable ≤ 10 m)
Differences in voltage between medium potential and device potential	As small as possible, usually in the mV range
Alternating voltage frequencies in the medium or at ground potential (PE)	Below typical power line frequency in the country

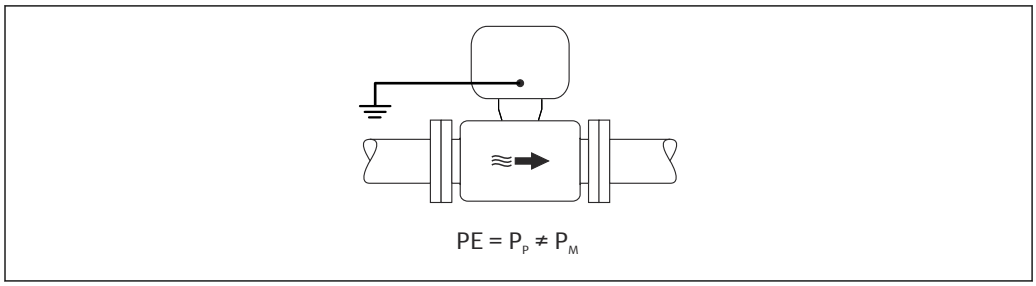
To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.

A full pipe adjustment is recommended when the device is installed.

Plastic pipe

Sensor and transmitter are correctly grounded. A difference in potential can occur between the medium and protective earth. Potential equalization between P_M and PE via the reference electrode is minimized with the "Measurement isolated from ground" option.

Starting conditions:
- The pipe has an insulating effect.
- Equalizing currents through the medium cannot be ruled out.

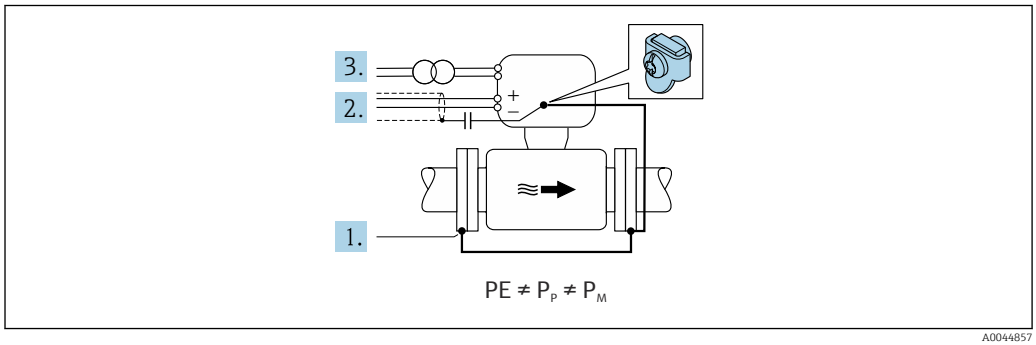


1. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Metal, ungrounded pipe with insulating liner

The sensor and transmitter are installed in a way that provides electrical insulation from PE. The medium and pipe have different potentials. The "Measurement isolated from ground" option minimizes harmful equalizing currents between P_M and P_P via the reference electrode.

Starting conditions:
- Metal pipe with insulating liner
- Equalizing currents through the medium cannot be ruled out.

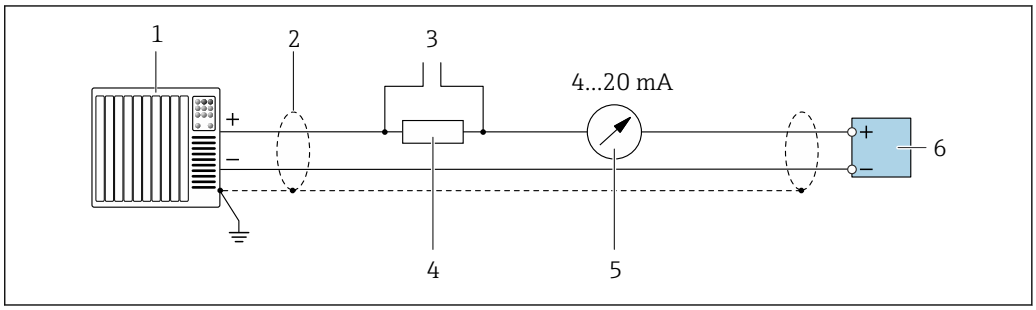


1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal cables via a capacitor (recommended value 1.5µF/ 50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).
4. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.

7.4 Special connection instructions

7.4.1 Connection examples

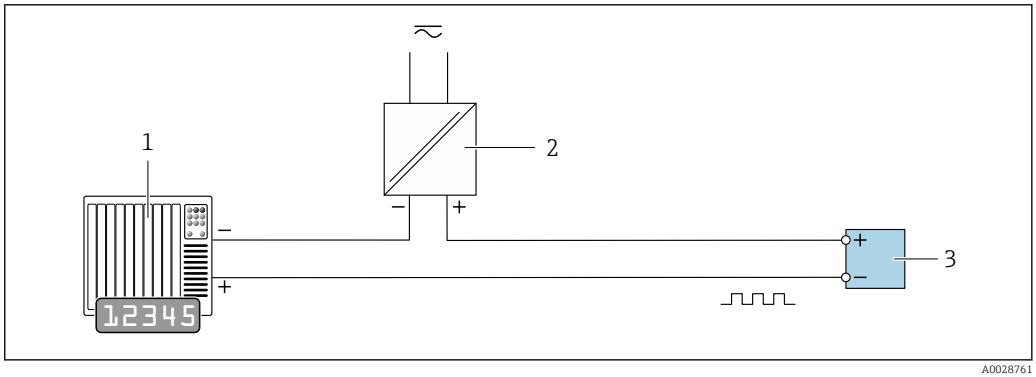
Current output 4 to 20 mA HART



13 *Connection example for 4 to 20 mA HART current output (active)*

1 *Automation system with current input (e.g. PLC)*
2 *Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications*
3 *Connection for HART operating devices → 80*
4 *Resistor for HART communication (≥ 250 Ω): observe maximum load → 165*
5 *Analog display unit: observe maximum load → 165*
6 *Transmitter*

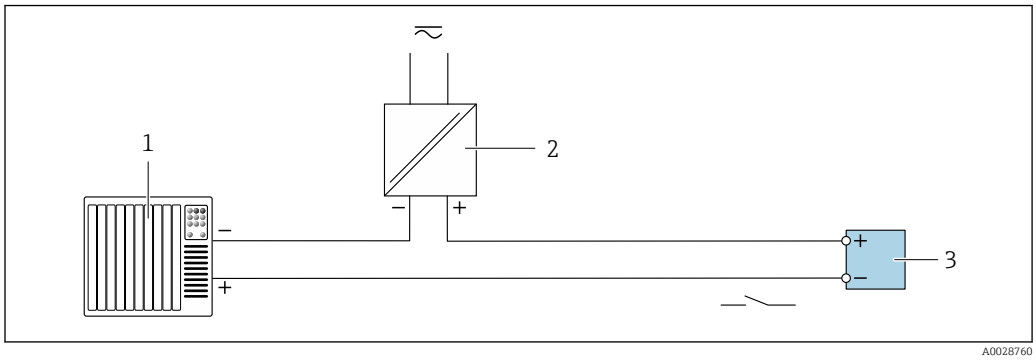
Pulse/frequency output



14 *Connection example for pulse/frequency output (passive)*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 166*

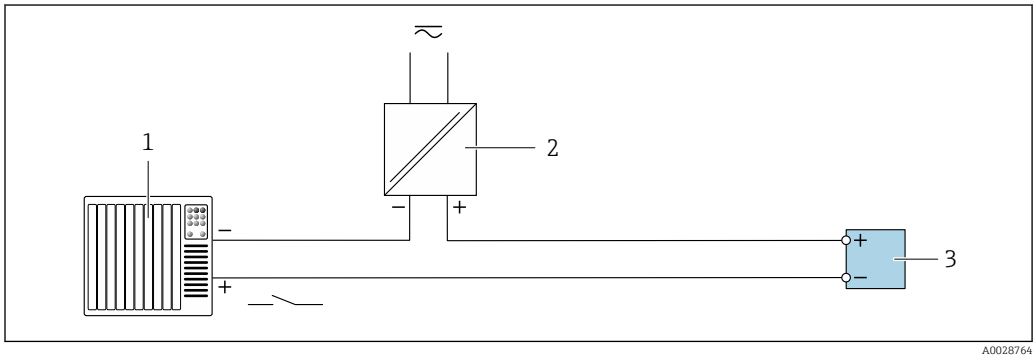
Switch output



15 *Connection example for switch output (passive)*

1 *Automation system with switch input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 166*

Status input



16 *Connection example for status input*

1 *Automation system with status output (e.g. PLC)*
2 *Power supply*
3 *Transmitter*

7.5 Ensuring the degree of protection

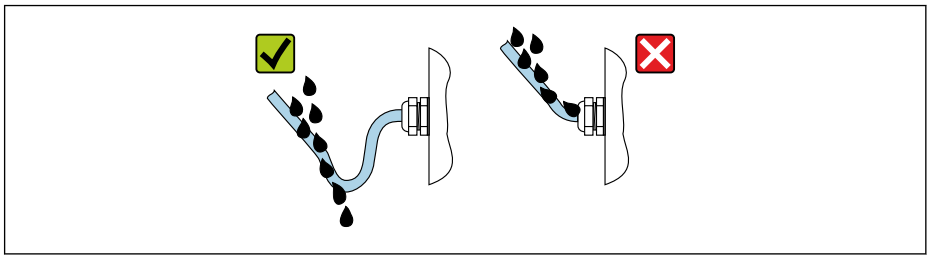
7.5.1 Degree of protection IP66/67, Type 4X enclosure

The measuring device fulfills all the requirements for the IP66/67 degree of protection, Type 4X enclosure.

To guarantee IP66/67 degree of protection, Type 4X enclosure, carry out the following steps after the electrical connection:

1. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
2. Tighten all housing screws and screw covers.
3. Firmly tighten the cable glands.

4. To ensure that moisture does not enter the cable entry, route the cable so that it loops down before the cable entry ("water trap").
   ↳



A0029278

5. Insert dummy plugs (corresponding to the housing degree of protection) into unused cable entries.

NOTICE

Standard dummy plugs used for transportation do not have the appropriate degree of protection and can result in damage to the device!

▶ Use suitable dummy plugs corresponding to the degree of protection.

7.5.2 Degree of protection IP68, Type 6P enclosure, with "Cust-potted" option

Depending on the version, the sensor meets all the requirements of IP68 degree of protection, Type 6P enclosure → 🖹 173 and can be used as a remote version → 🖹 27.

The degree of protection of the transmitter is always only IP66/67, Type 4X enclosure and the transmitter must therefore be treated accordingly → 🖹 56.

To guarantee IP68 degree of protection, Type 6P enclosure for the "Cust-potted" options, carry out the following steps after the electrical connection:

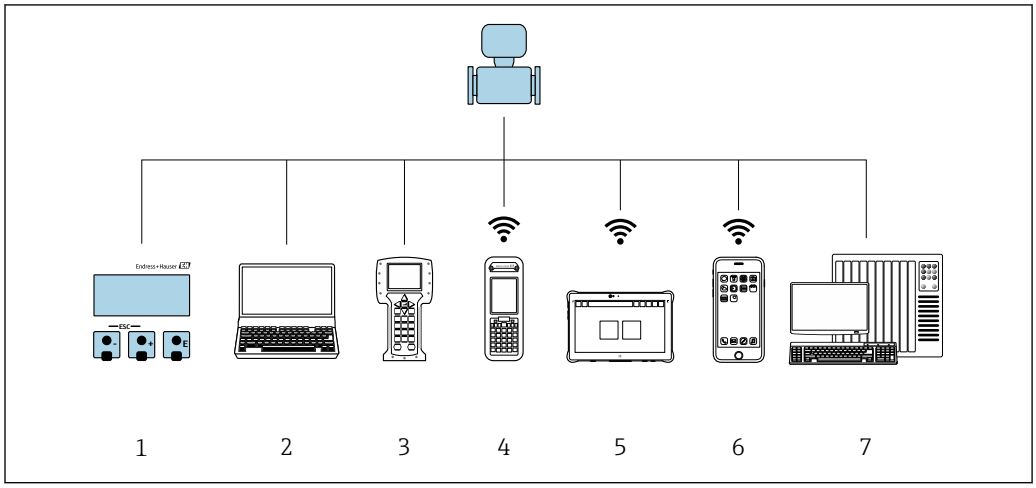
1. Firmly tighten the cable glands (torque: 2 to 3.5 Nm) until there is no gap between the bottom of the cover and the housing support surface.
2. Firmly tighten the union nut of the cable glands.
3. Pot the field housing with a potting compound.
4. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
5. Tighten all housing screws and screw covers (torque: 20 to 30 Nm).

7.6 Post-connection check

Are cables or the device undamaged (visual inspection)?	❑
Do the cables used meet the requirements → 🖹 41?	❑
Do the cables have adequate strain relief?	❑
Are all the cable glands installed, firmly tightened and leak-tight? Cable run with "water trap" → 🖹 56?	❑
Only for remote version: is the sensor connected to the right transmitter? Check the serial number on the nameplate of the sensor and transmitter.	❑
Does the supply voltage match the specifications on the transmitter nameplate → 🖹 169?	❑
Is the terminal assignment correct → 🖹 43?	❑
If supply voltage is present, do values appear on the display module?	❑
Is the potential equalization established correctly ?	❑
Are all housing covers installed and the screws tightened with the correct tightening torque?	❑

8 Operation methods

8.1 Overview of operation methods



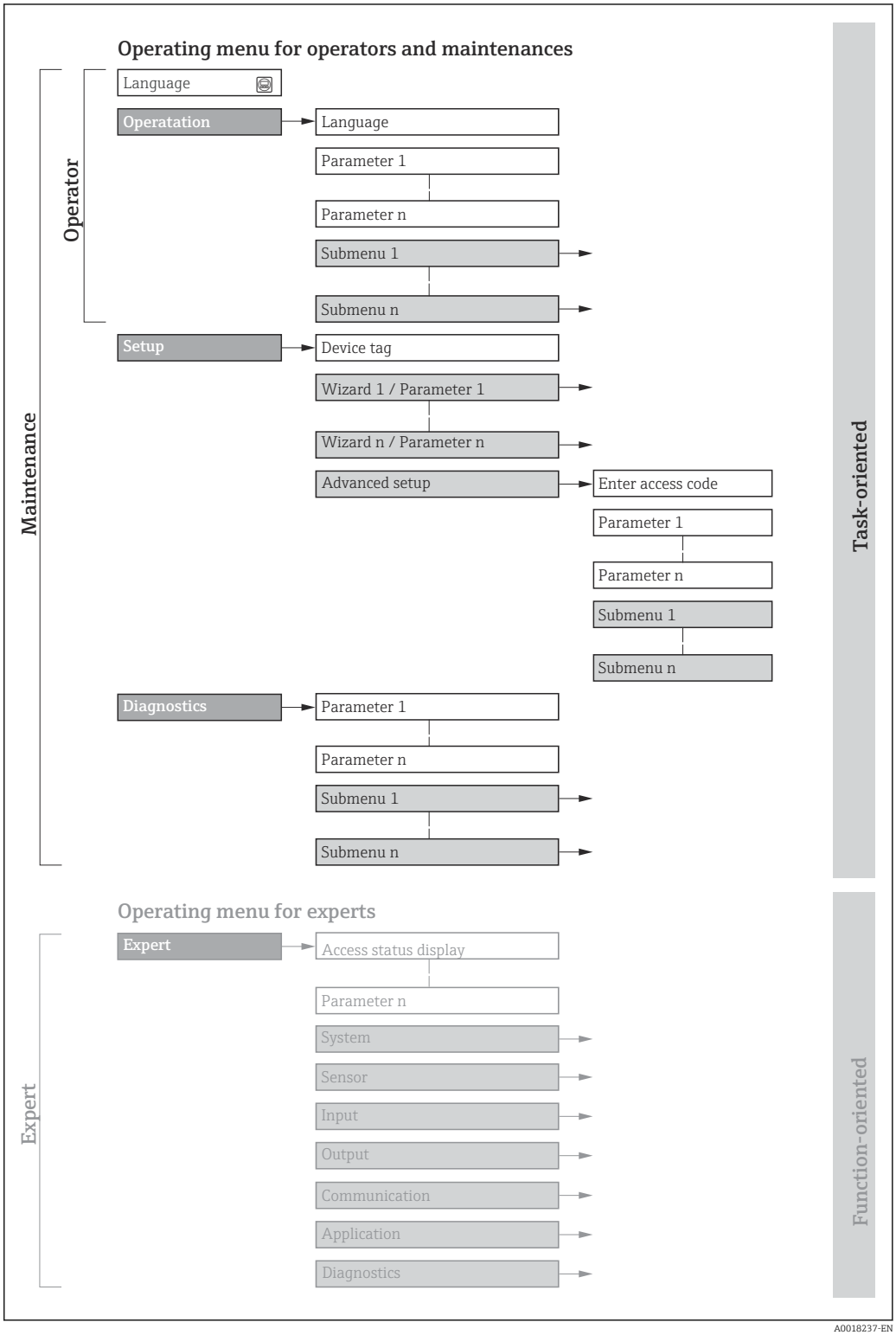
1 *Local operation via display module*
2 *Computer with Web browser (e.g. Internet Explorer) or with operating tool (e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM)*
3 *Field Communicator 475*
4 *Field Xpert SFX350 or SFX370*
5 *Field Xpert SMT70*
6 *Mobile handheld terminal*
7 *Control system (e.g. PLC)*

For custody transfer, once the device has been put into circulation or sealed, its operation is restricted.

8.2 Structure and function of the operating menu

8.2.1 Structure of the operating menu

For an overview of the operating menu for experts, see the "Description of Device Parameters" document supplied with the device → 193



17 *Schematic structure of the operating menu*

8.2.2 Operating philosophy

The individual parts of the operating menu are assigned to certain user roles (operator, maintenance etc.). Each user role contains typical tasks within the device lifecycle.

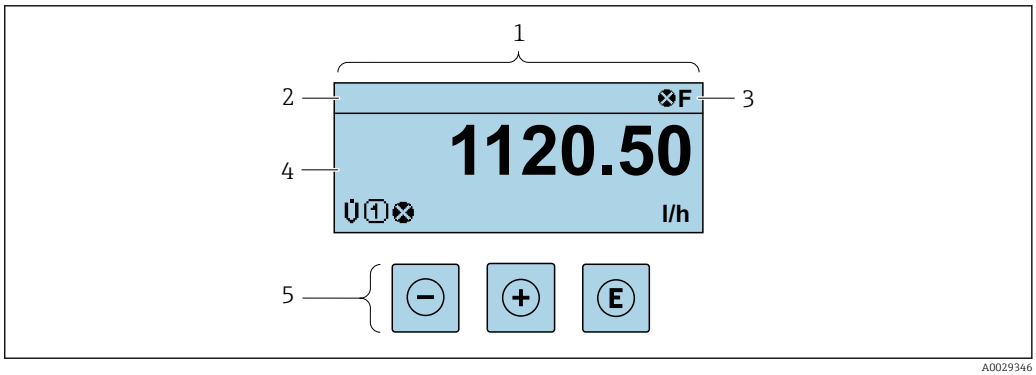
For custody transfer, once the device has been put into circulation or sealed, its operation is restricted.

Menu/parameter		User role and tasks	Content/meaning
Language	task-oriented	**Role "Operator", "Maintenance"** Tasks during operation: ▪ Configuration of the operational display ▪ Reading measured values	▪ Defining the operating language ▪ Defining the Web server operating language ▪ Resetting and controlling totalizers
Operation			▪ Configuring the operational display (e.g. display format, display contrast) ▪ Resetting and controlling totalizers
Setup		**"Maintenance" role** Commissioning: ▪ Configuration of the measurement ▪ Configuration of the outputs	Wizards for fast commissioning: ▪ Setting the system units ▪ Setting the input ▪ Configuring the outputs ▪ Configuration of the operational display ▪ Defining the output conditioning ▪ Setting the low flow cut off ▪ Configuring empty pipe detection Advanced setup ▪ For more customized configuration of the measurement (adaptation to special measuring conditions) ▪ Configuration of totalizers ▪ Configuration of electrode cleaning (optional) ▪ Configuring the WLAN settings ▪ Administration (define access code, reset measuring device)
Diagnostics		**"Maintenance" role** Fault elimination: ▪ Diagnostics and elimination of process and device errors ▪ Measured value simulation	Contains all parameters for error detection and analyzing process and device errors: ▪ Diagnostic list Contains up to 5 currently pending diagnostic messages. ▪ Event logbook Contains event messages that have occurred. ▪ Device information Contains information for identifying the device. ▪ Measured values Contains all current measured values. ▪ **Data logging** submenu with "Extended HistoROM" order option Storage and visualization of measured values ▪ Heartbeat The functionality of the device is checked on demand and the verification results are documented. ▪ Simulation Is used to simulate measured values or output values.

Menu/parameter		User role and tasks	Content/meaning
Expert	function-oriented	Tasks that require detailed knowledge of the function of the device: ▪ Commissioning measurements under difficult conditions ▪ Optimal adaptation of the measurement to difficult conditions ▪ Detailed configuration of the communication interface ▪ Error diagnostics in difficult cases	Contains all the parameters of the device and makes it possible to access these parameters directly using an access code. The structure of this menu is based on the function blocks of the device: ▪ System Contains all higher-order device parameters which do not concern the measurement or the communication interface. ▪ Sensor Configuration of the measurement. ▪ Input Configuring the status input. ▪ Output Configuration of the analog current outputs as well as the pulse/frequency and switch output. ▪ Communication Configuration of the digital communication interface and the Web server. ▪ Application Configuration of the functions that go beyond the actual measurement (e.g. totalizer). ▪ Diagnostics Error detection and analysis of process and device errors and for device simulation and Heartbeat Technology.

8.3 Access to the operating menu via the local display

8.3.1 Operational display



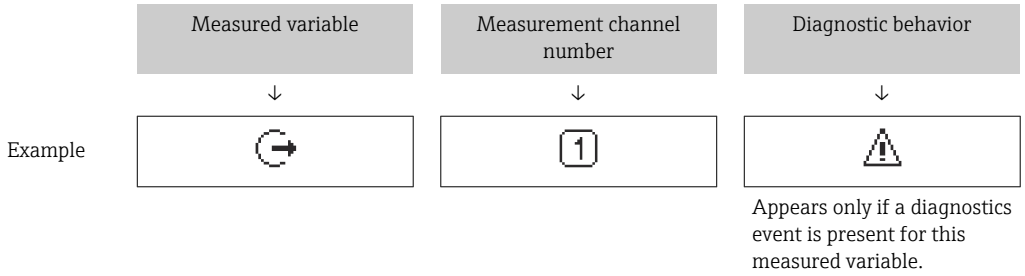
1 *Operational display*
2 *Device tag* → 🖹 *90*
3 *Status area*
4 *Display area for measured values (4-line)*
5 *Operating elements* → 🖹 *66*

Status area

The following symbols appear in the status area of the operational display at the top right:
- Status signals→ 🖹 137
  - **F**: Failure
  - **C**: Function check
  - **S**: Out of specification
  - **M**: Maintenance required
- Diagnostic behavior→ 🖹 138
  - ⊗: Alarm
  - ⚠: Warning
- 🔒: Locking (the device is locked via the hardware)
- ⇆: Communication (communication via remote operation is active)

Display area

In the display area, each measured value is prefaced by certain symbol types for further description:



Measured variables

Symbol	Meaning
V̇	Volume flow
G	Conductivity
ṁ	Mass flow
Σ	Totalizer The measurement channel number indicates which of the three totalizers is displayed.
	Output The measurement channel number indicates which of the outputs is displayed.
	Status input

Measurement channel numbers

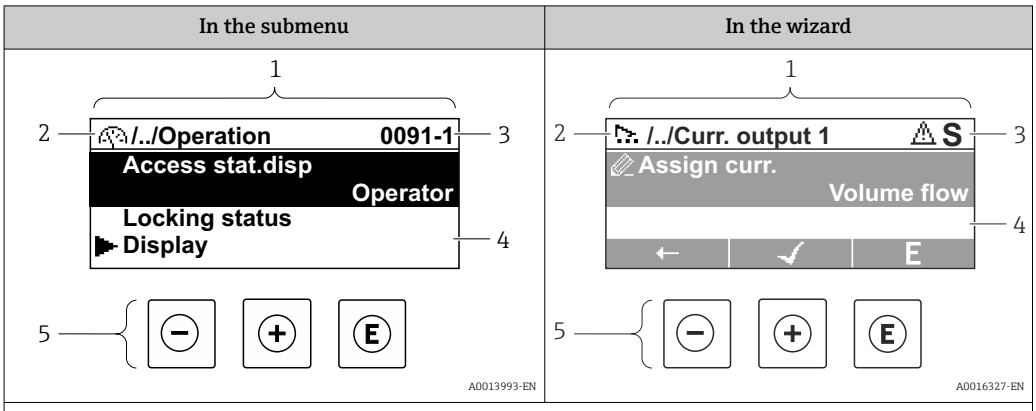
Symbol	Meaning
1 ... 4	Measurement channel 1 to 4
The measurement channel number is displayed only if more than one channel is present for the same measured variable type (e.g. Totalizer 1 to 3).	

Diagnostic behavior

The diagnostic behavior pertains to a diagnostic event that is relevant to the displayed measured variable. For information on the symbols → 138

The number and display format of the measured values can be configured via the **Format display** parameter (→ 102).

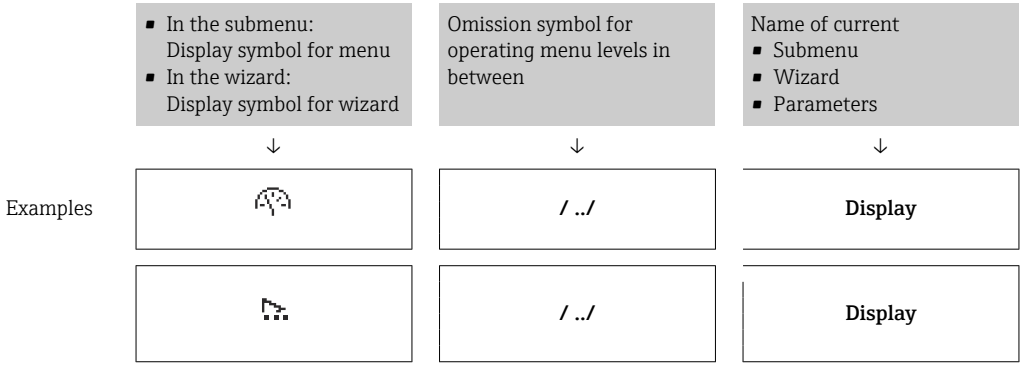
8.3.2 Navigation view



1 *Navigation view*
2 *Navigation path to current position*
3 *Status area*
4 *Display area for navigation*
5 *Operating elements* → 🖹 66

Navigation path

The navigation path - displayed at the top left in the navigation view - consists of the following elements:



For more information about the icons in the menu, refer to the "Display area" section → 🖹 64

Status area

The following appears in the status area of the navigation view in the top right corner:
- In the submenu
  - The direct access code for the parameter you are navigating to (e.g. 0022-1)
  - If a diagnostic event is present, the diagnostic behavior and status signal
- In the wizard
  If a diagnostic event is present, the diagnostic behavior and status signal

- For information on the diagnostic behavior and status signal → 🖹 137
- For information on the function and entry of the direct access code → 🖹 69

Display area

Menus

Symbol	Meaning
	Operation Appears: ▪ In the menu next to the "Operation" selection ▪ At the left in the navigation path in the **Operation** menu
	Setup Appears: ▪ In the menu next to the "Setup" selection ▪ At the left in the navigation path in the **Setup** menu
	Diagnostics Appears: ▪ In the menu next to the "Diagnostics" selection ▪ At the left in the navigation path in the **Diagnostics** menu
	Expert Appears: ▪ In the menu next to the "Expert" selection ▪ At the left in the navigation path in the **Expert** menu

Submenus, wizards, parameters

Symbol	Meaning
	Submenu
	Wizard
	Parameters within a wizard No display symbol exists for parameters in submenus.

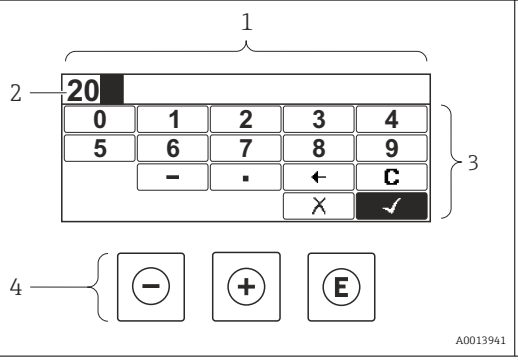
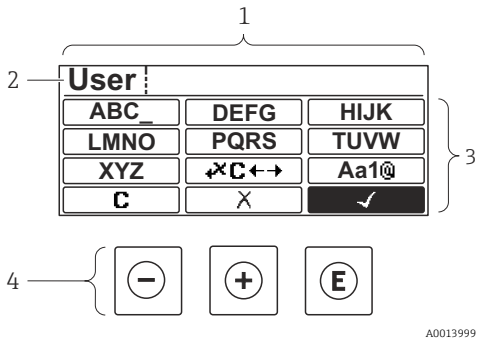
Locking

Symbol	Meaning
	Parameter locked When displayed in front of a parameter name, indicates that the parameter is locked. ▪ By a user-specific access code ▪ By the hardware write protection switch

Wizard operation

Symbol	Meaning
	Switches to the previous parameter.
	Confirms the parameter value and switches to the next parameter.
	Opens the editing view of the parameter.

8.3.3 Editing view

Numeric editor	Text editor
	

1 Editing view
2 Display area of the entered values
3 Input mask
4 Operating elements → 66

Input mask

The following input symbols are available in the input mask of the numeric and text editor:

Numeric editor

Symbol	Meaning
0 … 9	Selection of numbers from 0 to 9.
.	Inserts decimal separator at the input position.
–	Inserts minus sign at the input position.
✓	Confirms selection.
←	Moves the input position one position to the left.
✗	Exits the input without applying the changes.
C	Clears all entered characters.

Text editor

Symbol	Meaning
Aa1@	Toggle ▪ Between upper-case and lower-case letters ▪ For entering numbers ▪ For entering special characters
ABC_ … XYZ	Selection of letters from A to Z.

abc _ ... xyz	Selection of letters from a to z.
'"^ _ ... ~& _	Selection of special characters.
✓	Confirms selection.
✓C←→	Switches to the selection of the correction tools.
✗	Exits the input without applying the changes.
C	Clears all entered characters.

Correction symbols under ✓C←→

Symbol	Meaning
C	Clears all entered characters.
→	Moves the input position one position to the right.
←	Moves the input position one position to the left.
✓✗	Deletes one character immediately to the left of the input position.

8.3.4 Operating elements

Key	Meaning
−	**Minus key** *In menu, submenu* Moves the selection bar upwards in a picklist. *With a wizard* Confirms the parameter value and goes to the previous parameter. *For text and numeric editor* In the input mask, moves the selection bar to the left (backwards).
+	**Plus key** *In menu, submenu* Moves the selection bar downwards in a picklist. *With a wizard* Confirms the parameter value and goes to the next parameter. *For text and numeric editor* In the input mask, moves the selection bar to the right (forwards).

Key	Meaning

E	**Enter key**
	For operational display
	Pressing the key for 2 s opens the context menu including the selection for activating the keypad lock.
	In menu, submenu
	▪ Pressing the key briefly:
	  ▪ Opens the selected menu, submenu or parameter.
	  ▪ Starts the wizard.
	  ▪ If help text is open, closes the help text of the parameter.
	▪ Pressing the key for 2 s in a parameter:
	  If present, opens the help text for the function of the parameter.
	With a wizard
	Opens the editing view of the parameter.
	For text and numeric editor
	▪ Pressing the key briefly:
	  ▪ Opens the selected group.
	  ▪ Carries out the selected action.
	▪ Pressing the key for 2 s confirms the edited parameter value.

− + +	**Escape key combination (press keys simultaneously)**
	In menu, submenu
	▪ Pressing the key briefly:
	  ▪ Exits the current menu level and takes you to the next level up.
	  ▪ If help text is open, closes the help text of the parameter.
	▪ Pressing the key for 2 s returns you to the operational display ("home position").
	With a wizard
	Exits the wizard and takes you to the next level up.
	For text and numeric editor
	Closes the text or numeric editor without applying changes.

− + + E	**Minus/Plus/Enter key combination (press and hold down the keys simultaneously)** *For operational display* Enables or disables the keypad lock (only SD02 display module).

8.3.5 Opening the context menu

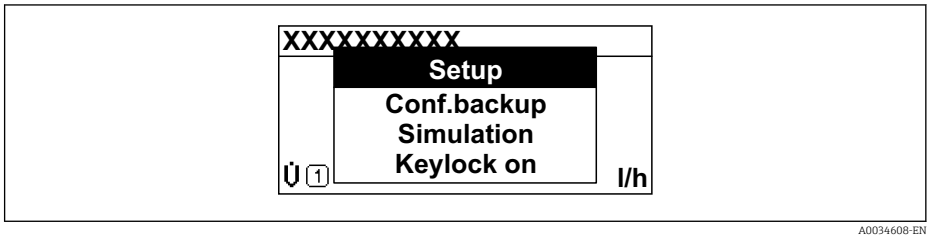
Using the context menu, the user can call up the following menus quickly and directly from the operational display:

- Setup
- Simulation

Calling up and closing the context menu

The user is in the operational display.

1. Press the − and E keys for longer than 3 seconds.
   ↳ The context menu opens.



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2. Press − + + simultaneously.
   ↳ The context menu is closed and the operational display appears.

Calling up the menu via the context menu

1. Open the context menu.

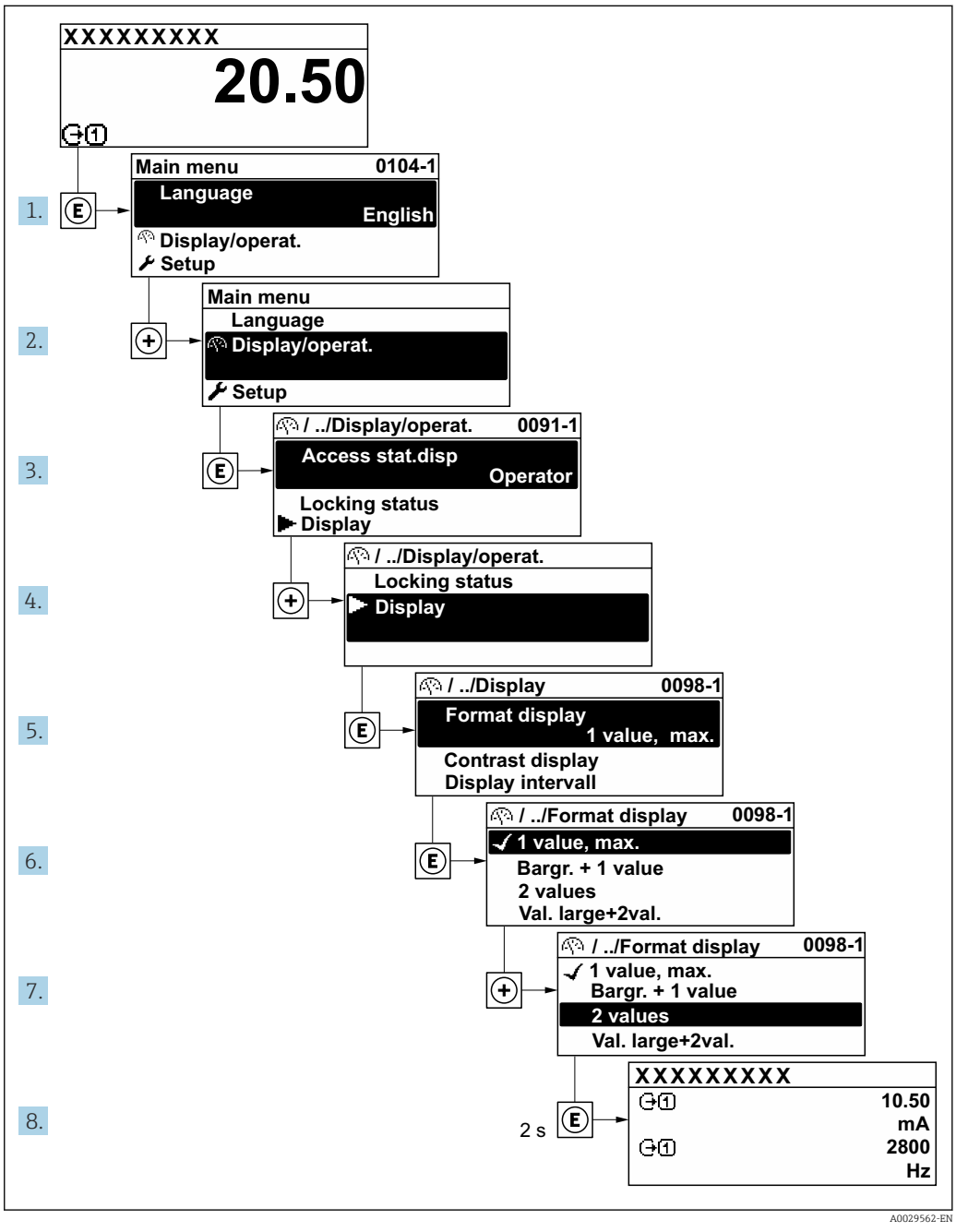
2. Press ⊞ to navigate to the desired menu.
3. Press Ⓔ to confirm the selection.
   ↳ The selected menu opens.

8.3.6 Navigating and selecting from list

Different operating elements are used to navigate through the operating menu. The navigation path is displayed on the left in the header. Icons are displayed in front of the individual menus. These icons are also shown in the header during navigation.

For an explanation of the navigation view with symbols and operating elements
→ 63

Example: Setting the number of displayed measured values to "2 values"

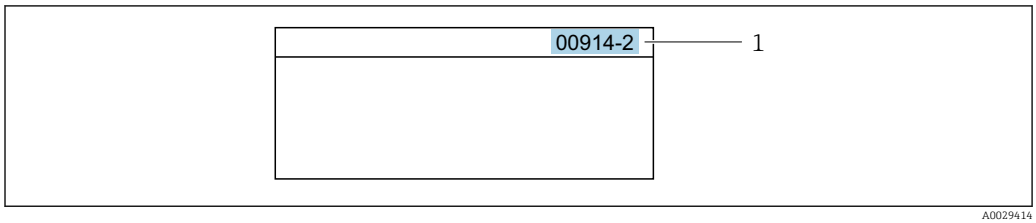


8.3.7 Calling the parameter directly

A parameter number is assigned to every parameter to be able to access a parameter directly via the onsite display. Entering this access code in the **Direct access** parameter calls up the desired parameter directly.

Navigation path
Expert → Direct access

The direct access code consists of a 5-digit number (at maximum) and the channel number, which identifies the channel of a process variable: e.g. 00914-2. In the navigation view, this appears on the right-hand side in the header of the selected parameter.



1 Direct access code

Note the following when entering the direct access code:
- The leading zeros in the direct access code do not have to be entered.
  Example: Enter **"914"** instead of **"00914"**
- If no channel number is entered, channel 1 is opened automatically.
  Example: Enter **00914** → **Assign process variable** parameter
- If a different channel is opened: Enter the direct access code with the corresponding channel number.
  Example: Enter **00914-2** → **Assign process variable** parameter

For the direct access codes of the individual parameters, see the "Description of Device Parameters" document for the device

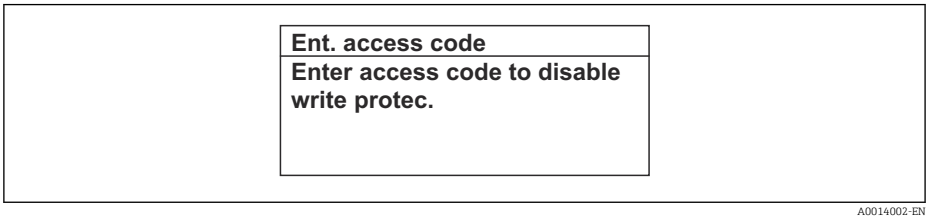
8.3.8 Calling up help text

Help text is available for some parameters and can be called up from the navigation view. The help text provides a brief explanation of the parameter function and thereby supports swift and safe commissioning.

Calling up and closing the help text

The user is in the navigation view and the selection bar is on a parameter.

1. Press E for 2 s.
   ↳ The help text for the selected parameter opens.



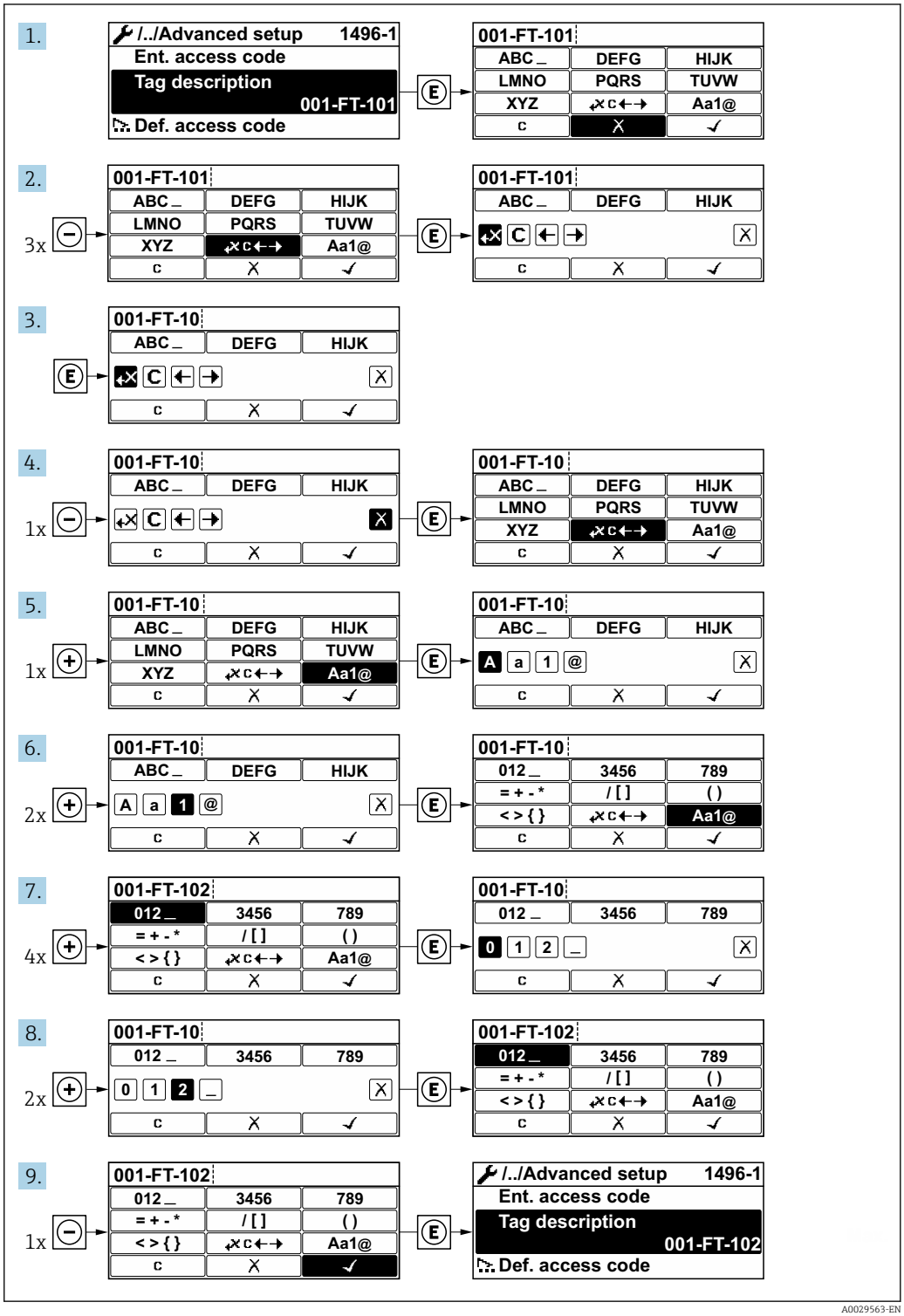
18 Example: Help text for parameter "Enter access code"

2. Press − + + simultaneously.
   ↳ The help text is closed.

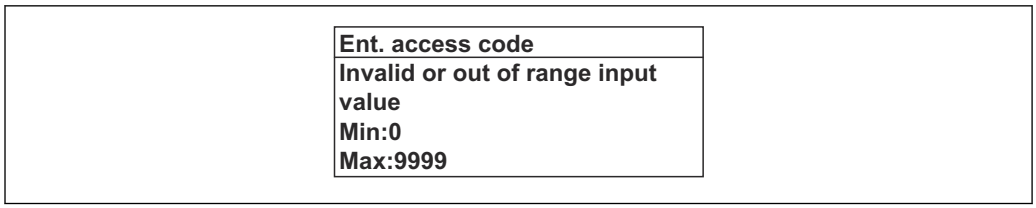
8.3.9 Changing the parameters

For a description of the editing view - consisting of the text editor and numeric editor - with symbols → 65, for a description of the operating elements → 66

Example: Changing the tag name in the "Tag description" parameter from 001-FT-101 to 001-FT-102



A message is displayed if the value entered is outside the permitted value range.



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8.3.10 User roles and related access authorization

The two user roles "Operator" and "Maintenance" have different write access to the parameters if the customer defines a user-specific access code. This protects the device configuration via the local display from unauthorized access → 122.

Defining access authorization for user roles

An access code is not yet defined when the device is delivered from the factory. Access authorization (read and write access) to the device is not restricted and corresponds to the "Maintenance" user role.

- Define the access code.
  - The "Operator" user role is redefined in addition to the "Maintenance" user role. Access authorization differs for the two user roles.

Access authorization to parameters: "Maintenance" user role

Access code status	Read access	Write access
An access code has not yet been defined (factory setting).	✔	✔
After an access code has been defined.	✔	✔ 1)

1) The user only has write access after entering the access code.

Access authorization to parameters: "Operator" user role

Access code status	Read access	Write access
After an access code has been defined.	✔	-- 1)

1) Despite the defined access code, certain parameters can always be modified and thus are excepted from the write protection, as they do not affect the measurement. Refer to the "Write protection via access code" section

The user role with which the user is currently logged on is indicated by the **Access status display** parameter. Navigation path: Operation → Access status display

8.3.11 Disabling write protection via access code

If the 🔒-symbol appears on the local display in front of a parameter, the parameter is write-protected by a user-specific access code and its value cannot be changed at the moment using local operation → 122.

Parameter write protection via local operation can be disabled by entering the user-specific access code in the **Enter access code** parameter (→ 108) via the respective access option.

1. After you press E, the input prompt for the access code appears.
2. Enter the access code.
   - The 🔒-symbol in front of the parameters disappears; all previously write-protected parameters are now re-enabled.

8.3.12 Enabling and disabling the keypad lock

The keypad lock makes it possible to block access to the entire operating menu via local operation. As a result, it is no longer possible to navigate through the operating menu or change the values of individual parameters. Users can only read the measured values on the operational display.

The keypad lock is switched on and off via the context menu.

Switching on the keypad lock

The keypad lock is switched on automatically:
- If the device has not been operated via the display for > 1 minute.
- Each time the device is restarted.

To activate the keylock manually:

1. The device is in the measured value display.
   Press the ⊟ and Ⓔ keys for 3 seconds.
   ↳ A context menu appears.
2. In the context menu select the **Keylock on** option.
   ↳ The keypad lock is switched on.

If the user attempts to access the operating menu while the keypad lock is active, the **Keylock on** message appears.

Switching off the keypad lock

- The keypad lock is switched on.
  Press the ⊟ and Ⓔ keys for 3 seconds.
  ↳ The keypad lock is switched off.

8.4 Access to the operating menu via the Web browser

8.4.1 Function scope

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

For additional information on the Web server, refer to the Special Documentation for the device → 193

8.4.2 Prerequisites

Computer hardware

Hardware	Interface	
	CDI-RJ45	**WLAN**
Interface	The computer must have an RJ45 interface.	The operating unit must have a WLAN interface.
Connection	Standard Ethernet cable with RJ45 connector.	Connection via Wireless LAN.
Screen	Recommended size: ≥12" (depends on the screen resolution)	

Computer software

Software	Interface	
	CDI-RJ45	**WLAN**

Recommended operating systems	▪ Microsoft Windows 8 or higher.
	▪ Mobile operating systems:
	  ▪ iOS
	  ▪ Android
	Microsoft Windows XP is supported.
	Microsoft Windows 7 is supported.	

Web browsers supported	▪ Microsoft Internet Explorer 8 or higher ▪ Microsoft Edge ▪ Mozilla Firefox ▪ Google Chrome ▪ Safari	

Computer settings

Settings	Interface	
	CDI-RJ45	**WLAN**
User rights	Appropriate user rights (e.g. administrator rights) for TCP/IP and proxy server settings are necessary (for adjusting the IP address, subnet mask etc.).	
Proxy server settings of the Web browser	The Web browser setting *Use a Proxy Server for Your LAN* must be **deselected** .	
JavaScript	JavaScript must be enabled. If JavaScript cannot be enabled: enter http://192.168.1.212/basic.html in the address line of the Web browser. A fully functional but simplified version of the operating menu structure starts in the Web browser. When installing a new firmware version: To enable correct data display, clear the temporary memory (cache) of the Web browser under **Internet options**.	
Network connections	Only the active network connections to the measuring device should be used.	
	Switch off all other network connections such as WLAN.	Switch off all other network connections.

In the event of connection problems: → 135

Measuring device: Via CDI-RJ45 service interface

Device	CDI-RJ45 service interface
Measuring device	The measuring device has an RJ45 interface.
Web server	Web server must be enabled; factory setting: ON For information on enabling the Web server → 79

Measuring device: via WLAN interface

Device	WLAN interface
Measuring device	The measuring device has a WLAN antenna: Transmitter with integrated WLAN antenna
Web server	Web server and WLAN must be enabled; factory setting: ON For information on enabling the Web server → 79

8.4.3 Establishing a connection

Via service interface (CDI-RJ45)

Preparing the measuring device

Configuring the Internet protocol of the computer

The following information refers to the default Ethernet settings of the device.

IP address of the device: 192.168.1.212 (factory setting)

1. Switch on the measuring device.
2. Connect to the computer using a cable .
3. If a 2nd network card is not used, close all the applications on the notebook.
   ↳ Applications requiring Internet or a network, such as e-mail, SAP applications, Internet or Windows Explorer.
4. Close any open Internet browsers.
5. Configure the properties of the Internet protocol (TCP/IP) as defined in the table:

IP address	192.168.1.XXX; for XXX all numerical sequences except: 0, 212 and 255 → e.g. 192.168.1.213
Subnet mask	255.255.255.0
Default gateway	192.168.1.212 or leave cells empty

Via WLAN interface

Configuring the Internet protocol of the mobile terminal

NOTICE

If the WLAN connection is lost during the configuration, settings made may be lost.

- Make sure that the WLAN connection is not disconnected while configuring the device.

NOTICE

In principle, avoid simultaneous access to the measuring device via the service interface (CDI-RJ45) and the WLAN interface from the same mobile terminal. This could cause a network conflict.

- ▶ Only activate one service interface (CDI-RJ45 service interface or WLAN interface).
- ▶ If simultaneous communication is necessary: configure different IP address ranges, e.g. 192.168.0.1 (WLAN interface) and 192.168.1.212 (CDI-RJ45 service interface).

Preparing the mobile terminal

- ▶ Enable WLAN reception on the mobile terminal.

Establishing a connection from the mobile terminal to the measuring device

1. In the WLAN settings of the mobile terminal:
   Select the measuring device using the SSID (e.g. EH_Promag__A802000).
2. If necessary, select the WPA2 encryption method.
3. Enter the password: serial number of the measuring device ex-works (e.g. L100A802000).
   ↳ LED on display module flashes: it is now possible to operate the measuring device with the Web browser, FieldCare or DeviceCare.

The serial number can be found on the nameplate.

To ensure the safe and swift assignment of the WLAN network to the measuring point, it is advisable to change the SSID name. It should be possible to clearly assign the SSID name to the measuring point (e.g. tag name) as it is displayed as the WLAN network.

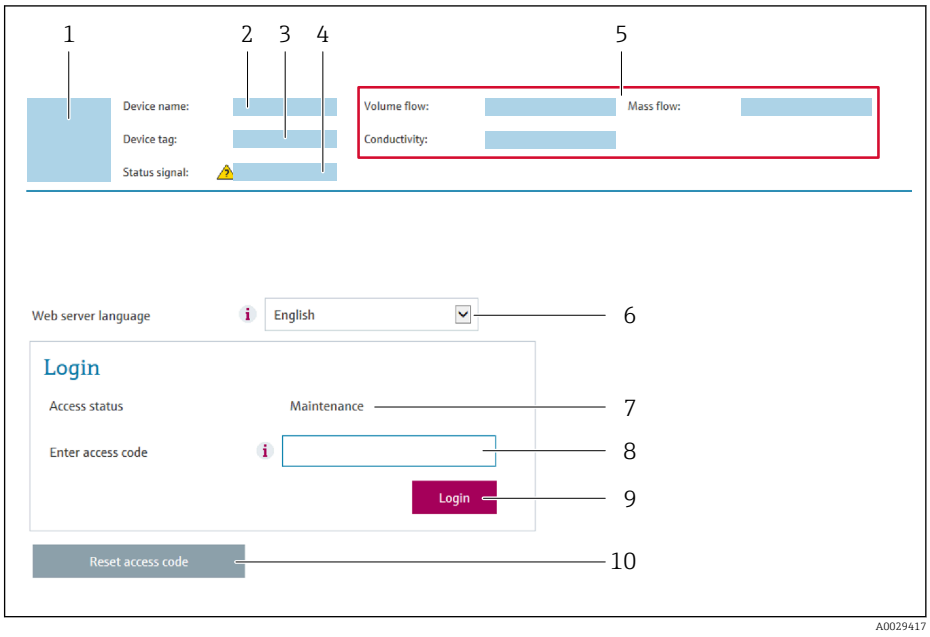
Disconnecting

- ▶ After configuring the device:
  Terminate the WLAN connection between the operating unit and measuring device.

Starting the Web browser

1. Start the Web browser on the computer.

2. Enter the IP address of the Web server in the address line of the Web browser: 192.168.1.212
   ↳ The login page appears.



1 *Picture of device*
2 *Device name*
3 *Device tag (→ 91)*
4 *Status signal*
5 *Current measured values*
6 *Operating language*
7 *User role*
8 *Access code*
9 *Login*
10 *Reset access code (→ 119)*

If a login page does not appear, or if the page is incomplete → 135

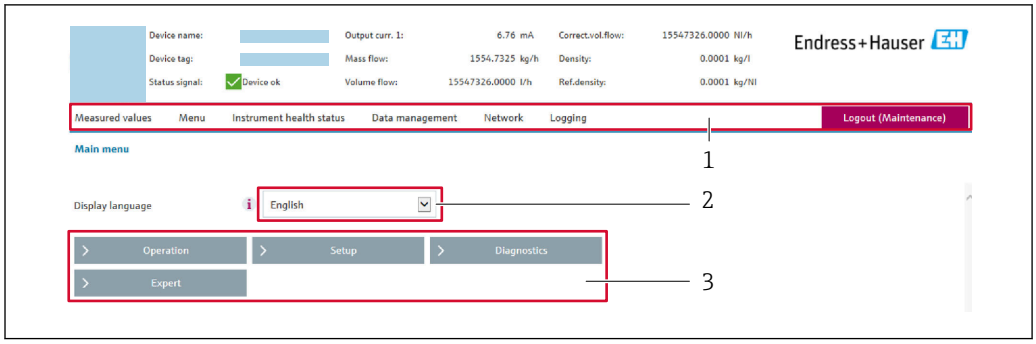
8.4.4 Logging on

1. Select the preferred operating language for the Web browser.
2. Enter the user-specific access code.
3. Press **OK** to confirm your entry.

Access code	0000 (factory setting); can be changed by customer

If no action is performed for 10 minutes, the Web browser automatically returns to the login page.

8.4.5 User interface



A0029418

1 *Function row*
2 *Local display language*
3 *Navigation area*

Header

The following information appears in the header:
- Device name
- Device tag
- Device status with status signal → 140
- Current measured values

Function row

Functions	Meaning
Measured values	Displays the measured values of the device
Menu	▪ Access to the operating menu from the measuring device ▪ The structure of the operating menu is the same as for the local display For detailed information on the structure of the operating menu, see the Operating Instructions for the measuring device
Device status	Displays the diagnostic messages currently pending, listed in order of priority

Data management	Data exchange between PC and measuring device:
	▪ Device configuration:
	  ▪ Load settings from the device (XML format, save configuration)
	  ▪ Save settings to the device (XML format, restore configuration)
	▪ Logbook - Export Event logbook (.csv file)
	▪ Documents - Export documents:
	  ▪ Export backup data record (.csv file, create documentation of the measuring point configuration)
	  ▪ Verification report (PDF file, only available with the "Heartbeat Verification" application package)

Network configuration	Configuration and checking of all the parameters required for establishing the connection to the measuring device: ▪ Network settings (e.g. IP address, MAC address) ▪ Device information (e.g. serial number, firmware version)
Logout	End the operation and call up the login page

Navigation area

If a function is selected in the function bar, the submenus of the function open in the navigation area. The user can now navigate through the menu structure.

Working area

Depending on the selected function and the related submenus, various actions can be performed in this area:
- Configuring parameters
- Reading measured values
- Calling up help text
- Starting an upload/download

8.4.6 Disabling the Web server

The Web server of the measuring device can be switched on and off as required using the **Web server functionality** parameter.

Navigation

"Expert" menu → Communication → Web server

Parameter overview with brief description

Parameter	Description	Selection	Factory setting
Web server functionality	Switch the Web server on and off.	▪ Off ▪ On	On

Function scope of the "Web server functionality" parameter

Option	Description
Off	▪ The web server is completely disabled. ▪ Port 80 is locked.
On	▪ The complete functionality of the web server is available. ▪ JavaScript is used. ▪ The password is transferred in an encrypted state. ▪ Any change to the password is also transferred in an encrypted state.

Enabling the Web server

If the Web server is disabled it can only be re-enabled with the **Web server functionality** parameter via the following operating options:
- Via local display
- Via Bedientool "FieldCare"
- Via "DeviceCare" operating tool

8.4.7 Logging out

Before logging out, perform a data backup via the **Data management** function (upload configuration from device) if necessary.

1. Select the **Logout** entry in the function row.
   ↳ The home page with the Login box appears.
2. Close the Web browser.
3. If no longer needed:
   Reset modified properties of the Internet protocol (TCP/IP) → 📄 75.

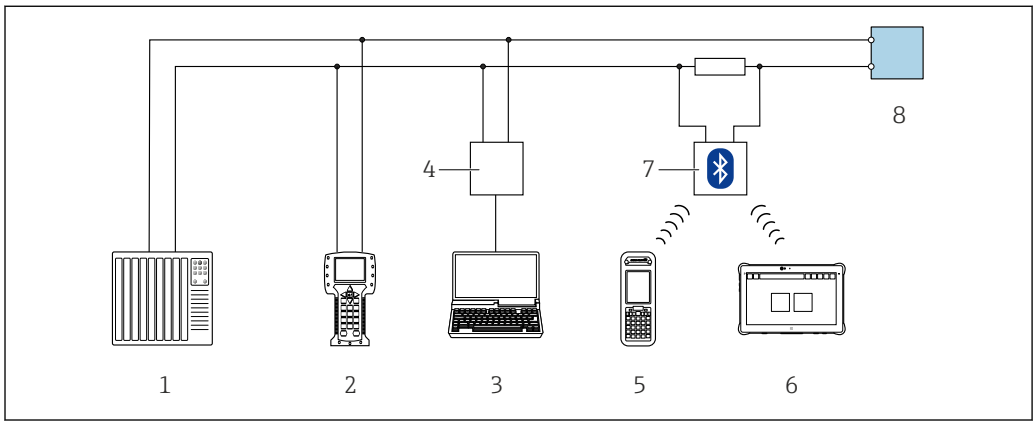
8.5 Access to the operating menu via the operating tool

The structure of the operating menu in the operating tools is identical to operation via the local display.

8.5.1 Connecting the operating tool

Via HART protocol

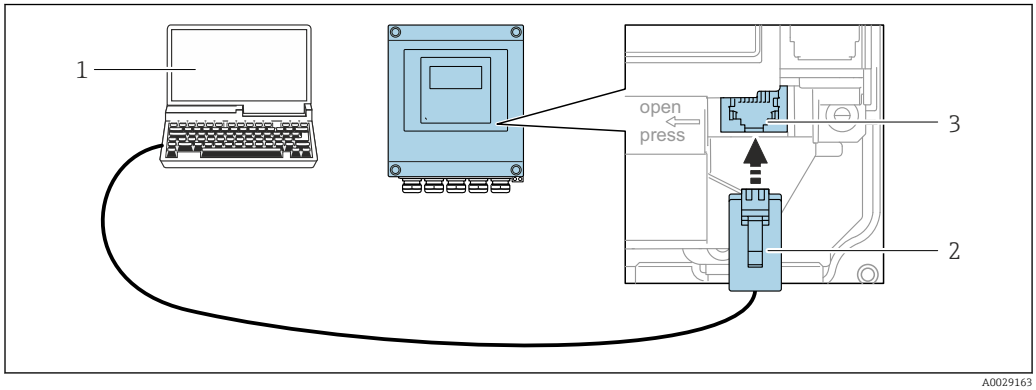
This communication interface is available in device versions with a HART output.



19 *Options for remote operation via HART protocol*

1 *Control system (e.g. PLC)*
2 *Field Communicator 475*
3 *Computer with operating tool (e.g. FieldCare, AMS Device Manager, SIMATIC PDM)*
4 *Commubox FXA195 (USB)*
5 *Field Xpert SFX350 or SFX370*
6 *Field Xpert SMT70*
7 *VIATOR Bluetooth modem with connecting cable*
8 *Transmitter*

Via service interface (CDI-RJ45)

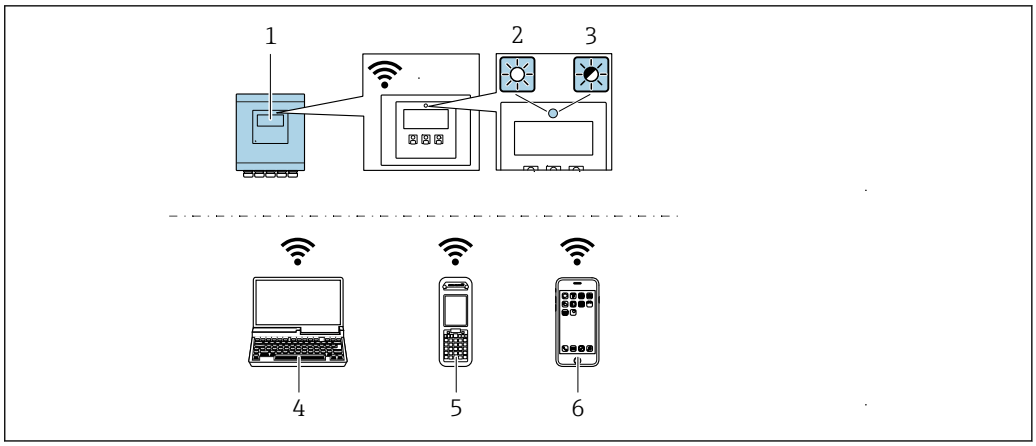


20 *Connection via service interface (CDI-RJ45)*

1 *Computer with Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with "FieldCare", "DeviceCare" operating tool with COM DTM "CDI Communication TCP/IP"*
2 *Standard Ethernet connecting cable with RJ45 plug*
3 *Service interface (CDI-RJ45) of the measuring device with access to the integrated Web server*

Via WLAN interface

The optional WLAN interface is available on the following device version:
Order code for "Display", option BA "WLAN":
4-line, illuminated, graphic display; touch control + WLAN



A0043149

1 *Transmitter with integrated WLAN antenna*
2 *LED lit constantly: WLAN reception is enabled on measuring device*
3 *LED flashing: WLAN connection established between operating unit and measuring device*
4 *Computer with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare)*
5 *Mobile handheld terminal with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or operating tool (e.g. FieldCare, DeviceCare)*
6 *Smart phone or tablet (e.g. Field Xpert SMT70)*

Function	WLAN: IEEE 802.11 b/g (2.4 GHz)
Encryption	WPA2-PSK AES-128 (in accordance with IEEE 802.11i)
Configurable WLAN channels	1 to 11
Degree of protection	IP67
Available antenna	Internal antenna
Range	Typically 10 m (32 ft)

Configuring the Internet protocol of the mobile terminal

NOTICE

If the WLAN connection is lost during the configuration, settings made may be lost.

- ▶ Make sure that the WLAN connection is not disconnected while configuring the device.

NOTICE

In principle, avoid simultaneous access to the measuring device via the service interface (CDI-RJ45) and the WLAN interface from the same mobile terminal. This could cause a network conflict.

- ▶ Only activate one service interface (CDI-RJ45 service interface or WLAN interface).
- ▶ If simultaneous communication is necessary: configure different IP address ranges, e.g. 192.168.0.1 (WLAN interface) and 192.168.1.212 (CDI-RJ45 service interface).

Preparing the mobile terminal

- ▶ Enable WLAN reception on the mobile terminal.

Establishing a connection from the mobile terminal to the measuring device

1. In the WLAN settings of the mobile terminal:
   Select the measuring device using the SSID (e.g. EH_Promag__A802000).
2. If necessary, select the WPA2 encryption method.

3. Enter the password: serial number of the measuring device ex-works (e.g. L100A802000).
   ↳ LED on display module flashes: it is now possible to operate the measuring device with the Web browser, FieldCare or DeviceCare.

The serial number can be found on the nameplate.

To ensure the safe and swift assignment of the WLAN network to the measuring point, it is advisable to change the SSID name. It should be possible to clearly assign the SSID name to the measuring point (e.g. tag name) as it is displayed as the WLAN network.

Disconnecting

▶ After configuring the device:
Terminate the WLAN connection between the operating unit and measuring device.

8.5.2 FieldCare

Function scope

FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field devices in a system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition.

Access is via:
- HART protocol
- CDI-RJ45 service interface

Typical functions:
- Parameterization of transmitters
- Loading and saving device data (upload/download)
- Documentation of the measuring point
- Visualization of the measured value memory (line recorder) and event logbook

For additional information about FieldCare, see Operating Instructions BA00027S and BA00059S

Source for device description files

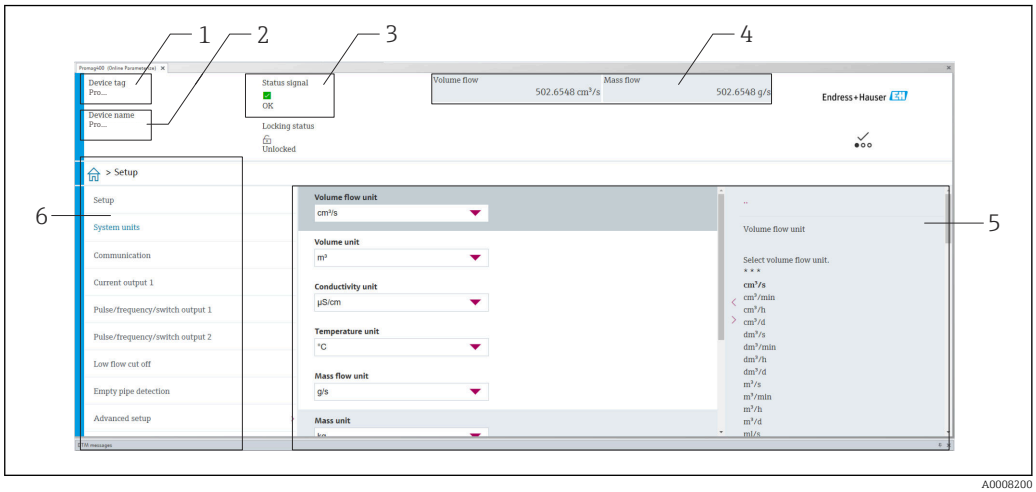
See information → 85

Establishing a connection

1. Start FieldCare and launch the project.
2. In the network: Add a device.
   ↳ The **Add device** window opens.
3. Select the **CDI Communication TCP/IP** option from the list and press **OK** to confirm.
4. Right-click **CDI Communication TCP/IP** and select the **Add device** option in the context menu that opens.
5. Select the desired device from the list and press **OK** to confirm.
   ↳ The **CDI Communication TCP/IP (Configuration)** window opens.
6. Enter the device address in the **IP address** field: 192.168.1.212 and press **Enter** to confirm.
7. Establish the online connection to the device.

For additional information, see Operating Instructions BA00027S and BA00059S

User interface



A0008200

1 *Device name*
2 *Tag name*
3 *Status area with status signal → 140*
4 *Display area for current measured values*
5 *Edit bar with additional functions*
6 *Navigation area with operating menu structure*

8.5.3 DeviceCare

Function scope

Tool for connecting and configuring Endress+Hauser field devices.

The fastest way to configure Endress+Hauser field devices is with the dedicated "DeviceCare" tool. Together with the device type managers (DTMs) it presents a convenient, comprehensive solution.

For details, see Innovation Brochure IN01047S

Source for device description files

See information → 85

8.5.4 Field Xpert SMT70, SMT77

Field Xpert SMT70

The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress.

This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle.

- Technical Information TI01342S
- Operating Instructions BA01709S
- Product page: www.endress.com/smt70

Source for device description files: → 85

Field Xpert SMT77

The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1.

- Technical Information TI01418S
- Operating Instructions BA01923S
- Product page: www.endress.com/smt77

Source for device description files: → 85

8.5.5 AMS Device Manager

Function scope

Program from Emerson Process Management for operating and configuring measuring devices via HART protocol.

Source for device description files

See data → 85

8.5.6 SIMATIC PDM

Function scope

SIMATIC PDM is a standardized, manufacturer-independent program from Siemens for the operation, configuration, maintenance and diagnosis of intelligent field devices via HART protocol.

Source for device description files

See information on → 85

9 System integration

9.1 Overview of device description files

9.1.1 Current version data for the device

Firmware version	02.01.zz	▪ On the title page of the Operating Instructions ▪ On the transmitter nameplate ▪ Firmware version Diagnostics → Device information → Firmware version
Release date of firmware version	05.2020	---
Manufacturer ID	0x11	Manufacturer ID Diagnostics → Device information → Manufacturer ID
Device type ID	0x1169	Device type Diagnostics → Device information → Device type
HART protocol revision	7	---
Device revision	9	▪ On the transmitter nameplate ▪ Device revision Diagnostics → Device information → Device revision

▪ Protocol-specific data → 168
▪ Firmware versions of the device → 153

9.1.2 Operating tools

The suitable device description file for the individual operating tools is listed in the table below, along with information on where the file can be acquired.

Operating tool via HART protocol	Sources for obtaining device descriptions
FieldCare	▪ www.endress.com → Download Area ▪ CD–ROM (contact Endress+Hauser) ▪ DVD (contact Endress+Hauser)
DeviceCare	▪ www.endress.com → Download Area ▪ CD–ROM (contact Endress+Hauser) ▪ DVD (contact Endress+Hauser)
▪ Field Xpert SMT70 ▪ Field Xpert SMT77	Use update function of handheld terminal
AMS Device Manager (Emerson Process Management)	www.endress.com → Download Area
SIMATIC PDM (Siemens)	www.endress.com → Download Area
Field Communicator 475 (Emerson Process Management)	Use update function of handheld terminal

9.2 Measured variables via HART protocol

The following measured variables (HART device variables) are assigned to the dynamic variables at the factory:

Dynamic variables	Measured variables (HART device variables)
Primary dynamic variable (PV)	Volume flow
Secondary dynamic variable (SV)	Totalizer 1
Tertiary dynamic variable (TV)	Totalizer 2
Quaternary dynamic variable (QV)	Totalizer 3

The assignment of the measured variables to the dynamic variables can be modified and assigned as desired via local operation and the operating tool using the following parameters:

- Expert → Communication → HART output → Output → Assign PV
- Expert → Communication → HART output → Output → Assign SV
- Expert → Communication → HART output → Output → Assign TV
- Expert → Communication → HART output → Output → Assign QV

The following measured variables can be assigned to the dynamic variables:

Measured variables for PV (primary dynamic variable)
- Off
- Volume flow
- Mass flow
- Corrected volume flow
- Flow velocity
- Conductivity [1)]
- Corrected conductivity [1)]
- Temperature
- Electronic temperature

Measured variables for SV, TV, QV (secondary, tertiary and quaternary dynamic variable)
- Volume flow
- Mass flow
- Corrected volume flow
- Flow velocity
- Conductivity [1)]
- Corrected conductivity [1)]
- Temperature [1)]
- Electronic temperature
- Density
- Totalizer 1
- Totalizer 2
- Totalizer 3
- HART input
- Noise [1)]
- Coil current shot time [1)]
- Reference electrode potential against PE [1)]
- Build-up measured value [1)]
- Test point 1
- Test point 2
- Test point 3

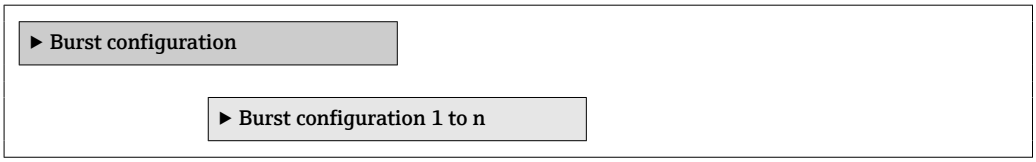
1) Visibility depends on order options or device settings

Device variables
The device variables are permanently assigned. A maximum of 8 device variables can be transmitted:
- 0 = volume flow
- 1 = mass flow
- 2 = corrected volume flow
- 3 = flow velocity
- 4 = conductivity
- 5 = corrected conductivity
- 6 = temperature
- 7 = electronic temperature
- 9 = totalizer 1
- 10 = totalizer 2
- 11 = totalizer 3

9.3 Other settings

Burst mode functionality in accordance with HART 7 Specification:

Navigation
"Expert" menu → Communication → HART output → Burst configuration → Burst configuration 1 to n



Parameter overview with brief description

Parameter	Description	Selection / User entry	Factory setting
Burst mode 1 to n	Activate the HART burst mode for burst message X.	▪ Off ▪ On	Off
Burst command 1 to n	Select the HART command that is sent to the HART master.	▪ Command 1 ▪ Command 2 ▪ Command 3 ▪ Command 9 ▪ Command 33 ▪ Command 48	Command 2
Burst variable 0	For HART command 9 and 33: select the HART device variable or the process variable.	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Electronic temperature ▪ Totalizer 1 ▪ Totalizer 2 ▪ Totalizer 3 ▪ Density ▪ Temperature * ▪ HART input ▪ Percent of range ▪ Measured current ▪ Primary variable (PV) ▪ Secondary variable (SV) ▪ Tertiary variable (TV) ▪ Quaternary variable (QV) ▪ Not used	Volume flow

Parameter	Description	Selection / User entry	Factory setting
Burst variable 1	For HART command 9 and 33: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 2	For HART command 9 and 33: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 3	For HART command 9 and 33: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 4	For HART command 9: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 5	For HART command 9: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 6	For HART command 9: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst variable 7	For HART command 9: select the HART device variable or the process variable.	See the **Burst variable 0** parameter.	Not used
Burst trigger mode	Select the event that triggers burst message X.	▪ Continuous ▪ Window * ▪ Rising * ▪ Falling * ▪ On change	Continuous
Burst trigger level	Enter the burst trigger value. Together with the option selected in the **Burst trigger mode** parameter the burst trigger value determines the time of burst message X.	Signed floating-point number	–
Min. update period	Enter the minimum time span between two burst commands of burst message X.	Positive integer	1 000 ms
Max. update period	Enter the maximum time span between two burst commands of burst message X.	Positive integer	2 000 ms

* Visibility depends on order options or device settings

10 Commissioning

10.1 Function check

Before commissioning the measuring device:

▶ Make sure that the post-installation and post-connection checks have been performed.

- "Post-installation check" checklist→ 40
- "Post-connection check" checklist→ 57

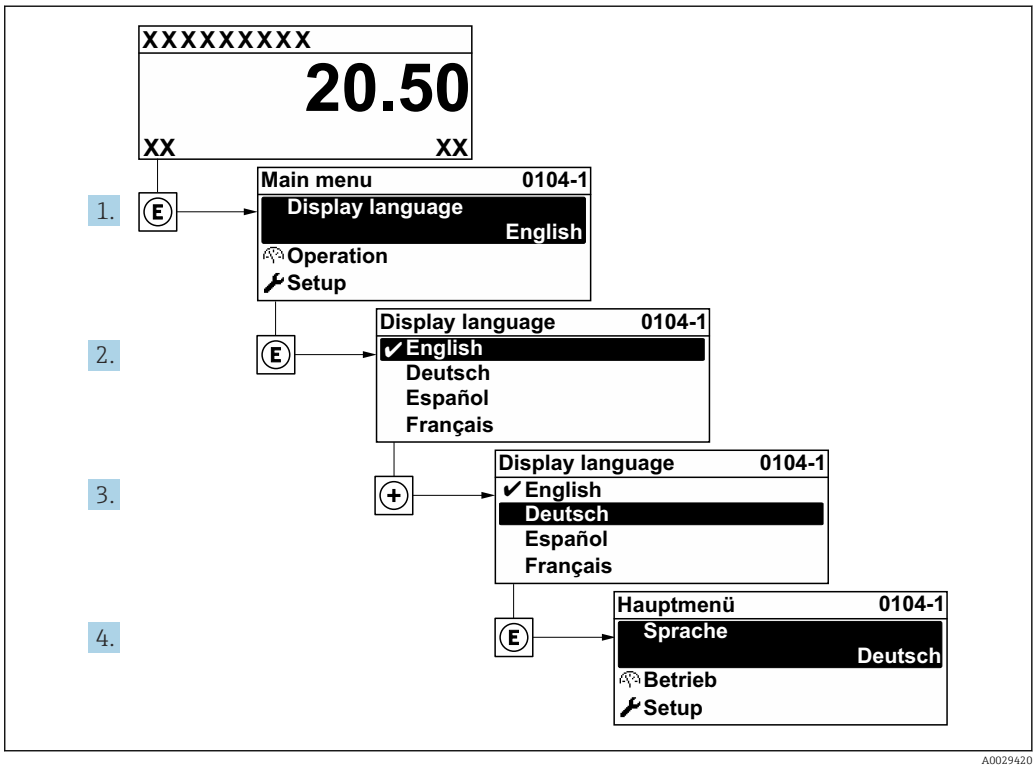
10.2 Switching on the measuring device

▶ After a successful function check, switch on the measuring device.
  ↳ After a successful startup, the local display switches automatically from the startup display to the operational display.

If nothing appears on the local display or a diagnostic message is displayed, refer to the section on "Diagnostics and troubleshooting" → 134.

10.3 Setting the operating language

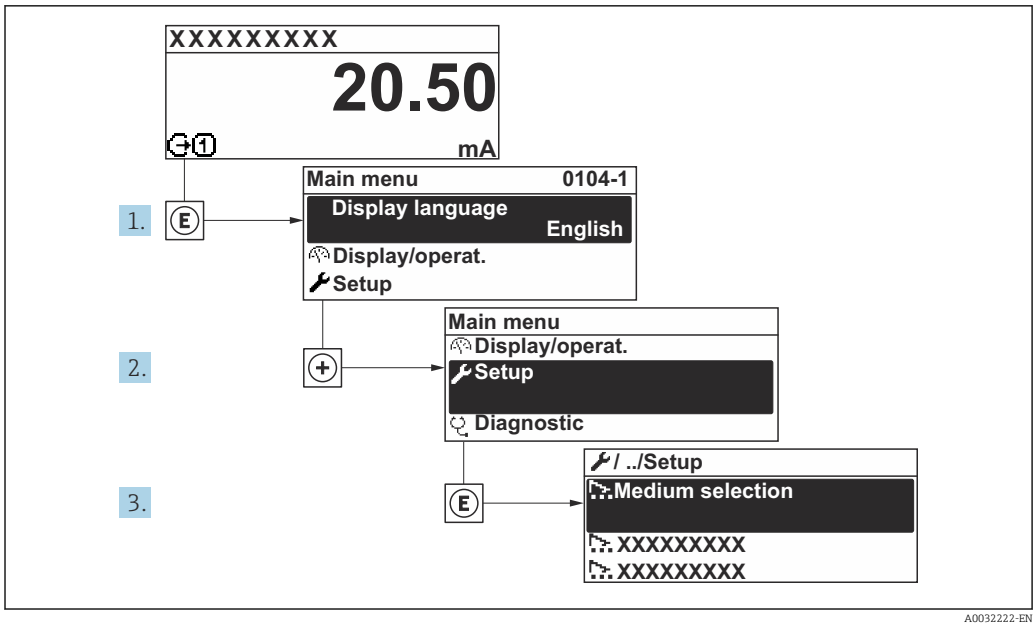
Factory setting: English or ordered local language



21 *Taking the example of the local display*

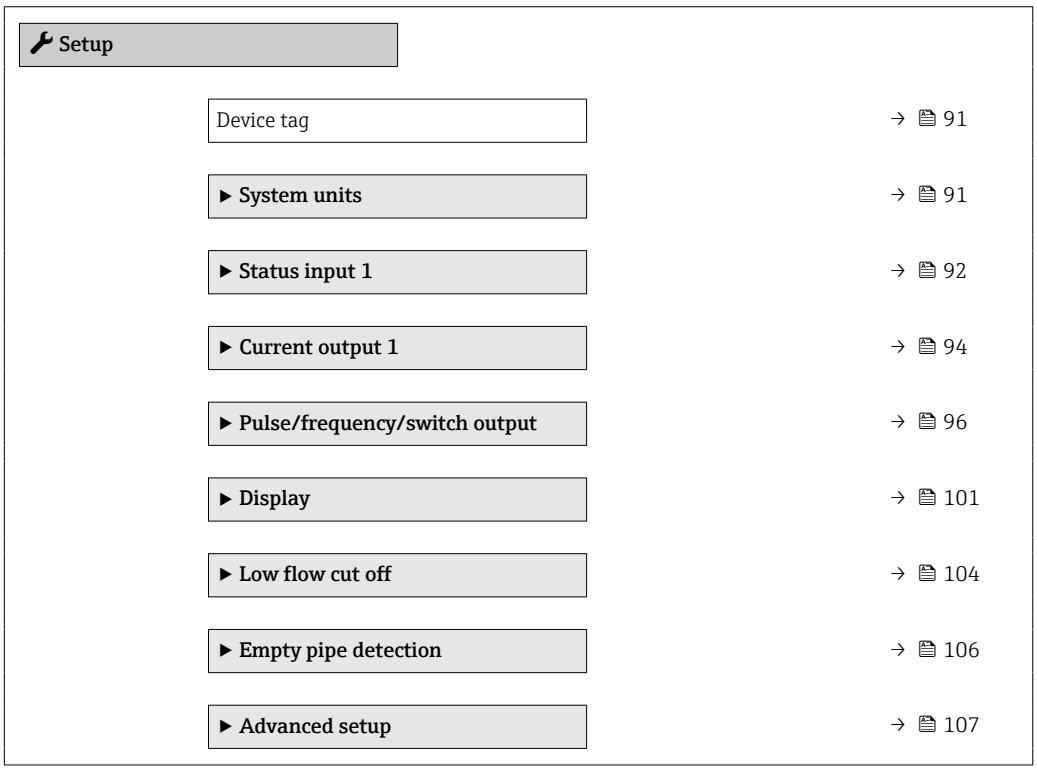
10.4 Configuring the measuring device

- The **Setup** menu with its guided wizards contains all the parameters needed for standard operation.
- Navigation to the **Setup** menu



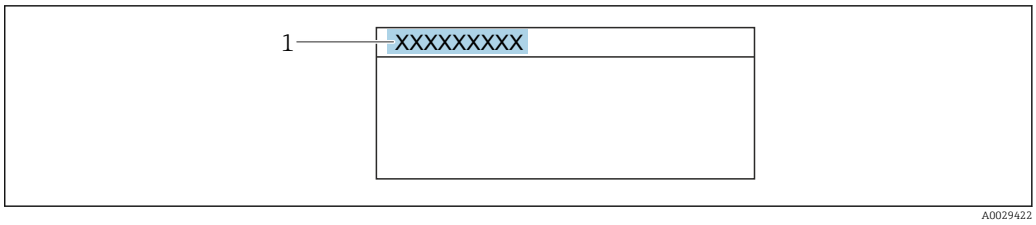
22 *Taking the example of the local display*

Navigation
"Setup" menu



10.4.1 Defining the tag name

To enable fast identification of the measuring point within the system, you can enter a unique designation using the **Device tag** parameter and thus change the factory setting.



23 Header of the operational display with tag name

1 Tag name

Enter the tag name in the "FieldCare" operating tool → 83

Navigation
"Setup" menu → Device tag

Parameter overview with brief description

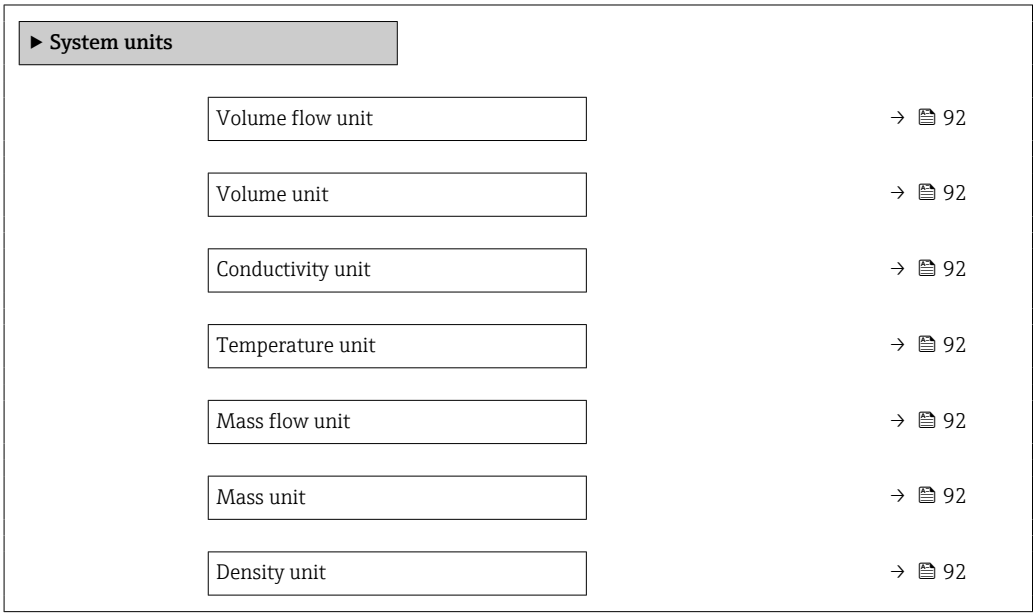
Parameter	Description	User entry	Factory setting
Device tag	Enter the name for the measuring point.	Max. 32 characters, such as letters, numbers or special characters (e.g. @, %, /).	Promag

10.4.2 Setting the system units

In the **System units** submenu the units of all the measured values can be set.

The number of submenus and parameters can vary depending on the device version. Certain submenus and parameters in these submenus are not described in the Operation Instructions. Instead a description is provided in the Special Documentation for the device (→ "Supplementary documentation" section).

Navigation
"Setup" menu → System units



Parameter overview with brief description

Parameter	Prerequisite	Description	Selection	Factory setting
Volume flow unit	–	Select volume flow unit. *Effect* The selected unit applies for: ▪ Output ▪ Low flow cut off ▪ Simulation process variable	Unit choose list	Country-specific: ▪ l/h ▪ gal/min (us)
Volume unit	–	Select volume unit.	Unit choose list	Country-specific: ▪ m^3 ▪ gal (us)
Conductivity unit	The **On** option is selected in the **Conductivity measurement** parameter parameter.	Select conductivity unit. *Effect* The selected unit applies for: ▪ Current output ▪ Frequency output ▪ Switch output ▪ Simulation process variable	Unit choose list	µS/cm
Temperature unit	–	Select temperature unit. *Effect* The selected unit applies for: ▪ **Maximum value** parameter ▪ **Minimum value** parameter	Unit choose list	Country-specific: ▪ °C ▪ °F
Mass flow unit	–	Select mass flow unit. *Effect* The selected unit applies for: ▪ Output ▪ Low flow cut off ▪ Simulation process variable	Unit choose list	Country-specific: ▪ kg/h ▪ lb/min
Mass unit	–	Select mass unit.	Unit choose list	Country-specific: ▪ kg ▪ lb
Density unit	–	Select density unit. *Effect* The selected unit applies for: ▪ Output ▪ Simulation process variable	Unit choose list	Country-specific: ▪ kg/l ▪ lb/ft^3

10.4.3 Configuring the status input

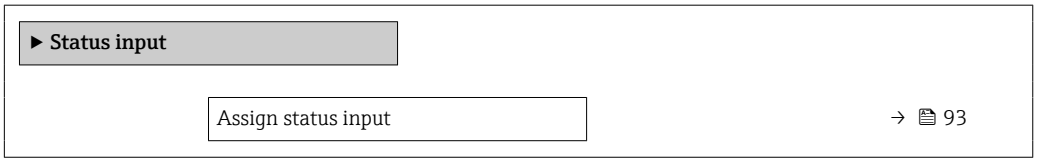
The **Status input** submenu guides the user systematically through all the parameters that have to be set for configuring the status input.

The submenu only appears if the device was ordered with a status input .

Navigation

"Setup" menu → Status input

Structure of the submenu



Active level	→ 93
Response time status input	→ 93

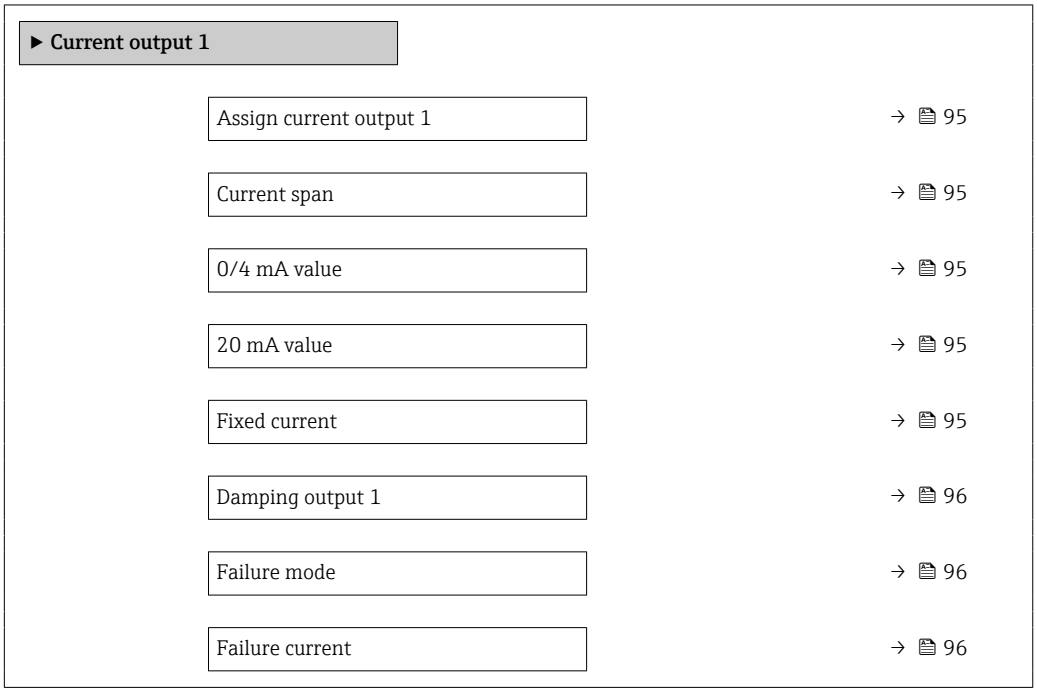
Parameter overview with brief description

Parameter	Description	Selection / User entry	Factory setting
Assign status input	Select function for the status input.	▪ Off ▪ Reset totalizer 1 ▪ Reset totalizer 2 ▪ Reset totalizer 3 ▪ Reset all totalizers ▪ Flow override	Off
Active level	Define input signal level at which the assigned function is triggered.	▪ High ▪ Low	High
Response time status input	Define the minimum amount of time the input signal level must be present before the selected function is triggered.	5 to 200 ms	50 ms

10.4.4 Configuring the current output

The **Current output** wizard guides you systematically through all the parameters that have to be set for configuring the current output.

Navigation
"Setup" menu → Current output 1



Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Assign current output	–	Select process variable for current output.	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature * ▪ Electronic temperature ▪ Reference electrode potential against PE * ▪ Coil current shot time * ▪ Noise * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Volume flow
Current span	–	Select current range for process value output and upper/lower level for alarm signal.	▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA) ▪ 4...20 mA (4... 20.5 mA) ▪ 0...20 mA (0... 20.5 mA) ▪ Fixed current	Country-specific: ▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA)
0/4 mA value	One of the following options is selected in the **Current span** parameter (→ 🖹 95): ▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA) ▪ 4...20 mA (4... 20.5 mA) ▪ 0...20 mA (0... 20.5 mA)	Enter 4 mA value.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)
20 mA value	In the **Current span** parameter (→ 🖹 95), one of the following options is selected: ▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA) ▪ 4...20 mA (4... 20.5 mA) ▪ 0...20 mA (0... 20.5 mA)	Enter 20 mA value.	Signed floating-point number	Depends on country and nominal diameter
Fixed current	The **Fixed current** option is selected in the **Current span** parameter (→ 🖹 95).	Defines the fixed output current.	0 to 22.5 mA	22.5 mA

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Damping output	A process variable is selected in the **Assign current output** parameter (→ 🖹 95) and one of the following options is selected in the **Current span** parameter (→ 🖹 95): ▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA) ▪ 4...20 mA (4... 20.5 mA) ▪ 0...20 mA (0... 20.5 mA)	Set reaction time for output signal to fluctuations in the measured value.	0.0 to 999.9 s	1.0 s
Failure mode	A process variable is selected in the **Assign current output** parameter (→ 🖹 95) and one of the following options is selected in the **Current span** parameter (→ 🖹 95): ▪ 4...20 mA NAMUR (3.8...20.5 mA) ▪ 4...20 mA US (3.9...20.8 mA) ▪ 4...20 mA (4... 20.5 mA) ▪ 0...20 mA (0... 20.5 mA)	Define output behavior in alarm condition.	▪ Min. ▪ Max. ▪ Last valid value ▪ Actual value ▪ Defined value	Max.
Failure current	The **Defined value** option is selected in the **Failure mode** parameter.	Enter current output value in alarm condition.	0 to 22.5 mA	22.5 mA

* Visibility depends on order options or device settings

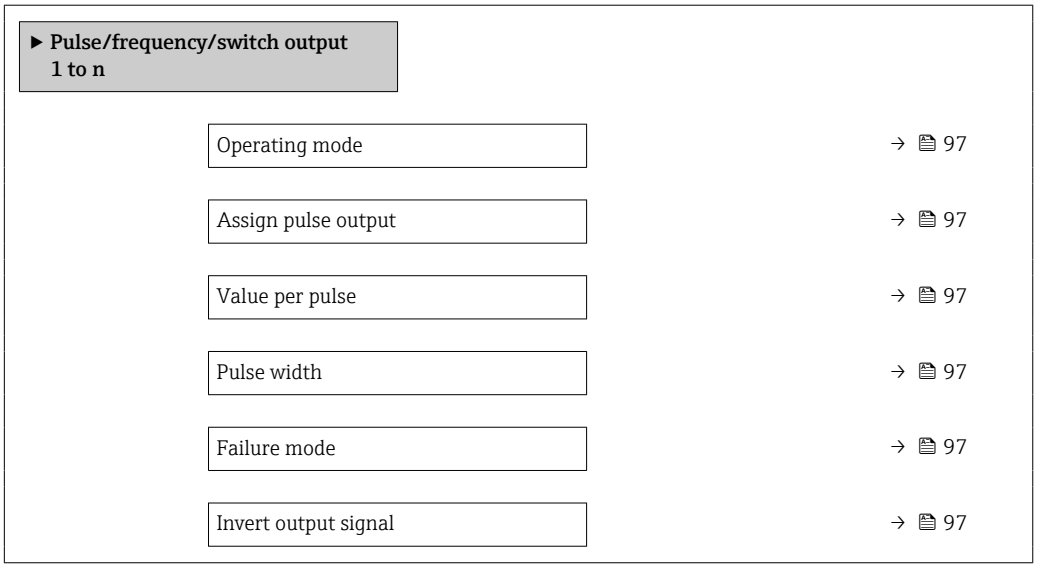
10.4.5 Configuring the pulse/frequency/switch output

The **Pulse/frequency/switch output** wizard guides you systematically through all the parameters that can be set for configuring the selected output type.

Configuring the pulse output

Navigation

"Setup" menu → Pulse/frequency/switch output 1 to n



Parameter overview with brief description

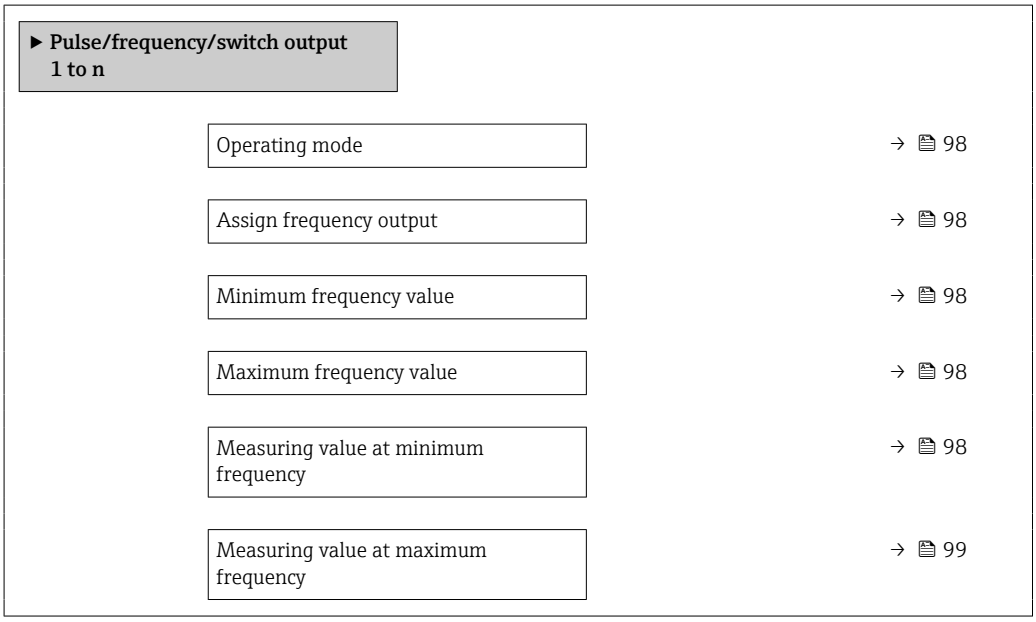
Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Operating mode	–	Define the output as a pulse, frequency or switch output.	▪ Pulse * ▪ Frequency * ▪ Switch *	Pulse
Assign pulse output	The **Pulse** option is selected in the **Operating mode** parameter.	Select process variable for pulse output.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Off
Pulse scaling	The **Pulse** option is selected in the **Operating mode** parameter (→ 🖹 97) and a process variable is selected in the **Assign pulse output** parameter (→ 🖹 97).	Enter quantity for measured value at which a pulse is output.	Positive floating point number	Depends on country and nominal diameter
Pulse width	The **Pulse** option is selected in the **Operating mode** parameter (→ 🖹 97) and a process variable is selected in the **Assign pulse output** parameter (→ 🖹 97).	Define time width of the output pulse.	0.05 to 2 000 ms	100 ms
Failure mode	The **Pulse** option is selected in the **Operating mode** parameter (→ 🖹 97) and a process variable is selected in the **Assign pulse output** parameter (→ 🖹 97).	Define output behavior in alarm condition.	▪ Actual value ▪ No pulses	No pulses
Invert output signal	–	Invert the output signal.	▪ No ▪ Yes	No

* Visibility depends on order options or device settings

Configuring the frequency output

Navigation

"Setup" menu → Pulse/frequency/switch output 1 to n



Failure mode	→ 99
Failure frequency	→ 99
Invert output signal	→ 99

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Operating mode	–	Define the output as a pulse, frequency or switch output.	▪ Pulse * ▪ Frequency * ▪ Switch *	Pulse
Assign frequency output	The **Frequency** option is selected in the **Operating mode** parameter (→ 97).	Select process variable for frequency output.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature * ▪ Electronic temperature ▪ Noise * ▪ Coil current shot time * ▪ Reference electrode potential against PE * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Off
Minimum frequency value	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Enter minimum frequency.	0.0 to 10 000.0 Hz	0.0 Hz
Maximum frequency value	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Enter maximum frequency.	0.0 to 10 000.0 Hz	10 000.0 Hz
Measuring value at minimum frequency	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Enter measured value for minmum frequency.	Signed floating-point number	Depends on country and nominal diameter

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Measuring value at maximum frequency	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Enter measured value for maximum frequency.	Signed floating-point number	Depends on country and nominal diameter
Failure mode	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Define output behavior in alarm condition.	▪ Actual value ▪ Defined value ▪ 0 Hz	0 Hz
Failure frequency	The **Frequency** option is selected in the **Operating mode** parameter (→ 97) and a process variable is selected in the **Assign frequency output** parameter (→ 98).	Enter frequency output value in alarm condition.	0.0 to 12 500.0 Hz	0.0 Hz
Invert output signal	–	Invert the output signal.	▪ No ▪ Yes	No

* Visibility depends on order options or device settings

Configuring the switch output

Navigation

"Setup" menu → Pulse/frequency/switch output 1 to n

► **Pulse/frequency/switch output 1 to n**

- Operating mode → 100
- Switch output function → 100
- Assign diagnostic behavior → 100
- Assign limit → 100
- Assign flow direction check → 100
- Assign status → 100
- Switch-on value → 100
- Switch-off value → 101
- Switch-on delay → 101
- Switch-off delay → 101

Failure mode	→ 101
Invert output signal	→ 101

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Operating mode	–	Define the output as a pulse, frequency or switch output.	▪ Pulse * ▪ Frequency * ▪ Switch *	Pulse
Switch output function	The **Switch** option is selected in the **Operating mode** parameter parameter.	Select function for switch output.	▪ Off ▪ On ▪ Diagnostic behavior ▪ Limit ▪ Flow direction check ▪ Status	Off
Assign diagnostic behavior	▪ In the **Operating mode** parameter, the **Switch** option is selected. ▪ In the **Switch output function** parameter, the **Diagnostic behavior** option is selected.	Select diagnostic behavior for switch output.	▪ Alarm ▪ Alarm or warning ▪ Warning	Alarm
Assign limit	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Limit** option is selected in the **Switch output function** parameter.	Select process variable for limit function.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Totalizer 1 ▪ Totalizer 2 ▪ Totalizer 3 ▪ Temperature * ▪ Electronic temperature	Volume flow
Assign flow direction check	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Flow direction check** option is selected in the **Switch output function** parameter.	Select process variable for flow direction monitoring.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Volume flow
Assign status	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Status** option is selected in the **Switch output function** parameter.	Select device status for switch output.	▪ Empty pipe detection ▪ Low flow cut off ▪ Build-up detection *	Empty pipe detection
Switch-on value	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Limit** option is selected in the **Switch output function** parameter.	Enter measured value for the switch-on point.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)

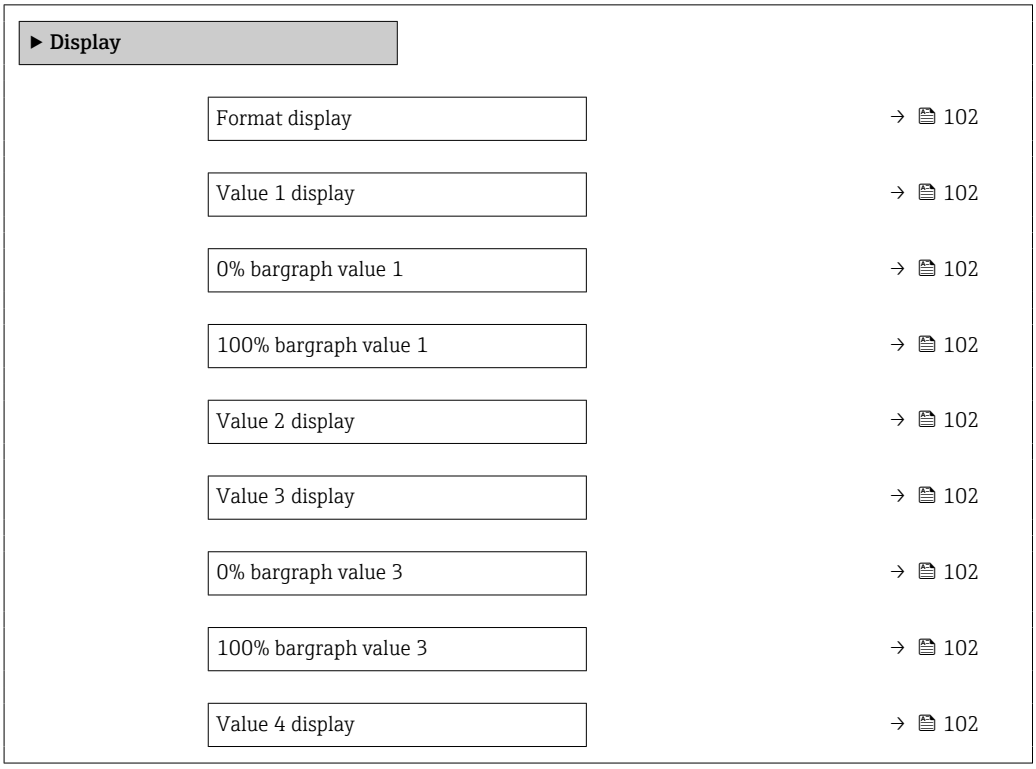
Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Switch-off value	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Limit** option is selected in the **Switch output function** parameter.	Enter measured value for the switch-off point.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)
Switch-on delay	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Limit** option is selected in the **Switch output function** parameter.	Define delay for the switch-on of status output.	0.0 to 100.0 s	0.0 s
Switch-off delay	▪ The **Switch** option is selected in the **Operating mode** parameter. ▪ The **Limit** option is selected in the **Switch output function** parameter.	Define delay for the switch-off of status output.	0.0 to 100.0 s	0.0 s
Failure mode	–	Define output behavior in alarm condition.	▪ Actual status ▪ Open ▪ Closed	Open
Invert output signal	–	Invert the output signal.	▪ No ▪ Yes	No

* Visibility depends on order options or device settings

10.4.6 Configuring the local display

The **Display** wizard guides you systematically through all the parameters that can configured for configuring the local display.

Navigation
"Setup" menu → Display



Parameter overview with brief description

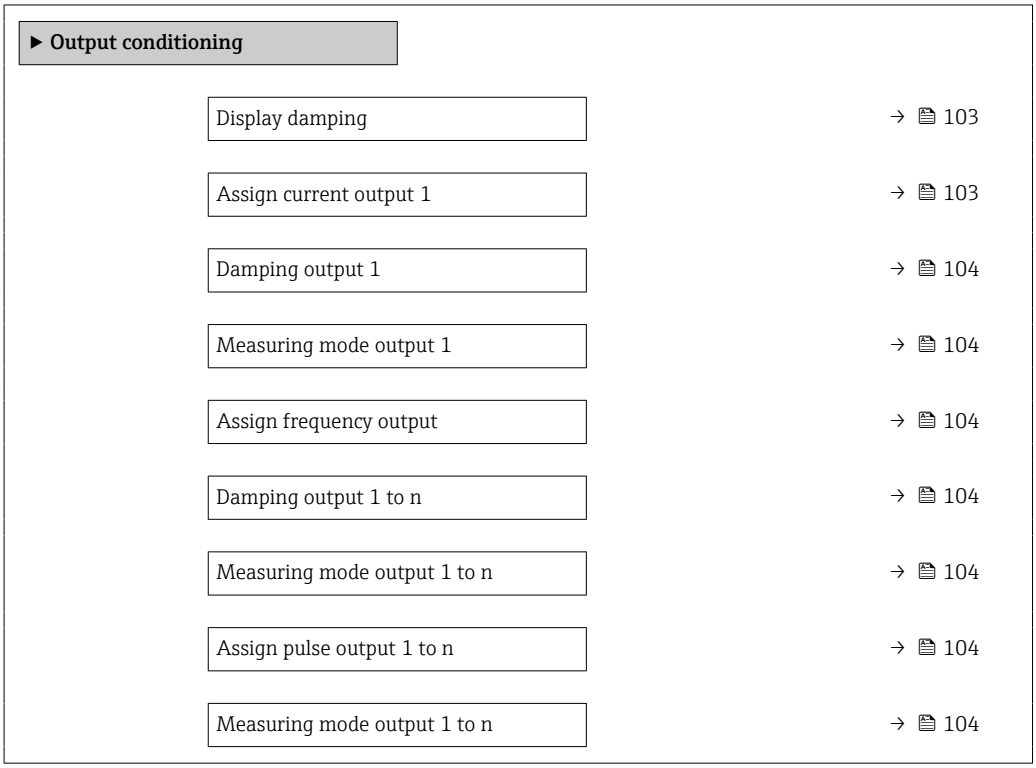
Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Format display	A local display is provided.	Select how measured values are shown on the display.	▪ 1 value, max. size ▪ 1 bargraph + 1 value ▪ 2 values ▪ 1 value large + 2 values ▪ 4 values	1 value, max. size
Value 1 display	A local display is provided.	Select the measured value that is shown on the local display.	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Electronic temperature ▪ Totalizer 1 ▪ Totalizer 2 ▪ Totalizer 3 ▪ Current output 1 ▪ Noise * ▪ Coil current shot time * ▪ Reference electrode potential against PE * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Volume flow
0% bargraph value 1	A local display is provided.	Enter 0% value for bar graph display.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)
100% bargraph value 1	A local display is provided.	Enter 100% value for bar graph display.	Signed floating-point number	Depends on country and nominal diameter
Value 2 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None
Value 3 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None
0% bargraph value 3	A selection was made in the **Value 3 display** parameter.	Enter 0% value for bar graph display.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)
100% bargraph value 3	A selection was made in the **Value 3 display** parameter.	Enter 100% value for bar graph display.	Signed floating-point number	0
Value 4 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None

* Visibility depends on order options or device settings

10.4.7 Configuring the output conditioning

The **Output conditioning** wizard guides you systematically through all the parameters that have to be set for configuring the output conditioning.

Navigation
"Setup" menu → Output conditioning



Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection	Factory setting
Display damping	–	Set display reaction time to fluctuations in the measured value.	0.0 to 999.9 s	0.0 s
Assign current output	–	Select process variable for current output.	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature * ▪ Electronic temperature ▪ Reference electrode potential against PE * ▪ Coil current shot time * ▪ Noise * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Volume flow

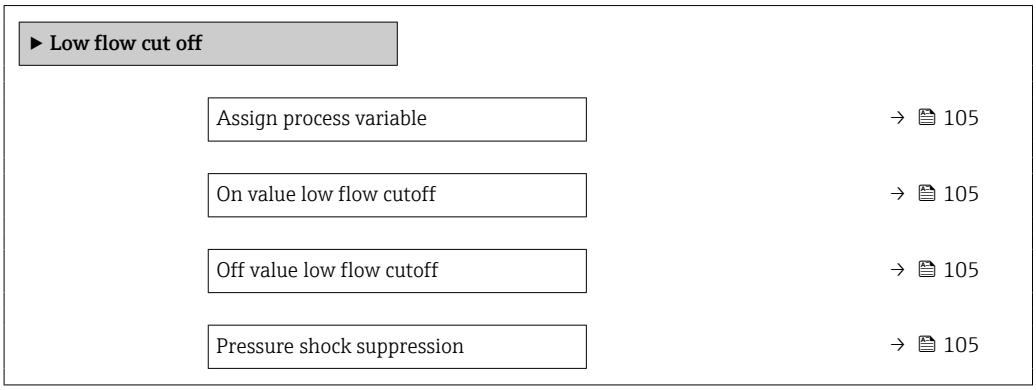
Parameter	Prerequisite	Description	User entry / Selection	Factory setting
Damping output 1	–	Set reaction time for output signal to fluctuations in the measured value.	0 to 999.9 s	1 s
Measuring mode output 1	–	Select measuring mode for output.	▪ Forward flow ▪ Forward/Reverse flow ▪ Reverse flow compensation	Forward flow
Assign frequency output	The **Frequency** option is selected in the **Operating mode** parameter (→ 🖹 97).	Select process variable for frequency output.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature * ▪ Electronic temperature ▪ Noise * ▪ Coil current shot time * ▪ Reference electrode potential against PE * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Off
Damping output 1	–	Set reaction time for output signal to fluctuations in the measured value.	0 to 999.9 s	1 s
Measuring mode output 1	–	Select measuring mode for output.	▪ Forward flow ▪ Forward/Reverse flow ▪ Reverse flow ▪ Reverse flow compensation	Forward flow
Assign pulse output	The **Pulse** option is selected in the **Operating mode** parameter.	Select process variable for pulse output.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Off
Measuring mode output 1	–	Select measuring mode for output.	▪ Forward flow ▪ Forward/Reverse flow ▪ Reverse flow ▪ Reverse flow compensation	Forward flow

* Visibility depends on order options or device settings

10.4.8 Configuring the low flow cut off

The **Low flow cut off** wizard systematically guides the user through all the parameters that must be set to configure low flow cut off.

Navigation
"Setup" menu → Low flow cut off



Parameter overview with brief description

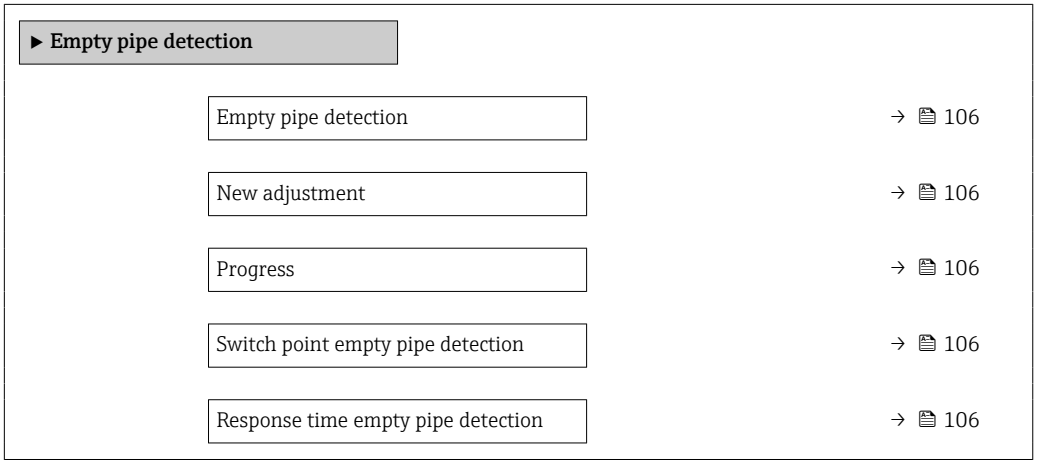
Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Assign process variable	–	Select process variable for low flow cut off.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Volume flow
On value low flow cutoff	A process variable is selected in the **Assign process variable** parameter (→ 105).	Enter on value for low flow cut off.	Positive floating-point number	Depends on country and nominal diameter
Off value low flow cutoff	A process variable is selected in the **Assign process variable** parameter (→ 105).	Enter off value for low flow cut off.	0 to 100.0 %	50 %
Pressure shock suppression	A process variable is selected in the **Assign process variable** parameter (→ 105).	Enter time frame for signal suppression (= active pressure shock suppression).	0 to 100 s	0 s

10.4.9 Configuring empty pipe detection

- The measuring devices are calibrated with water (approx. 500 µS/cm) at the factory. For liquids with a lower conductivity, it is advisable to perform a new full pipe adjustment onsite.
- It is recommended to perform a new empty pipe adjustment onsite if a cable longer than 50 meters is used.

The **Empty pipe detection** wizard guides you systematically through all the parameters that have to be set for configuring empty pipe detection.

Navigation
"Setup" menu → Empty pipe detection



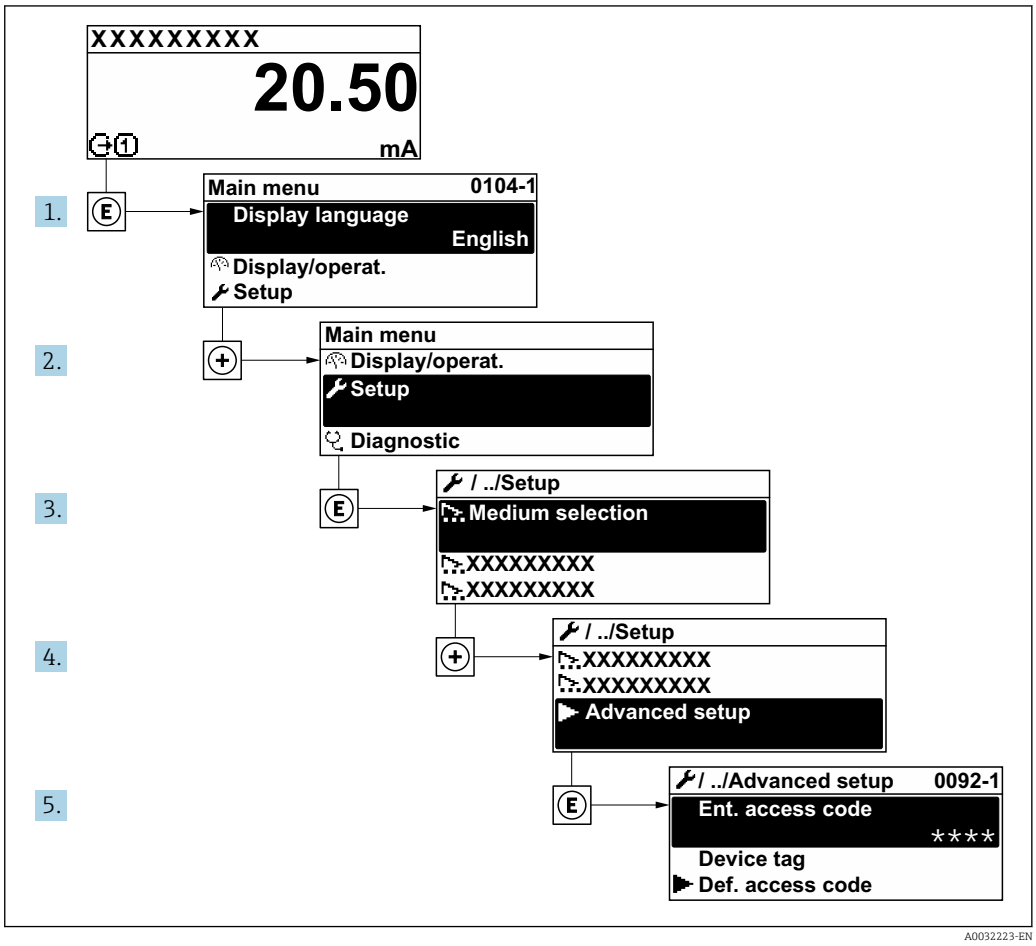
Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User interface / User entry	Factory setting
Empty pipe detection	–	Switch empty pipe detection on and off.	▪ Off ▪ On	Off
New adjustment	The **On** option is selected in the **Empty pipe detection** parameter.	Select type of adjustment.	▪ Cancel ▪ Empty pipe adjust ▪ Full pipe adjust	Cancel
Progress	The **On** option is selected in the **Empty pipe detection** parameter.	Shows the progress.	▪ Ok ▪ Busy ▪ Not ok	–
Switch point empty pipe detection	The **On** option is selected in the **Empty pipe detection** parameter.	Enter hysteresis in %, below this value the measuring tube will detected as empty.	0 to 100 %	50 %
Response time empty pipe detection	A process variable is selected in the **Assign process variable** parameter (→ 106).	Enter the time before diagnostic message S862 "Pipe empty" is displayed for empty pipe detection.	0 to 100 s	1 s

10.5 Advanced settings

The **Advanced setup** submenu together with its submenus contains parameters for specific settings.

Navigation to the "Advanced setup" submenu

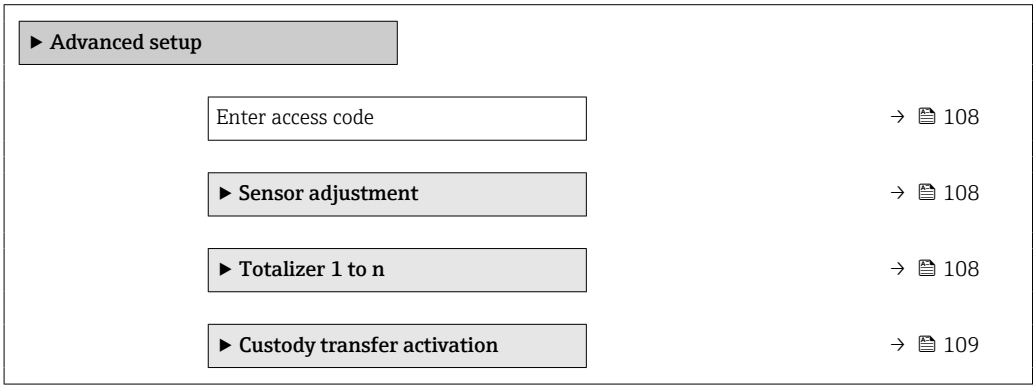


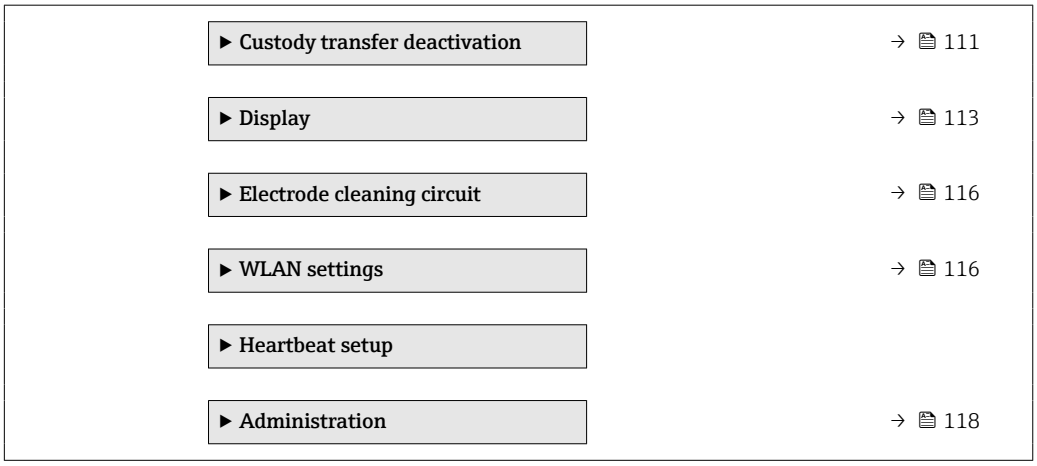
A0032223-EN

The number of submenus and parameters can vary depending on the device version. Certain submenus and parameters in these submenus are not described in the Operation Instructions. Instead a description is provided in the Special Documentation for the device (→ "Supplementary documentation" section).

Navigation

"Setup" menu → Advanced setup





10.5.1 Using the parameter to enter the access code

Navigation
"Setup" menu → Advanced setup

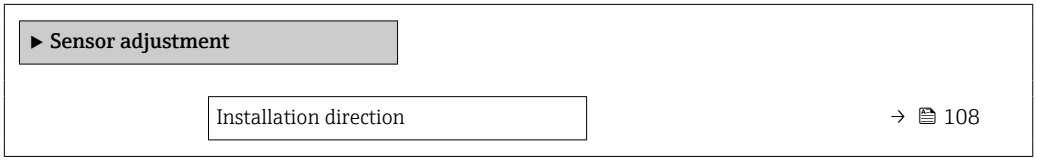
Parameter overview with brief description

Parameter	Description	User entry
Enter access code	Enter access code to disable write protection of parameters.	Max. 16-digit character string comprising numbers, letters and special characters

10.5.2 Carrying out a sensor adjustment

The **Sensor adjustment** submenu contains parameters that pertain to the functionality of the sensor.

Navigation
"Setup" menu → Advanced setup → Sensor adjustment



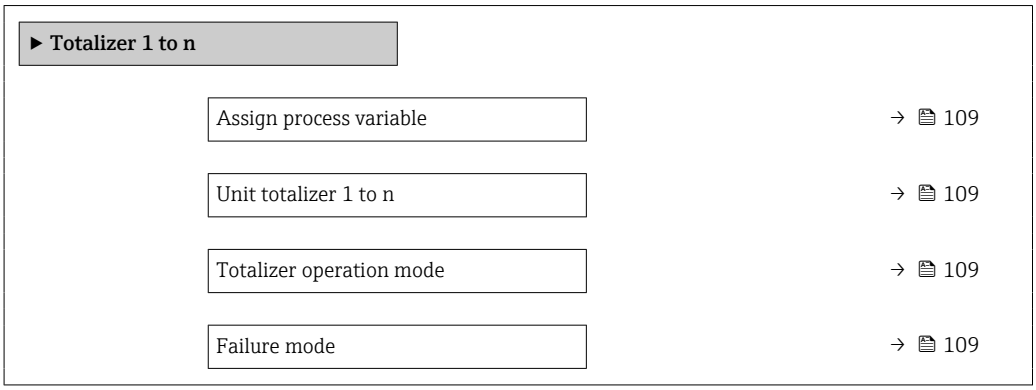
Parameter overview with brief description

Parameter	Description	Selection	Factory setting
Installation direction	Select sign of flow direction.	▪ Flow in arrow direction ▪ Flow against arrow direction	Flow in arrow direction

10.5.3 Configuring the totalizer

In the **"Totalizer 1 to n" submenu** the individual totalizer can be configured.

Navigation
"Setup" menu → Advanced setup → Totalizer 1 to n



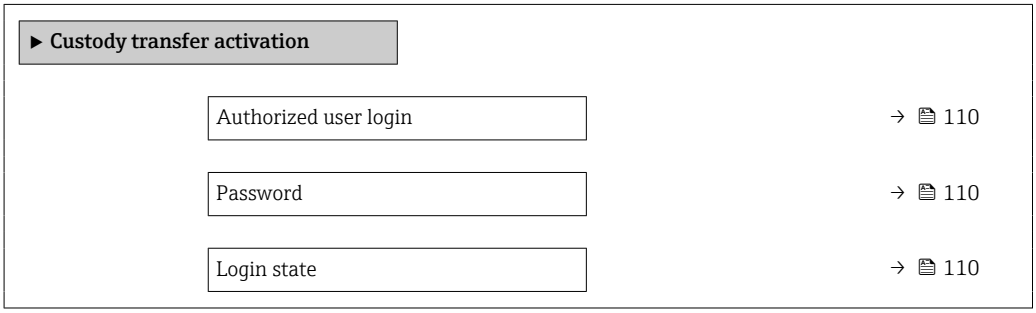
Parameter overview with brief description

Parameter	Prerequisite	Description	Selection	Factory setting
Assign process variable	–	Select process variable for totalizer.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Volume flow
Unit totalizer 1 to n	A process variable is selected in the **Assign process variable** parameter (→ 109) of the **Totalizer 1 to n** submenu.	Select process variable totalizer unit.	Unit choose list	Country-specific: ▪ l ▪ gal (us)
Totalizer operation mode	A process variable is selected in the **Assign process variable** parameter (→ 109) of the **Totalizer 1 to n** submenu.	Select totalizer calculation mode.	▪ Net flow total ▪ Forward flow total ▪ Reverse flow total	Net flow total
Failure mode	A process variable is selected in the **Assign process variable** parameter (→ 109) of the **Totalizer 1 to n** submenu.	Define totalizer behavior in alarm condition.	▪ Stop ▪ Actual value ▪ Last valid value	Stop

10.5.4 Parameter description for Custody transfer activation

An **authorized user login** is available: EH000 with password 177801. This **authorized user login** is the non-personalized factory login and enables the activation and deactivation of the custody transfer mode. Settings made using this login must be documented and personalized by the system operator. In addition, the responsible calibration authority must be informed of these changes.

Navigation
"Setup" menu → Advanced setup → Custody transfer activation



Parameter overview with brief description

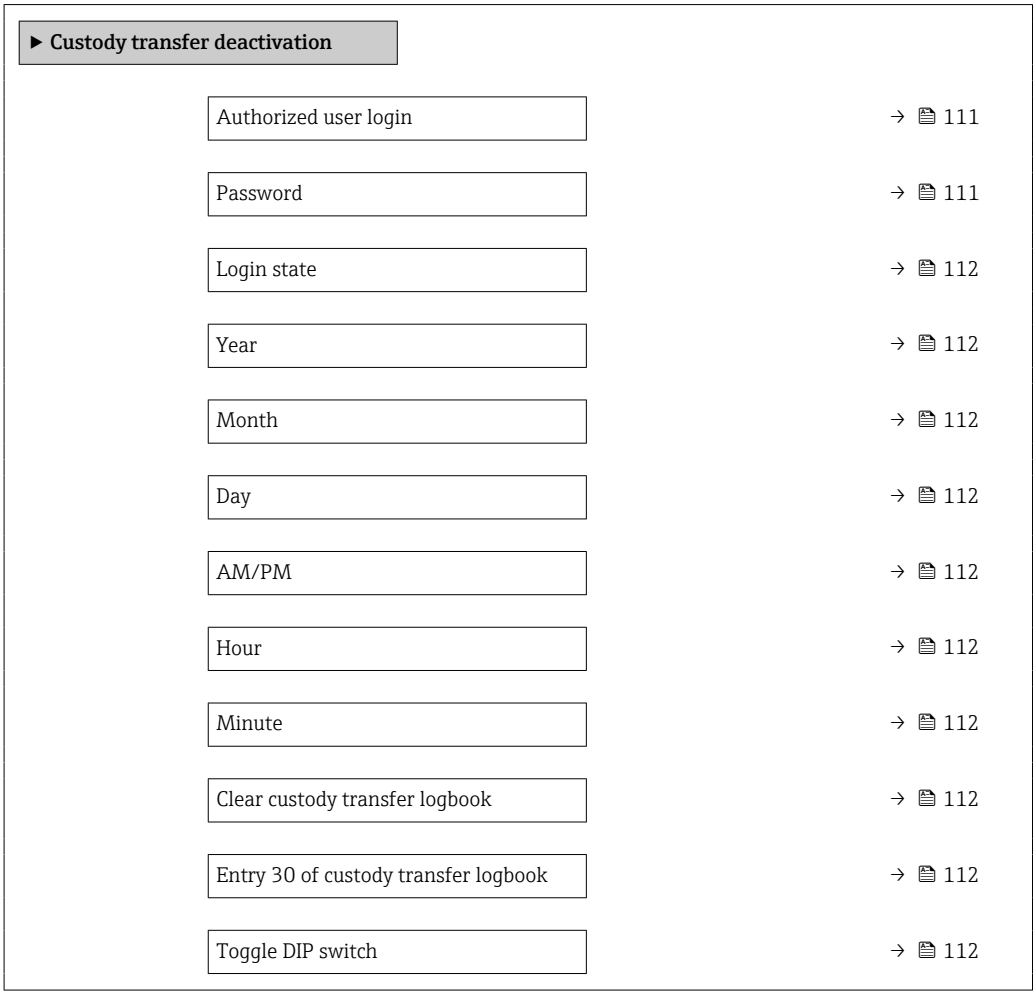
Parameter	Description	User entry / User interface / Selection	Factory setting
Authorized user login	Enter a specified authorized user login.	Authorized user login	EH000
Password	Enter a specified password.	0 to 999 999	177 801
Login state	Display login status.	▪ Logged in ▪ Logged out	Logged out
Display test	Start or cancel display test.	▪ Cancel ▪ Start	Cancel
Year	Enter the year.	9 to 99	10
Month	Enter the month.	▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December	January
Day	Enter the day.	1 to 31 d	1 d
AM/PM	Select AM/PM.	▪ AM ▪ PM	AM
Hour	Enter the hour.	0 to 23 h	12 h
Minute	Enter the minutes.	0 to 59 min	0 min
Clear custody transfer logbook	Delete custody transfer logbook selection.	▪ Cancel ▪ Clear data	Cancel

Parameter	Description	User entry / User interface / Selection	Factory setting
Entry 30 of custody transfer logbook	Display the recorded logbook entries.	0...30	0
Checksum	Shows the checksum of the entire firmware.	Positive integer	–
Toggle DIP switch	Display the DIP switch status.	▪ Off ▪ On	Off

10.5.5 Parameter description - deactivating Custody transfer

An **authorized user login** is available: EH000 with password 177801. This **authorized user login** is the non-personalized factory login and enables the activation and deactivation of the custody transfer mode. Settings made using this login must be documented and personalized by the system operator. In addition, the responsible calibration authority must be informed of these changes.

Navigation
"Setup" menu → Advanced setup → Custody transfer deactivation



Parameter overview with brief description

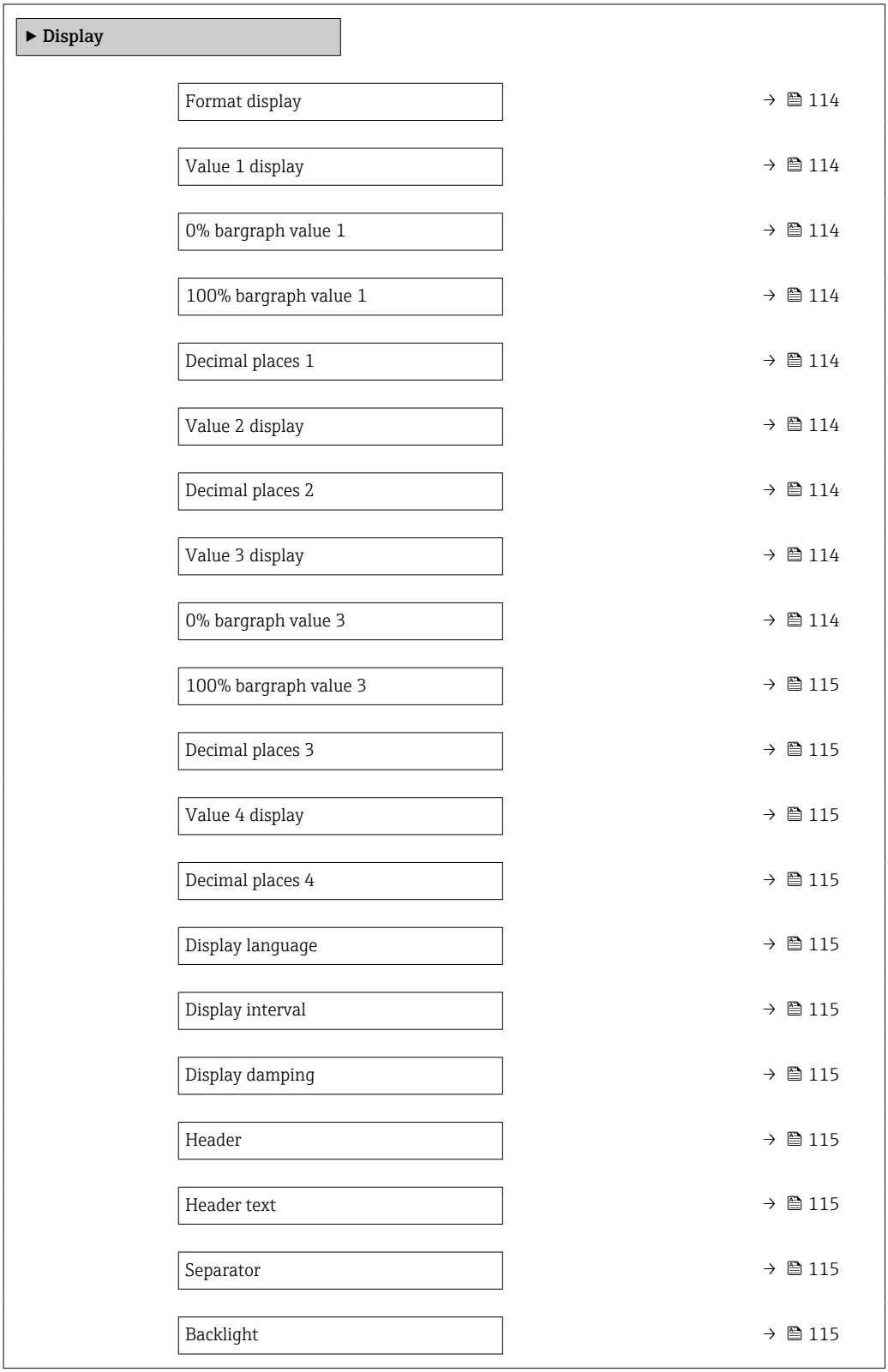
Parameter	Description	User entry / User interface / Selection	Factory setting
Authorized user login	Enter a specified authorized user login.	Authorized user login	EH000
Password	Enter a specified password.	0 to 999 999	177 801

Parameter	Description	User entry / User interface / Selection	Factory setting
Login state	Display login status.	▪ Logged in ▪ Logged out	Logged out
Year	Enter the year.	9 to 99	10
Month	Enter the month.	▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December	January
Day	Enter the day.	1 to 31 d	1 d
AM/PM	Select AM/PM.	▪ AM ▪ PM	AM
Hour	Enter the hour.	0 to 23 h	12 h
Minute	Enter the minutes.	0 to 59 min	0 min
Clear custody transfer logbook	Delete custody transfer logbook selection.	▪ Cancel ▪ Clear data	Cancel
Entry 30 of custody transfer logbook	Display the recorded logbook entries.	0…30	0
Toggle DIP switch	Display the DIP switch status.	▪ Off ▪ On	Off

10.5.6 Carrying out additional display configurations

In the **Display** submenu you can set all the parameters associated with the configuration of the local display.

Navigation
"Setup" menu → Advanced setup → Display



Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Format display	A local display is provided.	Select how measured values are shown on the display.	▪ 1 value, max. size ▪ 1 bargraph + 1 value ▪ 2 values ▪ 1 value large + 2 values ▪ 4 values	1 value, max. size
Value 1 display	A local display is provided.	Select the measured value that is shown on the local display.	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Electronic temperature ▪ Totalizer 1 ▪ Totalizer 2 ▪ Totalizer 3 ▪ Current output 1 ▪ Noise * ▪ Coil current shot time * ▪ Reference electrode potential against PE * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Volume flow
0% bargraph value 1	A local display is provided.	Enter 0% value for bar graph display.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)
100% bargraph value 1	A local display is provided.	Enter 100% value for bar graph display.	Signed floating-point number	Depends on country and nominal diameter
Decimal places 1	A measured value is defined in the **Value 1 display** parameter.	Select the number of decimal places for the display value.	▪ x ▪ x.x ▪ x.xx ▪ x.xxx ▪ x.xxxx	x.xx
Value 2 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None
Decimal places 2	A measured value is specified in the **Value 2 display** parameter.	Select the number of decimal places for the display value.	▪ x ▪ x.x ▪ x.xx ▪ x.xxx ▪ x.xxxx	x.xx
Value 3 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None
0% bargraph value 3	A selection was made in the **Value 3 display** parameter.	Enter 0% value for bar graph display.	Signed floating-point number	Country-specific: ▪ 0 l/h ▪ 0 gal/min (us)

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
100% bargraph value 3	A selection was made in the **Value 3 display** parameter.	Enter 100% value for bar graph display.	Signed floating-point number	0
Decimal places 3	A measured value is specified in the **Value 3 display** parameter.	Select the number of decimal places for the display value.	▪ x ▪ x.x ▪ x.xx ▪ x.xxx ▪ x.xxxx	x.xx
Value 4 display	A local display is provided.	Select the measured value that is shown on the local display.	For the picklist, see the **Value 2 display** parameter (→ 🖹 102)	None
Decimal places 4	A measured value is specified in the **Value 4 display** parameter.	Select the number of decimal places for the display value.	▪ x ▪ x.x ▪ x.xx ▪ x.xxx ▪ x.xxxx	x.xx
Display language	A local display is provided.	Set display language.	▪ English ▪ Deutsch ▪ Français ▪ Español ▪ Italiano ▪ Nederlands ▪ Portuguesa ▪ Polski ▪ русский язык (Russian) ▪ Svenska ▪ Türkçe ▪ 中文 (Chinese) ▪ 日本語 (Japanese) ▪ 한국어 (Korean) ▪ العَرَبِيَة (Arabic) * ▪ Bahasa Indonesia ▪ ภาษาไทย (Thai) * ▪ tiếng Việt (Vietnamese) ▪ čeština (Czech)	English (alternatively, the ordered language is preset in the device)
Display interval	A local display is provided.	Set time measured values are shown on display if display alternates between values.	1 to 10 s	5 s
Display damping	A local display is provided.	Set display reaction time to fluctuations in the measured value.	0.0 to 999.9 s	0.0 s
Header	A local display is provided.	Select header contents on local display.	▪ Device tag ▪ Free text	Device tag
Header text	In the **Header** parameter, the **Free text** option is selected.	Enter display header text.	Max. 12 characters such as letters, numbers or special characters (e.g. @, %, /)	----------
Separator	A local display is provided.	Select decimal separator for displaying numerical values.	▪ . (point) ▪ , (comma)	. (point)
Backlight	A local display is provided.	Switch the local display backlight on and off.	▪ Disable ▪ Enable	Enable

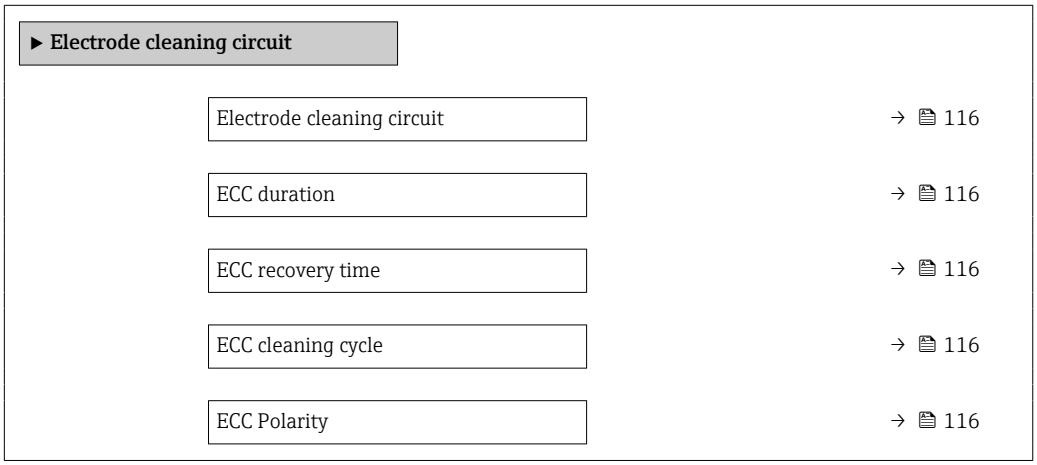
* Visibility depends on order options or device settings

10.5.7 Performing electrode cleaning

The **Electrode cleaning circuit** wizard guides the user systematically through all the parameters that have to be set for configuring electrode cleaning.

The wizard only appears if the device was ordered with an electrode cleaning circuit.

Navigation
"Setup" menu → Advanced setup → Electrode cleaning cycle



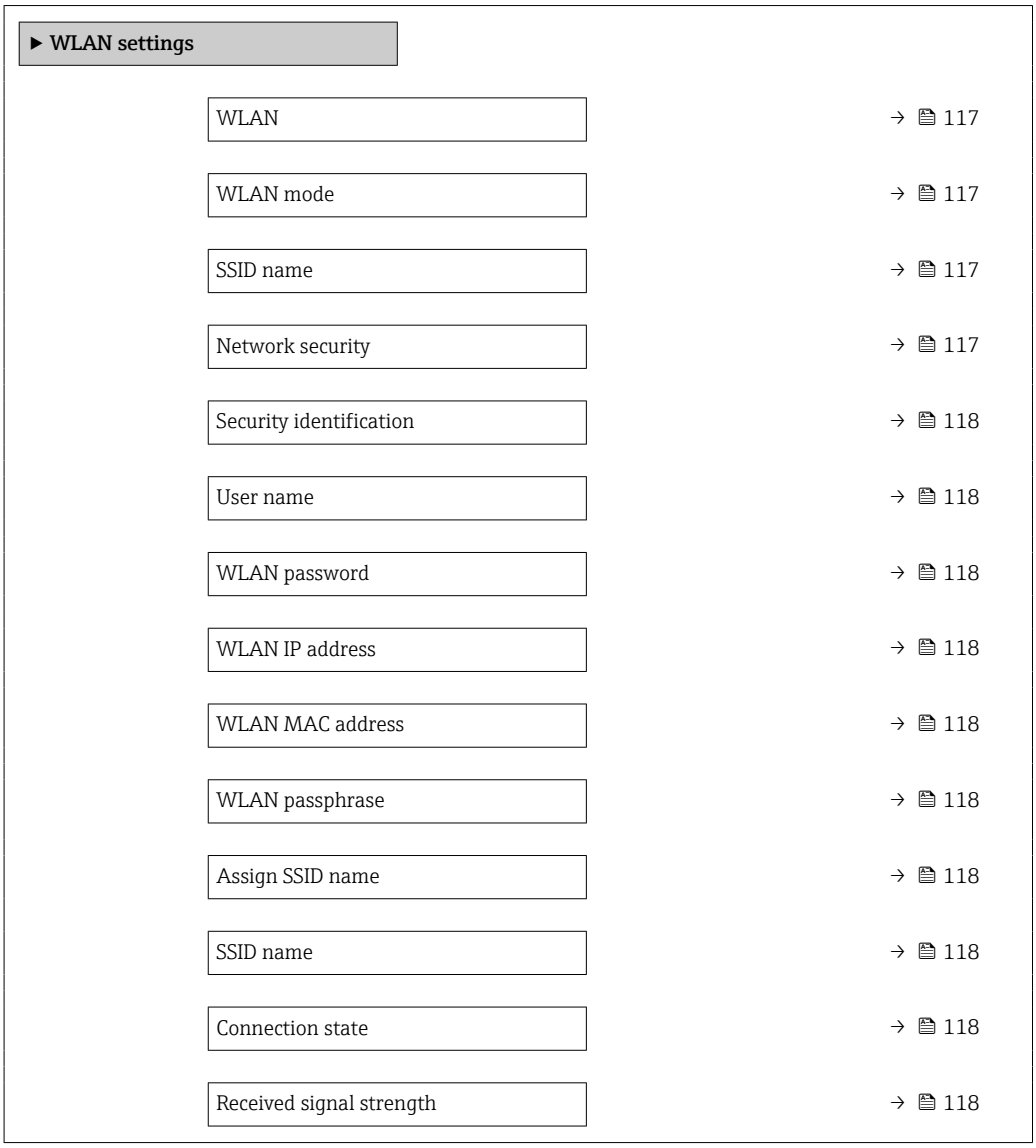
Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Electrode cleaning circuit	For the following order code: "Application package", option **EC** "ECC electrode cleaning"	Enable the cyclic electrode cleaning circuit.	▪ Off ▪ On	Off
ECC duration	For the following order code: "Application package", option **EC** "ECC electrode cleaning"	Enter the duration of electrode cleaning in seconds.	0.01 to 30 s	2 s
ECC recovery time	For the following order code: "Application package", option **EC** "ECC electrode cleaning"	Define recovery time after electrode cleaning. During this time the current output values will be held at last valid value.	1 to 600 s	5 s
ECC cleaning cycle	For the following order code: "Application package", option **EC** "ECC electrode cleaning"	Enter the pause duration between electrode cleaning cycles.	0.5 to 168 h	0.7 h
ECC Polarity	For the following order code: "Application package", option **EC** "ECC electrode cleaning"	Select the polarity of the electrode cleaning circuit.	▪ Positive ▪ Negative	Depends on the electrode material: ▪ Tantalum: **Negative** option ▪ Platinum, Alloy C22, stainless steel: **Positive** option

10.5.8 WLAN configuration

The **WLAN Settings** submenu guides the user systematically through all the parameters that have to be set for the WLAN configuration.

Navigation
"Setup" menu → Advanced setup → WLAN settings



Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
WLAN	–	Switch WLAN on and off.	▪ Disable ▪ Enable	Enable
WLAN mode	–	Select WLAN mode.	WLAN access point	WLAN access point
SSID name	The client is activated.	Enter the user-defined SSID name (max. 32 characters).	–	–
Network security	–	Select the security type of the WLAN network.	▪ Unsecured ▪ WPA2-PSK ▪ EAP-PEAP with MSCHAPv2 * ▪ EAP-PEAP MSCHAPv2 no server authentic. * ▪ EAP-TLS *	WPA2-PSK

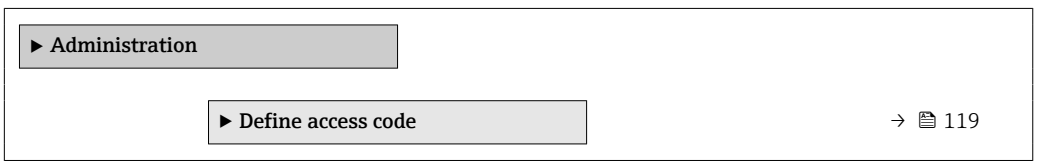
Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Security identification	–	Select security settings and download these settings via menu Data management > Security > WLAN.	▪ Trusted issuer certificate ▪ Device certificate ▪ Device private key	–
User name	–	Enter user name.	–	–
WLAN password	–	Enter WLAN password.	–	–
WLAN IP address	–	Enter IP address of the WLAN interface of the device.	4 octet: 0 to 255 (in the particular octet)	192.168.1.212
WLAN MAC address	–	Enter MAC address of the WLAN interface of the device.	Unique 12-digit character string comprising letters and numbers	Each measuring device is given an individual address.
WLAN passphrase	The **WPA2-PSK** option is selected in the **Security type** parameter.	Enter the network key (8 to 32 characters). The network key supplied with the device should be changed during commissioning for security reasons.	8 to 32-digit character string comprising numbers, letters and special characters (without spaces)	Serial number of the measuring device (e.g. L100A802000)
Assign SSID name	–	Select which name will be used for SSID: device tag or user-defined name.	▪ Device tag ▪ User-defined	User-defined
SSID name	▪ The **User-defined** option is selected in the **Assign SSID name** parameter. ▪ The **WLAN access point** option is selected in the **WLAN mode** parameter.	Enter the user-defined SSID name (max. 32 characters). The user-defined SSID name may only be assigned once. If the SSID name is assigned more than once, the devices can interfere with one another.	Max. 32-digit character string comprising numbers, letters and special characters	
Connection state	–	Displays the connection status.	▪ Connected ▪ Not connected	Not connected
Received signal strength	–	Shows the received signal strength.	▪ Low ▪ Medium ▪ High	High

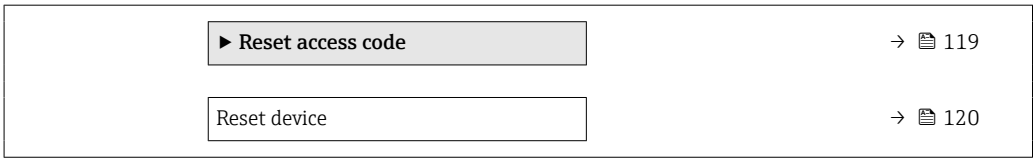
* Visibility depends on order options or device settings

10.5.9 Using parameters for device administration

The **Administration** submenu systematically guides the user through all the parameters that can be used for device administration purposes.

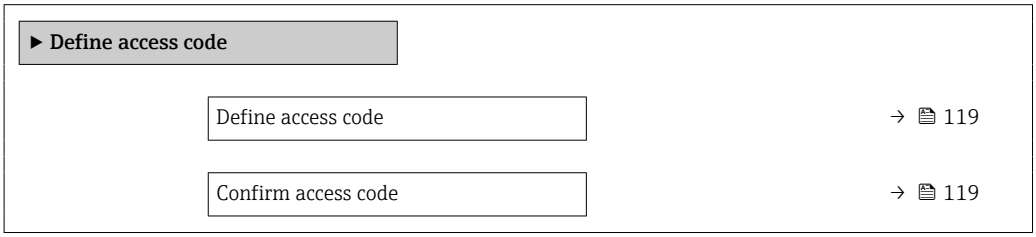
Navigation
"Setup" menu → Advanced setup → Administration





Using the parameter to define the access code

Navigation
"Setup" menu → Advanced setup → Administration → Define access code

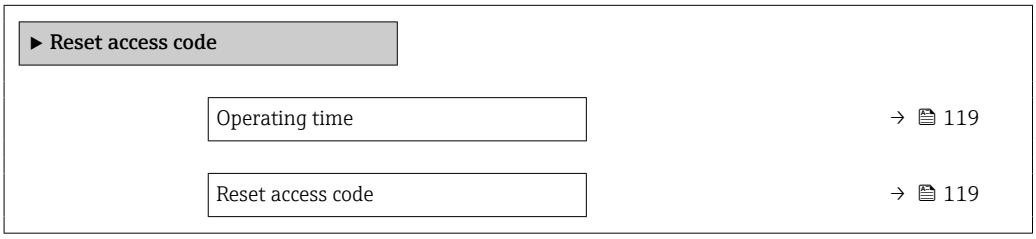


Parameter overview with brief description

Parameter	Description	User entry
Define access code	Restrict write-access to parameters to protect the configuration of the device against unintentional changes.	Max. 16-digit character string comprising numbers, letters and special characters
Confirm access code	Confirm the entered access code.	Max. 16-digit character string comprising numbers, letters and special characters

Using the parameter to reset the access code

Navigation
"Setup" menu → Advanced setup → Administration → Reset access code



Parameter overview with brief description

Parameter	Description	User interface / User entry	Factory setting
Operating time	Indicates how long the device has been in operation.	Days (d), hours (h), minutes (m) and seconds (s)	–
Reset access code	Reset access code to factory settings. For a reset code, contact your Endress+Hauser service organization. The reset code can only be entered via: ▪ Web browser ▪ DeviceCare, FieldCare (via CDI-RJ45 service interface) ▪ Fieldbus	Character string comprising numbers, letters and special characters	0x00

Using the parameter to reset the device

Navigation
"Setup" menu → Advanced setup → Administration

Parameter overview with brief description

Parameter	Description	Selection	Factory setting
Reset device	Reset the device configuration - either entirely or in part - to a defined state.	▪ Cancel ▪ To delivery settings ▪ Restart device ▪ Restore S-DAT backup *	Cancel

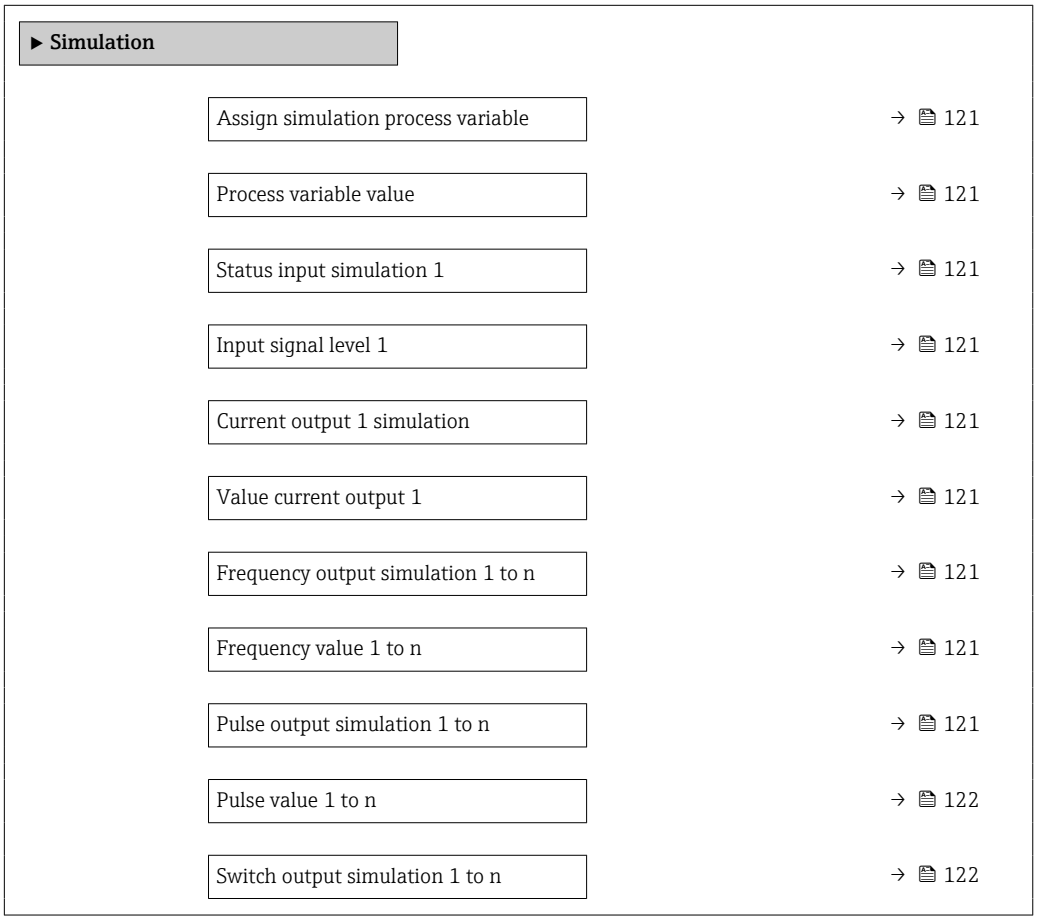
* Visibility depends on order options or device settings

10.6 Simulation

The **Simulation** submenu enables you to simulate, without a real flow situation, various process variables in the process and the device alarm mode and to verify downstream signal chains (switching valves or closed-control loops).

The parameters displayed depend on:
- The selected device order
- The set operating mode of the pulse/frequency/switch outputs

Navigation
"Diagnostics" menu → Simulation



Switch status 1 to n	→ 122
Device alarm simulation	→ 122
Diagnostic event category	→ 122
Diagnostic event simulation	→ 122

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Assign simulation process variable	–	Select a process variable for the simulation process that is activated.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature *	Off
Process variable value	A process variable is selected in the **Assign simulation process variable** parameter (→ 121).	Enter the simulation value for the selected process variable.	Depends on the process variable selected	0
Status input simulation 1	For the following order code: ▪ "Output; input", option I "4-20mA HART, 2x pul./ freq./switch output; status input" ▪ "Output; input", option J "4-20mA HART, certified pulse output, switch output; status input"	Switch simulation of the status input on and off.	▪ Off ▪ On	Off
Input signal level 1	In the **Status input simulation** parameter, the **On** option is selected.	Select the signal level for the simulation of the status input.	▪ High ▪ Low	High
Current output 1 simulation	–	Switch the simulation of the current output on and off.	▪ Off ▪ On	Off
Value current output 1	In the **Current output simulation** parameter, the **On** option is selected.	Enter the current value for simulation.	3.59 to 22.5 mA	3.59 mA
Frequency output simulation 1 to n	In the **Operating mode** parameter, the **Frequency** option is selected.	Switch the simulation of the frequency output on and off.	▪ Off ▪ On	Off
Frequency value 1 to n	In the **Frequency output simulation 1 to n** parameter, the **On** option is selected.	Enter the frequency value for the simulation.	0.0 to 12 500.0 Hz	0.0 Hz
Pulse output simulation 1 to n	In the **Operating mode** parameter, the **Pulse** option is selected.	Set and switch off the pulse output simulation. For **Fixed value** option: **Pulse width** parameter (→ 97) defines the pulse width of the pulses output.	▪ Off ▪ Fixed value ▪ Down-counting value	Off

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Pulse value 1 to n	In the **Pulse output simulation 1 to n** parameter, the **Down-counting value** option is selected.	Enter the number of pulses for simulation.	0 to 65 535	0
Switch output simulation 1 to n	In the **Operating mode** parameter, the **Switch** option is selected.	Switch the simulation of the switch output on and off.	▪ Off ▪ On	Off
Switch status 1 to n	–	Select the status of the status output for the simulation.	▪ Open ▪ Closed	Open
Device alarm simulation	–	Switch the device alarm on and off.	▪ Off ▪ On	Off
Diagnostic event category	–	Select a diagnostic event category.	▪ Sensor ▪ Electronics ▪ Configuration ▪ Process	Process
Diagnostic event simulation	–	Select a diagnostic event to simulate this event.	▪ Off ▪ Diagnostic event picklist (depends on the category selected)	Off

* Visibility depends on order options or device settings

10.7 Protecting settings from unauthorized access

The following options exist for protecting the configuration of the measuring device from unintentional modification after commissioning:
- Write protection via access code for the local display and Web browser
- Write protection via write protection switch
- Write protection via keypad lock

10.7.1 Write protection via access code

The effects of the user-specific access code are as follows:
- Via local operation, the parameters for the measuring device configuration are write-protected and their values can no longer be changed.
- Device access is protected via the Web browser, as are the parameters for the measuring device configuration.

Defining the access code via local display

1. Navigate to the **Define access code** parameter (→ 119).
2. Define a max. 16-digit character string comprising numbers, letters and special characters as the access code.
3. Enter the access code again in the to confirm the code.
   ↳ The -symbol appears in front of all write-protected parameters.

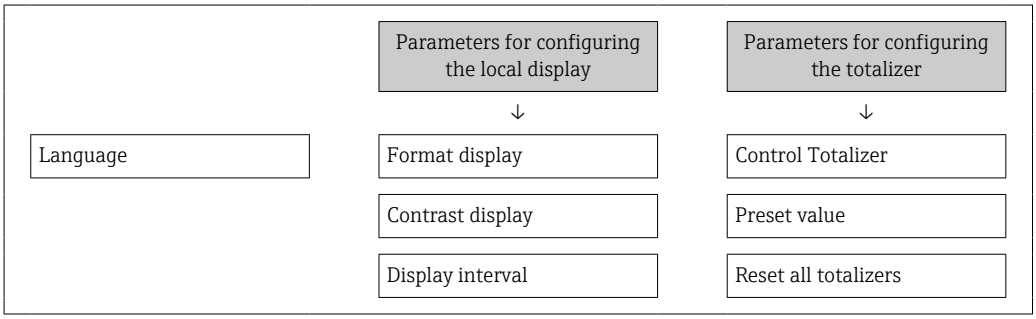
The device automatically locks the write-protected parameters again if a key is not pressed for 10 minutes in the navigation and editing view. The device locks the write-protected

parameters automatically after 60 s if the user skips back to the operational display mode from the navigation and editing view.

- If parameter write protection is activated via an access code, it can also only be deactivated via this access code → 72.
- The user role with which the user is currently logged on via the local display → 72 is indicated by the **Access status display** parameter. Navigation path: Operation → Access status display

Parameters which can always be modified via the local display

Certain parameters that do not affect the measurement are excepted from parameter write protection via the local display. Despite the user-specific access code, they can always be modified, even if the other parameters are locked.



Defining the access code via the Web browser

1. Navigate to the **Define access code** parameter (→ 119).
2. Define a max. 16-digit numeric code as an access code.
3. Enter the access code again in the to confirm the code.
   ↳ The Web browser switches to the login page.

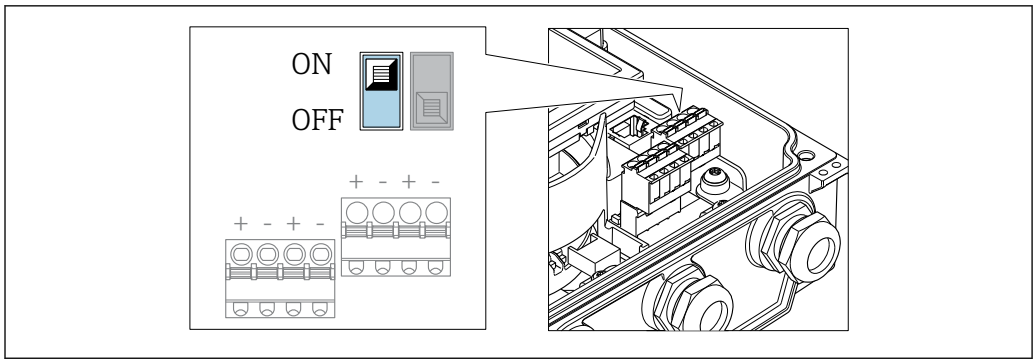
If no action is performed for 10 minutes, the Web browser automatically returns to the login page.

- If parameter write protection is activated via an access code, it can also only be deactivated via this access code → 72.
- The user role with which the user is currently logged on via Web browser is indicated by the **Access status tooling** parameter. Navigation path: Operation → Access status tooling

10.7.2 Write protection via write protection switch

Unlike parameter write protection via a user-specific access code, this allows the user to lock write access to the entire operating menu - apart from the **"Contrast display" parameter**.

The parameter values are now read only and cannot be edited any more (exception **"Contrast display" parameter**):
- Via local display
- Via service interface (CDI-RJ45)
- Via HART protocol



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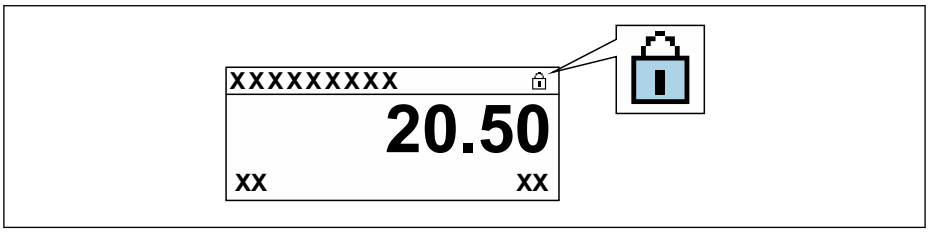
1. Loosen the 4 fixing screws on the housing cover and open the housing cover.
2. Setting the write protection switch (WP) on the main electronics module to the **ON** position enables the hardware write protection. Setting the write protection switch (WP) on the main electronics module to the **OFF** position (factory setting) disables the hardware write protection.
   ↳ If the hardware write protection is enabled: The **Hardware locked** option is displayed in the **Locking status** parameter . In addition, on the local display the 🔒 symbol appears in front of the parameters in the header of the operational display and in the navigation view.



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   If hardware write protection is disabled: No option is displayed in the **Locking status** parameter . On the local display, the 🔒 symbol disappears from in front of the parameters in the header of the operational display and in the navigation view.
3. **⚠ WARNING**

   Excessive tightening torque applied to the fixing screws!
   Risk of damaging the plastic transmitter.
   ► Tighten the fixing screws as per the tightening torque .

   Reverse the removal procedure to reassemble the transmitter.

11 Operation

11.1 Reading the device locking status

Device active write protection: **Locking status** parameter

Operation → Locking status

Function scope of the "Locking status" parameter

Options	Description
None	The access status displayed in the **Access status display** parameter applies → 72. Only appears on local display.
Hardware locked	The DIP switch for hardware locking is activated on the main electronics module. This locks write access to the parameters (e.g. via local display or operating tool) → 123.
CT active - defined parameters	Only available for Promag W. The DIP switch for custody transfer mode is activated on the I/O module. This locks write access to defined parameters (e.g. via local display or operating tool). For detailed information on custody transfer mode, see the Special Documentation for the device
CT active - all parameters	Only available for Promag W. The DIP switch for custody transfer mode is activated on the I/O module. This locks write access to all the parameters (e.g. via local display or operating tool). For detailed information on custody transfer mode, see the Special Documentation for the device
Temporarily locked	Write access to the parameters is temporarily locked on account of internal processes running in the device (e.g. data upload/download, reset etc.). Once the internal processing has been completed, the parameters can be changed once again.

11.2 Adjusting the operating language

Detailed information:
- To configure the operating language → 89
- For information on the operating languages supported by the measuring device → 186

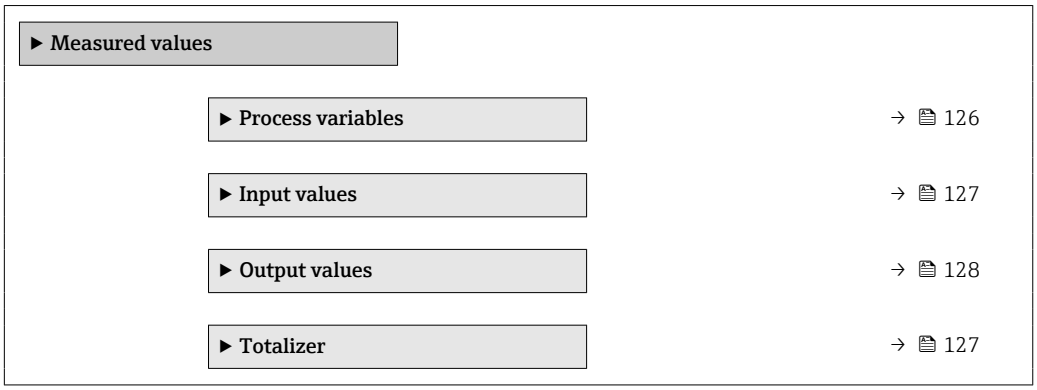
11.3 Configuring the display

Detailed information:
- On the basic settings for the local display → 101
- On the advanced settings for the local display → 113

11.4 Reading measured values

With the **Measured values** submenu, it is possible to read all the measured values.

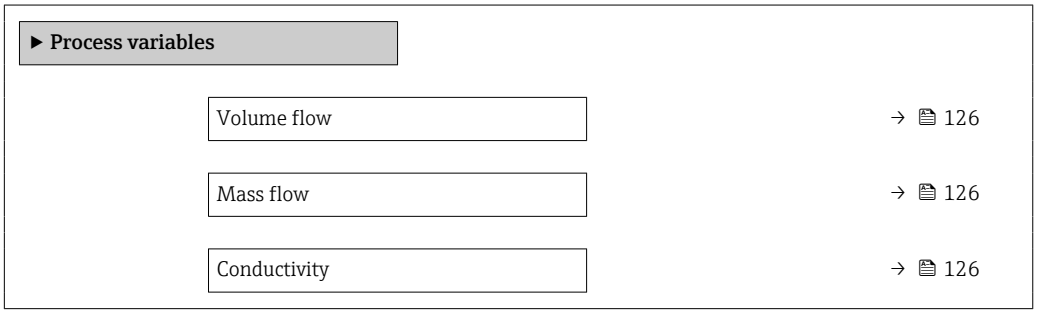
Navigation
"Diagnostics" menu → Measured values → Output values



11.4.1 Process variables

The **Process variables** submenu contains all the parameters needed to display the current measured values for each process variable.

Navigation
"Diagnostics" menu → Measured values → Process variables



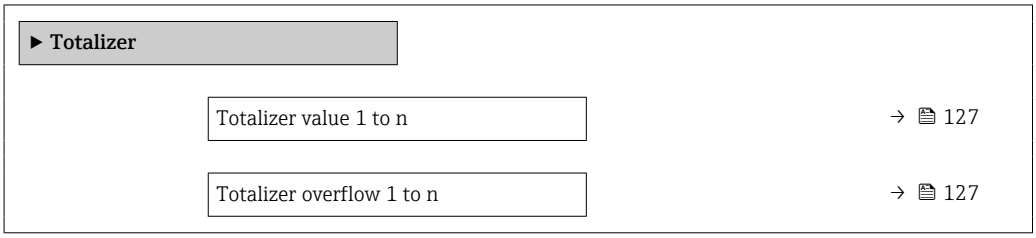
Parameter overview with brief description

Parameter	Prerequisite	Description	User interface
Volume flow	–	Displays the volume flow that is currently measured. *Dependency* The unit is taken from the **Volume flow unit** parameter (→ 92).	Signed floating-point number
Mass flow	–	Displays the mass flow that is currently calculated. *Dependency* The unit is taken from the **Mass flow unit** parameter (→ 92).	Signed floating-point number
Conductivity	The **On** option is selected in the **Conductivity measurement** parameter.	Displays the conductivity that is currently measured. *Dependency* The unit is taken from the **Conductivity unit** parameter (→ 92).	Signed floating-point number

11.4.2 "Totalizer" submenu

The **Totalizer** submenu contains all the parameters needed to display the current measured values for every totalizer.

Navigation
"Diagnostics" menu → Measured values → Totalizer



Parameter overview with brief description

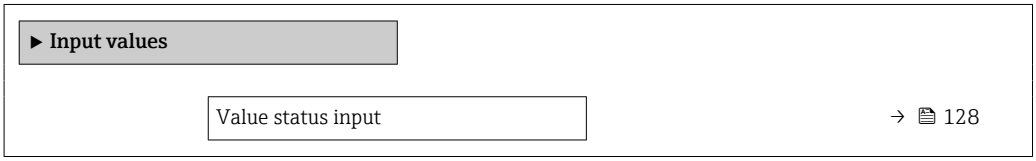
Parameter	Prerequisite	Description	User interface
Totalizer value 1 to n	One of the following options is selected in the **Assign process variable** parameter (→ 109) of the **Totalizer 1 to n** submenu: ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Displays the current totalizer counter reading.	Signed floating-point number
Totalizer overflow 1 to n	One of the following options is selected in the **Assign process variable** parameter (→ 109) of the **Totalizer 1 to n** submenu: ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow	Displays the current totalizer overflow.	Integer with sign

11.4.3 Input values

The **Input values** submenu guides you systematically to the individual input values.

The submenu appears only if the device was ordered with a status input → 43.

Navigation
"Diagnostics" menu → Measured values → Input values



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface
Value status input	For the following order code: ▪ "Output; input", option **I** "4-20mA HART, 2x pul./freq./switch output; status input" ▪ "Output; input", option **J** "4-20mA HART, certified pulse output, switch output; status input"	Shows the current input signal level.	▪ High ▪ Low

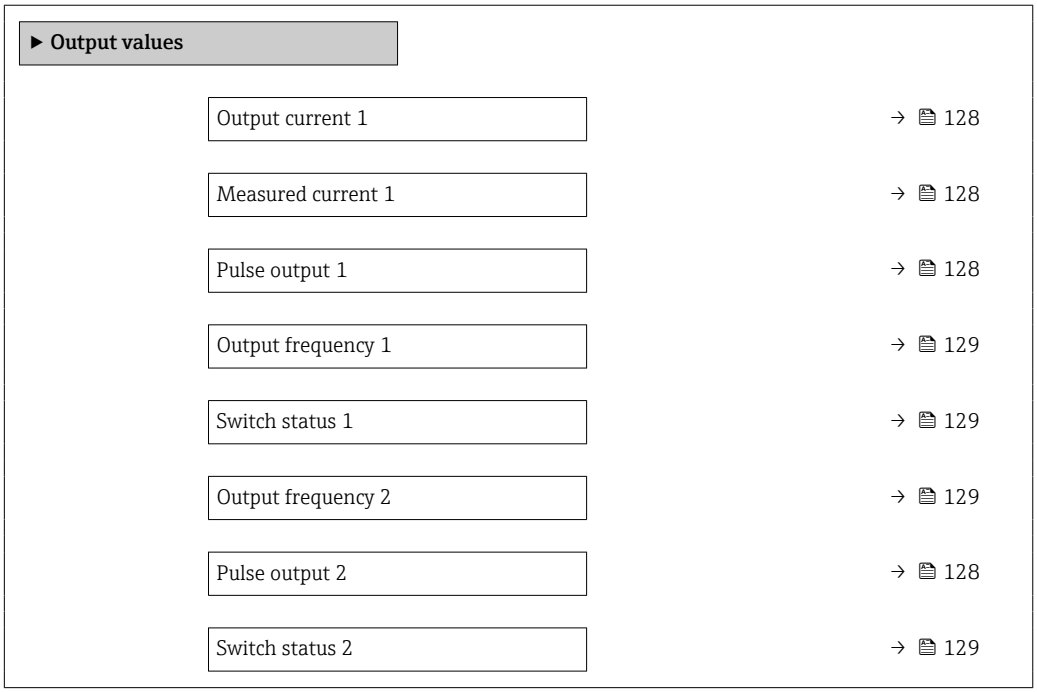
11.4.4 Output values

The **Output values** submenu contains all the parameters needed to display the current measured values for every output.

The parameters displayed depend on:
- The selected device order
- The set operating mode of the pulse/frequency/switch outputs

Navigation

"Diagnostics" menu → Measured values → Output values



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface
Output current	–	Displays the current value currently calculated for the current output.	3.59 to 22.5 mA
Measured current	–	Displays the current value currently measured for the current output.	0 to 30 mA
Pulse output 1 to n	The **Pulse** option is selected in the **Operating mode** parameter parameter.	Displays the pulse frequency currently output.	Positive floating-point number

Parameter	Prerequisite	Description	User interface
Output frequency 1 to n	In the **Operating mode** parameter, the **Frequency** option is selected.	Displays the value currently measured for the frequency output.	0.0 to 12 500.0 Hz
Switch status 1 to n	In the **Operating mode** parameter, the **Switch** option is selected.	Displays the current switch output status.	▪ Open ▪ Closed

11.5 Adapting the measuring device to the process conditions

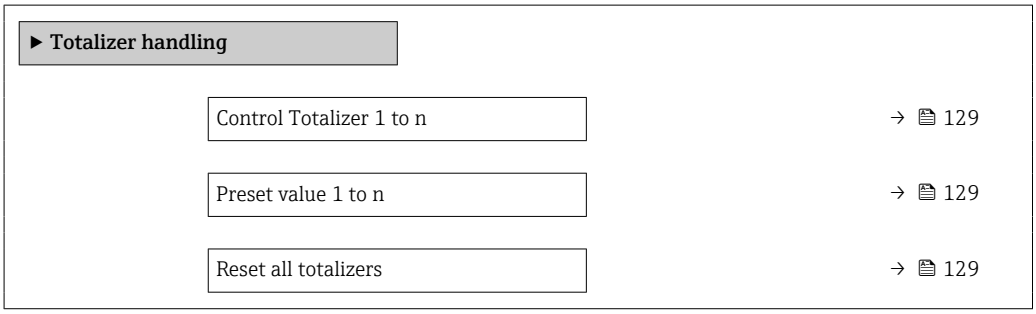
The following are available for this purpose:
- Basic settings using the**Setup** menu (→ 🖹 89)
- Advanced settings using the**Advanced setup** submenu (→ 🖹 107)

11.6 Performing a totalizer reset

The totalizers are reset in the **Operation** submenu:
- Control Totalizer
- Reset all totalizers

Navigation

"Operation" menu → Totalizer handling



Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
Control Totalizer 1 to n	A process variable is selected in the **Assign process variable** parameter (→ 🖹 109) of the **Totalizer 1 to n** submenu.	Control totalizer value.	▪ Totalize ▪ Reset + hold ▪ Preset + hold ▪ Reset + totalize ▪ Preset + totalize ▪ Hold	Totalize
Preset value 1 to n	A process variable is selected in the **Assign process variable** parameter (→ 🖹 109) of the **Totalizer 1 to n** submenu.	Specify start value for totalizer. *Dependency* The unit of the selected process variable is specified for the totalizer in the **Unit totalizer** parameter (→ 🖹 109).	Signed floating-point number	0 l
Reset all totalizers	–	Reset all totalizers to 0 and start.	▪ Cancel ▪ Reset + totalize	Cancel

11.6.1 Function scope of the "Control Totalizer" parameter

Options	Description
Totalize	The totalizer is started or continues running.
Reset + hold	The totaling process is stopped and the totalizer is reset to 0.
Preset + hold	The totaling process is stopped and the totalizer is set to its defined start value from the **Preset value** parameter.
Reset + totalize	The totalizer is reset to 0 and the totaling process is restarted.
Preset + totalize	The totalizer is set to the defined start value from the **Preset value** parameter and the totaling process is restarted.

11.6.2 Function scope of the "Reset all totalizers" parameter

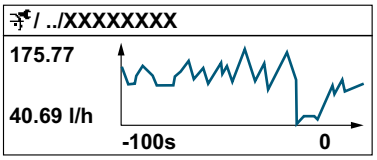
Options	Description
Cancel	No action is executed and the user exits the parameter.
Reset + totalize	Resets all totalizers to 0 and restarts the totaling process. This deletes all the flow values previously totalized.

11.7 Showing data logging

The **Extended HistoROM** application package must be enabled in the device (order option) for the **Data logging** submenu to appear. This contains all the parameters for the measured value history.

Data logging is also available via:
- Plant Asset Management Tool FieldCare → 82.
- Web browser

Function scope
- A total of 1000 measured values can be stored
- 4 logging channels
- Adjustable logging interval for data logging
- Display of the measured value trend for each logging channel in the form of a chart



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- x-axis: depending on the number of channels selected displays 250 to 1000 measured values of a process variable.
- y-axis: displays the approximate measured value span and constantly adapts this to the ongoing measurement.

If the length of the logging interval or the assignment of the process variables to the channels is changed, the content of the data logging is deleted.

Navigation
"Diagnostics" menu → Data logging

▶ **Data logging**

Assign channel 1	→ 132
Assign channel 2	→ 132
Assign channel 3	→ 132
Assign channel 4	→ 132
Logging interval	→ 132
Clear logging data	→ 132
Data logging	→ 132
Logging delay	→ 133
Data logging control	→ 133
Data logging status	→ 133
Entire logging duration	→ 133
▶ **Display channel 1**	
▶ **Display channel 2**	
▶ **Display channel 3**	
▶ **Display channel 4**	

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Assign channel 1	The **Extended HistoROM** application package is available.	Assign process variable to logging channel.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity * ▪ Corrected conductivity * ▪ Temperature * ▪ Electronic temperature ▪ Current output 1 ▪ Noise * ▪ Coil current shot time * ▪ Reference electrode potential against PE * ▪ Build-up measured value * ▪ Test point 1 ▪ Test point 2 ▪ Test point 3	Off
Assign channel 2	The **Extended HistoROM** application package is available. The software options currently enabled are displayed in the **Software option overview** parameter.	Assign process variable to logging channel.	For the picklist, see the **Assign channel 1** parameter (→ 132)	Off
Assign channel 3	The **Extended HistoROM** application package is available. The software options currently enabled are displayed in the **Software option overview** parameter.	Assign process variable to logging channel.	For the picklist, see the **Assign channel 1** parameter (→ 132)	Off
Assign channel 4	The **Extended HistoROM** application package is available. The software options currently enabled are displayed in the **Software option overview** parameter.	Assign process variable to logging channel.	For the picklist, see the **Assign channel 1** parameter (→ 132)	Off
Logging interval	The **Extended HistoROM** application package is available.	Define the logging interval for data logging. This value defines the time interval between the individual data points in the memory.	0.1 to 3 600.0 s	1.0 s
Clear logging data	The **Extended HistoROM** application package is available.	Clear the entire logging data.	▪ Cancel ▪ Clear data	Cancel
Data logging	–	Select the data logging method.	▪ Overwriting ▪ Not overwriting	Overwriting

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Logging delay	In the **Data logging** parameter, the **Not overwriting** option is selected.	Enter the time delay for measured value logging.	0 to 999 h	0 h
Data logging control	In the **Data logging** parameter, the **Not overwriting** option is selected.	Start and stop measured value logging.	▪ None ▪ Delete + start ▪ Stop	None
Data logging status	In the **Data logging** parameter, the **Not overwriting** option is selected.	Displays the measured value logging status.	▪ Done ▪ Delay active ▪ Active ▪ Stopped	Done
Entire logging duration	In the **Data logging** parameter, the **Not overwriting** option is selected.	Displays the total logging duration.	Positive floating-point number	0 s

* Visibility depends on order options or device settings

12 Diagnostics and troubleshooting

12.1 General troubleshooting

For local display

Error	Possible causes	Remedy
Local display dark and no output signals	Supply voltage does not match that specified on the nameplate.	Apply the correct supply voltage → 🖹 49.
Local display dark and no output signals	No contact between connecting cables and terminals.	Check the connection of the cables and correct if necessary.
Local display dark and no output signals	Terminals are not plugged into the main electronics module correctly.	Check terminals.
Local display dark and no output signals	Main electronics module is defective.	Order spare part → 🖹 155.
Local display dark and no output signals	The connector between the main electronics module and display module is not plugged in correctly.	Check the connection and correct if necessary.
Local display dark and no output signals	The connecting cable is not plugged in correctly.	1. Check the connection of the electrode cable and correct if necessary. 2. Check the connection of the coil current cable and correct if necessary.
Local display is dark, but signal output is within the valid range	Display is set too bright or too dark.	▪ Set the display brighter by simultaneously pressing ⊞ + Ⓔ. ▪ Set the display darker by simultaneously pressing ⊟ + Ⓔ.
Local display is dark, but signal output is within the valid range	Display module is defective.	Order spare part → 🖹 155.
Backlighting of local display is red	Diagnostic event with "Alarm" diagnostic behavior has occurred.	Take remedial measures → 🖹 143
Text on local display appears in a foreign language and cannot be understood.	Incorrect operating language is configured.	1. Press 2 s ⊟ + ⊞ ("home position"). 2. Press Ⓔ. 3. Set the desired language in the **Display language** parameter (→ 🖹 115).
Message on local display: "Communication Error" "Check Electronics"	Communication between the display module and the electronics is interrupted.	▪ Check the cable and the connector between the main electronics module and display module. ▪ Order spare part → 🖹 155.

For output signals

Error	Possible causes	Solution
Signal output outside the valid range	Main electronics module is defective.	Order spare part → 🖹 155.
Device shows correct value on local display, but signal output is incorrect, though in the valid range.	Configuration error	Check and correct the parameter configuration.
Device measures incorrectly.	Configuration error or device is operated outside the application.	1. Check and correct parameter configuration. 2. Observe limit values specified in the "Technical Data".

For access

Error	Possible causes	Remedial action
No write access to parameters	Hardware write protection enabled	Set the write protection switch on the main electronics module to the **OFF** position → 🖹 123.
No write access to parameters	Current user role has limited access authorization	1. Check user role → 🖹 72. 2. Enter correct customer-specific access code → 🖹 72.
No connection via HART protocol	Communication resistor missing or incorrectly installed.	Install the communication resistor (250 Ω) correctly. Observe the maximum load → 🖹 165.
No connection via HART protocol	Commubox ▪ Connected incorrectly ▪ Configured incorrectly ▪ Drivers not installed correctly ▪ USB interface on computer configured incorrectly	Observe the documentation for the Commubox. 📖 FXA195 HART: Document "Technical Information" TI00404F
No connection to Web server	Web server disabled	Using the "FieldCare" or "DeviceCare" operating tool, check whether the Web server of the measuring device is enabled, and enable it if necessary→ 🖹 79.
	Incorrect settings for the Ethernet interface of the computer	1. Check the properties of the Internet protocol (TCP/IP) → 🖹 75→ 🖹 75. 2. Check the network settings with the IT manager.
No connection to Web server	Incorrect IP address	Check the IP address: 192.168.1.212 → 🖹 75→ 🖹 75
No connection to Web server	Incorrect WLAN access data	▪ Check WLAN network status. ▪ Log on to the device again using WLAN access data. ▪ Verify that WLAN is enabled on the measuring device and operating device .
	WLAN communication disabled	–
Not connecting to Web server, FieldCare or DeviceCare	No WLAN network available	▪ Check if WLAN reception is present: LED on display module is lit blue ▪ Check if WLAN connection is enabled: LED on display module flashes blue ▪ Switch on instrument function.
Network connection not present or unstable	WLAN network is weak.	Operating device is outside of reception range: Check network status on operating device.
	Parallel WLAN and Ethernet communication	▪ Check network settings. ▪ Temporarily enable only the WLAN as an interface.
Web browser frozen and operation no longer possible	Data transfer active	Wait until data transfer or current action is finished.
	Connection lost	1. Check cable connection and power supply. 2. Refresh the Web browser and restart if necessary.
Content of Web browser incomplete or difficult to read	Not using optimum version of Web server.	1. Use the correct Web browser version → 🖹 74. 2. Clear the Web browser cache and restart the Web browser.

Error	Possible causes	Remedial action
	Unsuitable view settings.	Change the font size/display ratio of the Web browser.
No or incomplete display of contents in the Web browser	▪ JavaScript not enabled ▪ JavaScript cannot be enabled	1. Enable JavaScript. 2. Enter http://192.168.1.212/basic.html as the IP address.
Operation with FieldCare or DeviceCare via CDI-RJ45 service interface (port 8000)	Firewall of computer or network is preventing communication	Depending on the settings of the firewall used on the computer or in the network, the firewall must be adapted or disabled to allow FieldCare/DeviceCare access.
Flashing of firmware with FieldCare or DeviceCare via CDI-RJ45 service interface (via port 8000 or TFTP ports)	Firewall of computer or network is preventing communication	Depending on the settings of the firewall used on the computer or in the network, the firewall must be adapted or disabled to allow FieldCare/DeviceCare access.

12.2 Diagnostic information via light emitting diodes

12.2.1 Transmitter

Different LEDs in the transmitter provide information on the device status.

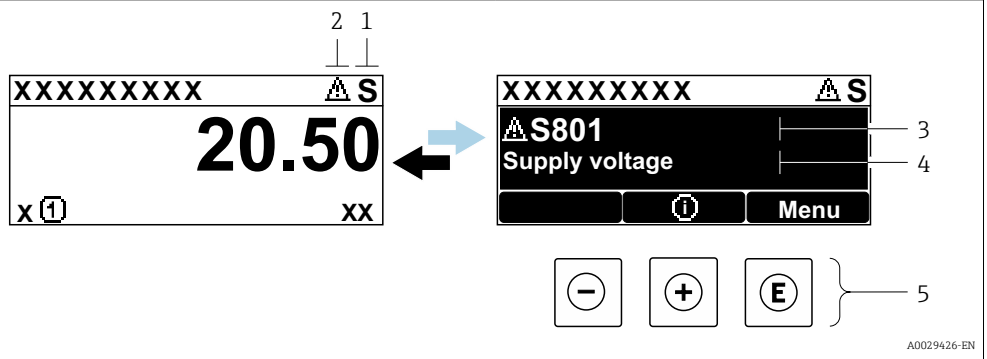
LED	Color	Meaning
Supply voltage	Off	Supply voltage is off or too low
	Green	Supply voltage is ok
Link/Activity	Orange	Link available but no activity
	Flashing orange	Activity present
Communication	Flashing white	HART communication is active.
Alarm	Green	Measuring device is ok
	Flashing green	Measuring device not configured
	Off	Firmware error
	Red	Main error
	Flashing red	Error
	Flashing red/green	Start measuring device

12.3 Diagnostic information on local display

12.3.1 Diagnostic message

Faults detected by the self-monitoring system of the measuring device are displayed as a diagnostic message in alternation with the operational display.

Operational display in alarm condition	Diagnostic message



1 *Status signal*
2 *Diagnostic behavior*
3 *Diagnostic behavior with diagnostic code*
4 *Short text*
5 *Operating elements*

If two or more diagnostic events are pending simultaneously, only the message of the diagnostic event with the highest priority is shown.

Other diagnostic events that have occurred can be displayed in the **Diagnostics** menu:
- Via parameter → 147
- Via submenus → 147

Status signals

The status signals provide information on the state and reliability of the device by categorizing the cause of the diagnostic information (diagnostic event).

The status signals are categorized according to VDI/VDE 2650 and NAMUR Recommendation NE 107: F = Failure, C = Function Check, S = Out of Specification, M = Maintenance Required

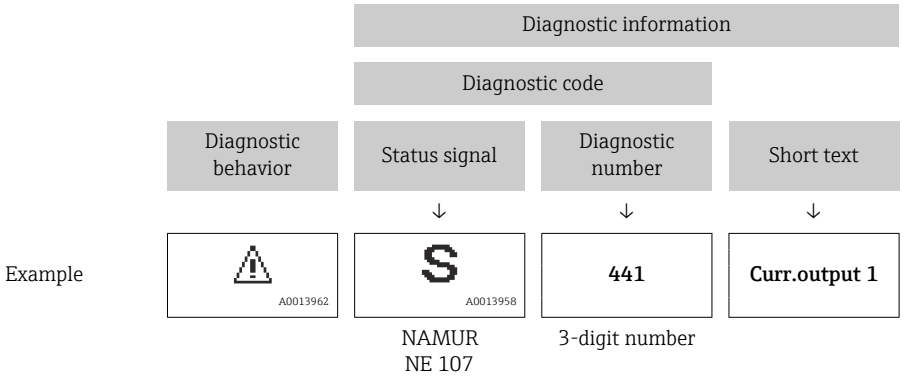
Symbol	Meaning
F	**Failure** A device error has occurred. The measured value is no longer valid.
C	**Function check** The device is in service mode (e.g. during a simulation).
S	**Out of specification** The device is operated: ▪ Outside its technical specification limits (e.g. outside the process temperature range) ▪ Outside of the configuration carried out by the user (e.g. maximum flow in parameter **20 mA value**)
M	**Maintenance required** Maintenance is required. The measured value remains valid.

Diagnostic behavior

Symbol	Meaning
	Alarm ▪ Measurement is interrupted. ▪ Signal outputs and totalizers assume the defined alarm condition. ▪ A diagnostic message is generated. ▪ The background lighting changes to red.
	Warning Measurement is resumed. The signal outputs and totalizers are not affected. A diagnostic message is generated.

Diagnostic information

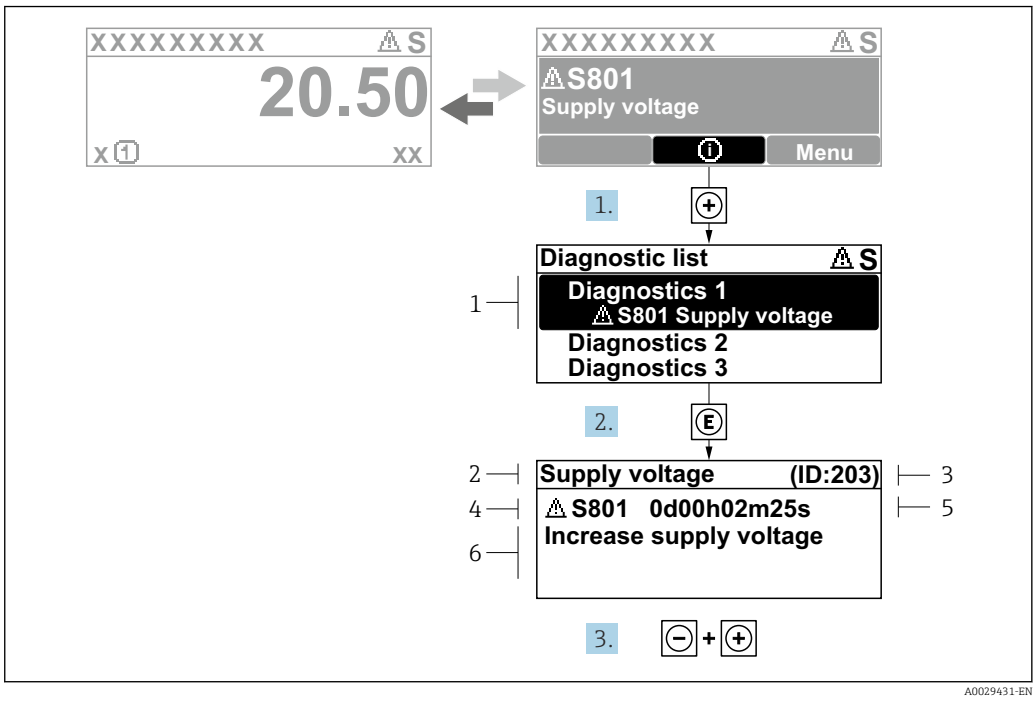
The fault can be identified using the diagnostic information. The short text helps you by providing information about the fault. In addition, the corresponding symbol for the diagnostic behavior is displayed in front of the diagnostic information on the local display.



Operating elements

Key	Meaning
	Plus key *In a menu, submenu* Opens the message about remedy information.
	Enter key *In a menu, submenu* Opens the operating menu.

12.3.2 Calling up remedial measures



24 *Message about remedial measures*

1 *Diagnostic information*
2 *Short text*
3 *Service ID*
4 *Diagnostic behavior with diagnostic code*
5 *Operation time of occurrence*
6 *Remedial measures*

1. The user is in the diagnostic message.
   Press ⊞ (ⓘ symbol).
   ↳ The **Diagnostic list** submenu opens.
2. Select the desired diagnostic event with ⊞ or ⊟ and press Ⓔ .
   ↳ The message about the remedial measures opens.
3. Press ⊟ + ⊞ simultaneously.
   ↳ The message about the remedial measures closes.

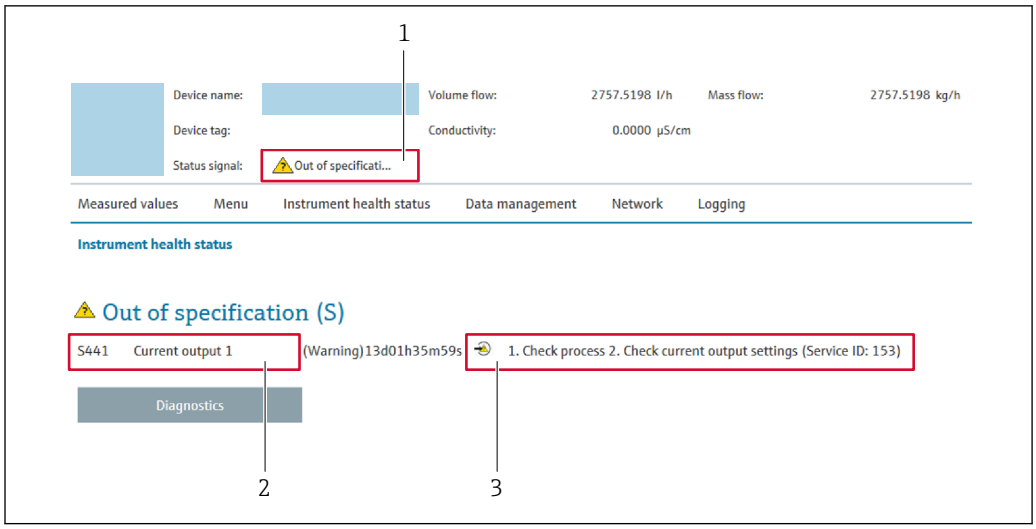
The user is in the **Diagnostics** menu at an entry for a diagnostics event, e.g. in the **Diagnostic list** submenu or **Previous diagnostics** parameter.

1. Press Ⓔ.
   ↳ The message for the remedial measures for the selected diagnostic event opens.
2. Press ⊟ + ⊞ simultaneously.
   ↳ The message for the remedial measures closes.

12.4 Diagnostic information in the Web browser

12.4.1 Diagnostic options

Any faults detected by the measuring device are displayed in the Web browser on the home page once the user has logged on.



1 *Status area with status signal*
2 *Diagnostics information → 138*
3 *Remedial measures with service ID*

In addition, diagnostic events which have occurred can be shown in the **Diagnostics** menu:
- Via parameter → 147
- Via submenu → 147

Status signals

The status signals provide information on the state and reliability of the device by categorizing the cause of the diagnostic information (diagnostic event).

Symbol	Meaning
	Failure A device error has occurred. The measured value is no longer valid.
	Function check The device is in service mode (e.g. during a simulation).
	Out of specification The device is operated: ▪ Outside its technical specification limits (e.g. outside the process temperature range) ▪ Outside of the configuration carried out by the user (e.g. maximum flow in parameter **20 mA value**)
	Maintenance required Maintenance is required. The measured value is still valid.

The status signals are categorized in accordance with VDI/VDE 2650 and NAMUR Recommendation NE 107.

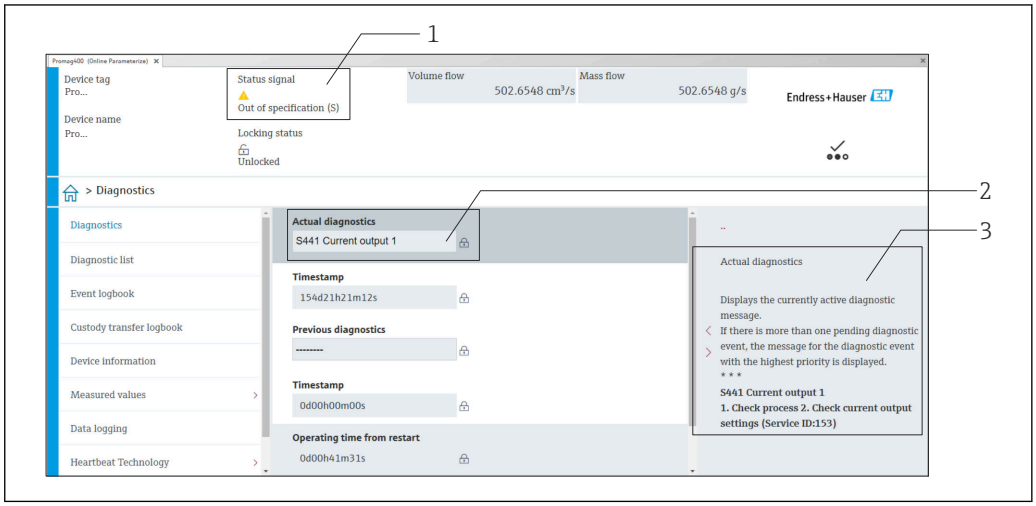
12.4.2 Calling up remedy information

Remedy information is provided for every diagnostic event to ensure that problems can be rectified quickly. These measures are displayed in red along with the diagnostic event and the related diagnostic information.

12.5 Diagnostic information in FieldCare or DeviceCare

12.5.1 Diagnostic options

Any faults detected by the measuring device are displayed on the home page of the operating tool once the connection has been established.

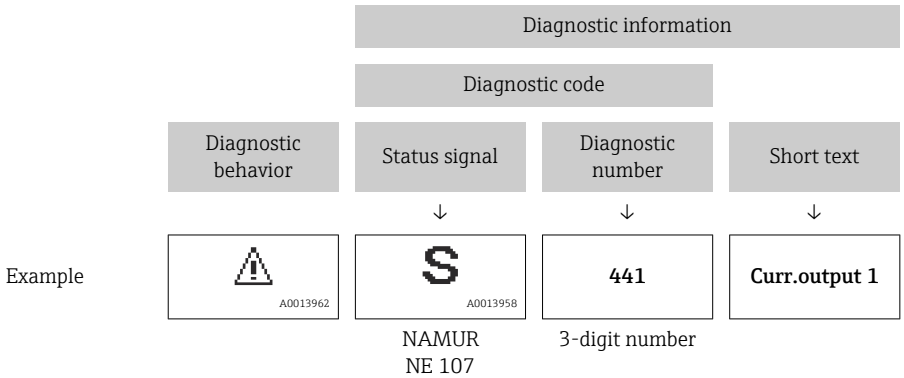


1 *Status area with status signal* → 🖹 *137*
2 *Diagnostics information* → 🖹 *138*
3 *Remedial measures with service ID*

In addition, diagnostic events which have occurred can be shown in the **Diagnostics** menu:
- Via parameter → 🖹 147
- Via submenu → 🖹 147

Diagnostic information

The fault can be identified using the diagnostic information. The short text helps you by providing information about the fault. In addition, the corresponding symbol for the diagnostic behavior is displayed in front of the diagnostic information on the local display.



12.5.2 Calling up remedy information

Remedy information is provided for every diagnostic event to ensure that problems can be rectified quickly:
- On the home page
  Remedy information is displayed in a separate field below the diagnostics information.
- In the **Diagnostics** menu
  Remedy information can be called up in the working area of the user interface.

The user is in the **Diagnostics** menu.

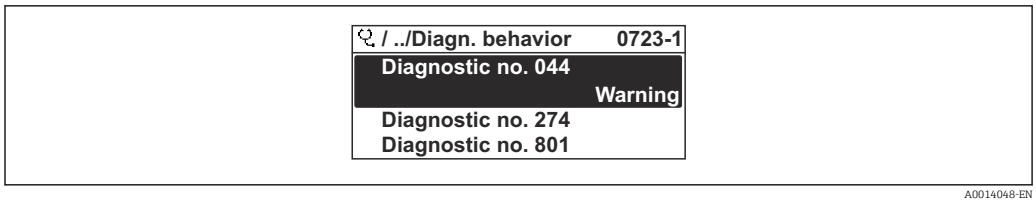
1. Call up the desired parameter.
2. On the right in the working area, mouse over the parameter.
   ↳ A tool tip with remedy information for the diagnostic event appears.

12.6 Adapting the diagnostic information

12.6.1 Adapting the diagnostic behavior

Each item of diagnostic information is assigned a specific diagnostic behavior at the factory. The user can change this assignment for specific diagnostic information in the **Diagnostic behavior** submenu.

Expert → System → Diagnostic handling → Diagnostic behavior



25 Taking the example of the local display

You can assign the following options to the diagnostic number as the diagnostic behavior:

Options	Description
Alarm	The device stops measurement. The signal outputs and totalizers assume the defined alarm condition. A diagnostic message is generated. The background lighting changes to red.
Warning	The device continues to measure. The signal outputs and totalizers are not affected. A diagnostic message is generated.
Logbook entry only	The device continues to measure. The diagnostic message is displayed only in the **Event logbook** submenu (**Event list** submenu) and is not displayed in alternation with the operational display.
Off	The diagnostic event is ignored, and no diagnostic message is generated or entered.

12.6.2 Adapting the status signal

Each item of diagnostic information is assigned a specific status signal at the factory. The user can change this assignment for specific diagnostic information in the **Diagnostic event category** submenu.

Expert → Communication → Diagnostic event category

Available status signals

Configuration as per HART 7 Specification (Condensed Status), in accordance with NAMUR NE107.

Symbol	Meaning
A0013956	**Failure** A device error is present. The measured value is no longer valid.
A0013959	**Function check** The device is in service mode (e.g. during a simulation).
A0013958	**Out of specification** The device is being operated: ▪ Outside its technical specification limits (e.g. outside the process temperature range) ▪ Outside of the configuration carried out by the user (e.g. maximum flow in parameter **20 mA value**)
A0013957	**Maintenance required** Maintenance is required. The measured value is still valid.
A0023076	Has no effect on the condensed status.

12.7 Overview of diagnostic information

The amount of diagnostic information and the number of measured variables affected increase if the measuring device has one or more application packages.

In the case of some items of diagnostic information, the status signal and the diagnostic behavior can be changed. Change the diagnostic information → 142

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
Diagnostic of sensor				
043	Sensor short circuit	1. Check sensor cable and sensor 2. Execute Heartbeat Verification 3. Replace sensor cable or sensor	S	Warning [1]
082	Data storage	1. Check module connections 2. Change electronic modules	F	Alarm
083	Memory content	1. Restart device 2. Restore HistoROM S-DAT backup ('Device reset' parameter) 3. Replace HistoROM S-DAT	F	Alarm
168	Build-up detected	Clean measuring tube	M	Warning
169	Conductivity measurement failed	1. Check grounding conditions 2. Deactivate conductivity measurement	M	Warning
170	Coil resistance	Check ambient and process temperature	F	Alarm
180	Temperature sensor defective	1. Check sensor connections 2. Replace sensor cable or sensor 3. Turn off temperature measurement	F	Warning
181	Sensor connection	1. Check sensor cable and sensor 2. Execute Heartbeat Verification 3. Replace sensor cable or sensor	F	Alarm

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
Diagnostic of electronic				
201	Device failure	Restart device	F	Alarm
242	Software incompatible	1. Check software 2. Flash or change main electronics module	F	Alarm
252	Modules incompatible	1. Check electronic modules 2. Check if correct modules are available (e.g. NEx, Ex) 3. Replace electronic modules	F	Alarm
252	Modules incompatible	1. Check if correct electronic modul is plugged 2. Replace electronic module	F	Alarm
261	Electronic modules	1. Restart device 2. Check electronic modules 3. Change I/O Modul or main electronics	F	Alarm
262	Sensor electronic connection faulty	1. Check or replace connection cable between sensor electronic module (ISEM) and main electronics 2. Check or replace ISEM or main electronics	F	Alarm
270	Main electronic failure	Change main electronic module	F	Alarm
271	Main electronic failure	1. Restart device 2. Change main electronic module	F	Alarm
272	Main electronic failure	Restart device	F	Alarm
273	Main electronic failure	Change electronic	F	Alarm
275	I/O module defective	Change I/O module	F	Alarm
276	I/O module faulty	1. Restart device 2. Change I/O module	F	Alarm
283	Memory content	Reset device	F	Alarm
283	Memory content	Restart device	F	Alarm
302	Device verification in progress	Device verification active, please wait.	C	Warning
311	Electronic failure	1. Do not reset device 2. Contact service	M	Warning
372	Sensor electronic (ISEM) faulty	1. Restart device 2. Check if failure recurs 3. Replace sensor electronic module (ISEM)	F	Alarm
373	Sensor electronic (ISEM) faulty	Transfer data or reset device	F	Alarm
375	I/O- communication failed	1. Restart device 2. Check if failure recurs 3. Replace module rack inclusive electronic modules	F	Alarm
376	Sensor electronic (ISEM) faulty	1. Replace sensor electronic module (ISEM) 2. Turn off diagnostic message	S	Warning [1)]
377	Sensor electronic (ISEM) faulty	1. Activate empty pipe detection 2. Check partial filled pipe and installation direction 3. Check sensor cabling 4. Deactivate diagnostic 377	S	Warning [1)]

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
378	Supply voltage ISEM faulty	Check supply voltage to the ISEM	F	Alarm
382	Data storage	1. Insert T-DAT 2. Replace T-DAT	F	Alarm
383	Memory content	1. Restart device 2. Delete T-DAT via 'Reset device' parameter 3. Replace T-DAT	F	Alarm
387	HistoROM data faulty	Contact service organization	F	Alarm
512	Sensor electronic (ISEM) faulty	1. Check ECC recovery time 2. Turn off ECC	F	Alarm
Diagnostic of configuration				
410	Data transfer	1. Check connection 2. Retry data transfer	F	Alarm
412	Processing download	Download active, please wait	C	Warning
431	Trim 1	Carry out trim	C	Warning
437	Configuration incompatible	Restart device	F	Alarm
438	Dataset	1. Check data set file 2. Check device configuration 3. Up- and download new configuration	M	Warning
441	Current output	1. Check process 2. Check current output settings	S	Warning [1)]
442	Frequency output 1 to n	1. Check process 2. Check frequency output settings	S	Warning [1)]
443	Pulse output 1 to n	1. Check process 2. Check pulse output settings	S	Warning [1)]
453	Flow override	Deactivate flow override	C	Warning
484	Failure mode simulation	Deactivate simulation	C	Alarm
485	Measured variable simulation	Deactivate simulation	C	Warning
491	Current output 1 simulation	Deactivate simulation	C	Warning
492	Simulation frequency output 1 to n	Deactivate simulation frequency output	C	Warning
493	Simulation pulse output 1 to n	Deactivate simulation pulse output	C	Warning
494	Switch output simulation 1 to n	Deactivate simulation switch output	C	Warning
495	Diagnostic event simulation	Deactivate simulation	C	Warning
496	Status input simulation	Deactivate simulation status input	C	Warning
502	CT activation/ deactivation failed	Follow the sequence of the custody transfer activation/deactivation: First authorized user login, then set the DIP switch on the main electonic module	C	Warning
511	ISEM settings faulty	1. Check measuring period and integration time 2. Check sensor properties	C	Alarm

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
530	Electrode cleaning is running	Turn off ECC	C	Warning
531	Empty pipe adjustment faulty	Execute EPD adjustment	S	Warning [1]
537	Configuration	1. Check IP addresses in network 2. Change IP address	F	Warning
540	Custody transfer mode failed	1. Power off device and toggle DIP switch 2. Deactivate custody transfer mode 3. Reactivate custody transfer mode 4. Check electronic components	F	Alarm
599	Custody transfer logbook full	1. Deactivate custody transfer mode 2. Clear custody transfer logbook (all 30 entries) 3. Activate custody transfer mode	F	Warning
Diagnostic of process				
803	Current loop	1. Check wiring 2. Change I/O module	F	Alarm
832	Electronic temperature too high	Reduce ambient temperature	S	Warning [1]
833	Electronic temperature too low	Increase ambient temperature	S	Warning [1]
834	Process temperature too high	Reduce process temperature	S	Warning [1]
835	Process temperature too low	Increase process temperature	S	Warning [1]
842	Process limit	Low flow cut off active! 1. Check low flow cut off configuration	S	Warning [1]
882	Input signal	1. Check input configuration 2. Check external device or process conditions	F	Alarm
937	Sensor symmetry	1. Eliminate external magnetic field near sensor 2. Turn off diagnostic message	S	Warning [1]
938	EMC interference	1. Check ambient conditions regarding EMC influence 2. Turn off diagnostic message	F	Alarm [1]
961	Electrode potential out of specification	1. Check process conditions 2. Check ambient conditions	S	Warning [1]
962	Pipe empty	1. Perform full pipe adjustment 2. Perform empty pipe adjustment 3. Turn off empty pipe detection	S	Warning [1]

1) Diagnostic behavior can be changed.

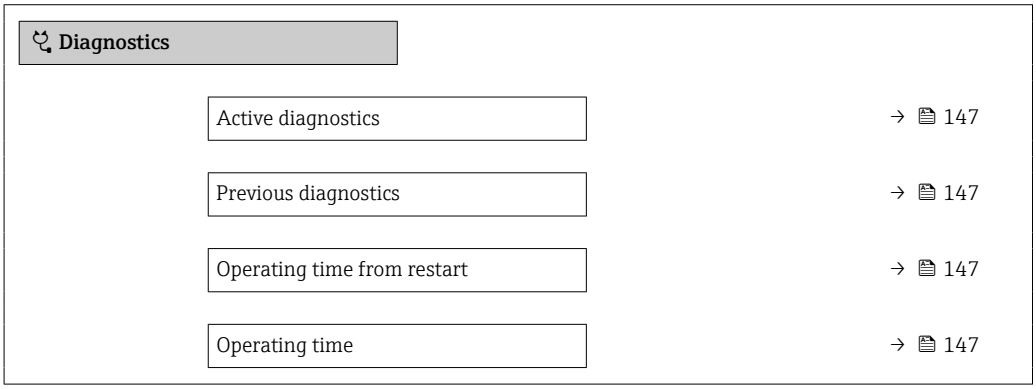
12.8 Pending diagnostic events

The **Diagnostics** menu allows the user to view the current diagnostic event and the previous diagnostic event separately.

To call up the measures to rectify a diagnostic event:
- Via local display → 139
- Via web browser → 140
- Via "FieldCare" operating tool → 142
- Via "DeviceCare" operating tool → 142

Other pending diagnostic events can be displayed in the **Diagnostic list** submenu → 147

Navigation
"Diagnostics" menu



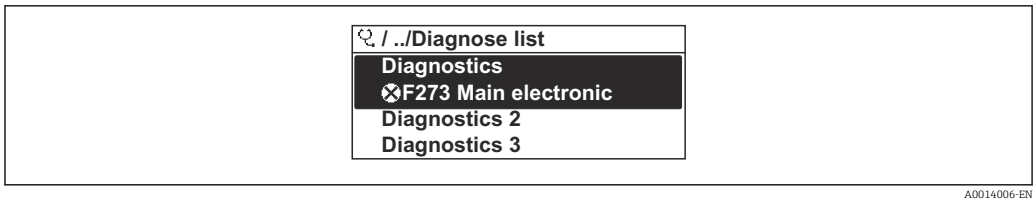
Parameter overview with brief description

Parameter	Prerequisite	Description	User interface
Active diagnostics	A diagnostic event has occurred.	Shows the current occured diagnostic event along with its diagnostic information. If two or more messages occur simultaneously, the message with the highest priority is shown on the display.	Symbol for diagnostic behavior, diagnostic code and short message.
Previous diagnostics	Two diagnostic events have already occurred.	Shows the diagnostic event that occurred prior to the current diagnostic event along with its diagnostic information.	Symbol for diagnostic behavior, diagnostic code and short message.
Operating time from restart	–	Shows the time the device has been in operation since the last device restart.	Days (d), hours (h), minutes (m) and seconds (s)
Operating time	–	Indicates how long the device has been in operation.	Days (d), hours (h), minutes (m) and seconds (s)

12.9 Diagnostic list

Up to 5 currently pending diagnostic events can be displayed in the **Diagnostic list** submenu along with the associated diagnostic information. If more than 5 diagnostic events are pending, the events with the highest priority are shown on the display.

Navigation path
Diagnostics → Diagnostic list



26 Taking the example of the local display

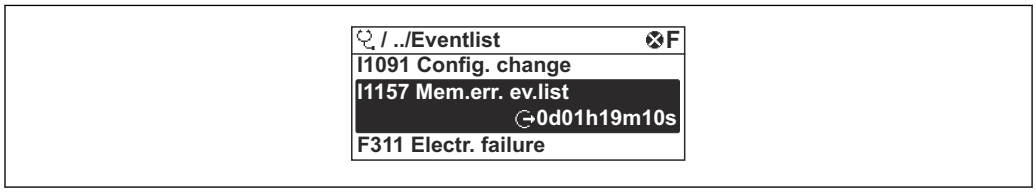
To call up the measures to rectify a diagnostic event:
- Via local display → 139
- Via web browser → 140
- Via "FieldCare" operating tool → 142
- Via "DeviceCare" operating tool → 142

12.10 Event logbook

12.10.1 Reading out the event logbook

A chronological overview of the event messages that have occurred is provided in the **Events list** submenu.

Navigation path
Diagnostics menu → **Event logbook** submenu → Event list



27 Taking the example of the local display

- A maximum of 20 event messages can be displayed in chronological order.
- If the **Extended HistoROM** application package (order option) is enabled in the device, the event list can contain up to 100 entries .

The event history includes entries for:
- Diagnostic events → 143
- Information events → 149

In addition to the operation time of its occurrence, each event is also assigned a symbol that indicates whether the event has occurred or is ended:
- Diagnostic event
  - ⊕: Occurrence of the event
  - ⊖: End of the event
- Information event
  ⊕: Occurrence of the event

To call up the measures to rectify a diagnostic event:
- Via local display → 139
- Via web browser → 140
- Via "FieldCare" operating tool → 142
- Via "DeviceCare" operating tool → 142

For filtering the displayed event messages → 149

12.10.2 Filtering the event logbook

Using the **Filter options** parameter you can define which category of event message is displayed in the **Events list** submenu.

Navigation path
Diagnostics → Event logbook → Filter options

Filter categories
- All
- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)
- Information (I)

12.10.3 Overview of information events

Unlike a diagnostic event, an information event is displayed in the event logbook only and not in the diagnostic list.

Info number	Info name
I1000	--------(Device ok)
I1079	Sensor changed
I1089	Power on
I1090	Configuration reset
I1091	Configuration changed
I1092	HistoROM backup deleted
I1137	Electronic changed
I1151	History reset
I1155	Reset electronic temperature
I1156	Memory error trend
I1157	Memory error event list
I1256	Display: access status changed
I1278	I/O module restarted
I1335	Firmware changed
I1351	Empty pipe detection adjustment failure
I1353	Empty pipe detection adjustment ok
I1361	Web server: login failed
I1397	Fieldbus: access status changed
I1398	CDI: access status changed
I1443	Build-up thickness not determined
I1444	Device verification passed
I1445	Device verification failed
I1457	Measurement error verification failed
I1459	I/O module verification failed
I1461	Sensor verification failed
I1462	Sensor electronic module verific. failed
I1512	Download started
I1513	Download finished

Info number	Info name
I1514	Upload started
I1515	Upload finished
I1517	Custody transfer active
I1518	Custody transfer inactive
I1622	Calibration changed
I1624	Reset all totalizers
I1625	Write protection activated
I1626	Write protection deactivated
I1627	Web server: login successful
I1628	Display: login successful
I1629	CDI: login successful
I1631	Web server access changed
I1632	Display: login failed
I1633	CDI: login failed
I1634	Reset to factory settings
I1635	Reset to delivery settings
I1643	Custody transfer logbook cleared
I1649	Hardware write protection activated
I1650	Hardware write protection deactivated
I1651	Custody transfer parameter changed
I1725	Sensor electronic module (ISEM) changed

12.11 Resetting the measuring device

Using the**Reset device** parameter (→ 🖹 120) it is possible to reset the entire device configuration or some of the configuration to a defined state.

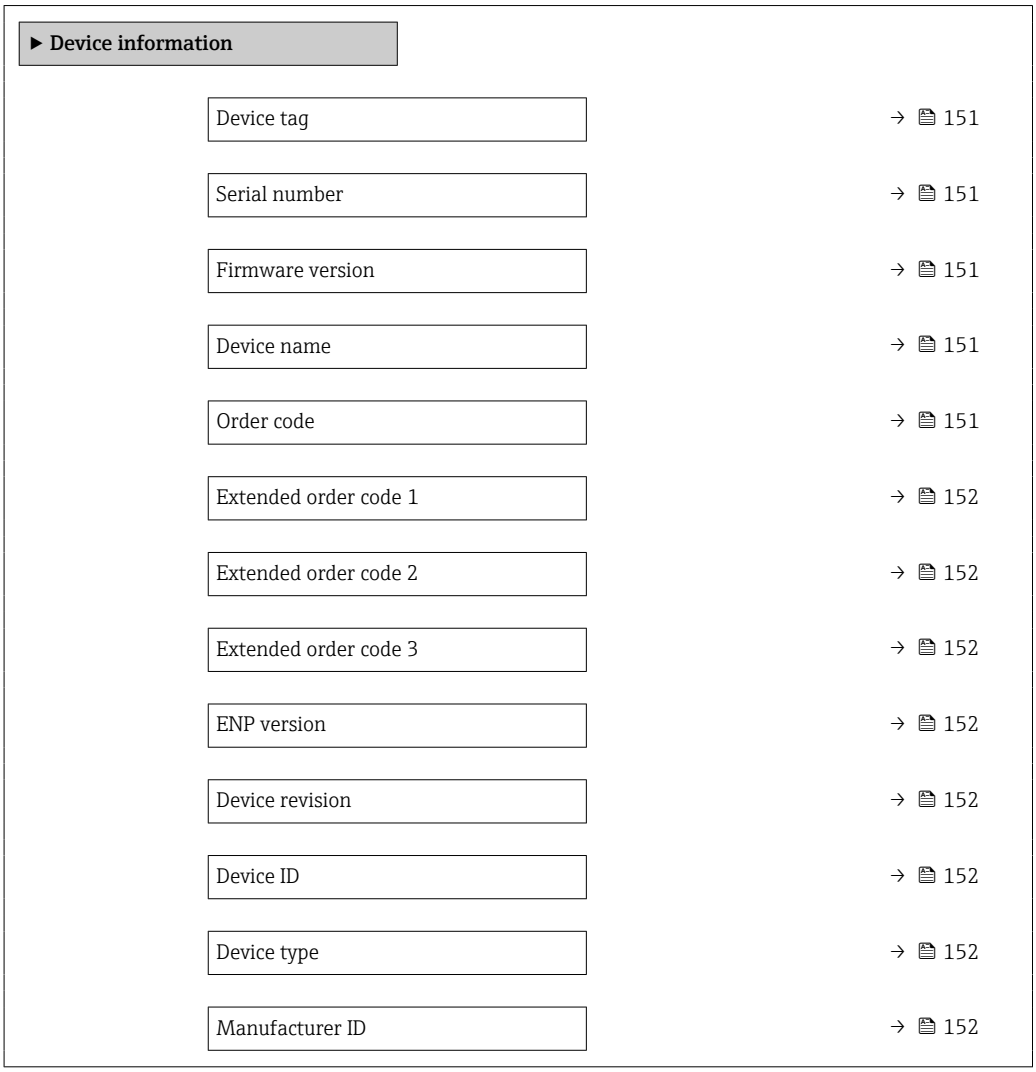
12.11.1 Function scope of the "Reset device" parameter

Options	Description
Cancel	No action is executed and the user exits the parameter.
To delivery settings	Every parameter for which a customer-specific default setting was ordered is reset to this customer-specific value. All other parameters are reset to the factory setting.
Restart device	The restart resets every parameter whose data are in the volatile memory (RAM) to the factory setting (e.g. measured value data). The device configuration remains unchanged.

12.12 Device information

The **Device information** submenu contains all parameters that display different information for device identification.

Navigation
"Diagnostics" menu → Device information



Parameter overview with brief description

Parameter	Description	User interface	Factory setting
Device tag	Shows name of measuring point.	Max. 32 characters, such as letters, numbers or special characters (e.g. @, %, /).	Promag
Serial number	Shows the serial number of the measuring device.	Max. 11-digit character string comprising letters and numbers.	–
Firmware version	Shows the device firmware version installed.	Character string in the format xx.yy.zz	–
Device name	Shows the name of the transmitter. The name can be found on the nameplate of the transmitter.	Max. 32 characters such as letters or numbers.	Promag 400
Order code	Shows the device order code. The order code can be found on the nameplate of the sensor and transmitter in the "Order code" field.	Character string composed of letters, numbers and certain punctuation marks (e.g. /).	–

Parameter	Description	User interface	Factory setting
Extended order code 1	Shows the 1st part of the extended order code. The extended order code can also be found on the nameplate of the sensor and transmitter in the "Ext. ord. cd." field.	Character string	–
Extended order code 2	Shows the 2nd part of the extended order code. The extended order code can also be found on the nameplate of the sensor and transmitter in the "Ext. ord. cd." field.	Character string	–
Extended order code 3	Shows the 3rd part of the extended order code. The extended order code can also be found on the nameplate of the sensor and transmitter in the "Ext. ord. cd." field.	Character string	–
ENP version	Shows the version of the electronic nameplate (ENP).	Character string	2.02.00
Device revision	Shows the device revision with which the device is registered with the HART Communication Foundation.	2-digit hexadecimal number	9
Device ID	Shows the device ID for identifying the device in a HART network.	6-digit hexadecimal number	–
Device type	Shows the device type with which the measuring device is registered with the HART Communication Foundation.	2-digit hexadecimal number	0x69 (for Promag 400)
Manufacturer ID	Shows the manufacturer ID device is registered with the HART Communication Foundation.	2-digit hexadecimal number	0x11 (for Endress+Hauser)

12.13 Firmware history

Release date	Firmware version	Order code for "Firmware version"	Firmware changes	Documentation type	Documentation
05.2020	02.01.zz	Option **70**	▪ Web server: Extended function range ▪ Heartbeat Technology: Extended function range and extended report ▪ Custody transfer measurement: New sealing mechanism ▪ Build-up detection	Operating Instructions	BA01063D/06/EN/06.21
11.2016	02.00.zz	Option **71**	Device type ID: 0x69 ▪ Web server: current version ▪ Logbook: current concept, including parameter change ▪ Upload/download: current concept ▪ Heartbeat Technology: new hardware, diagnostics, events ▪ Security concept: encrypted password transmission ▪ WLAN ▪ Custody transfer measurement	Operating Instructions	BA01063D/06/EN/05.16
05.2014	01.05.zz	Option **73**	▪ In accordance with HART 7 Specification ▪ Integrated HART input ▪ SD03 keypad lock ▪ Modification of SIL functionality ▪ HistoROM data logging in FieldCare "HistoROM" module ▪ Simulation of diagnostic events ▪ Ability to access Heartbeat Technology application package	Operating Instructions	BA01063D/06/EN/03.14
10.2013	01.04.zz	Option **76**	Original firmware	Operating Instructions	BA01063D/06/EN/02.13

It is possible to flash the firmware to the current version or the previous version using the service interface.

For the compatibility of the firmware version with the previous version, the installed device description files and operating tools, observe the information about the device in the "Manufacturer's information" document.

The manufacturer's information is available:
- In the Download Area of the Endress+Hauser web site: www.endress.com → Downloads
- Specify the following details:
  - Text search: Manufacturer's information
  - Media type: Documentation – Technical Documentation

13 Maintenance

13.1 Maintenance tasks

No special maintenance work is required.

13.1.1 Exterior cleaning

When cleaning the exterior of measuring devices, always use cleaning agents that do not attack the surface of the housing or the seals.

⚠ WARNING

Cleaning agents can damage the plastic transmitter housing!

- ▶ Do not use high-pressure steam.
- ▶ Only use the permitted cleaning agents specified.

Permitted cleaning agents for the plastic transmitter housing

- Commercially available household cleaners
- Methyl alcohol or isopropyl alcohol
- Mild soap solutions

13.1.2 Interior cleaning

No interior cleaning is planned for the device.

13.2 Measuring and test equipment

Endress+Hauser offers a wide variety of measuring and test equipment, such as W@M or device tests.

Your Endress+Hauser Sales Center can provide detailed information on the services.

List of some of the measuring and testing equipment: → 157→ 158

13.3 Endress+Hauser services

Endress+Hauser offers a wide variety of services for maintenance such as recalibration, maintenance service or device tests.

Your Endress+Hauser Sales Center can provide detailed information on the services.

14 Repair

14.1 General information

14.1.1 Repair and conversion concept

The Endress+Hauser repair and conversion concept provides for the following:
- The measuring devices have a modular design.
- Spare parts are grouped into logical kits with the associated Installation Instructions.
- Repairs are carried out by Endress+Hauser Service or by appropriately trained customers.
- Certified devices can only be converted to other certified devices by Endress+Hauser Service or at the factory.

14.1.2 Notes for repair and conversion

For repair and modification of a measuring device, observe the following notes:
- ▶ Use only original Endress+Hauser spare parts.
- ▶ Carry out the repair according to the Installation Instructions.
- ▶ Observe the applicable standards, federal/national regulations, Ex documentation (XA) and certificates.
- ▶ Document every repair and each conversion and enter them into the *W@M* life cycle management database and Netilion Analytics.

14.2 Spare parts

W@M Device Viewer (www.endress.com/deviceviewer):
All the spare parts for the measuring device, along with the order code, are listed here and can be ordered. If available, users can also download the associated Installation Instructions.

Measuring device serial number:
- Is located on the nameplate of the device.
- Can be read out via the **Serial number** parameter (→ 151) in the **Device information** submenu.

14.3 Endress+Hauser services

Endress+Hauser offers a wide range of services.

Your Endress+Hauser Sales Center can provide detailed information on the services.

14.4 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the website for more information:
   http://www.endress.com/support/return-material
2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

14.5 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to Endress+Hauser for disposal under the applicable conditions.

14.5.1 Removing the measuring device

1. Switch off the device.

⚠ WARNING

Danger to persons from process conditions!

- Beware of hazardous process conditions such as pressure in the measuring device, high temperatures or aggressive media.

2. Carry out the mounting and connection steps from the "Mounting the measuring device" and "Connecting the measuring device" sections in reverse order. Observe the safety instructions.

14.5.2 Disposing of the measuring device

⚠ WARNING

Danger to personnel and environment from fluids that are hazardous to health.

- Ensure that the measuring device and all cavities are free of fluid residues that are hazardous to health or the environment, e.g. substances that have permeated into crevices or diffused through plastic.

Observe the following notes during disposal:

- Observe valid federal/national regulations.
- Ensure proper separation and reuse of the device components.

15 Accessories

Various accessories, which can be ordered with the device or subsequently from Endress +Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

15.1 Device-specific accessories

15.1.1 For the transmitter

Accessories	Description
Promag 400 transmitter	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Output/input ▪ Display/operation ▪ Housing ▪ Software For details, see Installation Instructions EA00104D
Display guard	Is used to protect the display against impact or scoring, for example from sand in desert areas. Order number: 71228792 Installation Instructions EA01093D
Connecting cable for remote version	Coil current and electrode cables, various lengths, reinforced cables available on request.
Ground cable	Set, consisting of two ground cables for potential equalization.
Post mounting kit	Post mounting kit for transmitter.
Compact → Remote conversion kit	For converting a compact device version to a remote device version.
Conversion kit Promag 50/53 → Promag 400	For converting a Promag with transmitter 50/53 to a Promag 400.

15.1.2 For the sensor

Accessory	Description
Ground disks	Are used to ground the medium in lined measuring tubes to ensure proper measurement. For details, see Installation Instructions EA00070D

15.2 Communication-specific accessories

Accessories	Description
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB interface. Technical Information TI00404F
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI405C/07

HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. ▪ Technical Information TI00429F ▪ Operating Instructions BA00371F
Wireless HART adapter SWA70	Is used for the wireless connection of field devices. The WirelessHART adapter can be easily integrated into field devices and existing infrastructures, offers data protection and transmission safety and can be operated in parallel with other wireless networks with minimum cabling complexity. Operating Instructions BA00061S
Fieldgate FXA42	Is used to transmit the measured values of connected 4 to 20 mA analog measuring devices, as well as digital measuring devices ▪ Technical Information TI01297S ▪ Operating Instructions BA01778S ▪ Product page: www.endress.com/fxa42
Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt70
Field Xpert SMT77	The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1. ▪ Technical Information TI01418S ▪ Operating Instructions BA01923S ▪ Product page: www.endress.com/smt77

15.3 Service-specific accessories

Accessory	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Choice of measuring devices with industrial requirements ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, flow velocity and accuracy. ▪ Graphic illustration of the calculation results ▪ Determination of the partial order code, administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://portal.endress.com/webapp/applicator ▪ As a downloadable DVD for local PC installation.
W@M	W@M Life Cycle Management Improved productivity with information at your fingertips. Data relevant to a plant and its components is generated from the first stages of planning and during the asset's complete life cycle. W@M Life Cycle Management is an open and flexible information platform with online and on-site tools. Instant access for your staff to current, in-depth data shortens your plant's engineering time, speeds up procurement processes and increases plant uptime. Combined with the right services, W@M Life Cycle Management boosts productivity in every phase. For more information, see: www.endress.com/lifecyclemanagement

Accessory	Description
FieldCare	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Operating Instructions BA00027S and BA00059S
DeviceCare	Tool for connecting and configuring Endress+Hauser field devices. Innovation brochure IN01047S

15.4 System components

Accessories	Description
Memograph M graphic data manager	The Memograph M graphic data manager provides information on all the relevant measured variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a SD card or USB stick. ▪ Technical Information TI00133R ▪ Operating Instructions BA00247R

16 Technical data

16.1 Application

The measuring device is only suitable for the flow measurement of liquids with a minimum conductivity of 5 µS/cm.

Depending on the version ordered, the measuring device can also measure potentially explosive, flammable, poisonous and oxidizing media.

To ensure that the device remains in proper operating condition for its service life, use the measuring device only for media against which the process-wetted materials are sufficiently resistant.

16.2 Function and system design

Measuring principle

Electromagnetic flow measurement on the basis of *Faraday's law of magnetic induction*.

Measuring system

The device consists of a transmitter and a sensor.

Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

For information on the structure of the device → 13

16.3 Input

Measured variable

Direct measured variables

- Volume flow (proportional to induced voltage)
- Electrical conductivity

In custody transfer: only volume flow

Calculated measured variables

Mass flow

Measuring range

Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Electrical conductivity: ≥ 5 µS/cm for liquids in general

Flow characteristic values in SI units: DN 25 to 125 mm (1 to 4 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
25	1	9 to 300	75	0.5	1
32	–	15 to 500	125	1	2
40	1 ½	25 to 700	200	1.5	3

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
50	2	35 to 1 100	300	2.5	5
65	–	60 to 2 000	500	5	8
80	3	90 to 3 000	750	5	12
100	4	145 to 4 700	1 200	10	20
125	–	220 to 7 500	1 850	15	30

Flow characteristic values in SI units: DN 150 to 3 000 mm (6 to 120 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
150	6	20 to 600	150	0.025	2.5
200	8	35 to 1 100	300	0.05	5
250	10	55 to 1 700	500	0.05	7.5
300	12	80 to 2 400	750	0.1	10
350	14	110 to 3 300	1 000	0.1	15
375	15	140 to 4 200	1 200	0.15	20
400	16	140 to 4 200	1 200	0.15	20
450	18	180 to 5 400	1 500	0.25	25
500	20	220 to 6 600	2 000	0.25	30
600	24	310 to 9 600	2 500	0.3	40
700	28	420 to 13 500	3 500	0.5	50
750	30	480 to 15 000	4 000	0.5	60
800	32	550 to 18 000	4 500	0.75	75
900	36	690 to 22 500	6 000	0.75	100
1000	40	850 to 28 000	7 000	1	125
–	42	950 to 30 000	8 000	1	125
1200	48	1 250 to 40 000	10 000	1.5	150
–	54	1 550 to 50 000	13 000	1.5	200
1400	–	1 700 to 55 000	14 000	2	225
–	60	1 950 to 60 000	16 000	2	250
1600	–	2 200 to 70 000	18 000	2.5	300
–	66	2 500 to 80 000	20 500	2.5	325
1800	72	2 800 to 90 000	23 000	3	350
–	78	3 300 to 100 000	28 500	3.5	450
2000	–	3 400 to 110 000	28 500	3.5	450
–	84	3 700 to 125 000	31 000	4.5	500

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
2200	–	4100 to 136000	34000	4.5	540
–	90	4300 to 143000	36000	5	570
2400	–	4800 to 162000	40000	5.5	650
–	96	5000 to 168000	42000	6	675
–	102	5700 to 190000	47500	7	750
2600	–	5700 to 191000	48000	7	775
–	108	6500 to 210000	55000	7	850
2800	–	6700 to 222000	55500	8	875
–	114	7100 to 237000	59500	8	950
3000	–	7600 to 254000	63500	9	1025
–	120	7900 to 263000	65500	9	1050

Flow characteristic values in SI units: DN 50 to 200 mm (2 to 8 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
50	2	15 to 600	300	1.25	1.25
65	–	25 to 1000	500	2	2
80	3	35 to 1500	750	3	3.25
100	4	60 to 2400	1200	5	4.75
125	–	90 to 3700	1850	8	7.5
150	6	145 to 5400	2500	10	11
200	8	220 to 9400	5000	20	19

Flow characteristic values in SI units: DN 250 to 300 mm (10 to 12 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
250	10	20 to 850	500	0.03	1.75
300	12	35 to 1300	750	0.05	2.75

Flow characteristic values in US units: DN 1 to 48 in (25 to 1200 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
1	25	2.5 to 80	18	0.2	0.25
–	32	4 to 130	30	0.2	0.5
1 ½	40	7 to 185	50	0.5	0.75
2	50	10 to 300	75	0.5	1.25
–	65	16 to 500	130	1	2
3	80	24 to 800	200	2	2.5
4	100	40 to 1250	300	2	4
–	125	60 to 1950	450	5	7
6	150	90 to 2650	600	5	12
8	200	155 to 4850	1200	10	15
10	250	250 to 7500	1500	15	30
12	300	350 to 10600	2400	25	45
14	350	500 to 15000	3600	30	60
15	375	600 to 19000	4800	50	60
16	400	600 to 19000	4800	50	60
18	450	800 to 24000	6000	50	90
20	500	1000 to 30000	7500	75	120
24	600	1400 to 44000	10500	100	180
28	700	1900 to 60000	13500	125	210
30	750	2150 to 67000	16500	150	270
32	800	2450 to 80000	19500	200	300
36	900	3100 to 100000	24000	225	360
40	1000	3800 to 125000	30000	250	480
42	–	4200 to 135000	33000	250	600
48	1200	5500 to 175000	42000	400	600

Flow characteristic values in US units: DN 54 to 120 in (1400 to 3000 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
54	–	9 to 300	75	0.0005	1.3
–	1400	10 to 340	85	0.0005	1.3
60	–	12 to 380	95	0.0005	1.3
–	1600	13 to 450	110	0.0008	1.7
66	–	14 to 500	120	0.0008	2.2
72	1800	16 to 570	140	0.0008	2.6

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
78	–	18 to 650	175	0.0010	3.0
–	2000	20 to 700	175	0.0010	2.9
84	–	24 to 800	190	0.0011	3.2
–	2200	26 to 870	210	0.0012	3.4
90	–	27 to 910	220	0.0013	3.6
–	2400	31 to 1030	245	0.0014	4.0
96	–	32 to 1066	265	0.0015	4.0
102	–	34 to 1203	300	0.0017	5.0
–	2600	34 to 1212	305	0.0018	5.0
108	–	35 to 1300	340	0.0020	5.0
–	2800	42 to 1405	350	0.0020	6.0
114	–	45 to 1503	375	0.0022	6.0
–	3000	48 to 1613	405	0.0023	6.0
120	–	50 to 1665	415	0.0024	7.0

Flow characteristic values in US units: DN 2 to 12 in (50 to 300 mm) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
2	50	4 to 160	75	0.3	0.35
–	65	7 to 260	130	0.5	0.6
3	80	10 to 400	200	0.8	0.8
4	100	16 to 650	300	1.2	1.25
–	125	24 to 1000	450	1.8	2
6	150	40 to 1400	600	2.5	3
8	200	60 to 2500	1200	5	5
10	250	90 to 3700	1500	6	8
12	300	155 to 5700	2400	9	12

Recommended measuring range

Flow limit → 176

For custody transfer, the applicable approval determines the permitted measuring range, the pulse value and the low flow cut off.

Operable flow range

Over 1000 : 1

For custody transfer, the operable flow range is 100 : 1 to 630 : 1, depending on the nominal diameter. Further details are specified by the applicable approval.

Input signal

External measured values

Various pressure transmitters and temperature measuring devices can be ordered from Endress+Hauser: see "Accessories" section → 159

It is recommended to read in external measured values to calculate the following measured variables:
Mass flow

HART protocol

The measured values are written from the automation system to the measuring device via the HART protocol. The pressure transmitter must support the following protocol-specific functions:
- HART protocol
- Burst mode

Status input

Maximum input values	▪ DC 30 V ▪ 6 mA
Response time	Configurable: 5 to 200 ms
Input signal level	▪ Low signal (low): DC −3 to +5 V ▪ High signal (high): DC 12 to 30 V
Assignable functions	▪ Off ▪ Reset totalizers 1-3 separately ▪ Reset all totalizers ▪ Flow override

16.4 Output

Output signal

Current output

Current output	Can be set as: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA HART ▪ 0 to 20 mA
Maximum output values	▪ DC 24 V (no flow) ▪ 22.5 mA
Load	0 to 700 Ω
Resolution	0.5 µA

Damping	Configurable: 0.07 to 999 s
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1] ▪ Corrected conductivity [1] ▪ Temperature [1] ▪ Electronics temperature ▪ Reference electrode potential [1] ▪ Coil current rise time [1] ▪ Noise [1] ▪ Build-up measured value [1] ▪ Test points 1-3

1) Visible depending on order options or device settings

Pulse/frequency/switch output

Function	▪ With the order code for "Output; Input", option **H**: output 2 can be set as a pulse or frequency output ▪ With the order code for "Output; Input", option **I**: output 2 and 3 can be set as a pulse, frequency or switch output ▪ With the order code for "Output; Input", option **J**: output 2 firmly assigned as certified pulse output
Version	Passive, open collector
Maximum input values	▪ DC 30 V ▪ 250 mA
Voltage drop	At 25 mA: ≤ DC 2 V
Pulse output	
Pulse width	Configurable: 0.05 to 2 000 ms
Maximum pulse rate	10 000 Impulse/s
Pulse value	Configurable
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow
Frequency output	
Output frequency	Configurable: 0 to 12 500 Hz
Damping	Configurable: 0 to 999 s
Pulse/pause ratio	1:1
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1] ▪ Corrected conductivity [1] ▪ Temperature [1] ▪ Electronics temperature ▪ Noise [1] ▪ Coil current rise time [1] ▪ Reference electrode potential [1] ▪ Build-up measured value [1] ▪ Test points 1-3
Switch output	
Switching behavior	Binary, conductive or non-conductive
Switching delay	Configurable: 0 to 100 s

Number of switching cycles	Unlimited

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value:
	  ▪ Off
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ Mass flow
	  ▪ Flow velocity
	  ▪ Conductivity [1)]
	  ▪ Corrected conductivity [1)]
	  ▪ Totalizer 1-3
	  ▪ Temperature [1)]
	  ▪ Electronics temperature
	▪ Flow direction monitoring
	▪ Status:
	  ▪ Empty pipe detection
	  ▪ Low flow cut off
	  ▪ Build-up limit value [1)]

1) Visible depending on order options or device settings

Signal on alarm

Depending on the interface, failure information is displayed as follows:

Current output 4 to 20 mA

4 to 20 mA

Failure mode	Choose from: ▪ 4 to 20 mA in accordance with NAMUR recommendation NE 43 ▪ 4 to 20 mA in accordance with US ▪ Min. value: 3.59 mA ▪ Max. value: 22.5 mA ▪ Freely definable value between: 3.59 to 22.5 mA ▪ Actual value ▪ Last valid value

0 to 20 mA

Failure mode	Choose from: ▪ Maximum alarm: 22 mA ▪ Freely definable value between: 0 to 22.5 mA

HART current output

Device diagnostics	Device condition can be read out via HART Command 48

Pulse/frequency/switch output

Pulse output	
Failure mode	Choose from: ▪ Actual value ▪ No pulses
Frequency output	
Failure mode	Choose from: ▪ Actual value ▪ 0 Hz ▪ Defined value: 0 to 12 500 Hz

Switch output	
Failure mode	Choose from: ▪ Current status ▪ Open ▪ Closed

Local display

Plain text display	With information on cause and remedial measures
Backlight	Red backlighting indicates a device error.

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  HART protocol
- Via service interface
  - CDI-RJ45 service interface
  - WLAN interface

Plain text display	With information on cause and remedial measures

Web browser

Plain text display	With information on cause and remedial measures

Light emitting diodes (LED)

Status information	Status indicated by various light emitting diodes The following information is displayed depending on the device version: ▪ Supply voltage active ▪ Data transmission active ▪ Device alarm/error has occurred Diagnostic information via light emitting diodes → 136

Low flow cut off

The switch points for low flow cut off are user-selectable.

Galvanic isolation

The following connections are galvanically isolated from each other:
- Inputs
- Outputs
- Power supply

Protocol-specific data

HART

Manufacturer ID	0x11
Device type ID	0x1169
HART protocol revision	7
Device description files (DTM, DD)	Information and files under: www.endress.com

HART load	Min. 250 Ω
Dynamic variables PV, SV, TV, QV	▪ Read out the dynamic variables via HART command 3 ▪ The measured variables can be freely assigned to the dynamic variables
Device variables	▪ Read out the device variables via HART command 9 ▪ The measured variables can be freely assigned ▪ A maximum of 8 device variables can be transmitted
System integration	→ 🖹 85

16.5 Power supply

Terminal assignment → 🖹 43

Supply voltage

Transmitter

Order code for "Power supply"	terminal voltage		Frequency range
Option **L**	DC 24 V	±25%	–
	AC 24 V	±25%	50/60 Hz, ±4 Hz
	AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Power consumption

Order code for "Output"	Maximum power consumption
Option **H**: 4-20mA HART, pulse/frequency output, switch output	30 VA/8 W
Option **I**: 4-20mA HART, 2 x pulse/frequency/switch output, status input	30 VA/8 W
Option **J**: 4-20mA HART, certified pulse output, switch output, status input	30 VA/8 W

Current consumption

Transmitter

Order code for "Power supply"	Maximum Current consumption	Maximum switch-on current
Option **L**: AC 100 to 240 V	145 mA	25 A (< 5 ms)
Option **L**: AC/DC 24 V	350 mA	27 A (< 5 ms)

Power supply failure

- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memoryor in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Electrical connection → 🖹 46

Potential equalization → 🖹 51

Terminals

Transmitter
- Supply voltage cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Signal cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Electrode cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Coil current cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Sensor connection housing
Spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Cable entries

Cable entry thread
- M20 x 1.5
- Via adapter:
  - NPT ½"
  - G ½"

Cable gland
- For standard cable: M20 × 1.5 with cable ϕ 6 to 12 mm (0.24 to 0.47 in)
- For armored cable: M20 × 1.5 with cable ϕ 9.5 to 16 mm (0.37 to 0.63 in)

If metal cable entries are used, use a grounding plate.

Cable specification

→ 41

16.6 Performance characteristics

Reference operating conditions
- Error limits following DIN EN 29104, in future ISO 20456
- Water, typically +15 to +45 °C (+59 to +113 °F); 0.5 to 7 bar (73 to 101 psi)
- Data as indicated in the calibration protocol
- Accuracy based on accredited calibration rigs according to ISO 17025

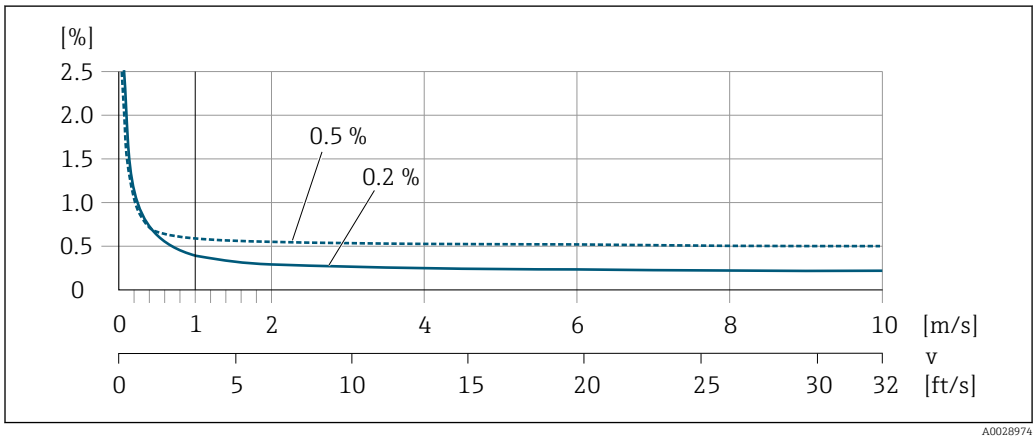
Maximum measured error

Error limits under reference operating conditions

Volume flow

- ±0.5 % o.r. ± 1 mm/s (0.04 in/s)
- Optional: ±0.2 % o.r. ± 2 mm/s (0.08 in/s)

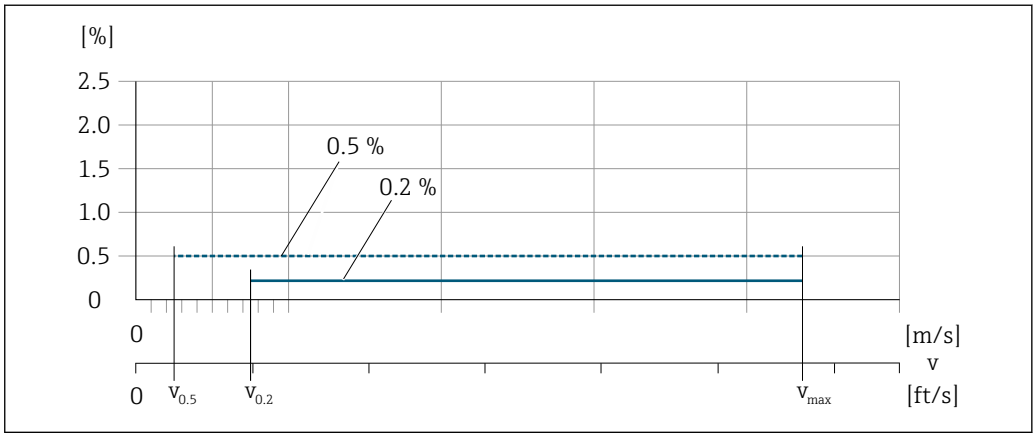
Fluctuations in the supply voltage do not have any effect within the specified range.



28 *Maximum measured error in % o.r.*

Flat Spec

For Flat Spec in the range $v_{0.5}$ ($v_{0.2}$) up to v_{max} the measured error is constant.



29 *Flat Spec in % o.r.*

Flat Spec flow values 0.5 %

Nominal diameter		$v_{0.5}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	0.5	1.64	10	32
50 to 300 [1)]	2 to 12	0.25	0.82	5	16

1) Order code for "Design", option C

Flat Spec flow values 0.2 %

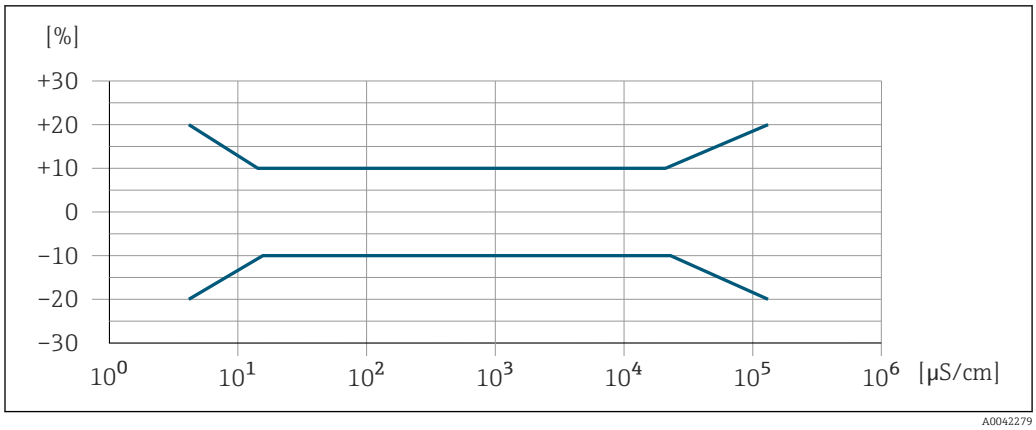
Nominal diameter		$v_{0.2}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	1.5	4.92	10	32
50 to 300 [1)]	2 to 12	0.6	1.97	4	13

1) Order code for "Design", option C

Electrical conductivity

The values apply for:
- Measurements at a reference temperature of 25 °C (77 °F)
  At different temperatures, attention must be paid to the temperature coefficient of the medium (typically 2.1 %/K)
- Device version: compact version - transmitter and sensor form a mechanical unit
- Devices installed in a metal pipe or in a non-metal pipe with ground disks
- Devices whose potential equalization was performed according to the instructions in the associated Operating Instructions

Conductivity [µS/cm]	Measured error [%] o. r.
5 to 20	± 20%
20 to 20 000	± 10%
20 000 to 100 000	± 20%



30 Measured error

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	Max. ±5 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±50 ppm o.r. (over the entire ambient temperature range)

Repeatability

o.r. = of reading

Volume flow
max. ±0.1 % o.r. ± 0.5 mm/s (0.02 in/s)

Electrical conductivity
Max. ±5 % o.r.

Influence of ambient temperature

Current output

o.r. = of reading

Temperature coefficient	Max. ±0.005 % o.r./°C

Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

16.7 Installation

Installation conditions

→ 19

16.8 Environment

Ambient temperature range	→ 25
Storage temperature	The storage temperature corresponds to the operating temperature range of the transmitter and the sensor → 25. ▪ Protect the measuring device against direct sunlight during storage in order to avoid unacceptably high surface temperatures. ▪ Select a storage location where moisture cannot collect in the measuring device as fungus or bacteria infestation can damage the liner. ▪ If protection caps or protective covers are mounted these should never be removed before installing the measuring device.
Atmosphere	If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing. In cases of doubt, please contact the Sales Center.

Degree of protection	**Transmitter**
	▪ IP66/67, type 4X enclosure
	▪ When housing is open: IP20, type 1 enclosure
	▪ Display module: IP20, type 1 enclosure
	
	Sensor
	Compact and remote version
	IP66/67, type 4X enclosure
	
	Optionally available for compact and remote version:
	Order code for "Sensor option", option CA, C3
	▪ IP66/67, type 4X enclosure
	▪ Fully welded, with protective coating as per EN ISO 12944 C5-M
	▪ For the operation of the device in corrosive environments
	
	Optionally available for remote version:
	Order code for "Sensor option", option CB, CC
	▪ IP68, type 6P enclosure
	▪ Fully welded, with protective coating as per EN ISO 12944 C5-M/Im1 and EN 60529
	▪ For the operation of the device under water
	▪ Operating duration at a maximum depth of:
	  ▪ 3 m (10 ft): permanent use
	  ▪ 10 m (30 ft): maximum 48 hours
	Order code for "Sensor option", option CQ
	▪ IP68, type 6P, temporarily waterproof
	▪ Sensor with aluminum half-shell housing
	▪ For the temporary operation of the device under non-corrosive water
	▪ Operating duration at a maximum depth of:
	3 m (10 ft): maximum 168 hours

Order code for "Sensor option", option CD, CE
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 Im2/Im3 and EN 60529
- For the operation of the device in buried applications
- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Vibration- and shock-resistance

Sinusoidal vibration according to IEC 60068-2-6

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 2 to 8.4 Hz, 3.5 mm peak
- 8.4 to 2 000 Hz, 1 g peak

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 10 to 200 Hz, 0.003 g^2/Hz
- 200 to 2 000 Hz, 0.001 g^2/Hz
- Total: 1.54 g rms

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Shock half-sine, according to IEC 60068-2-27

- Compact version; order code for "Housing", option A "Compact, aluminum, coated"
  6 ms 30 g
- Compact version; order code for "Housing", option M "Compact, polycarbonate"
  6 ms 50 g
- Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
  6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Mechanical load
- Protect the transmitter housing against mechanical effects, such as shock or impact; the use of the remote version is sometimes preferable.
- Never use the transmitter housing as a ladder or climbing aid.

Electromagnetic compatibility (EMC)

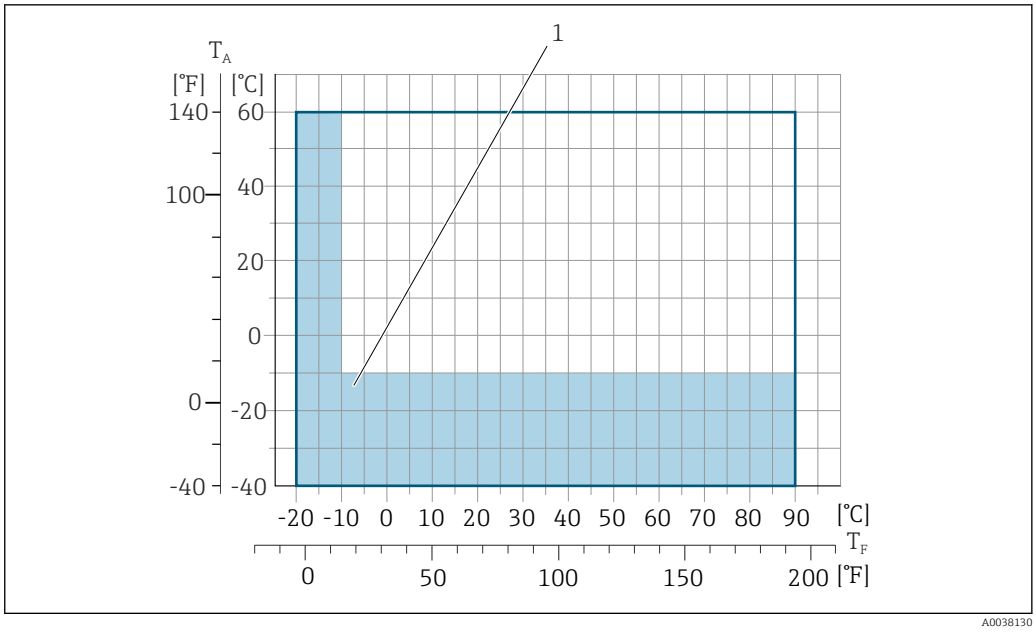
- As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)
- Complies with emission limits for industry as per EN 55011 (Class A)

Details are provided in the Declaration of Conformity.

16.9 Process

Medium temperature range

- 0 to +80 °C (+32 to +176 °F) for hard rubber, DN 50 to 3000 (2 to 120")
- –20 to +50 °C (–4 to +122 °F) for polyurethane, DN 25 to 1200 (1 to 48")
- –20 to +90 °C (–4 to +194 °F) for PTFE, DN 25 to 300 (1 to 12")



T_A *Ambient temperature*
T_F *Medium temperature*
1 *Colored area: The ambient temperature range of –10 to –40 °C (+14 to –40 °F) and the medium temperature range of –10 to –20 °C (+14 to –4 °F) only apply for stainless flanges*

The permitted fluid temperature in custody transfer is 0 to +50 °C (+32 to +122 °F).

Conductivity

≥5 µS/cm for liquids in general.

- Note that in the case of the remote version, the requisite minimum conductivity additionally depends on the length of the connecting cable → 26.
- Maximum measured error for electrical conductivity → 171.

Pressure-temperature ratings

For an overview of the pressure-temperature ratings for the process connections, see the Technical Information → 192

Pressure tightness

Liner: hard rubber

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:		
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)	+80 °C (+176 °F)
50 … 3000	2 … 120	0 (0)	0 (0)	0 (0)

Liner: polyurethane

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)
25 … 1200	1 … 48	0 (0)	0 (0)

Liner: PTFE

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
25	1	0 (0)	0 (0)
40	2	0 (0)	0 (0)
50	2	0 (0)	0 (0)
65	2 ½	0 (0)	40 (0.58)
80	3	0 (0)	40 (0.58)
100	4	0 (0)	135 (2.0)
125	5	135 (2.0)	240 (3.5)
150	6	135 (2.0)	240 (3.5)
200	8	200 (2.9)	290 (4.2)
250	10	330 (4.8)	400 (5.8)
300	12	400 (5.8)	500 (7.3)

Flow limit

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 to 3 m/s (6.56 to 9.84 ft/s). Also match the velocity of flow (v) to the physical properties of the medium:

- v < 2 m/s (6.56 ft/s): for abrasive media (e.g. potter's clay, lime milk, ore slurry)
- v > 2 m/s (6.56 ft/s): for media producing buildup (e.g. wastewater sludge)

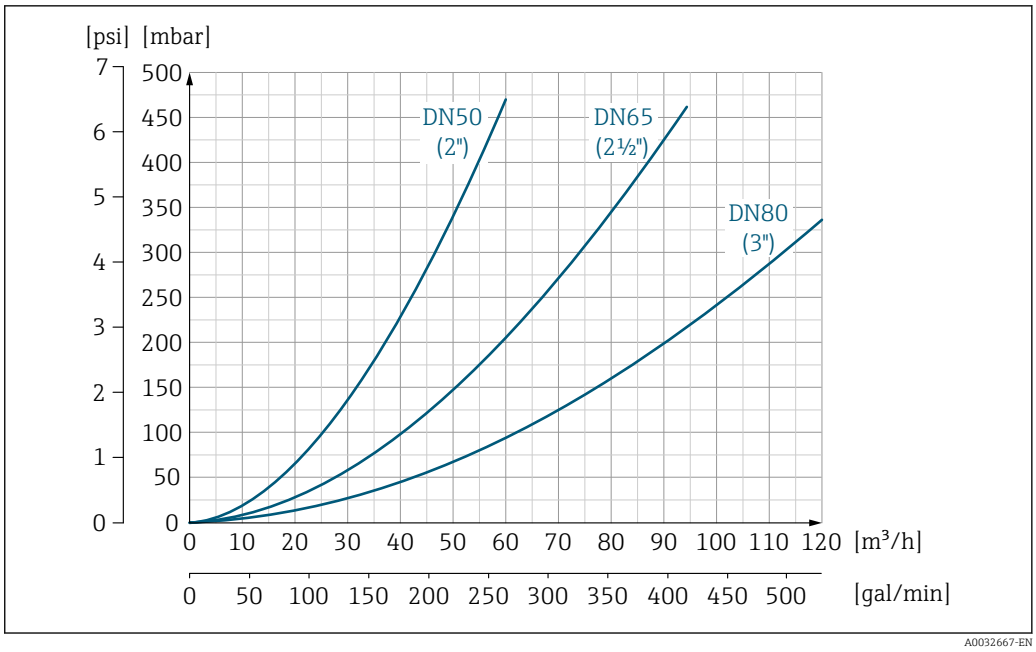
A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter.

For an overview of the full scale values for the measuring range, see the "Measuring range" section → 160

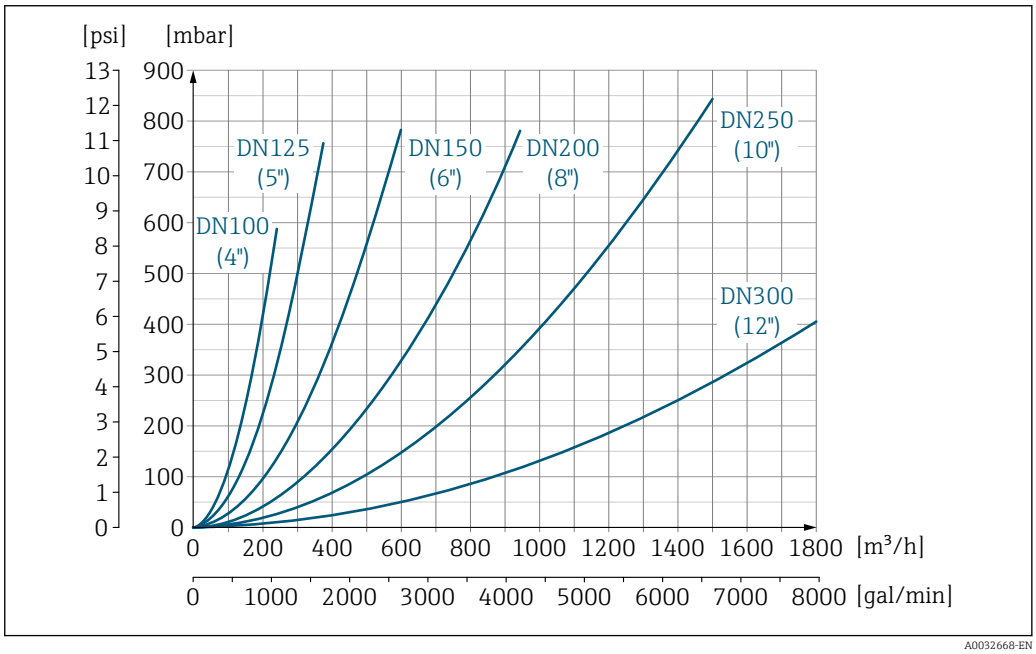
For custody transfer, the applicable approval determines the permitted measuring range.

Pressure loss

- No pressure loss occurs if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → 26



31 *Pressure loss DN 50 to 80 (2 to 3") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*



32 *Pressure loss DN 100 to 300 (4 to 12") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*

System pressure	Installation near pumps → 20
Vibrations	Installation in event of pipe vibrations → 21

16.10 Mechanical construction

Design, dimensions	For the dimensions and installed lengths of the device, see the "Technical Information" document, "Mechanical construction" section → 192

Weight

All values (weight exclusive of packaging material) refer to devices with flanges of the standard pressure rating.
The weight may be lower than indicated depending on the pressure rating and design.

Weight in SI units

Order code for "Design", option C, D, E, H, I : DN 25 to 400 mm (1 to 16 in)			
Nominal diameter		Reference values EN (DIN), AS, JIS	
[mm]	[in]	Pressure rating	[kg]
25	1	PN 40	10
32	–	PN 40	11
40	1 ½	PN 40	12
50	2	PN 40	13
65	–	PN 16	13
80	3	PN 16	15
100	4	PN 16	18
125	–	PN 16	25
150	6	PN 16	31
200	8	PN 10	52
250	10	PN 10	81
300	12	PN 10	95
350	14	PN 6	106
375	15	PN 6	121
400	16	PN 6	121

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
450	18	142	138
500	20	182	186
600	24	227	266
700	28	291	369
–	30	–	447
800	32	353	524
900	36	444	704
1000	40	566	785
–	42	–	–
1200	48	843	1 229
–	54	–	–
1400	–	1 204	–
–	60	–	–
1600	–	1 845	–
–	66	–	–

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values	
		EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
1800	72	2 357	–
–	78	2 929	–
2000	–	2 929	–

Order code for "Design", option F, J: DN 2 200 to 3 000 mm (84 to 120 in)		
Nominal diameter		Reference values
		EN (DIN) (PN6)
[mm]	[in]	[kg]
–	84	–
2200	–	3 422
–	90	–
2400	–	4 094
–	96	–
–	102	–
2600	–	7 601.5
–	108	–
2800	–	9 466.5
–	114	–
3000	–	11 911
–	120	–

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values
		EN (DIN) (PN 6)
[mm]	[in]	[kg]
450	18	161
500	20	156
600	24	208
700	28	304
–	30	–
800	32	357
900	36	485
1000	40	589
–	42	–
1200	48	850
–	54	850
1400	–	1 300
–	60	–
1600	–	1 845

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values EN (DIN) (PN 6)
[mm]	[in]	[kg]
–	66	–
1800	72	2 357
–	78	2 929
2000	–	2 929

Weight in US units

Order code for "Design", option C, D, E, H, I: DN 1 to 16 in (25 to 400 mm)		
Nominal diameter		Reference values ASME (Class 150)
[mm]	[in]	[lb]
25	1	11
32	–	–
40	1 ½	15
50	2	20
65	–	–
80	3	31
100	4	42
125	–	–
150	6	73
200	8	115
250	10	198
300	12	284
350	14	379
375	15	–
400	16	448

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	421
500	20	503
600	24	666
700	28	587
–	30	701
800	32	845
900	36	1036
1000	40	1294
–	42	1477
1200	48	1987

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
–	54	2 807
1400	–	–
–	60	3 515
1600	–	–
–	66	4 699
1800	72	5 662
–	78	6 864
2000	–	6 864
–	84	8 280
2200	–	–
–	90	10 577
2400	–	–
–	96	15 574.6
–	102	18 023.9
2600	–	–
–	108	20 783.0
2800	–	–
–	114	24 060.2
3000	–	–
–	120	27 724.3

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	562
500	20	628
600	24	893
700	28	882
–	30	1 014
800	32	1 213
900	36	1 764
1000	40	1 984
–	42	2 426
1200	48	3 087
–	54	4 851
1400	–	–
–	60	5 954
1600	–	–
–	66	8 158

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
1800	72	9040
–	78	10143
2000	–	–

Measuring tube specification

The values are reference values and can vary depending on the pressure rating, design and order option.

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
25	1	PN 40	Class 150	–	20K	–	–	24	0.93	25	1.00
32	–	PN 40	–	–	20K	–	–	32	1.28	34	1.34
40	1 ½	PN 40	Class 150	–	20K	–	–	38	1.51	40	1.57
50	2	PN 40	Class 150	Table E, PN 16	10K	50	1.98	50	1.98	52	2.04
50 [1]	2	PN 40	Class 150	Table E, PN 16	10K	32	1.26	–	–	–	–
65	–	PN 16	–	–	10K	66	2.60	66	2.60	68	2.67
65 [1]	–	PN 16	–	–	10K	38	1.50	–	–	–	–
80	3	PN 16	Class 150	Table E, PN 16	10K	79	3.11	79	3.11	80	3.15
80 [1]	3	PN 16	Class 150	Table E, PN 16	10K	50	1.97	–	–	–	–
100	4	PN 16	Class 150	Table E, PN 16	10K	101	3.99	104	4.11	104	4.09
100 [1]	4	PN 16	Class 150	Table E, PN 16	10K	66	2.60	–	–	–	–
125	–	PN 16	–	–	10K	127	4.99	130	5.11	129	5.08
125 [1]	–	PN 16	–	–	10K	79	3.11	–	–	–	–
150	6	PN 16	Class 150	Table E, PN 16	10K	155	6.11	158	6.23	156	6.15
150 [1]	6	PN 16	Class 150	Table E, PN 16	10K	102	4.02	–	–	–	–
200	8	PN 10	Class 150	Table E, PN 16	10K	204	8.02	207	8.14	202	7.96
200 [1]	8	PN 16	Class 150	Table E, PN 16	10K	127	5.00	–	–	–	–
250	10	PN 10	Class 150	Table E, PN 16	10K	258	10.14	261	10.26	256	10.09
250 [1]	10	PN 16	Class 150	Table E, PN 16	10K	156	6.14	–	–	–	–
300	12	PN 10	Class 150	Table E, PN 16	10K	309	12.15	312	12.26	306	12.03
300 [1]	12	PN 16	Class 150	Table E, PN 16	10K	204	8.03	–	–	–	–
350	14	PN 10	Class 150	Table E, PN 16	10K	337	13.3	340	13.4	–	–
375	15	–	–	PN 16	10K	389	15.3	392	15.4	–	–
400	16	PN 10	Class 150	Table E, PN 16	10K	387	15.2	390	15.4	–	–
450	18	PN 10	Class 150	–	10K	436	17.2	439	17.3	–	–
500	20	PN 10	Class 150	Table E, PN 16	10K	487	19.2	490	19.3	–	–
600	24	PN 10	Class 150	Table E, PN 16	10K	585	23.0	588	23.1	–	–
700	28	PN 10	Class D	Table E, PN 16	10K	694	27.3	697	27.4	–	–
750	30	–	Class D	Table E, PN 16	10K	743	29.3	746	29.4	–	–

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
800	32	PN 10	Class D	Table E, PN 16	–	794	31.3	797	31.4	–	–
900	36	PN 10	Class D	Table E, PN 16	–	895	35.2	898	35.4	–	–
1000	40	PN 6	Class D	Table E, PN 16	–	991	39.0	994	39.1	–	–
–	42	–	Class D	–	–	1043	41.1	1043	41.1	–	–
1200	48	PN 6	Class D	Table E, PN 16	–	1191	46.9	1197	47.1	–	–
–	54	–	Class D	–	–	1339	52.7	–	–	–	–
1400	–	PN 6	–	–	–	1402	55.2	–	–	–	–
–	60	–	Class D	–	–	1492	58.7	–	–	–	–
1600	–	PN 6	–	–	–	1600	63.0	–	–	–	–
–	66	–	Class D	–	–	1638	64.5	–	–	–	–
1800	72	PN 6	–	–	–	1786	70.3	–	–	–	–
–	78	–	Class D	–	–	1989	78.3	–	–	–	–
2000	–	PN 6	–	–	–	1989	78.3	–	–	–	–
–	84	–	Class D	–	–	2099	84.0	–	–	–	–
2200	–	PN 6	–	–	–	2194	87.8	–	–	–	–
–	90	–	Class D	–	–	2246	89.8	–	–	–	–
2400	–	PN 6	–	–	–	2391	94.1	–	–	–	–
–	96	–	Class D	–		2382	93.8	–	–	–	–
–	102	–	Class D	–		2533	99.7	–	–	–	–
2600	–	PN 6	–	–		2580	101.6	–	–	–	–
–	108	–	Class D	–		2683	105.6	–	–	–	–
2800	–	PN 6	–	–		2780	109.5	–	–	–	–
–	114	–	Class D	–		2832	111.5	–	–	–	–
3000	–	PN 6	–	–		2976	117.2	–	–	–	–
–	120	–	Class D	–		2980	117.3	–	–	–	–

1) Order code for "Design", option C

Materials

Transmitter housing

Compact version

- Order code for "Housing", option **A** "Compact, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **M**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **A**: glass
  - For order code for "Housing", option **M**: plastic

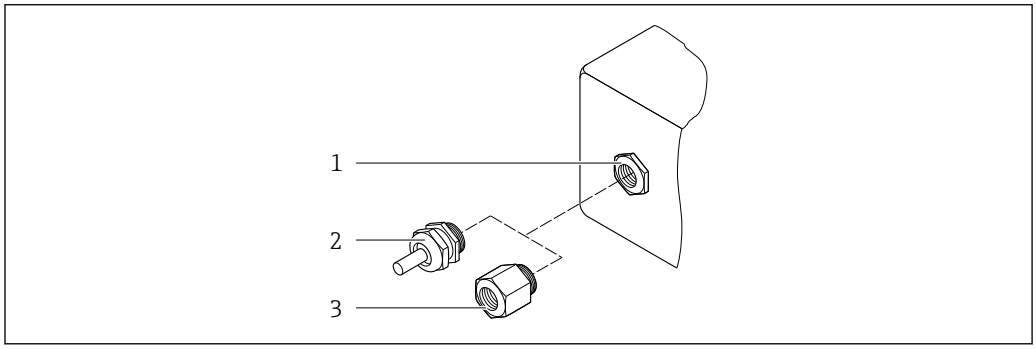
Remote version (wall-mount housing)

- Order code for "Housing", option **P** "Remote, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **N**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **P**: glass
  - For order code for "Housing", option **N**: plastic

Sensor connection housing

- Aluminum, AlSi10Mg, coated
- Polycarbonate plastic (only in conjunction with order code for "Sensor option", options CA, C3, CB, CC, CD, CD)

Cable entries/cable glands



33 *Possible cable entries/cable glands*

1 Female thread M20 × 1.5
2 Cable gland M20 × 1.5
3 Adapter for cable entry with female thread G ½" or NPT ½"

Compact and remote versions and sensor connection housing

Cable entry/cable gland	Material
Cable gland M20 × 1.5	▪ Plastic ▪ Nickel-plated brass
Remote version: cable gland M20 × 1.5 Option of armored connecting cable	▪ Sensor connection housing: Nickel-plated brass ▪ Transmitter wall-mount housing: Plastic
Adapter for cable entry with female thread G ½" or NPT ½"	Nickel-plated brass

Remote version connecting cable

UV rays can impair the cable outer sheath. Protect the cable from exposure to sun as much as possible.

Electrode and coil current cable:
- Standard cable: PVC cable with copper shield
- Armored cable: PVC cable with copper shield and additional steel wire braided jacket

Sensor housing

- DN 25 to 300 (1 to 12")
  - Aluminum half-shell housing, aluminum, AlSi10Mg, coated
  - Fully welded carbon steel housing with protective varnish
- DN 350 to 3000 (14 to 120")
  Fully welded carbon steel housing with protective varnish

Measuring tubes

- DN 25 to 600 (1 to 24")
  Stainless steel: 1.4301, 1.4306, 304, 304L
- DN 700 to 3000 (28 to 120")
  Stainless steel: 1.4301, 304

Liner

- DN 25 to 300 (1 to 12"): PTFE
- DN 25 to 1200 (1 to 48"): polyurethane
- DN 50 to 3000 (2 to 120"): hard rubber

Electrodes

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

For flanges made of carbon steel:
- DN ≤ 300 (12"): with Al/Zn protective coating or protective varnish
- DN ≥ 350 (14"): protective varnish

All carbon steel lap joint flanges are supplied with a hot-dip galvanized finish.

EN 1092-1 (DIN 2501)

Fixed flange
- Carbon steel:
  - DN ≤ 300: S235JRG2, S235JR+N, P245GH, A105, E250C
  - DN 350 to 3000: P245GH, S235JRG2, A105, E250C
- Stainless steel:
  - DN ≤ 300: 1.4404, 1.4571, F316L
  - DN 350 to 600: 1.4571, F316L, 1.4404
  - DN 700 to 1000: 1.4404, F316L

Lap joint flange
- Carbon steel DN ≤ 300: S235JRG2, A105, E250C
- Stainless steel DN ≤ 300: 1.4306,1.4404, 1.4571, F316L

Lap joint flange, stamped plate
- Carbon steel DN ≤ 300: S235JRG2 similar to S235JR+AR or 1.0038
- Stainless steel DN ≤ 300: 1.4301 similar to 304

ASME B16.5

Fixed flange, lap joint flange
- Carbon steel: A105
- Stainless steel: F316L

JIS B2220

- Carbon steel: A105, A350 LF2
- Stainless steel: F316L

AWWA C207

Carbon steel: A105, P265GH, A181 Class 70, E250C, S275JR

AS 2129

Carbon steel: A105, E250C, P235GH, P265GH, S235JRG2

AS 4087

Carbon steel: A105, P265GH, S275JR

Seals

As per DIN EN 1514-1, form IBC

Accessories

Display guard

Stainless steel, 1.4301 (304L)

Ground disks

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Fitted electrodes

Measurement, reference and empty pipe detection electrodes available as standard with:
- 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

- EN 1092-1 (DIN 2501)
- ASME B16.5
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16
- AWWA C207 Class D

For information on the different materials used in the process connections → 185

Surface roughness

Electrodes with 1.4435 (316L); Alloy C22, 2.4602 (UNS N06022); tantalum:
< 0.5 µm (19.7 µin)

(All data relate to parts in contact with medium)

16.11 Human interface

Languages

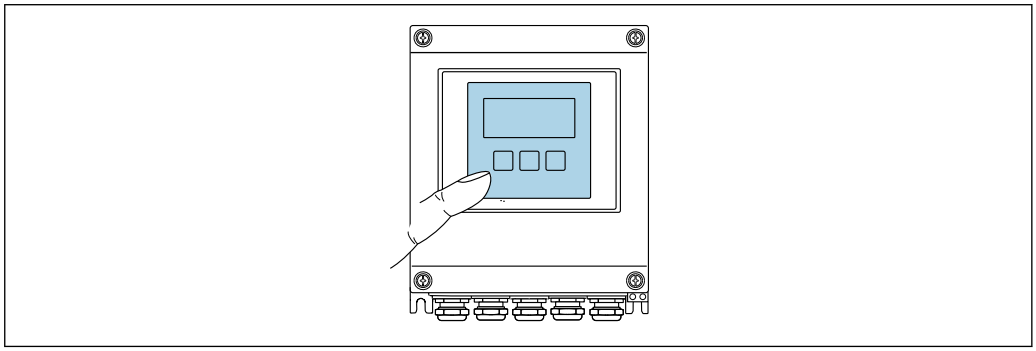
Can be operated in the following languages:
- Via local operation:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool:
  English, German, French, Spanish, Italian, Chinese, Japanese
- Via Web browser
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish

Local operation

Via display module

Equipment:
- Standard features 4-line, illuminated, graphic display; touch control
- Order code for "Display; operation", option BA "WLAN" offers standard equipment features in addition to access via Web browser

Information about WLAN interface → 80



A0032074

34 *Operation with touch control*

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- Format for displaying measured variables and status variables can be individually configured
- Permitted ambient temperature for the display: –20 to +60 °C (–4 to +140 °F)
  The readability of the display may be impaired at temperatures outside the temperature range.

Operating elements

- External operation via touch control (3 optical keys) without opening the housing: ⊞, ⊟, Ⓔ
- Operating elements also accessible in the various zones of the hazardous area

Remote operation

→ 80

Service interface

→ 80

Supported operating tools

Different operating tools can be used for local or remote access to the measuring device. Depending on the operating tool used, access is possible with different operating units and via a variety of interfaces.

Supported operating tools	Operating unit	Interface	Additional information
Web browser	Notebook, PC or tablet with Web browser	▪ CDI-RJ45 service interface ▪ WLAN interface	Special Documentation for the device
DeviceCare SFE100	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 158

Supported operating tools	Operating unit	Interface	Additional information
FieldCare SFE500	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 158
Device Xpert	Field Xpert SFX 100/350/370	Fieldbus protocol HART	Operating Instructions BA01202S Device description files: Use update function of handheld terminal

Other operating tools based on FDT technology with a device driver such as DTM/iDTM or DD/EDD can be used for device operation. These operating tools are available from the individual manufacturers. Integration into the following operating tools, among others, is supported:

- FactoryTalk AssetCentre (FTAC) from Rockwell Automation → www.rockwellautomation.com
- Process Device Manager (PDM) from Siemens → www.siemens.com
- Asset Management Solutions (AMS) from Emerson → www.emersonprocess.com
- FieldCommunicator 375/475 from Emerson → www.emersonprocess.com
- Field Device Manager (FDM) from Honeywell → www.honeywellprocess.com
- FieldMate from Yokogawa → www.yokogawa.com
- PACTWare → www.pactware.com

The related device description files are available: www.endress.com → Downloads

Web server

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

Supported functions
Data exchange between the operating unit (such as a notebook for example) and the measuring device:
- Upload the configuration from the measuring device (XML format, configuration backup)
- Save the configuration to the measuring device (XML format, restore configuration)
- Export event list (.csv file)
- Export parameter settings (.csv file or PDF file, document the measuring point configuration)
- Export the Heartbeat verification log (PDF file, only available with the "Heartbeat Verification" application package)
- Flash firmware version for device firmware upgrade, for instance
- Download driver for system integration
- Visualize up to 1000 saved measured values (only available with the **Extended HistoROM** application package → 192)

Web server special documentation → 193

HistoROM data management

The measuring device features HistoROM data management. HistoROM data management comprises both the storage and import/export of key device and process data, making operation and servicing far more reliable, secure and efficient.

Additional information on the data storage concept

There are different types of data storage units in which device data are stored and used by the device:

	HistoROM backup	T-DAT	S-DAT
Available data	▪ Event logbook such as diagnostic events for example ▪ Device firmware package	▪ Measured value logging ("Extended HistoROM" order option) ▪ Current parameter data record (used by firmware at run time) ▪ Peakhold indicator (min/max values) ▪ Totalizer values	▪ Sensor data: nominal diameter etc. ▪ Serial number ▪ Calibration data ▪ Device configuration (e.g. SW options, fixed I/O or multi I/O)
Storage location	Fixed on the user interface board in the connection compartment	Attachable to the user interface board in the connection compartment	In the sensor plug in the transmitter neck part

Data backup

Automatic
- The most important device data (sensor and transmitter) are automatically saved in the DAT modules
- If the transmitter or measuring device is replaced: once the T-DAT containing the previous device data has been exchanged, the new measuring device is ready for operation again immediately without any errors
- If the sensor is replaced: once the sensor has been replaced, new sensor data are transferred from the S-DAT in the measuring device and the measuring device is ready for operation again immediately without any errors

Data transmission

Manual
Transfer of a device configuration to another device using the export function of the specific operating tool, e.g. with FieldCare, DeviceCare or Web server: to duplicate the configuration or to store in an archive (e.g. for backup purposes)

Event list

Automatic
- Chronological display of up to 20 event messages in the events list
- If the **Extended HistoROM** application package (order option) is enabled: up to 100 event messages are displayed in the events list along with a time stamp, plain text description and remedial measures
- The events list can be exported and displayed via a variety of interfaces and operating tools e.g. DeviceCare, FieldCare or Web server

Data logging

Manual
If the **Extended HistoROM** application package (order option) is enabled:
- Record up to 1 000 measured values via 1 to 4 channels
- User configurable recording interval
- Record up to 250 measured values via each of the 4 memory channels
- Export the measured value log via a variety of interfaces and operating tools e.g. FieldCare, DeviceCare or web server

16.12 Certificates and approvals

Current certificates and approvals for the product are available via the Product Configurator at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.

The **Configuration** button opens the Product Configurator.

CE mark	The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
UKCA marking	The device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards. By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark. Contact address Endress+Hauser UK: Endress+Hauser Ltd. Floats Road Manchester M23 9NF United Kingdom www.uk.endress.com
RCM mark	The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".
Ex approval	The devices are certified for use in hazardous areas and the relevant safety instructions are provided in the separate "Control Drawing" document. Reference is made to this document on the nameplate.
Drinking water approval	▪ ACS ▪ KTW/W270 ▪ NSF 61 ▪ WRAS BS 6920
HART certification	**HART interface** The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications: ▪ Certified according to HART 7 ▪ The device can also be operated with certified devices of other manufacturers (interoperability)
Radio approval	The measuring device has radio approval. For detailed information regarding radio approval, see the Special Documentation → 193
Measuring instrument approval	The measuring device is (optionally) approved as a cold water meter (MI-001) for volume measurement in service subject to legal metrological control in accordance with the European Measuring Instruments Directive 2014/32/EU (MID). The measuring device is qualified to OIML R49: 2013.

Other standards and guidelines

- EN 60529
  Degrees of protection provided by enclosures (IP code)
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements
- IEC/EN 61326-3-2
  Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements).
- ANSI/ISA-61010-1 (82.02.01)
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- CAN/CSA-C22.2 No. 61010-1-12
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment
- NAMUR NE 32
  Data retention in the event of a power failure in field and control instruments with microprocessors
- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics
- NAMUR NE 105
  Specifications for integrating fieldbus devices in engineering tools for field devices
- NAMUR NE 107
  Self-monitoring and diagnosis of field devices
- NAMUR NE 131
  Requirements for field devices for standard applications

16.13 Application packages

Many different application packages are available to enhance the functionality of the device. Such packages might be needed to address safety aspects or specific application requirements.

The application packages can be ordered with the device or subsequently from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Cleaning

Package	Description
Electrode cleaning circuit (ECC)	The electrode cleaning circuit (ECC) function has been developed to have a solution for applications where magnetite (Fe_3O_4) deposits frequently occur (e.g. hot water). Since magnetite is highly conductive this build up leads to measuring errors and ultimately to the loss of signal. The application package is designed to avoid build-up of very conductive matter and thin layers (typical of magnetite).

Diagnostics functions

Package	Description
Extended HistoROM	Comprises extended functions concerning the event log and the activation of the measured value memory. Event log: Memory volume is extended from 20 message entries (standard version) to up to 100 entries. Data logging (line recorder): ▪ Memory capacity for up to 1000 measured values is activated. ▪ 250 measured values can be output via each of the 4 memory channels. The recording interval can be defined and configured by the user. ▪ Measured value logs can be accessed via the local display or operating tool e.g. FieldCare, DeviceCare or Web server.

Heartbeat Technology

Package	Description
Heartbeat Verification +Monitoring	**Heartbeat Verification** Meets the requirement for traceable verification to DIN ISO 9001:2008 Chapter 7.6 a) "Control of monitoring and measuring equipment". ▪ Functional testing in the installed state without interrupting the process. ▪ Traceable verification results on request, including a report. ▪ Simple testing process via local operation or other operating interfaces. ▪ Clear measuring point assessment (pass/fail) with high test coverage within the framework of manufacturer specifications. ▪ Extension of calibration intervals according to operator's risk assessment. **Heartbeat Monitoring** Continuously supplies data, which are characteristic of the measuring principle, to an external condition monitoring system for the purpose of preventive maintenance or process analysis. These data enable the operator to: ▪ Draw conclusions - using these data and other information - about the impact process influences (such as corrosion, abrasion, buildup etc.) have on the measuring performance over time. ▪ Schedule servicing in time. ▪ Monitor the process or product quality, e.g. gas pockets.

16.14 Accessories

Overview of accessories available for order → 157

16.15 Supplementary documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Standard documentation

Technical Information

Measuring device	Documentation code
Promag W 400	TI01046D

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
Proline Promag W	KA01266D

Brief Operating Instructions for the transmitter

Measuring device	Documentation code
Proline 400	KA01263D

Description of device parameters

Measuring device	Documentation code
Promag 400	GP01043D

Supplementary device-dependent documentation

Special Documentation

Content	Documentation code
Web server	SD01811D
Heartbeat Verification + Monitoring application package	SD01847D
Display modules A309/A310	SD01793D
Information on Custody Transfer Measurement	SD02038D

Installation Instructions

Content	Comment
Installation instructions for spare part sets and accessories	▪ Access the overview of all the available spare part sets via *W@M Device Viewer* → 155 ▪ Accessories available for order with Installation Instructions → 157

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Write protection
Via access code 122
Via write protection switch 123
Write protection switch 123

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Endress+Hauser

People for Process Automation

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Valid as of version
02.00.zz (Device firmware)

Special Documentation
Proline Promag 400 HART

Web server

Endress+Hauser
People for Process Automation

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1 Document information

1.1 Document function

This manual is a Special Documentation; it does not replace the Operating Instructions pertaining to the device. It serves as a reference for using the Web server integrated in the measuring device.

1.2 Target group

The document is aimed at specialists who work with the device over the entire life cycle and perform specific configurations.

1.3 Using this document

1.3.1 Information on the document structure

This Special Documentation contains a range of information, including:
- Prerequisites for use on the computer and measuring device
- Connection of the computer via the service interface
- Configuration of the communication interface
- Establishing a connection
- Diagnostics and troubleshooting

The information and safety instructions in the Operating Instructions pertaining to the measuring device must always be observed → 4.

1.3.2 Device documentation

The Technical Documentation for the measuring device is available:
- On the CD-ROM supplied with the measuring device (depending on the device version, the CD-ROM might not be part of the delivery!)
- Via the *W@M Device Viewer*: enter the serial number from the nameplate (www.endress.com/deviceviewer)
- Via the *Endress+Hauser Operations App*: enter the serial number from the nameplate or scan the 2-D matrix code (QR code) on the nameplate.

Technical documentation can also be downloaded from the Download Area of the Endress+Hauser web site: www.endress.com → Download. However this technical documentation applies to a particular instrument family and is not assigned to a specific measuring device.

1.4 Symbols used

1.4.1 Safety symbols

Symbol	Meaning
DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

Symbol	Meaning
CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** This symbol contains information on procedures and other facts which do not result in personal injury.

1.4.2 Symbols for certain types of information

Symbol	Meaning
	Permitted Indicates procedures, processes or actions that are allowed.
	Forbidden Indicates procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
▶	Notice or individual step to be observed
1., 2., 3...	Series of steps
↳	Result of a step

1.4.3 Symbols in graphics

Symbol	Meaning
1, 2, 3,...	Item numbers
1., 2., 3...	Series of steps

2 Basic safety instructions

2.1 Requirements for personnel

Personnel involved in installation, commissioning, diagnostics and maintenance must meet the following requirements:
- Trained, qualified specialists must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application)
- Follow instructions and comply with basic conditions

Operating personnel must meet the following requirements:
- Be instructed and authorized by the plant operator with regard to the requirements of the task
- Follow the instructions in this manual

2.2 Designated use

The designated use of the measuring device is described in the Operating Instructions pertaining to the device → 🖹 4.

2.3 Occupational safety

For work on and with the device:
- Wear the required personal protective equipment according to federal/national regulations.

If working on and with the device with wet hands:
- It is recommended to wear gloves on account of the higher risk of electric shock.

2.4 Operational safety

Risk of injury!
- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.
- If, despite this, modifications are required, consult with Endress+Hauser.

2.5 Product safety

This device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EC directives listed in the device-specific EC Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

2.6 IT security

We only provide a warranty if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the device settings.

IT security measures in line with operators' security standards and designed to provide additional protection for the device and device data transfer must be implemented by the operators themselves.

3 Product features and availability

3.1 Product features

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, status information on the device is also displayed and allows the user to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

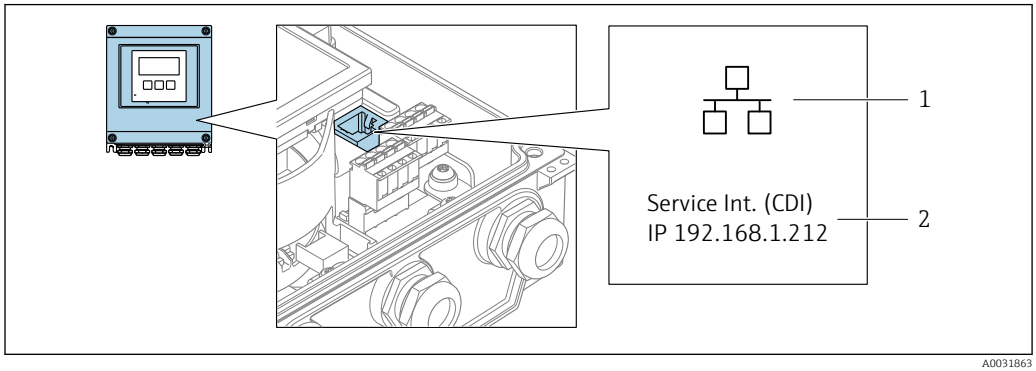
A device that has a WLAN interface (can be ordered as an option) is required for the WLAN connection: order code for "Display", option **W1** "WLAN display": 4-line, illuminated; touch control + WLAN. The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

3.2 Availability

The integrated Web server is a standard feature. It does not need to be ordered for the device ex works as it is provided as standard when the device is delivered to the customer. No particular measures are required to put the feature into operation.

3.3 Identification in the measuring device

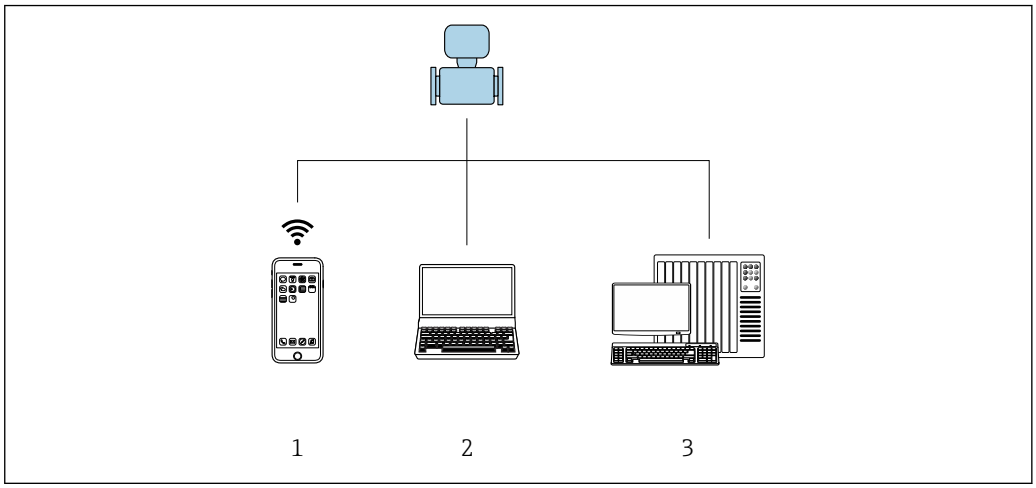
All the hardware components available and their functions for the measuring device are described on an adhesive label on the electronics board. The service interface (CDI-RJ45) has the following identification:



1 Example of the CDI-RJ45 service interface

1 Symbol for service interface
2 Information on the default setting for the WLAN IP address

4 Operation options



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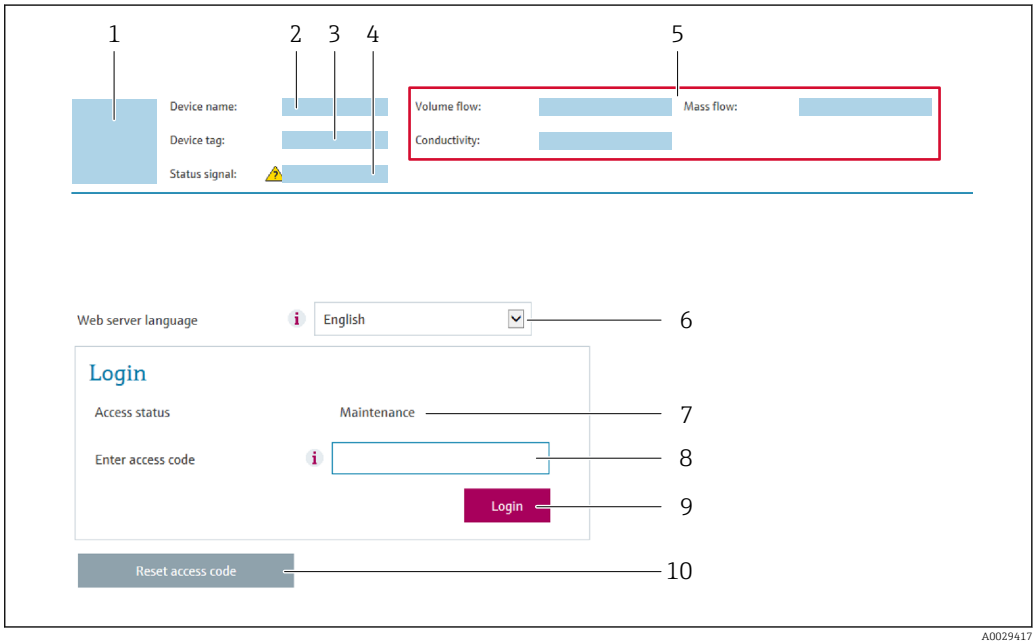
2 *Example of a Proline flowmeter with an integrated Web server*

1 *Mobile end device with Web browser (e.g. Internet Explorer) and WLAN interface*
2 *Computer with Web browser (e.g. Internet Explorer), connection via cable or WLAN interface*
3 *Control station via network*

4.1 Logging on



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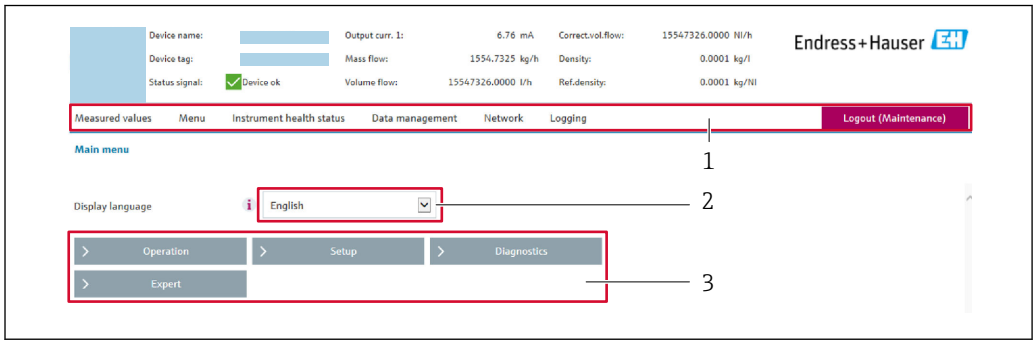
1 *Picture of device*
2 *Device name*
3 *Device tag*
4 *Status signal*
5 *Current measured values*
6 *Operating language*
7 *User role*
8 *Access code*
9 *Login*
10 *Reset access code*

1. Select the preferred operating language for the Web browser (6).
2. Enter the user-specific access code (8).
3. Click **Login** to confirm your entry (9).

Access code	0000 (factory setting); can be changed by customer

If no action is performed for 10 minutes, the Web browser automatically returns to the login page.

4.2 User interface



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1 *Function row*
2 *Operating language*
3 *Navigation area*

4.2.1 Header

The following information appears in the header:
- Device tag
- Device status with status signal → 24
- Current measured values

4.2.2 Function row

Functions	Meaning
Measured values	Displays the measured values of the measuring device
Menu	▪ Access to the operating menu from the measuring device ▪ The structure of the operating menu is the same as for the local display For detailed information on the structure of the operating menu, see the Operating Instructions for the measuring device
Device status	Displays the diagnostic messages currently pending, listed in order of priority
Data management	▪ Data exchange between PC and measuring device: – Load the configuration from the measuring device (XML format, save configuration) – Save the configuration to the measuring device (XML format, restore configuration) – Export the event list (.csv file) – Export parameter settings (.csv file, create documentation of the measuring point configuration) – Export the Heartbeat verification log (PDF file, only available with the "Heartbeat Verification" application package) ▪ Flashing a firmware version
Network configuration	Configuration and checking of all the parameters required for establishing the connection to the measuring device: ▪ Network settings (e.g. IP address, MAC address) ▪ Device information (e.g. serial number, firmware version)
Logout	End the operation and call up the login page

4.2.3 Navigation area

If a function is selected in the function bar, the submenus of the function open in the navigation area. The user can now navigate through the menu structure.

4.2.4 Working area

Depending on the selected function and the related submenus, various actions can be performed in this area:
- Configuring parameters
- Reading measured values
- Calling up help text
- Starting an upload/download

4.3 Logging out

Before logging out, perform a data backup via the **Data management** function (upload configuration from device) if necessary.

1. Select the **Logout** entry in the function row.
   ↳ The home page with the Login box appears.
2. Close the Web browser.
3. Reset the modified properties of the Internet protocol (TCP/IP) if they are no longer needed .

5 Commissioning

Establishing a connection to the integrated Web server

1. Configure the computer → 12.
2. Check the settings on the measuring device and change them if necessary → 18.
3. Connect the measuring device to the computer → 18.
4. Establish a connection to the Web server → 19.
5. Start the Web browser and access the operating menu → 20.
   ↳ The measuring device can be operated via the Web server.

5.1 Prerequisites - computer

5.1.1 Hardware

Hardware	Interface	
	CDI-RJ45	WLAN
Interface	The computer must have an RJ45 interface.	The operating unit must have a WLAN interface.
Connection	Standard Ethernet cable with RJ45 connector.	Connection via Wireless LAN.
Screen	Recommended size: ≥12" (depends on the screen resolution)	

5.1.2 Software

Software	Interface	
	CDI-RJ45	WLAN
Recommended operating systems	▪ Microsoft Windows 7 or higher. ▪ Mobile operating systems: – iOS – Android Microsoft Windows XP is supported.	
Web browsers supported	▪ Microsoft Internet Explorer 8 or higher ▪ Microsoft Edge ▪ Mozilla Firefox ▪ Google Chrome ▪ Safari	

5.1.3 Configuring the computer

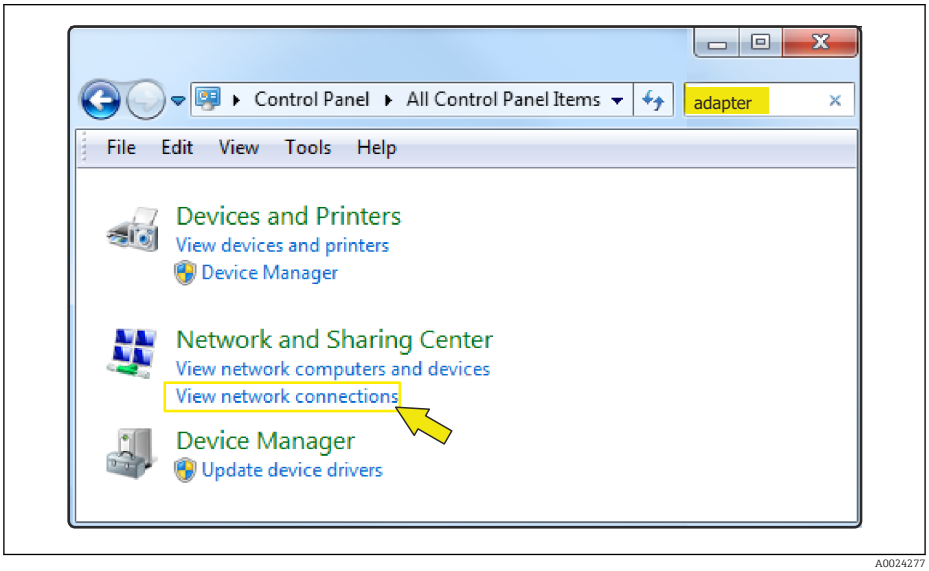
User rights	Appropriate user rights (e.g. administrator rights) for TCP/IP and proxy server settings are necessary (for adjusting the IP address, subnet mask etc.).
Proxy server settings of the Web browser	The Web browser setting *Use a Proxy Server for Your LAN* must be **deselected** .

JavaScript	JavaScript must be enabled. If JavaScript cannot be enabled: enter http://192.168.1.212/basic.html in the address line of the Web browser. A fully functional but simplified version of the operating menu structure starts in the Web browser. When installing a new firmware version: To enable correct data display, clear the temporary memory (cache) of the Web browser under **Internet options**.
Network connections	Only the active network connections to the measuring device should be used.
	Switch off all other network connections such as WLAN.

Configuring IP settings for Windows

- To configure the IP settings, appropriate user rights (e.g. administrator rights) are required for the computer.
- Before configuring the IP settings, close all the windows of the Web browser.

1. Click *Start* (Windows icon).
   ↳ The Start menu appears.
2. In the Start menu, select *Control Panel*.
   ↳ This opens a new window with the control panel elements.



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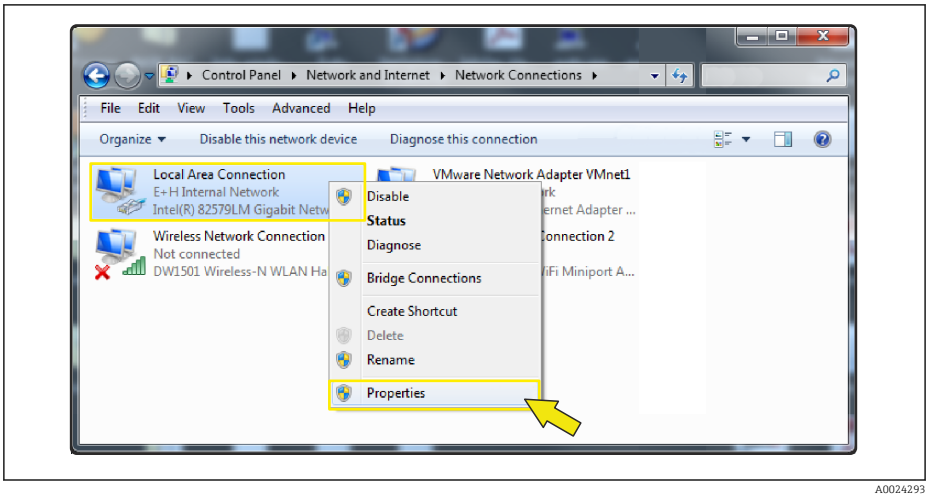
3. Enter the term "adapter" in the search field.
   ↳ The *Network and Sharing Center* is listed in the search results.
4. Select the *Network Connections* option under *Network and Sharing Center*.
   ↳ This opens a new window with the network connections.



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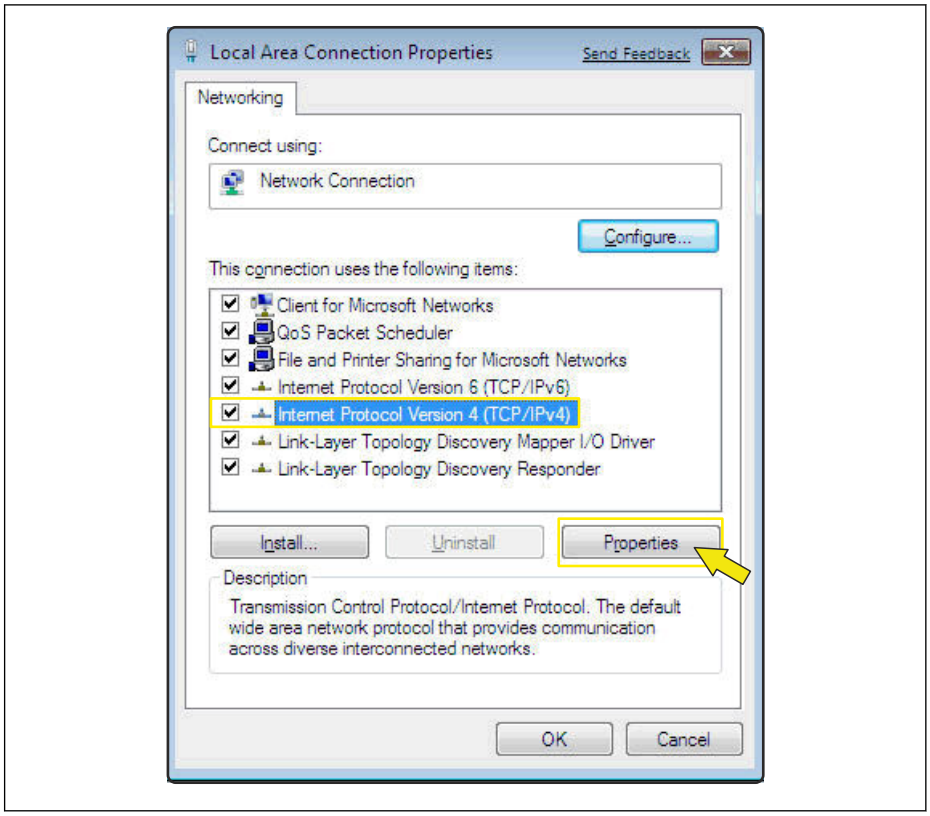
5. In this window, select the *Local Area Connection* (LAN).

6. Right-click to open the picklist and select *Properties*.
   ↳ The *Local Area Connection Properties* dialog box opens.



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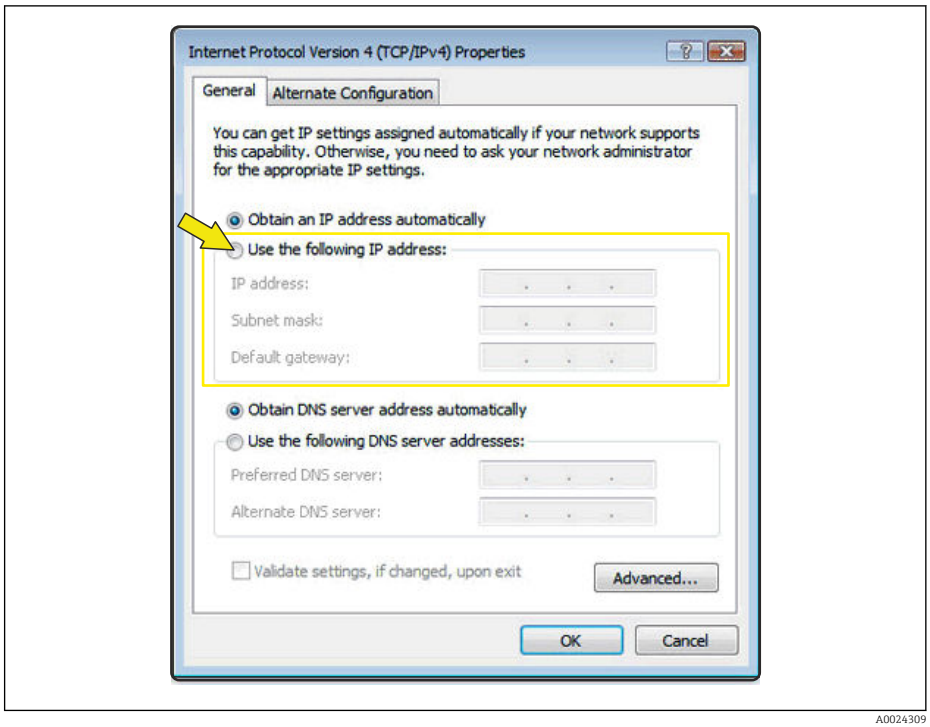
7. Select the *Internet Protocol Version 4 (TCP/IPv4)* item.
8. Click the *Properties* button.
   ↳ The *Internet Protocol Version 4 (TCP/IPv4) Properties* window opens.



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9. In the *General* tab, select the *Use the Following IP Address* option.

10. Enter the IP address, subnet mask and default gateway as indicated in the following table and then click *Ok* to confirm.

Standard settings for IP address, subnet mask and default gateway

IP address	192.168.1.XXX For XXX all numerical sequences except: 0, 212 and 255 → e.g. 192.168.1.213
Subnet mask	255.255.255.0
Default gateway	192.168.1.212 or leave cells empty

The standard settings correspond to those for private networks. In the case of Ethernet-based networks, the settings can deviate from these standard settings and must be changed if necessary.

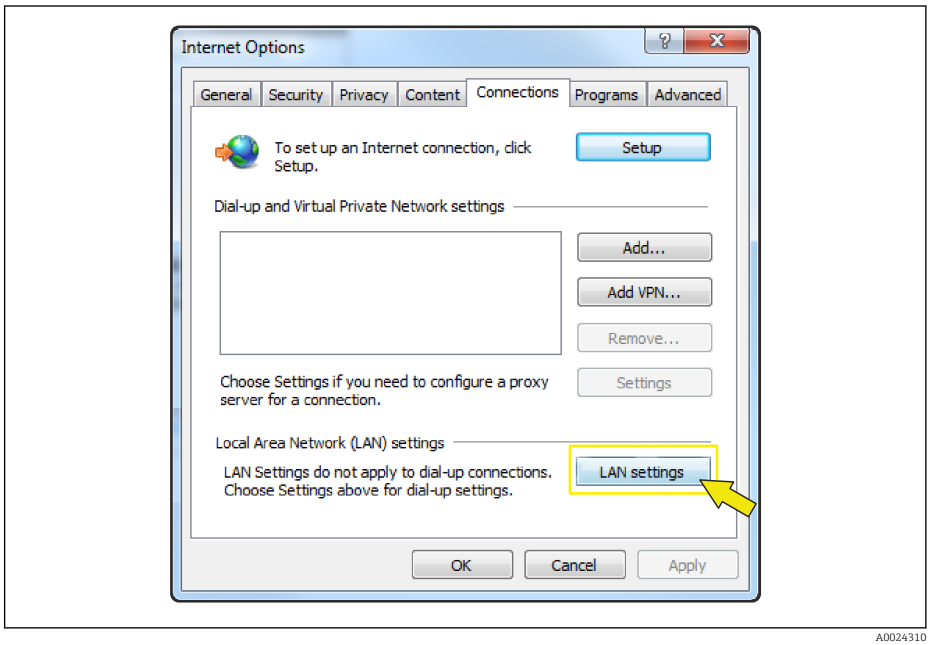
Changing the proxy server settings

To establish communication, the proxy server setting *Use a Proxy Server for Your LAN* must be deselected for the Web browser.

To change the proxy server setting, appropriate user rights (e.g. administrator rights) are required for the computer.

Changing the proxy server settings taking Internet Explorer as the sample browser

1. Open the Web browser.
2. In the *Options* menu, select the *Internet Options* item.
   ↳ This opens a new window with the Internet options.



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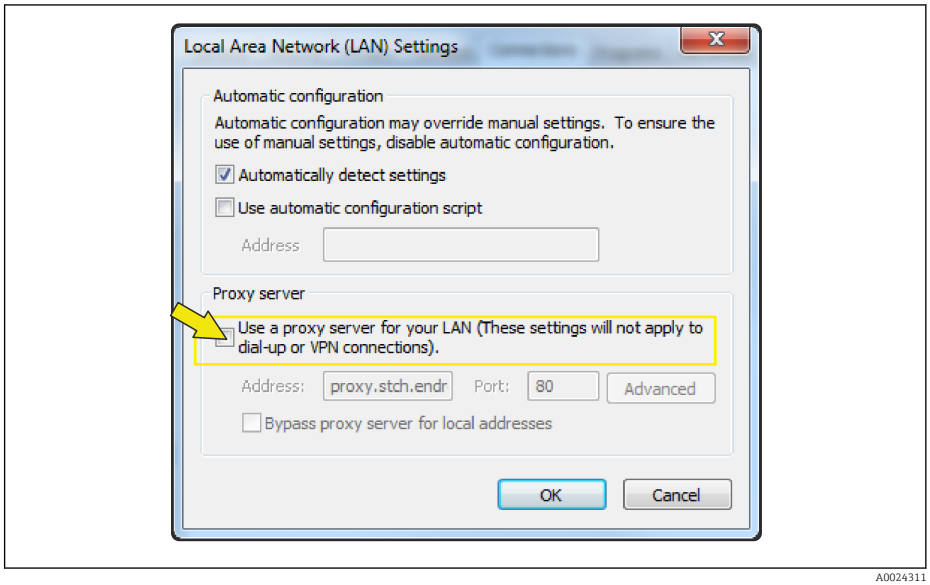
3. Select the *Connections* tab.
4. Under *Local Area Network Settings* click the *LAN Settings* button.
   ↳ This opens a new window with the *Local Area Network Settings*.



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5. Deselect the *Use a Proxy Server for Your LAN* checkbox and then click *Ok* to confirm.

5.2 Prerequisites - measuring device

5.2.1 Enabling the Web server

The Web server must be enabled in the measuring device (factory setting).

If the Web server is disabled it be enabled again via the **Web server functionality** parameter (→ 🖹 22). To do so, users can choose from the following operation options:
- Local display
- Operating tool e.g. FieldCare, DeviceCare, AMS Device Manager , SIMATIC PDM

5.2.2 Determining the IP address of the measuring device

The IP address of the device is required to establish communication between the device (Web server) and a computer (client). The device has the default fixed IP address: 192.168.1.212. This can be entered in the Web browser on the computer to establish communication.

Using the local display or an operating tool

The **IP address** parameter can be used to determine the IP address via the local display or via an operating tool e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM.

5.3 Connecting the computer to the measuring device

The measuring device can be connected to the computer via:
- Service interface (CDI-RJ45)
- WLAN interface

5.3.1 Via service interface (CDI-RJ45)

Preparing the measuring device

1. Loosen the 4 fixing screws on the housing cover.
2. Open the housing cover.
3. The location of the connection socket depends on the measuring device and the communication protocol:
   Connect the computer to the RJ45 connector via the standard Ethernet connecting cable → 🖹 8.

Configuring the Internet protocol of the computer

The following information refers to the default Ethernet settings of the device.

IP address of the device: 192.168.1.212 (factory setting)

NOTICE

Risk of electric shock! Components carry dangerous voltages!
- ▶ Never open the measuring device while it is connected to the supply voltage.
- ▶ The information and safety instructions in the Operating Instructions pertaining to the measuring device must always be observed → 🖹 4.

1. Switch on the measuring device.
2. Connect to the computer using a cable → 🖹 8.
3. If a 2nd network card is not used, close all the applications on the notebook.
   ↳ Applications requiring Internet or a network, such as e-mail, SAP applications, Internet or Windows Explorer.

4. Close any open Internet browsers.
5. Configure the properties of the Internet protocol (TCP/IP) as defined in the table:

IP address	192.168.1.XXX; for XXX all numerical sequences except: 0, 212 and 255 → e.g. 192.168.1.213
Subnet mask	255.255.255.0
Default gateway	192.168.1.212 or leave cells empty

5.3.2 Via WLAN interface

Configuring the Internet protocol of the mobile terminal

NOTICE

If the WLAN connection is lost during the configuration, settings made may be lost.

- Make sure that the WLAN connection is not disconnected while configuring the device.

NOTICE

In principle, avoid simultaneous access to the measuring device via the service interface (CDI-RJ45) and the WLAN interface from the same mobile terminal. This could cause a network conflict.

- Only activate one service interface (CDI-RJ45 service interface or WLAN interface).
- If simultaneous communication is necessary: configure different IP address ranges, e.g. 192.168.0.1 (WLAN interface) and 192.168.1.212 (CDI-RJ45 service interface).

Preparing the mobile terminal

- Enable WLAN reception on the mobile terminal.

Establishing a connection from the mobile terminal to the measuring device

1. In the WLAN settings of the mobile terminal:
   Select the measuring device using the SSID (e.g. EH_Promag__A802000).
2. If necessary, select the WPA2 encryption method.
3. Enter the password: serial number of the measuring device ex-works (e.g. L100A802000).
   ↳ LED on display module flashes: it is now possible to operate the measuring device with the Web browser.

The serial number can be found on the nameplate.

Disconnecting

- After configuring the device:
  Terminate the WLAN connection between the operating unit and measuring device.

5.4 Establishing a connection to the Web server

5.4.1 Prerequisites

The IP settings in the measuring device and computer must match before a connection can be established successfully. In particular this concerns the IP addressing and Web browser settings.

The following conditions must be met to connect:
- The Web server of the measuring device is enabled → 18.
- The IP address of the measuring device is known → 18.
- The computer used meets the requirements for hardware and software → 12.
- The measuring device and computer are connected to one another → 18
- The measuring device is switched on.

5.4.2 Starting the Web browser

If JavaScript cannot be enabled:
enter http://192.168.1.212/basic.html in the address line of the Web browser. A fully functional but simplified version of the operating menu structure starts in the Web browser.

When installing a new firmware version: To enable correct data display, clear the temporary memory (cache) of the Web browser under **Internet options**.

1. Start the Web browser on the computer.
2. Enter the IP address of the Web server in the address line of the Web browser: 192.168.1.212
   ↳ The login page appears.

If a login page does not appear, or if the page is incomplete → 23

5.5 Setting the IP address

The IP address of the measuring device is required to establish communication between the measuring device (Web server) and a computer (client). Depending on the communication protocol of the measuring device, the hardware and the software settings there are different ways of assigning or specifying the IP address.

Assign or specify the IP address via:	Description
The use of the standard IP address [1]	▪ The measuring device uses the fixed IP address: 192.168.1.212 ▪ The device is connected via the CDI RJ45 service interface.

1) Factory setting

5.6 Overview of the Web server parameters

5.6.1 Language

Navigation
"Operation" menu → Web server language

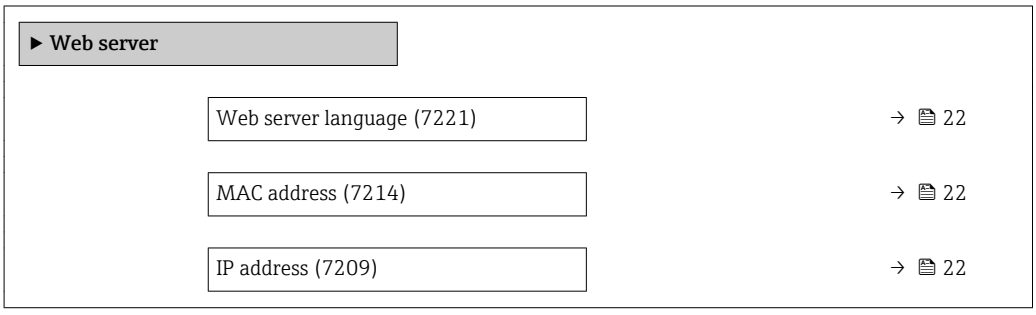
Parameter overview with brief description

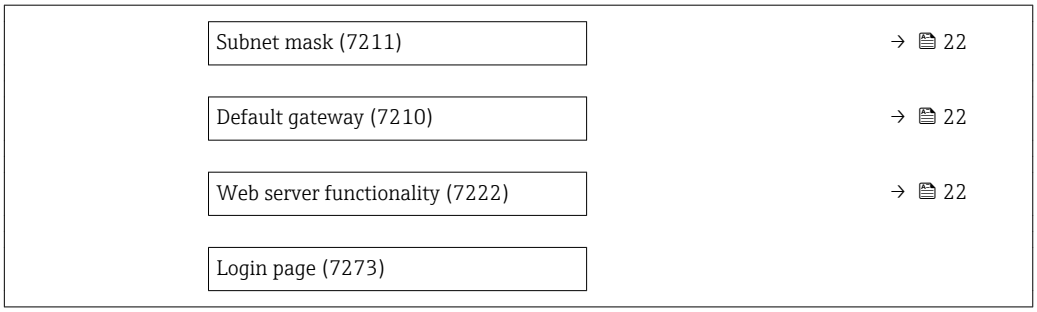
Parameter	Description	Selection	Factory setting
Web server language	Set web server language.	▪ English ▪ Deutsch * ▪ Français * ▪ Español * ▪ Italiano * ▪ Nederlands * ▪ Portuguesa * ▪ Polski * ▪ русский язык (Russian) * ▪ Svenska * ▪ Türkçe * ▪ 中文 (Chinese) * ▪ 日本語 (Japanese) * ▪ 한국어 (Korean) * ▪ Bahasa Indonesia * ▪ tiếng Việt (Vietnamese) * ▪ čeština (Czech) *	English

* Visibility depends on order options or device settings

5.6.2 "Web server" submenu

Navigation
"Expert" menu → Communication → Web server





Parameter overview with brief description

Parameter	Description	Selection / User interface	Factory setting
Web server language	Set web server language.	▪ English ▪ Deutsch * ▪ Français * ▪ Español * ▪ Italiano * ▪ Nederlands * ▪ Portuguesa * ▪ Polski * ▪ русский язык (Russian) * ▪ Svenska * ▪ Türkçe * ▪ 中文 (Chinese) * ▪ 日本語 (Japanese) * ▪ 한국어 (Korean) * ▪ Bahasa Indonesia * ▪ tiếng Việt (Vietnamese) * ▪ čeština (Czech) *	English
MAC address	Displays the MAC address of the measuring device. MAC = Media Access Control	Unique 12-digit character string comprising letters and numbers, e.g.: 00:07:05:10:01:5F	Each measuring device is given an individual address.
IP address	Displays the IP address of the Web server of the measuring device.	4 octet: 0 to 255 (in the particular octet)	192.168.1.212
Subnet mask	Displays the subnet mask.	4 octet: 0 to 255 (in the particular octet)	255.255.255.0
Default gateway	Displays the default gateway.	4 octet: 0 to 255 (in the particular octet)	0.0.0.0
Web server functionality	Switch the Web server on and off.	▪ Off ▪ On	On

* Visibility depends on order options or device settings

6 Diagnostics and troubleshooting

For details on the diagnostic information, see the Operating Instructions for the device → 4.

6.1 General Web server troubleshooting

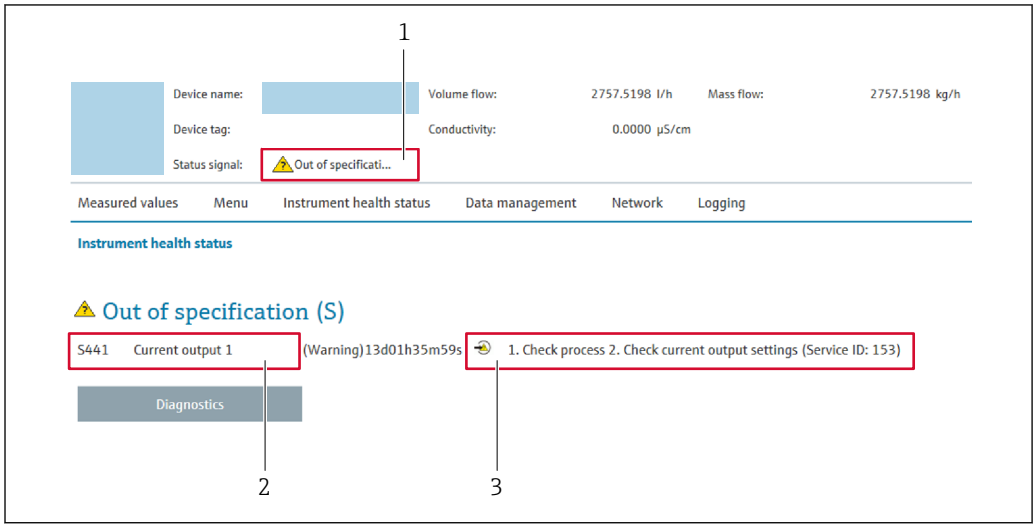
For access

Error	Possible causes	Solution
Not connecting to Web server	Web server disabled	Using the "FieldCare" or "DeviceCare" operating tool, check whether the Web server of the measuring device is enabled, and enable it if necessary .
	Incorrect setting for the Ethernet interface of the computer	1. Check the properties of the Internet protocol (TCP/IP) . 2. Check the network settings with the IT manager.
Not connecting to Web server	Incorrect IP address	Check the IP address: 192.168.1.212
Not connecting to Web server	Incorrect WLAN access data	▪ Check WLAN network status. ▪ Log on to the device again using WLAN access data. ▪ Verify that WLAN is enabled on the measuring device and operating device .
	WLAN communication disabled	–
Not connecting to Web server, FieldCare or DeviceCare	No WLAN network available	▪ Check if WLAN reception is present: LED on display module is lit blue ▪ Check if WLAN connection is enabled: LED on display module flashes blue ▪ Switch on instrument function.
Network connection not present or unstable	WLAN network is weak.	Operating device is outside of reception range: Check network status on operating device.
	Parallel WLAN and Ethernet communication	▪ Check network settings. ▪ Temporarily enable only the WLAN as an interface.
Web browser frozen and operation no longer possible	Data transfer active	Wait until data transfer or current action is finished.
	Connection lost	1. Check cable connection and power supply. 2. Refresh the Web browser and restart if necessary.
Content of Web browser incomplete or difficult to read	Not using optimum version of Web server.	1. Use the correct Web browser version . 2. Clear the Web browser cache and restart the Web browser.
	Unsuitable view settings.	Change the font size/display ratio of the Web browser.
No or incomplete display of contents in the Web browser	▪ JavaScript not enabled ▪ JavaScript cannot be enabled	1. Enable JavaScript. 2. Enter http://192.168.1.212/basic.html as the IP address.

6.2 Diagnostic information in the Web browser

6.2.1 Diagnostic options

Any faults detected by the measuring device are displayed in the Web browser on the home page once the user has logged on.



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1 *Status area with status signal*
2 *Diagnostic information*
3 *Remedy information with Service ID*

In addition, diagnostic events which have occurred can be shown in the **Diagnostics** menu:
- Via parameter
- Via submenu

Status signals

The status signals provide information on the state and reliability of the device by categorizing the cause of the diagnostic information (diagnostic event).

Symbol	Meaning
	Failure A device error has occurred. The measured value is no longer valid.
	Function check The device is in service mode (e.g. during a simulation).
	Out of specification The device is operated: ▪ Outside its technical specification limits (e.g. outside the process temperature range) ▪ Outside of the configuration carried out by the user (e.g. maximum flow in parameter **20 mA value**)
	Maintenance required Maintenance is required. The measured value is still valid.

The status signals are categorized in accordance with VDI/VDE 2650 and NAMUR Recommendation NE 107.

6.2.2 Calling up remedy information

Remedy information is provided for every diagnostic event to ensure that problems can be rectified quickly. These measures are displayed in red along with the diagnostic event and the related diagnostic information.

6.3 Diagnostic information in the measuring device

6.3.1 Overview of Web server information events

Unlike a diagnostic event, an information event is displayed in the event logbook only and not in the diagnostic list.

Information event	Event text
I1000	--------(device OK)
I1110	Write protection switch changed
I1361	Web server login failed
I1627	Web server login successful
I1631	Web server access changed

6.4 Checking the network connection

The network connection between the computer and measuring device can be checked using the "ping" utility of the Internet Control Message Protocol (ICMP).

The "ping" utility sends ICMP(v6) "echo request" packets (ping, ICMP packet type 8 (0x08)) to the target address of the measuring device. According to the protocol specification, the measuring device must send back a response: ICMP "echo reply" (pong, ICMP packet type 0 (0x00)).

1. Click *Start* (Windows icon).
   ↳ The Start screen opens along with the search field.
2. In the search field, enter "cmd" (command).
   ↳ A link to "cmd.exe" is displayed in the results field.
3. Select the "cmd.exe" link.
   ↳ A new command window opens.
4. Enter ping and the IP address, e.g.: ping 192.168.1.212
   ↳ The network connection status is displayed.

Depending on the operating system used, or the version of the operating system, other tools can also be used, such as Powershell.exe, prompt etc.

If the measuring device cannot be reached the router responsible delivers the following response:
- "Network unreachable"
  or
- "Host unreachable"

1. Check the IP address settings → 18.
2. Check whether the Web server is enabled → 18.

7 Technical data

Web server	Stack: standard TCP stack with IPv4 functionality
Connection and session management	▪ Fixed IP address, i.e. no access possible from outside the network ▪ Open ports: – 80 (HTTP for Web server) – 8000 (for Endress+Hauser Service communication) ▪ Only one connection possible at any one time via Hypertext Transfer Protocol (HTTP) ▪ Time out after 10 minutes
Supported functions	▪ Java Script ▪ Communication protocol: Dynamic Host Configuration Protocol (DHCP), based on RFC 2131 ▪ Hypertext Markup Language (HTML) ▪ Cascading Style Sheets (CSS)
Functions not supported	▪ Domain Name System (DNS) ▪ Hyper Text Transfer Protocol Secure (HTTPS)

www.addresses.endress.com

Endress+Hauser

People for Process Automation

SD01847D/06/EN/03.21
71535951
2021-09-01

Valid as of version
02.01.zz (Device firmware)

Special Documentation
Proline Promag 400
HART

Heartbeat Verification + Monitoring application package

Endress+Hauser
People for Process Automation

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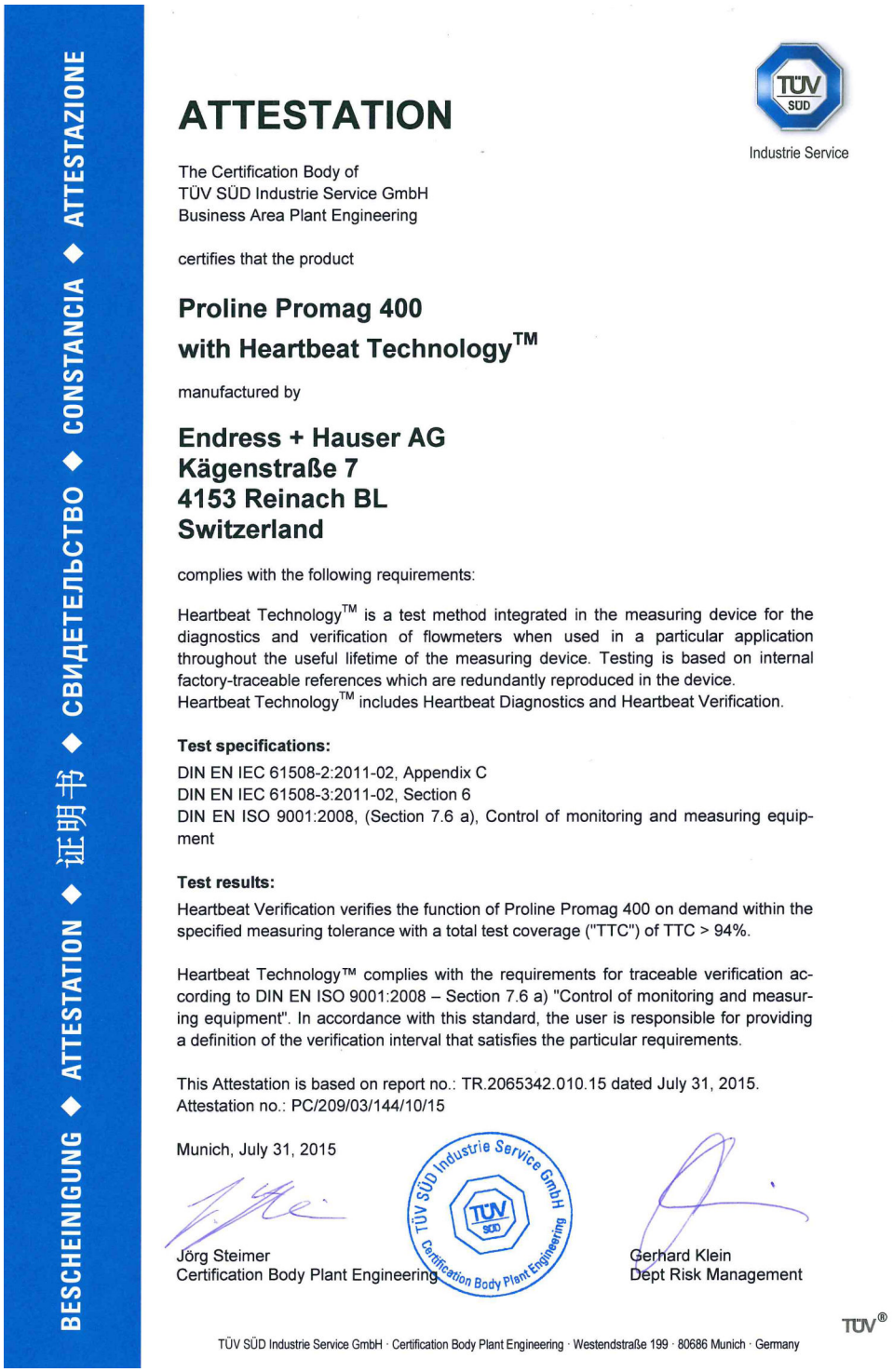
1 Certification



BESCHEINIGUNG ◆ ATTESTATION ◆ 证明书 ◆ СВИДЕТЕЛЬСТВО ◆ CONSTANCIA ◆ ATTESTAZIONE

ATTESTATION

Industrie Service

The Certification Body of
TÜV SÜD Industrie Service GmbH
Business Area Plant Engineering

certifies that the product

Proline Promag 400
with Heartbeat Technology™

manufactured by

Endress + Hauser AG
Kägenstraße 7
4153 Reinach BL
Switzerland

complies with the following requirements:

Heartbeat Technology™ is a test method integrated in the measuring device for the diagnostics and verification of flowmeters when used in a particular application throughout the useful lifetime of the measuring device. Testing is based on internal factory-traceable references which are redundantly reproduced in the device.
Heartbeat Technology™ includes Heartbeat Diagnostics and Heartbeat Verification.

Test specifications:

DIN EN IEC 61508-2:2011-02, Appendix C
DIN EN IEC 61508-3:2011-02, Section 6
DIN EN ISO 9001:2008, (Section 7.6 a), Control of monitoring and measuring equipment

Test results:

Heartbeat Verification verifies the function of Proline Promag 400 on demand within the specified measuring tolerance with a total test coverage ("TTC") of TTC > 94%.

Heartbeat Technology™ complies with the requirements for traceable verification according to DIN EN ISO 9001:2008 – Section 7.6 a) "Control of monitoring and measuring equipment". In accordance with this standard, the user is responsible for providing a definition of the verification interval that satisfies the particular requirements.

This Attestation is based on report no.: TR.2065342.010.15 dated July 31, 2015.
Attestation no.: PC/209/03/144/10/15

Munich, July 31, 2015

Jörg Steimer
Certification Body Plant Engineering

TÜV SÜD Industrie Service GmbH · Certification Body Plant Engineering

Gerhard Klein
Dept Risk Management

TÜV®

TÜV SÜD Industrie Service GmbH · Certification Body Plant Engineering · Westendstraße 199 · 80686 Munich · Germany

Requirements according to DIN EN ISO 9001
All products with Heartbeat Technology™, which meet the requirements of traceable verification according to DIN EN ISO 9001:2008 – Clause 7.6 a) «Control of monitoring and measuring devices», also meet the comparable requirement for traceable verification as per ISO 9001:2015, Clause 7.1.5/7.1.5.2 a) "Monitoring and measuring resources".

2 About this document

2.1 Document function

This manual is a Special Documentation and does not replace the Operating Instructions included in the scope of supply. It is a part of the Operating Instructions and serves as a reference for using the Heartbeat Technology function integrated in the measuring device.

2.2 Content and scope

This document contains descriptions of the additional parameters and technical data of the application package and detailed explanations regarding:

- Application-specific parameters
- Advanced technical specifications

2.3 Symbols

2.3.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

2.3.2 Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
▶	Notice or individual step to be observed
1., 2., 3....	Series of steps

Symbol	Meaning
	Result of a step
A0028662	Operation via local display
A0028663	Operation via operating tool
A0028665	Write-protected parameter

2.3.3 Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections

2.4 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

This documentation is an integral part of the following Operating Instructions:

Measuring device	Documentation code
Promag D 400	BA01061D
Promag L 400	BA01062D
Promag W 400	BA01063D

This Special Documentation is available:
In the Download Area of the Endress+Hauser Internet site: www.endress.com → Downloads

2.5 Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

3 Product features and availability

3.1 Product features

Heartbeat Technology offers diagnostic functionality through continuous self-monitoring, the transmission of additional measured variables to an external Condition Monitoring system and the in-situ verification of flowmeters in the application.

The test scope achieved using these diagnostic and verification tests is referred to as the **Total Test Coverage** (TTC). The TTC is calculated using the following formula for random errors (calculation based on FMEDA as per IEC 61508):

$TTC = (\lambda_{TOT} - \lambda_{du}) / \lambda_{TOT}$

λ_{TOT}: Rate of all theoretically possible failures

λ_{du}: Rate of dangerous undetected failures

Only the dangerous undetected failures are not diagnosed by the device diagnostics. If these failures occur, they can distort the measured value that is displayed or interrupt the output of measured values.

Heartbeat Technology checks the device function within the specified measuring tolerance with a defined TTC.

The current value for the TTC depends on the configuration and integration of the measuring device. The values indicated above were determined under the following conditions:
- Integration of measuring device for measured value output via 4 to 20 mA HART output
- Simulation operation not active
- Error behavior, current output set to **Minimum alarm** or **Maximum alarm** and evaluation unit recognizes both alarms
- Settings for diagnostic behavior correspond to factory settings

3.2 Availability of the application package

The application package can be ordered together with the device or can be activated subsequently with an activation code. Detailed information on the order code is available via the Endress+Hauser website www.endress.com or from your local Endress+Hauser Sales Center.

Promag 400: Devices with generation index B

Devices with generation index B (5X4**B**, see the order code on the transmitter nameplate) can be retrofitted with Heartbeat Technology by replacing the transmitter with generation index C (5X4**C**).

Contact your Endress+Hauser service organization.

3.2.1 Order code

If ordering directly with the device or subsequently as a retrofit kit:

The availability of the application package can be checked as follows:
- Order code with breakdown of the device features on the delivery note
- Call up the Device Viewer via the website www.endress.com/deviceviewer: enter the serial number from the nameplate and check whether the feature is displayed
- In the operating menu Expert → System → Administration : The **Software option overview** parameter indicates whether the application package is enabled

3.2.2 Activation

The **Heartbeat Verification + Monitoring** application package must be enabled in the device if the package is ordered subsequently as a retrofit kit. The retrofit kit contains an activation code that must be entered via the operating menu:

Expert → System → Administration

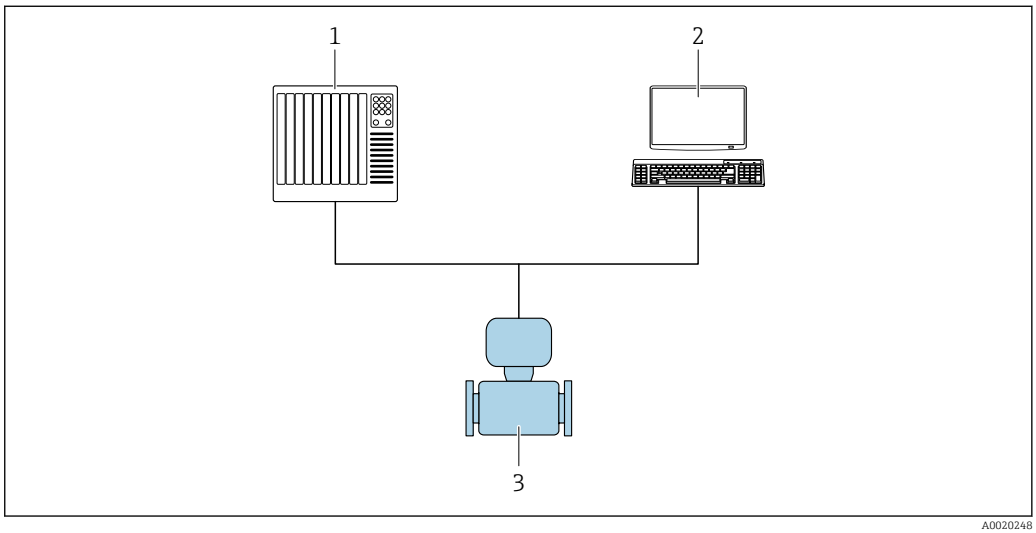
- Enter the activation code.
  - The application package is available.
    The **Software option overview** parameter displays the packages that are currently activated.

3.2.3 Access

Heartbeat Technology is compatible with all the system integration options. Interfaces with digital communication are required to access the data saved in the device. The speed of data transmission depends on the type of communication interface used.

4 System integration

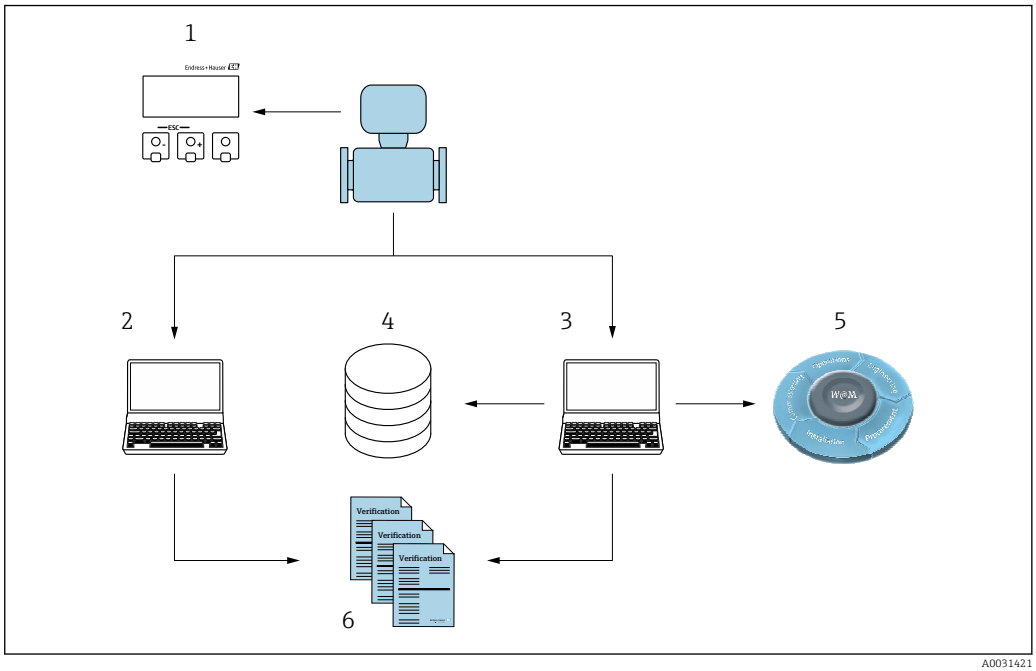
The **Heartbeat Technology** features are available via the local display module and the digital interfaces. The features can be used both via an asset management system and via the automation infrastructure (e.g. PLC).



1 *General layout*

1 PLC
2 Asset management system
3 Measuring device

4.1 Performing the verification and creating a verification report



1 Local display
2 Web browser
3 FieldCare
4 Data archive in the device
5 W@M Portal
6 Verification report

Run the **Heartbeat Verification** via one of the following interfaces:
- System integration interface of a higher-level system
- Local display
- WLAN interface
- CDI-RJ45 service interface (CDI: Common Data Interface)

The device must be accessed externally from a higher-level system via the system integration interface in order to start a verification and signal the verification result (Passed oder Failed). It is not possible to start the verification via an external status signal and relay the results to a higher-level system via the status output.

The detailed results of the verification (8 data records) are saved in the device and provided in the form of a verification report.

Verification reports can be created using the device DTM and the Web server integrated in the measuring device or the FieldCare plant asset management software from Endress+Hauser.

With the Flow Verification DTM, FieldCare also offers the possibility of data management and of archiving the verification results to create traceable documentation.

The Flow Verification DTM also enables trend analysis – i.e. the ability to monitor, compare and track the verification results of all the verifications performed on the device. This can be used for assessment purposes, e.g. to be able to extend recalibration intervals.

Data exchange can take place automatically or be triggered by a user.

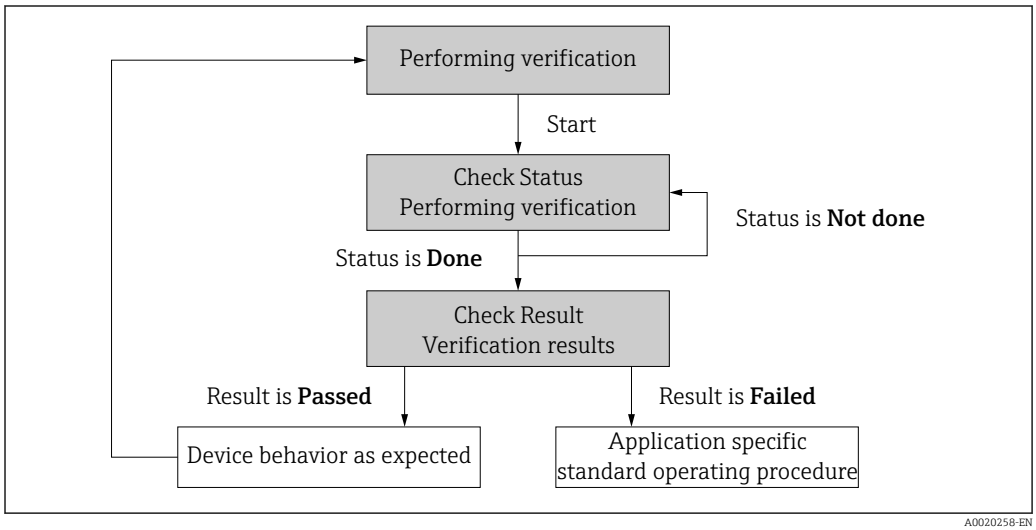
4.2 Automated data exchange

- Instrument check via self-monitoring
- Start verification and verification status

The verification function integrated in the measuring device can be activated by a control system and the results can be checked.

For more information on "System integration", see the Operating Instructions (documentation code)

The following procedure must be implemented for this purpose:



Verification result: The overall result of the verification is indicated in the **Overall result** parameter. Different, application-specific measures must be performed by system routines depending on the result, e.g. a "Maintenance Required" alert is triggered if the result is **Failed**.

4.3 Data exchange performed by the user (asset management system)

Heartbeat Monitoring
The user can read the monitoring measured variables in the operating menu.

Heartbeat Verification
- Start of verification
- Upload, archive and document the verification results including detailed results

4.4 Data management

The results of a **Heartbeat Verification** are saved as a non-volatile parameter set in the measuring device memory:
- Availability of 8 storage locations for parameter data sets
- New verification results overwrite old data following the FIFO [1] principle

The results can be documented in the form of a verification report using the web server integrated in the measuring device or the Endress+Hauser asset management software FieldCare.

FieldCare also offers additional capabilities with the Flow Verification DTM:
- Archiving of verification results
- Export of data from these archives
- Trend analysis of verification results (line recorder function)

4.4.1 Data management via Web browser

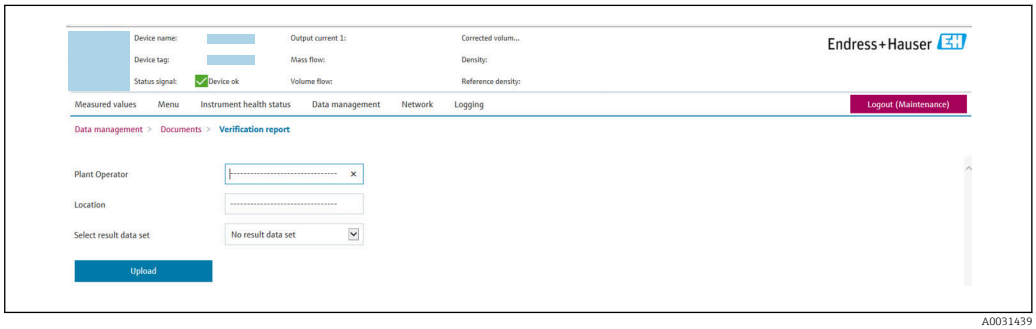
Thanks to the integrated Web server the device can be operated and configured via a Web browser. In addition, it is possible to query the results of the verification and create a verification report.

Printing a verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

User interface in the Web browser following login:



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1. Click the navigation buttons **Data management** → **Documents** → **Verification report**.
   ↳ The input area for downloading verification reports is displayed.
2. Enter the necessary information in the **Plant operator** and **Location** fields.
   ↳ The information entered here appears in the verification report.

1) First In – First Out

3. Select the result data set.
   ↳ A result data set is indicated as a time stamp in the drop-down list.
   If no verification has been performed, the message "No result data set" is displayed here.
4. Click **Upload**.
   ↳ The Web server generates a verification report in PDF format.

4.4.2 Data management via Flow Verification DTM

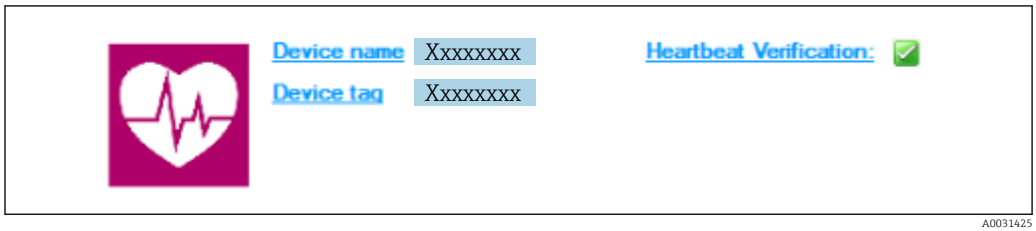
A special DTM (Flow Verification DTM) is available for **Heartbeat Verification**. The Flow Verification DTM offers advanced capabilities for managing and visualizing the results.

Basic functions

The following basic functions are available:

	Read data records from the device
	Create a new archive
	Open saved archive files
	Save data sets to an existing archive file or initial saving of data sets to a new archive file
	Save the data sets under a new file name; a new archive file is created in this case
	Create a verification report in PDF format

Header



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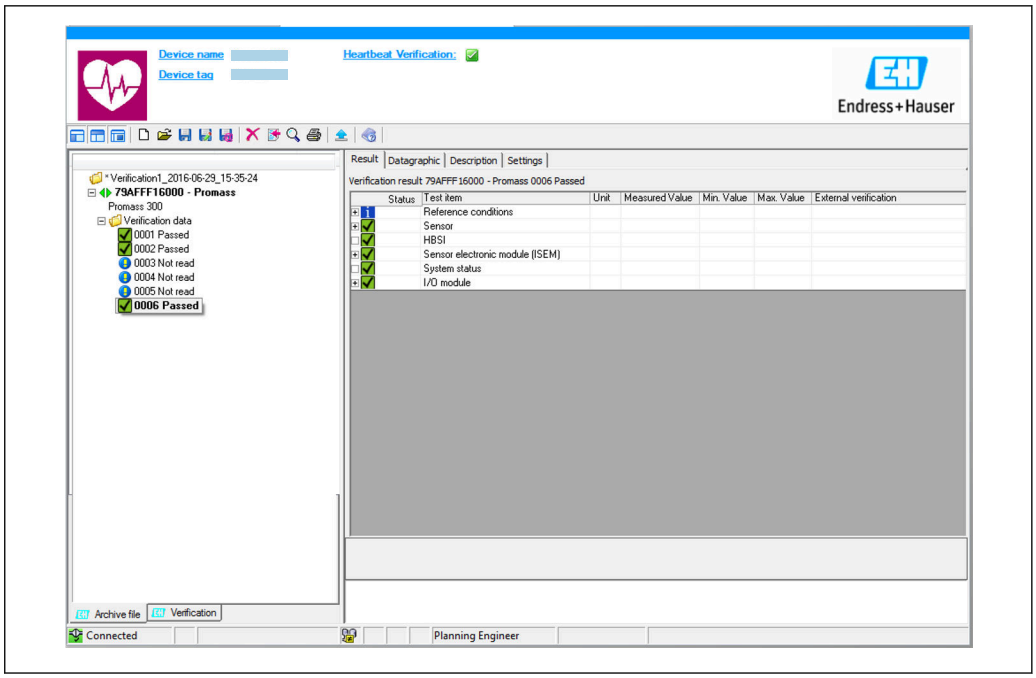
- Top display area of the DTM
- Contains the following information:
  - Measuring device
  - Device tag
- Indicates whether verification is active: ☑

Reading out data

Start uploading the data from the measuring device to the asset management software.



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2 *Sample graphic*

- ▶ Click an individual data set.
  - ↳ Selected data sets, which are saved in the measuring device, are transmitted to the asset management software and visualized.

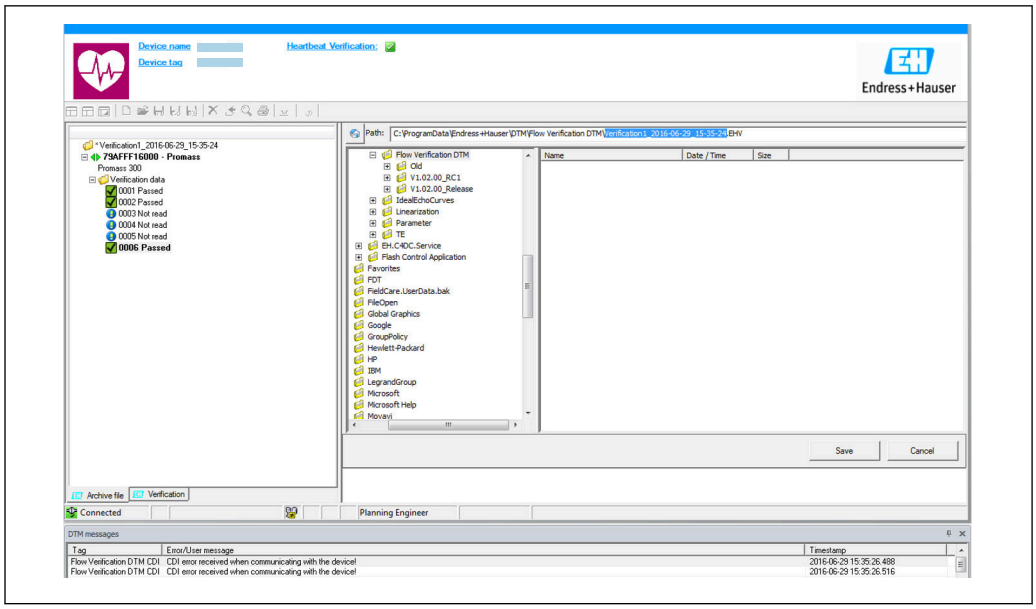
Verification results

Details for the verification results are displayed in the data area.

The data area is split into 3 tabs:
- Result – status, test group and detailed results including limit values
- Data graphic – visualization of results as a trend curve
- Description – additional descriptions and information entered by the user

Saving to an archive file

Save the data to an archive after upload.



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3 Sample graphic

- Click the icons and .
  - A file with the extension ".EHV" is generated.
    This file is used to archive the data. It can be read and interpreted by every asset management system with an installed Flow Verification DTM and is therefore also suitable for analysis by a third party (e.g. Endress+Hauser service organization).

Opening the archive file

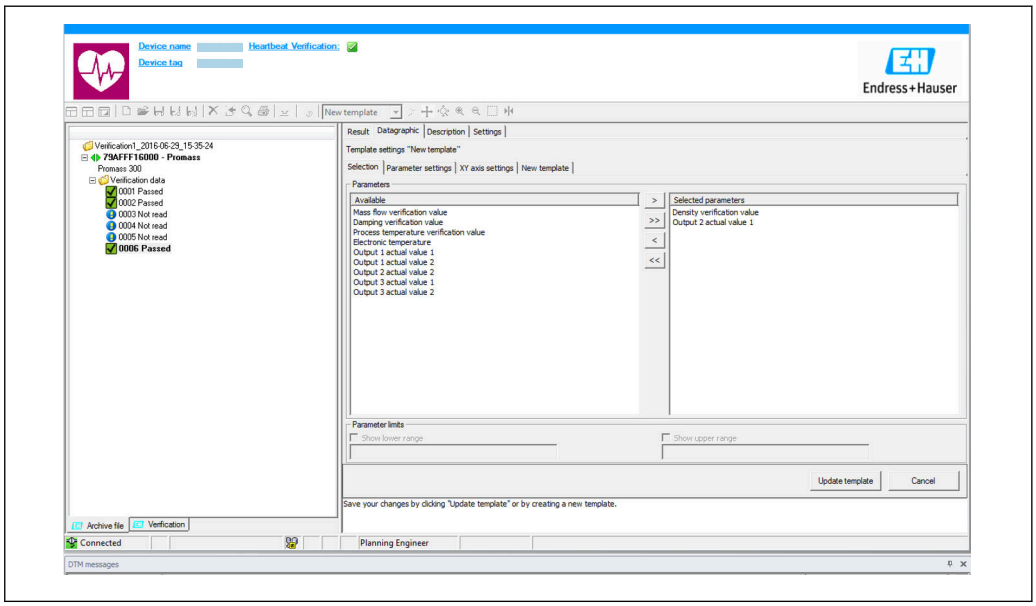
Open archive files already available.

- Click the icon.
  - The archive data are uploaded to the Flow Verification DTM.

Configuring visualization and trending

The verification data can be visualized in the Graphic tab in the data area. The data saved in the archive are visualized as a graph over time. For this purpose, any of the data available can be selected.

Selecting the measured variables



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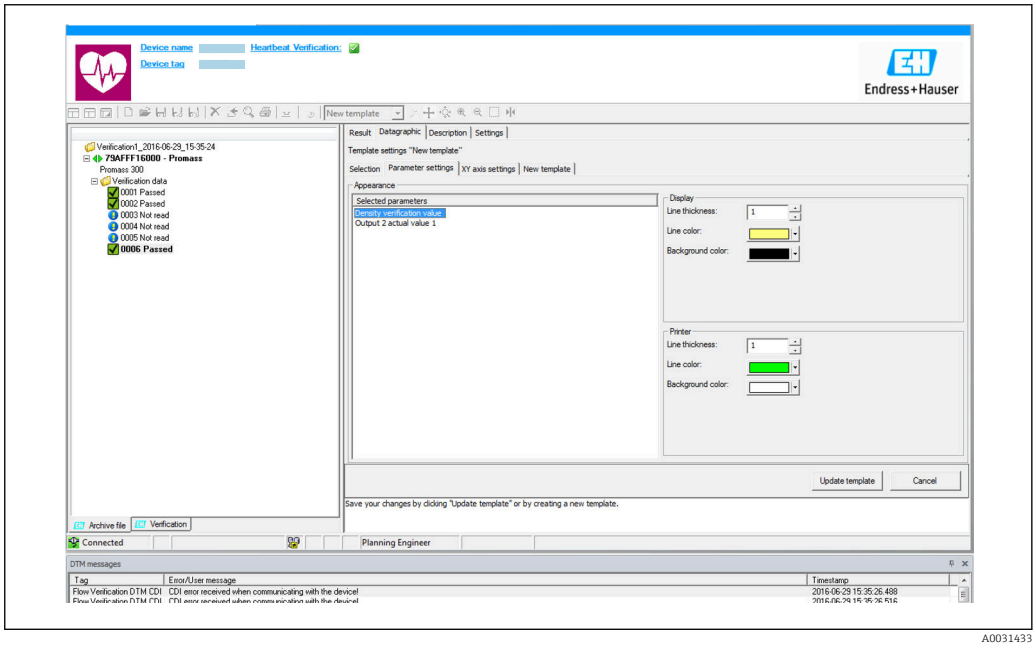
4 *Sample graphic*

- Select the measured variables using the list displayed.

Visualizing a graph



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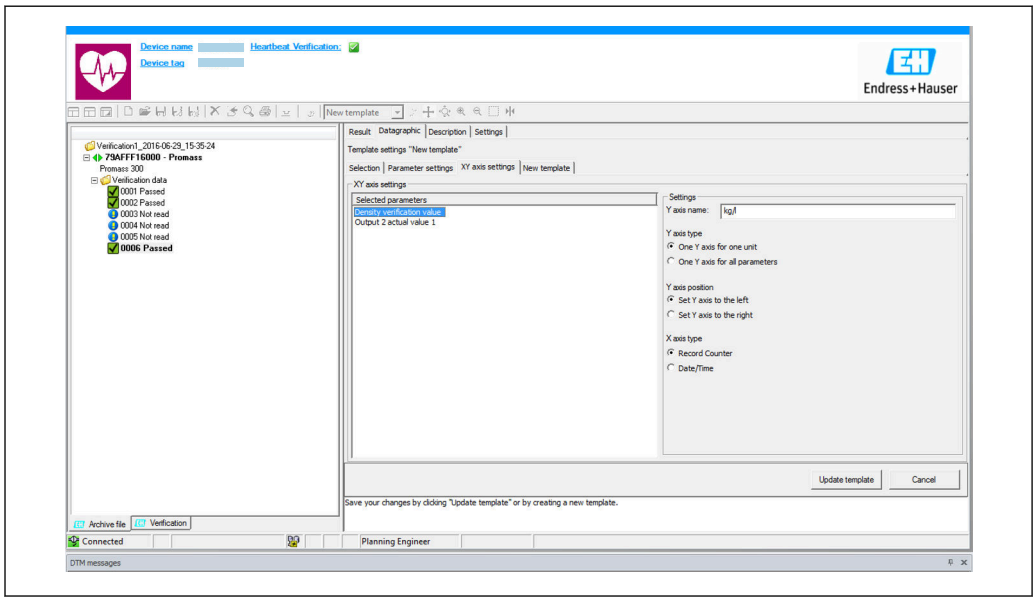
5 *Sample graphic*

- Assign properties for visualization of the graph.

Configuring the Y-axis



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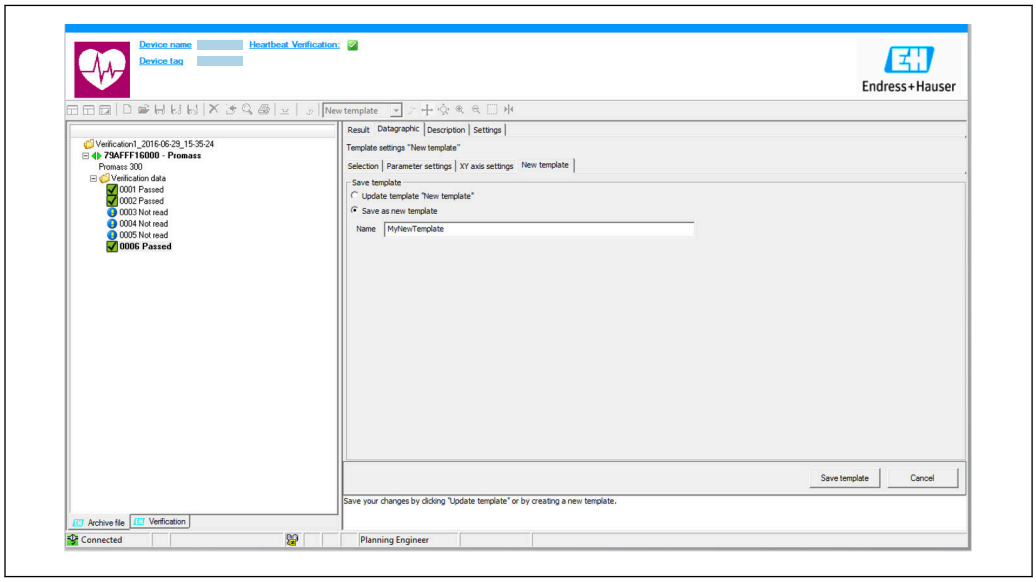
6 *Sample graphic*

- ▶ Assign the measured variables of the Y-axis.

Updating template or creating new template



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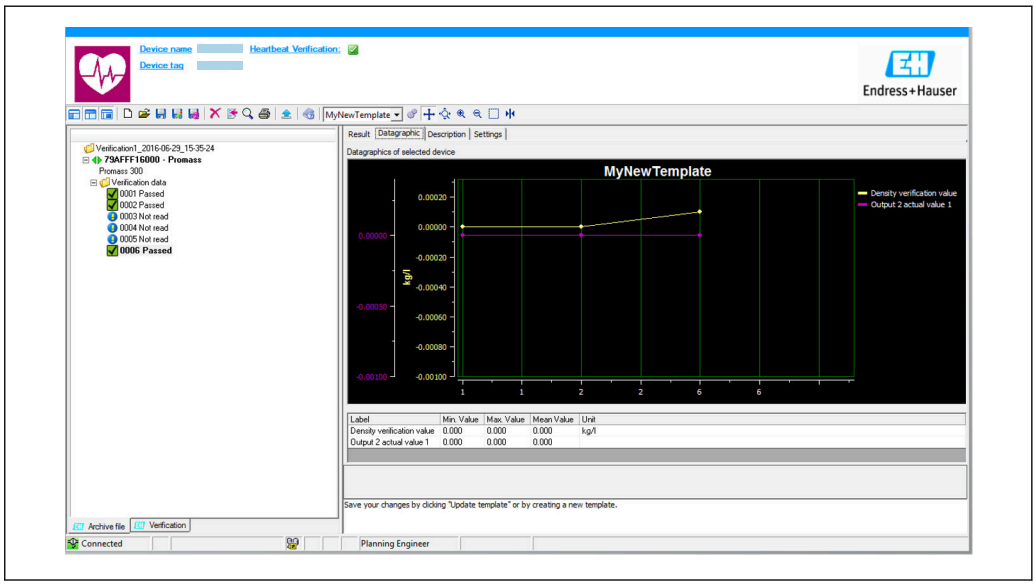
7 *Sample graphic*

- ▶ Add a selected parameter configuration to the template or save under a new template name.

Showing the visualization trend



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8 *Sample graphic*

- ▶ Display the template.
  - ↳ The template shows the data in chronological order. The data points are referenced by the verification ID (X-axis), the Y-axis displays the parameters defined in the configuration.

Creating a verification report

1. Click the icon.
2. Select the data set.
   - ↳ A verification report is generated.

5 Heartbeat Verification

Heartbeat Verification checks the device function within the specified measuring tolerance on demand. The result of the verification is "Passed" or "Failed".

The verification data are saved in the device and, optionally, are archived on a PC with the FieldCare asset management software . A verification report is generated automatically on the basis of these data to ensure the traceable documentation of the verification results.

Heartbeat Technology offers two ways to perform Heartbeat Verification:
- Standard verification → 20
  Verification is performed by the device without manual checking of external measured variables.
- Extended verification → 23
  Verification also includes the entry of external measured variables.

5.1 Performance characteristics

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with further checks (coil circuit measurement, shot control circuit, electrode signal integrity).

Standard verification additionally checks the following inputs and outputs:
- 4 to 20 mA current output
- Pulse/frequency output
- Reference voltage

Extended verification supports verification of the following output modules:
- 4 to 20 mA current output
- Pulse/frequency output
- Reference voltage

The verification is based on references that are incorporated in the measuring device, traceable from the factory and redundant in the device. **Heartbeat Verification** confirms on demand the device function with the total test coverage (TTC).

Assessed by an independent body: **Heartbeat Technology** meets the requirement for traceable verification according to DIN EN ISO 9001: 2015 Chapter 7.1.5.2 a) Control of monitoring and measuring equipment.

5.2 Commissioning

The configuration (factory reference) required as part of **Heartbeat Verification** is recorded during calibration at the factory and is permanently stored in the measuring device. When verifying in the application, the current situation of the measuring device is compared against this factory reference.

Recommendation: Perform initial verification when commissioning the device (and all other verifications in the life cycle) under process or reference conditions. → 11.

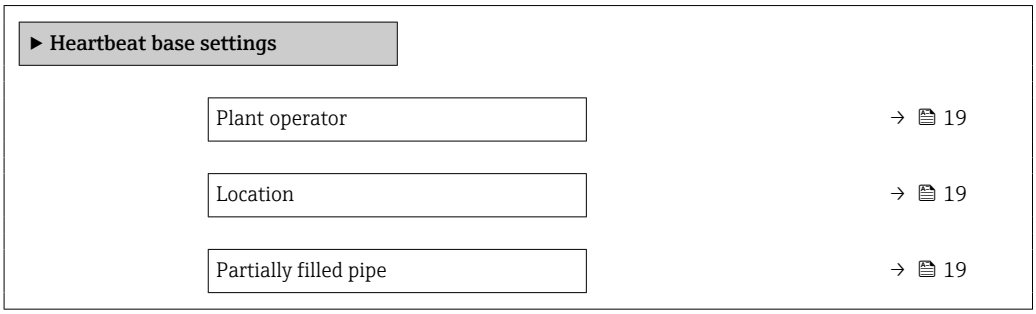
The results are saved as an initial situation in the measuring device life cycle up until the 8th verification; from the 9th verification onwards an upload using the verification DTM is recommended.

5.2.1 Recording reference data

It is possible to manually record reference data relating to the operator and the location. These reference data appear on the verification report.

Navigation
"Setup" menu → Advanced setup → Heartbeat setup → Heartbeat base settings

Navigation
"Expert" menu → Diagnostics → Heartbeat → Heartbeat base settings



Parameter overview with brief description

Parameter	Description	User entry / Selection	Factory setting
Plant operator	Enter the plant operator.	Max. 32 characters such as letters, numbers or special characters (e.g. @, %, /)	–
Location	Enter the location.	Max. 32 characters such as letters, numbers or special characters (e.g. @, %, /)	–
Partially filled pipe	Indicate, if the measuring tube is partially filled during the verification process in order to avoid evaluating the EPD electrode cable.	▪ No ▪ Yes	No

5.3 Operation

5.3.1 General information

The **Heartbeat Verification** function can be used without restriction on a custody-transfer (CT) measuring device in the custody transfer mode.

In the case of measuring devices that are used in safety-related applications according to IEC 61508, the SIL mode must be disabled in order to use the **Heartbeat Verification** feature.

Initial verification

▶ When commissioning the measuring device:
Perform an initial verification to save the results as an initial situation in the life cycle of the measuring device. From the ninth verification onwards, an upload using the Verification DTM is recommended.

Initial verification can be performed in 2 ways:
▪ Standard verification → 20
▪ Extended verification → 23

Device behavior and interpretation

Result "Passed"

All test results are within the specifications.

If the calibration factor and the zero point match the factory settings, there is a high degree of certainty that the measuring device complies with the specification for flow.

Verification generally delivers the result Passed in most applications.

Result "Failed"

One or more test results are outside the specifications.

If the result of the verification is "Failed", take the following measures:

1. Establish defined and stable process conditions.
   ↳ Ensure a constant process temperature.
   Avoid wet gases, pulsating flow, pressure shock and very high flow rates.
2. Repeat verification.
   ↳ Repeat verification "Passed"
   If the result of the second verification is "Passed", the result of the first verification can be ignored. In order to identify possible deviations, compare the current process conditions with the process conditions of a previous verification.

If the result of the verification is "Failed" again, take the following measures:

1. Take remedial action on the basis of the verification results and the diagnostic information of the measuring device.
   ↳ The cause of the error can be narrowed down if the test group that "Failed" the verification is identified.
2. Provide Endress+Hauser Service with the verification result with the current process conditions.
3. Check the calibration or calibrate the measuring device.
   ↳ The calibration has the advantage that the "as found" measuring device state is recorded and the actual measured error is determined.

5.3.2 Standard verification

Standard verification is performed automatically by the device and without manual checking of external measured variables.

Diagnostic behavior

The device signals that standard verification is being performed: ⚠**C302 Device verification in progress** diagnostic message
- Factory setting for diagnostic behavior: warning
- The device continues to measure.
- The last good value is output intermittently for 10 seconds.
- All the measured values are counted up on the totalizers during the verification.
- Test duration: Approximately 60 seconds.

- The diagnostic behavior can be changed by the user if necessary:
  Expert → System → Diagnostic handling → Diagnostic behavior
  If **Alarm** is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and totalizers adopt the defined alarm condition.
- A category is assigned to the diagnostic message of the outputs in the **Diagnostic configuration** submenu.
  Expert → Communication → Diagnostic configuration
  If the device does not have outputs, they are output as an error. To prevent an error from being output, assign the **No effect (N)** option to any outputs that are not present on the device.

For detailed information on diagnostics and troubleshooting and for diagnostic information and associated remedial measures, see the Operating Instructions → 6.

Performing standard verification

Before verification starts

The date and time are saved with the current operating time and the verification results and also appear in the verification report.

The **Year** parameter, **Month, Day, Hour, AM/PM and Minute** are used to manually record the data at the time of verification.

1. Enter date and time.

Select the verification mode

2. In the **Verification mode** parameter, select the **Standard verification** option.

Starting the verification test

3. In the **Start verification** parameter, select the **Start** option.
   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the **Progress** parameter.

Displaying the verification status and result

The current status of the standard verification is indicated in the **Status** parameter (→ 23):
- Done
  The verification test is finished.
- Busy
  The verification test is running.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  A precondition for performing the verification has not been met; verification cannot start (e.g. due to unstable process parameters) → 19.

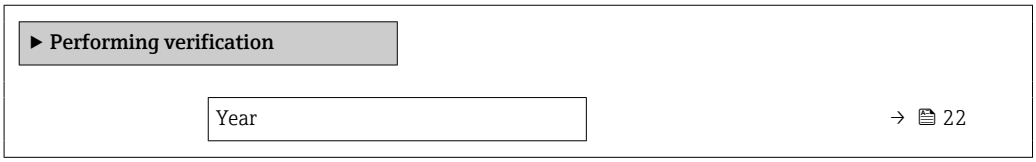
The result of the verification is displayed in the **Overall result** parameter (→ 23):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

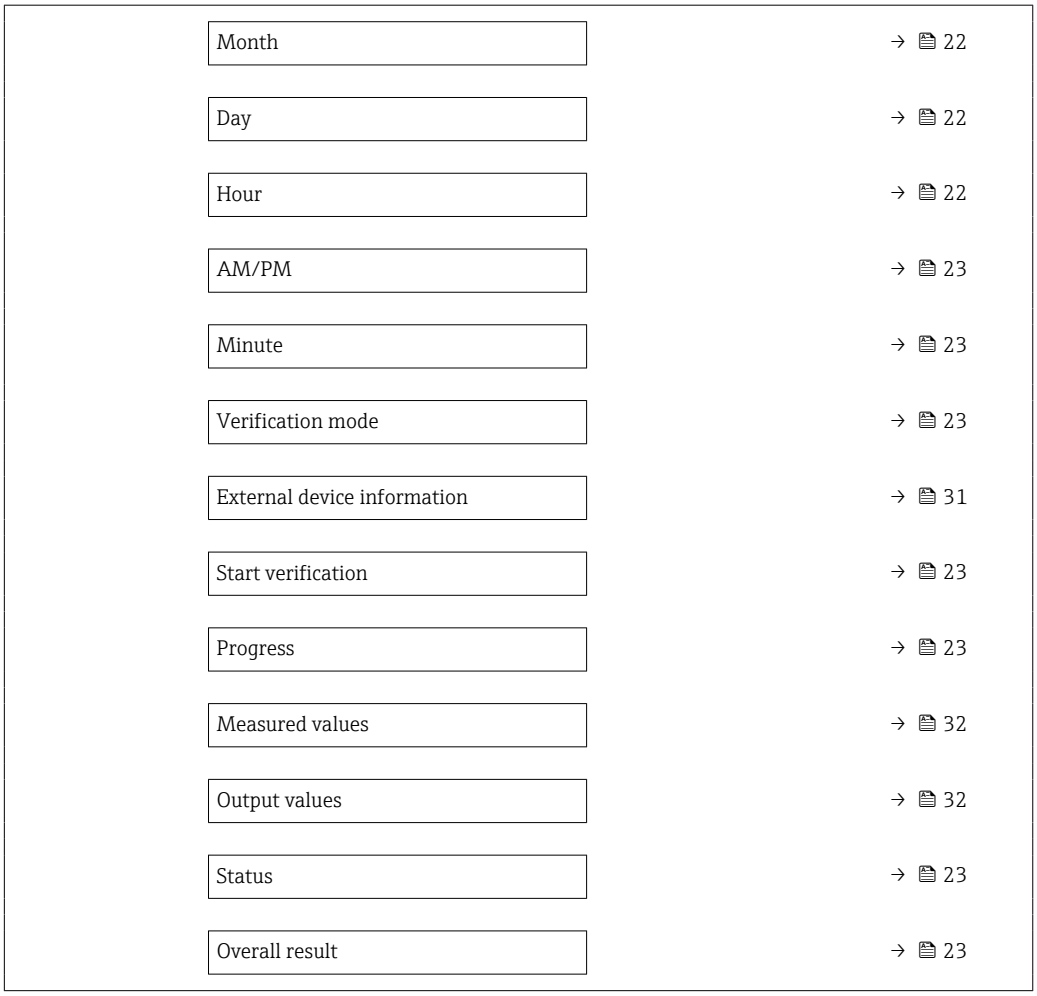
- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the result of the verification (test groups and test status) is also provided in the verification report in addition to the overall result → 35.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This helps users to perform a targeted search for the cause of the error → 19.

"Performing verification" submenu

Navigation

"Diagnostics" menu → Heartbeat Technology → Performing verification





Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 1): enter the year verification is performed.	9 to 99	10
Month	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 2): enter the month verification is performed.	▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December	January
Day	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 3): enter the day verification is performed.	1 to 31 d	1 d
Hour	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 4): enter the hour verification is performed.	0 to 23 h	12 h

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
AM/PM	Can be edited if Heartbeat Verification is not active. The **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected in the **Date/ time format** parameter (2812).	Entry for date and time (field 5): enter the morning or afternoon.	▪ AM ▪ PM	AM
Minute	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Standard verification Verification is performed automatically by the device and without manual checking of external measured variables.	▪ Standard verification ▪ Extended verification	Standard verification
Start verification	–	Start the verification. Start the verification with the **Start** option.	▪ Cancel ▪ Start ▪ Output 1 low value * ▪ Output 1 high value * ▪ Frequency output 1 * ▪ Pulse output 1 * ▪ Frequency output 2 * ▪ Pulse output 2 *	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	0 %
Status	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done	–
Overall result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	–

* Visibility depends on order options or device settings

5.3.3 Extended verification

Extended verification extends the standard verification by additionally outputting a number of different measured variables and by verifying the sensors using a test kit [material no. 71097625 for DN 15 to 65 (½ to 2½") or 50093274 for DN 50 to 4000 (2 to 160")]. During the verification process, these measured variables are recorded manually with the help of external measuring equipment and entered into the measuring device (e.g. actual value at current output). The value entered is checked and verified by the measuring device to ensure that it complies with the factory specifications. A status (Passed or Failed) is issued accordingly and is documented as an individual result of the verification and taken into account in the overall result.

Permanently predefined output signals are simulated during extended verification of the outputs. These output signals do not represent the current measured value. To measure the simulated signals, it may be necessary to set the higher-level process control system to

a safe state beforehand. In order to perform a verification, the pulse/frequency/switch output must be enabled and assigned to a measured variable.

Extended verification measured variables
Device reference voltage
The device uses an internal reference voltage. The actual value of the reference voltages can be accessed at the sensor electronic module (ISEM). The measured values of both test points are entered at the device.

Output current (current output)
- Simulation of the measured values for every output physically present on the device
- Simulation "Low value" and "High value"
- Measurement of the two values
- Entry of the two measured values in the verification screen

Output frequency (pulse/frequency output)
- Simulation of the measured values for every output physically present on the device
- Simulation value pulse output: Simulated frequency depending on the pulse width configured
- Simulation value frequency output: Maximum frequency

Measuring equipment requirements

Recommendations for the measuring equipment

DC current measuring uncertainty	±0.2 %
DC current resolution	10 µA
DC voltage measuring uncertainty	±0.1 %
DC voltage resolution	1 mV
Frequency measuring uncertainty	±0.1 %
Frequency resolution	1 Hz
Temperature coefficient	0.0075 %/°C

Connecting the measuring equipment in the measuring circuit

⚠ WARNING

Danger to persons from non-approved equipment in the hazardous area!
- ▶ Only use intrinsically safe measuring equipment in hazardous zones.
- ▶ Measure intrinsically safe circuits with approved equipment only.
- ▶ Outputs (passive) for the hazardous area may only be connected to suitable intrinsically safe circuits.

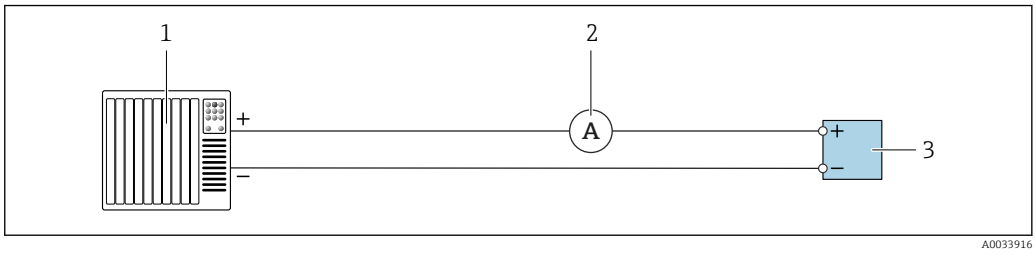
Determining the terminal assignment for the outputs

The terminal assignment depends on the specific device version.

To determine the device-specific terminal assignment:
See the adhesive label in the terminal cover

For detailed information on the terminal assignment, see the Operating Instructions for the device → 🖹 6

Active current output



9 *Extended verification of the active current output*

1 *Automation system with current input (e.g. PLC)*
2 *Ammeter*
3 *Transmitter*

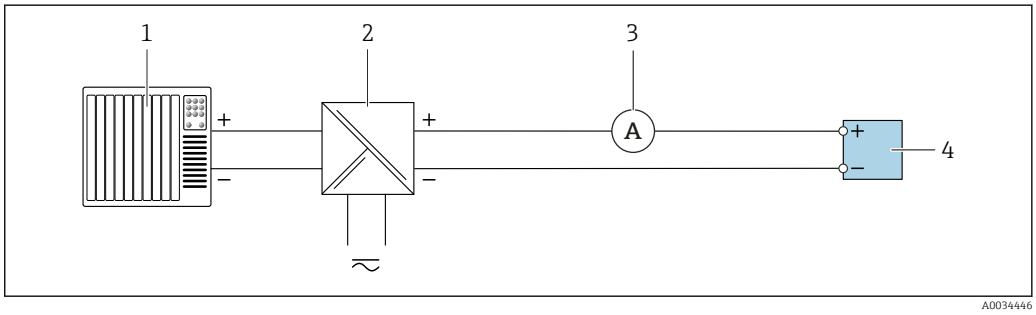
Extended verification of the active current output

- Connect the ammeter to the transmitter by looping it in series into the circuit.

If the automation system is switched off, the measuring circuit may be interrupted as a result. It is then not possible to perform a measurement. If this is the case, proceed as follows:

1. Disconnect the output cables of the current output (+/−) from the automation system.
2. Short the output cables of the current output (+ / -).
3. Connect the ammeter to the transmitter by looping it in series into the circuit.

Passive current output



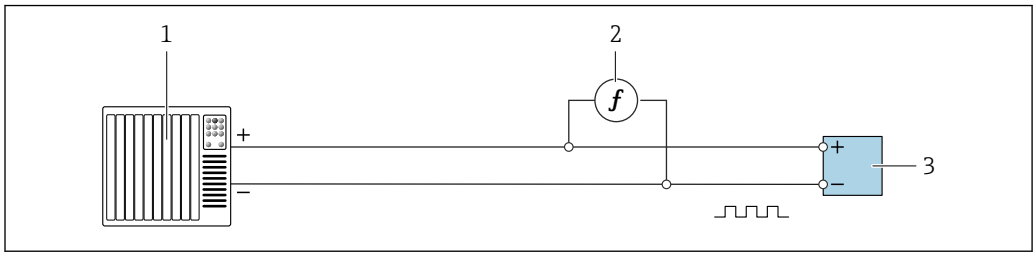
10 *Extended verification of the passive current output*

1 *Automation system with current input (e.g. PLC)*
2 *Power supply unit*
3 *Ammeter*
4 *Transmitter*

Extended verification of the passive current output

1. Connect the ammeter to the transmitter by looping it in series into the circuit.
2. Connect the power supply unit.

Active pulse/frequency/switch output



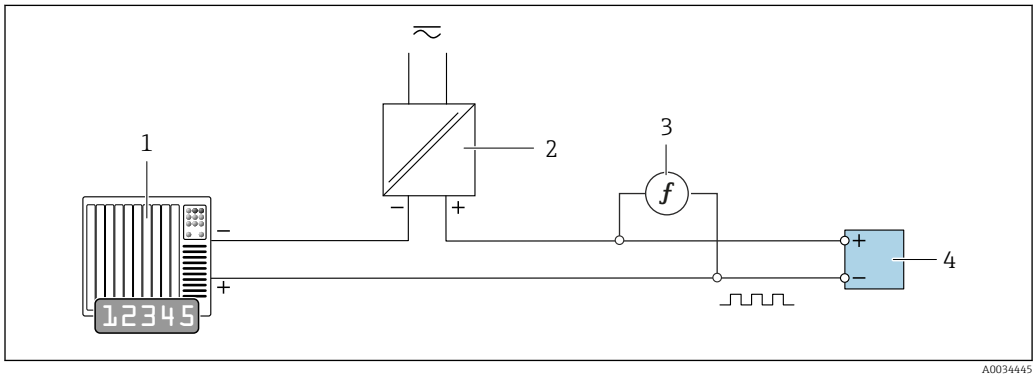
11 *Extended verification of the active pulse/frequency output*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Frequency meter*
3 *Transmitter*

Extended verification of the active pulse/frequency output

- Connect the frequency meter in parallel to the pulse/frequency output of the transmitter

Passive pulse/frequency/switch output



12 *Extended verification of the passive pulse/frequency output*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply unit*
3 *Frequency meter*
4 *Transmitter*

Extended verification of the passive pulse/frequency output

1. Connect the power supply unit
2. Connect the frequency meter in parallel to the pulse/frequency output of the transmitter

Extended verification via reference voltage

WARNING

Danger to persons from non-approved equipment in the hazardous area!

- Only use intrinsically safe measuring equipment in hazardous zones.

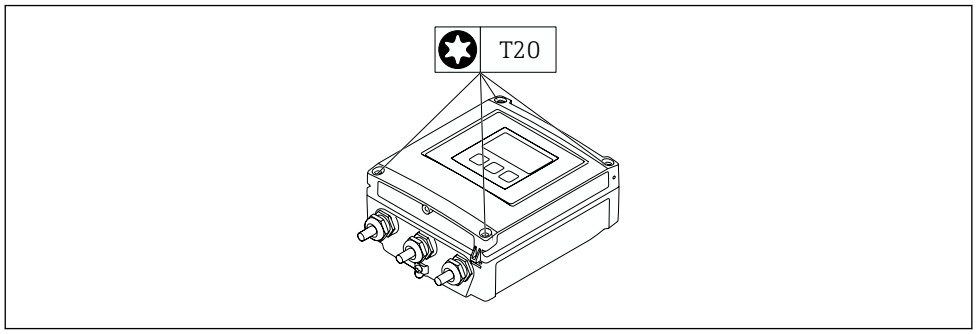
WARNING

Risk of electric shock! Components carry dangerous voltages!

- Only properly trained specialist staff may perform electrical connection work.
- Observe applicable federal/national installation codes and regulations.
- Comply with local workplace safety regulations.
- Do not open the measuring device while it is connected to the supply voltage.

The connection for measuring the reference voltage is established via the sensor electronics module (ISEM).

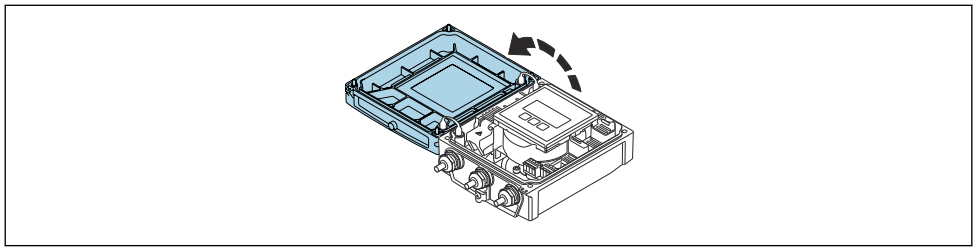
1.



A0021571

Loosen the 4 fixing screws on the housing cover.

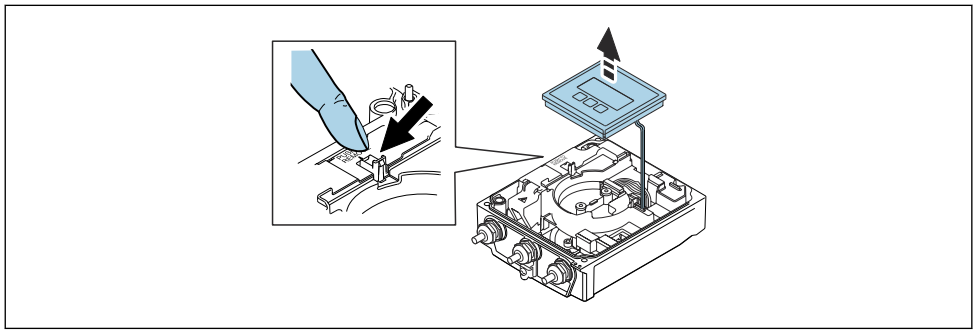
2.



A0021572

Open the housing cover.

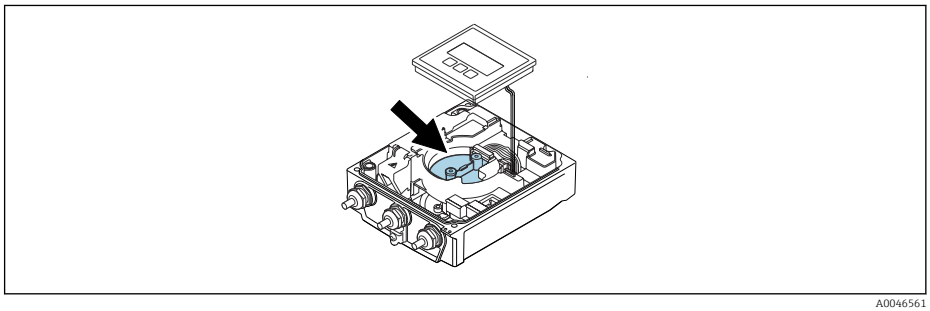
3.



A0046553

Lift the display module.

↳ The sensor electronics module (ISEM) is located under the display module.



A0046561

4. The external reference voltage can be measured via the GND and REF terminals of the sensor electronics module (ISEM).

For detailed information on the **External reference voltage 1** parameter → 30

Diagnostic behavior

A diagnostic event signals that extended verification is being performed:
- The screen alternates between the status signal "C" (Function Check) and the operational display:
  Verification is currently active in the device.
- Different diagnostic behaviors, along with the relevant diagnostic codes, can be displayed depending on the device version.
  The output selected under the **Start verification** parameter is always displayed, however:
  Output 1…n low value option, **Output 1…n high value** option

Diagnostic code	Diagnostic behavior	Options in Start verification
C491	**Current output 1 to n simulation** active	Output 1…n low value Output 1…n high value
C492	**Simulation frequency output 1 to n** active	Frequency output 1…n
C493	**Simulation pulse output 1 to n** active	Pulse output 1…n
C302	⚠**C302 Device verification in progress**	

If the **Start** option is selected in the **Start verification** parameter, the following diagnostic event is shown on the display (2nd part of external verification): ⚠**C302 Device verification in progress** diagnostic message
- Factory setting for diagnostic behavior: warning
- The device continues to measure.
- The last good value is output intermittently for 10 seconds.
- All the measured values are counted up on the totalizers during the verification.
- Test duration (all outputs switched on): Approximately 60 seconds.

- The diagnostic behavior can be changed by the user if necessary:
  Expert → System → Diagnostic handling → Diagnostic behavior
  If **Alarm** is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and totalizers adopt the defined alarm condition.
- A category is assigned to the diagnostic message of the outputs in the **Diagnostic configuration** submenu.
  Expert → Communication → Diagnostic configuration
  If the device does not have outputs, they are output as an error. To prevent an error from being output, assign the **No effect (N)** option to any outputs that are not present on the device.

For detailed information on diagnostics and troubleshooting and for diagnostic information and associated remedial measures, see the Operating Instructions → 🖹 6.

Performing extended verification

A full standard verification is performed in the course of the verification. The validity of the entered and measured values of the outputs is checked. Additional standard verification of the outputs does not take place.

NOTICE

Extended verification is not possible if no connection has been established and the ammeter is looped in during verification.
- ▶ Establish a connection before extended verification starts.
- ▶ Loop in ammeter before extended verification starts.

Before verification starts

The date and time are saved with the current operating time and the verification results and also appear in the verification report.

The **Year** parameter, **Month, Day, Hour, AM/PM and Minute** are used to manually record the data at the time of verification.

1. Enter date and time.

Select the verification mode

2. In the **Verification mode** parameter, select the **Extended verification** option.

Further parameter settings

3. In the **External device information** parameter, enter a unique ID (e.g. serial number) of the measuring equipment used (max. 32 characters).
4. In the **Start verification** parameter, select one of the options available (e.g. the **Output 1 low value** option).
5. In the **Measured values** parameter, enter the value shown on the external measuring equipment.
6. Repeat steps 4 and 5 until all the output options are checked.
7. Adhere to the sequence indicated and enter the measured values.

The duration of the process and number of outputs depend on the device configuration.

The value displayed in the **Output values** parameter (→ 32) shows the value simulated by the device at the selected output → 24

Starting the verification test

8. In the **Start verification** parameter, select the **Start** option.
   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the **Progress** parameter.

Displaying the verification status and result

The current status of the standard verification is indicated in the **Status** parameter (→ 23):

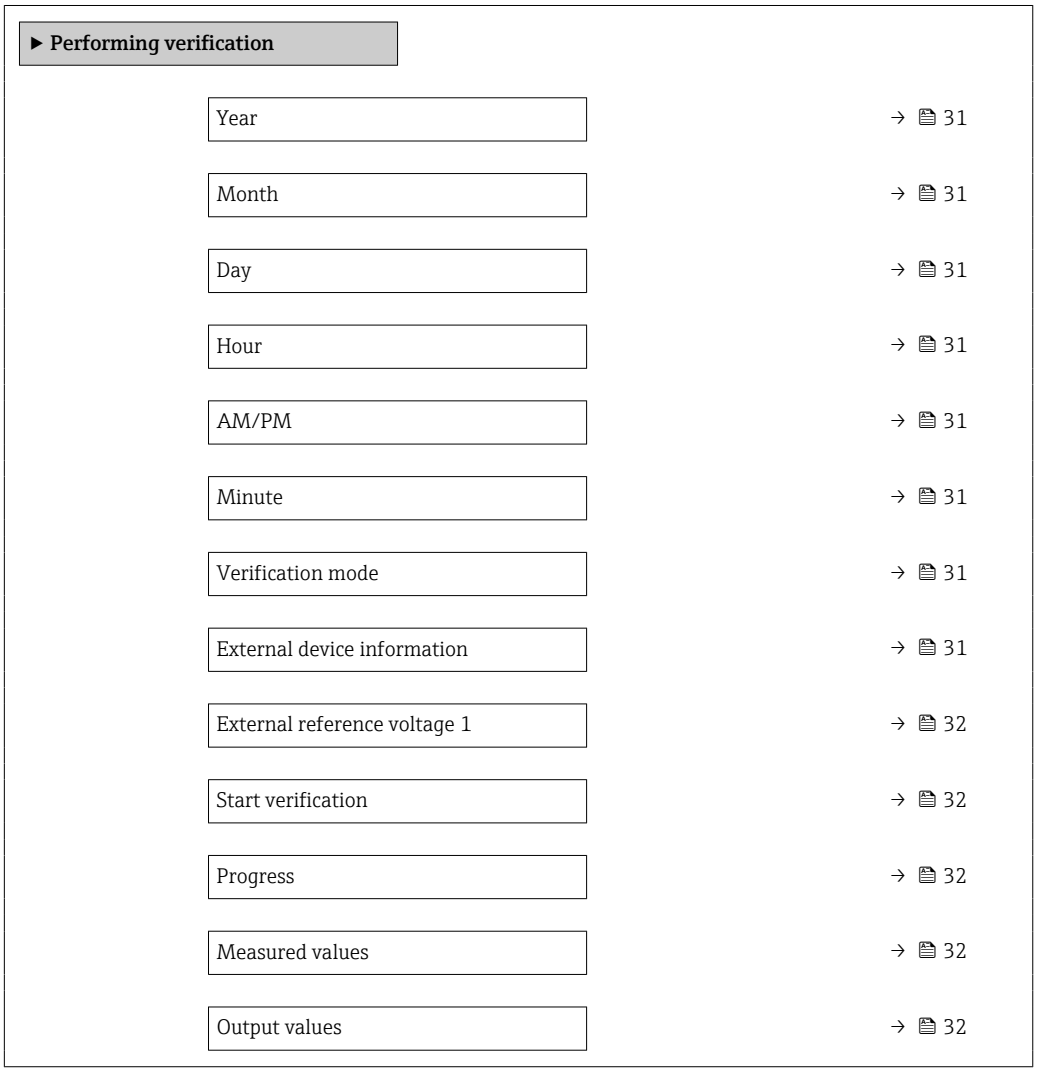
- Done
  The verification test is finished.
- Busy
  The verification test is running.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  A precondition for performing the verification has not been met; verification cannot start (e.g. due to unstable process parameters) → 19.

The result of the verification is displayed in the **Overall result** parameter (→ 23):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the result of the verification (test groups and test status) is also provided in the verification report in addition to the overall result → 35.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This helps users to perform a targeted search for the cause of the error → 19.

"Performing verification" submenu

Navigation
"Diagnostics" menu → Heartbeat Technology → Performing verification



Status	→ 32
Overall result	→ 32

Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 1): enter the year verification is performed.	9 to 99	10
Month	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 2): enter the month verification is performed.	▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December	January
Day	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 3): enter the day verification is performed.	1 to 31 d	1 d
Hour	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 4): enter the hour verification is performed.	0 to 23 h	12 h
AM/PM	Can be edited if Heartbeat Verification is not active. The **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected in the **Date/ time format** parameter (2812).	Entry for date and time (field 5): enter the morning or afternoon.	▪ AM ▪ PM	AM
Minute	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Extended verification Standard verification is extended by the additional entry of external measured variables: **Measured values** parameter.	Extended verification	Standard verification
External device information	With the following conditions: ▪ The **Extended verification** option is selected in the **Verification mode** parameter. ▪ Can be edited if the verification status is not active.	Record measuring equipment for extended verification.	Free text entry	–

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
External reference voltage 1	–	Use this function to enter the reference voltage. The external reference voltage can be measured at the GND and REF terminals.	Signed floating-point number	2.5 V
Start verification	–	Start the verification. To carry out a complete verification, select the selection parameters individually. Once the external measured values have been recorded, verification is started using the **Start** option.	▪ Cancel ▪ Start ▪ Output 1 low value * ▪ Output 1 high value * ▪ Frequency output 1 * ▪ Pulse output 1 * ▪ Frequency output 2 * ▪ Pulse output 2 *	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	0 %
Measured values	In the **Start verification** parameter (→ 🖹 23), one of the following options is selected: ▪ Output 1 low value ▪ Output 1 high value ▪ Output 2 low value ▪ Output 2 high value ▪ Frequency output 1 ▪ Pulse output 1 ▪ Frequency output 2 ▪ Pulse output 2	Displays the references for the external measured variables. ▪ Current output: Output current in [mA] ▪ Pulse/frequency output: Output frequency in [Hz]	Signed floating-point number	0
Output values	–	Displays the references for the external measured variables. Pulse/frequency output: Output frequency in [Hz].	Signed floating-point number	0
Status	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done	–
Overall result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 🖹 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	–

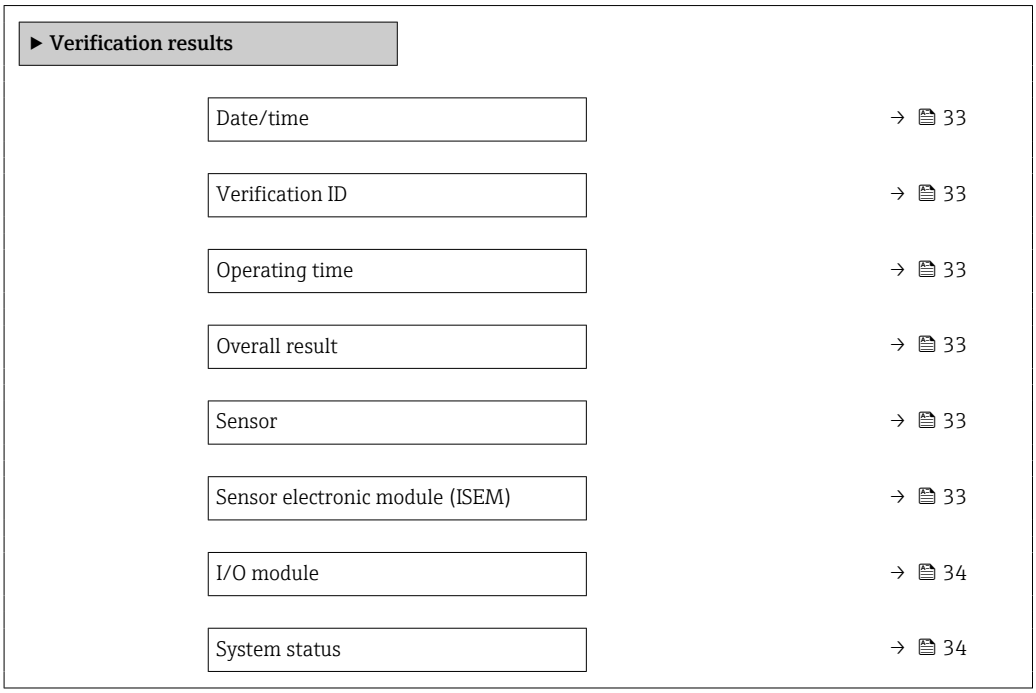
* Visibility depends on order options or device settings

5.3.4 Verification results

Access to the verification results:
In the operating menu via the local display, operating tool or Web browser
▪ Diagnostics → Heartbeat Technology → Verification results
▪ Expert → Diagnostics → Heartbeat Technology → Verification results

Navigation
"Diagnostics" submenu → Heartbeat → Verification results

Navigation
"Expert" menu → Diagnostics → Heartbeat → Verification results



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time	The verification has been performed.	Date and time.	dd.mmmm.yyyy; hh:mm	1 January 2010; 12:00
Verification ID	The verification has been performed.	Displays consecutive numbering of the verification results in the measuring device.	0 to 65 535	0
Operating time	The verification has been performed.	Indicates how long the device has been in operation up to the verification.	Days (d), hours (h), minutes (m), seconds (s)	–
Overall result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	–
Sensor	In the **Overall result** parameter, the **Failed** option was displayed.	Displays the result for the sensor. Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	Not done
Sensor electronic module (ISEM)	In the **Overall result** parameter, the **Failed** option was displayed.	Displays the result for the sensor electronics module (ISEM). Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	Not done

Parameter	Prerequisite	Description	User interface	Factory setting
I/O module	In the **Overall result** parameter, the **Failed** option was displayed.	Displays the result for I/O module monitoring of the I/O module. ▪ For pulse output: Accuracy of pulses (for external verification only) ▪ For frequency output: Accuracy of frequency (for external verification only) Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	Not done
System status	In the **Overall result** parameter, the **Failed** option was displayed.	Displays the system condition. Tests the measuring device for active errors. Detailed description of the classification of the results: → 34	▪ Not used ▪ Passed ▪ Not done ▪ Failed	Not done

Classification of results

Individual results

Result	Description
Failed	At least one individual test in the test group was outside the specifications.
Not used	The result is used for internal purposes.
Passed	All individual tests in the test group complied with the specifications. The result is also "Passed" if the result of an individual test is "Check not done" and the result of all other tests is "Passed".
Not done	No test has been performed for this test group.

Overall results

Result	Description
Failed	At least one test group was outside the specifications.
Not used	The result is used for internal purposes.
Passed	All verified test groups complied with the specifications (result "Passed"). The overall result is also "Passed" if the result for an individual test group is "Check not done" and the result for all other test groups is "Passed".
Not done	No verification was performed for any of the test groups (result for all test groups is "Check not done").

If a result is classified as **Check not done**, the output concerned has not been used.

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand. Based on redundant references in the device which are traceable from the factory, **Heartbeat Technology** meets all the requirements concerning traceable device verification according to DIN ISO 9001: 2015 Chapter 7.1.5.2 a).

Test groups

Test group	Description
Sensor	Electrical components of the sensor (signals, circuits and cables)
Sensor electronics module (ISEM)	Electronics module for activating and converting the sensor signals

Test group	Description
I/O module	Results of all the input and output modules installed on the measuring device.
System condition	Test for active measuring device errors of "alarm"-type diagnostic behavior

For more information on the test groups and individual tests .

The results for a test group (e.g. sensor) contain the result of several individual tests. All the individual tests must be passed for the test group to pass.

The same applies to the overall result: All the test groups must pass for the overall result to be "passed". Information on the individual tests is provided in the verification report and the detailed verification resultswhich can be accessed with the Flow Verification DTM.

Limit values

I/O module

Input; Output	Internal verification	External verification
Current output 4 to 20 mA	▪ ±1 % ▪ ±100 µA (offset)	▪ Lower value 4mA: ±1 % ▪ Upper value 20mA: ±0.5 %
Pulse/frequency/switch output	±0.05 %, with a 120 s cycle	▪ Pulse: ±0.3 % ▪ Frequency:±0.3 %

5.3.5 Detailed verification results

The process conditions at the time of verification and the individual test group results can be accessed with the Flow Verification DTM.

- Process conditions: "VerificationDetailedResults → VerificationActualProcessConditions"
- Verification results: "VerificationDetailedResults → VerificationSensorResults"

Process conditions

To increase the comparability of the results, the process conditions that apply at the time of verification are recorded and documented as process conditions on the last page of the verification report.

Process conditions	Description
Verification value volume flow	Current measured value for volume flow
Verification value conductivity	Current measured value for medium conductivity (if switched on)
Current potential difference	Current measured value for potential difference
Current potential of electrode 1	Current measured value for potential of electrode 1
Current potential of electrode 2	Current measured value for potential of electrode 2
Current potential of pipe GND electrode	Current measured value for potential of pipe GND electrode
Electronic temperature	Current measured value for the electronic temperature in the transmitter

Individual test group results

The individual test group results listed below provide information on the results of the individual tests within a test group.

Sensor

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Rise time symmetry	Monitoring of symmetry in the exciter circuit for coil current shot times while both field polarities are changed.	No value range ▪ Passed ▪ Failed ▪ Not done	▪ EMC interference ▪ Defective H-bridge in the amplifier
Holding voltage symmetry	Monitoring of symmetry in holding voltages of exciter circuit for setting the coil current for both field polarities.	No value range ▪ Passed ▪ Failed ▪ Not done	▪ EMC interference ▪ Defective H-bridge in the amplifier
Coil current loss	Monitoring of the coil current path for leak current. Comparison of incoming and outgoing currents.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor short-circuit. Check entire sensor system: ▶ Check for moisture (e.g. condensation) ▶ Check for faulty sensor and cable connections or interfaces ▶ Check coils ▶ Checking the insulation resistance
Coil current stability	Monitoring the correct adjustment of the coil current.	No value range ▪ Passed ▪ Failed ▪ Not done	EMC interference
Coil resistance	Monitoring of the coil resistance.	No value range ▪ Passed ▪ Failed ▪ Not done	▪ Faulty connections: check the outer connection parts, clamp connections and connecting cables ▪ Process temperature too high ▪ Coil in the sensor is defective
Electrode circuit 1	Monitoring of the impedance in electrode circuit 1.	No value range ▪ Passed ▪ Failed ▪ Not done	Electrode cable defective The test is not performed if the measuring tube is empty Status indicated: "Not done"
Electrode circuit 2	Monitoring of the impedance in electrode circuit 2.	No value range ▪ Passed ▪ Failed ▪ Not done	Electrode cable defective The test is not performed if the measuring tube is empty Status indicated: "Not done"
EPD electrode circuit	Monitoring of the impedance in the EPD circuit.	No value range ▪ Passed ▪ Failed ▪ Not done	EPD cable defective The test is not performed if the measuring tube is empty Status indicated: "Not done"

Sensor electronics module (ISEM)

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Supply voltage	All the relevant supply voltages are checked. Monitoring of the supply voltage for the sensor electronics module guarantees that the system is functioning correctly.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective ▶ Replace sensor electronics module (ISEM)
External reference voltage	Monitoring of reference voltages in flowmeter circuit and exciter circuit.	No value range ▪ Passed ▪ Failed ▪ Not done	
Linearity and reference voltage	▪ Monitoring of flowmeter circuit with regard to gain and linearity. ▪ Monitoring of reference voltages in flowmeter circuit and exciter circuit	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective ▶ Replace sensor electronics module (ISEM)
Offset electrode signal amplifier	Monitoring of flow measurement amplifier with regard to zero point.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective ▶ Replace sensor electronics module (ISEM)

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Hold voltage feedback	The configured hold voltage is fed back to ensure the secure and constant functioning of the hold voltage.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective ▶ Replace sensor electronics module (ISEM)
Overvoltage feedback	The overvoltage is fed back to ensure the secure and constant functioning of the overvoltage.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective
Electronic current loss	Monitoring of the coil current path for leak current.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective
Coil current measurement	Monitoring of low-side current measurement.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective
Overvoltage circuit	Monitoring of overvoltage.	No value range ▪ Passed ▪ Failed ▪ Not done	Sensor electronics module (ISEM) defective
Electrode signal integrity	Monitoring of input stage, sensor and electrode cable.	No value range ▪ Passed ▪ Failed ▪ Not done	One of the electrode signals is missing. This can be due to the following: ▪ Sensor electronics module (ISEM) defective ▪ Faulty connection to the sensor ▪ Electrode short-circuit or open circuit ▪ Sensor defective

System condition

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
System condition	System condition monitoring	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** System error during verification **Corrective action** ▶ Check diagnostic event in the **Event logbook** submenu.

I/O modules

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Output 1 to n	Check of all the input and output modules installed at the measuring device→ 🖹 18	No value range ▪ Passed ▪ Failed ▪ Not done Limit values→ 🖹 35	**Causes** ▪ Output values out of specification ▪ I/O modules defective **Corrective action** ▶ Check cabling. ▶ Check connections. ▶ Check load (current output). ▶ Replace I/O module.

5.3.6 Verification report

The results of the verification can be documented in the form of a verification report via the web server or FieldCare operating tool → 11. The verification report is created on the basis of the data records saved in the measuring device after verification. As the verification results are automatically and uniquely identified with a verification ID and the operating time, they are suitable for the traceable documentation of the verification of flowmeters.

First page: identification → 13, 39
Measuring point identification, identification of the verification results and confirmation of completion:
- System operator
  Customer reference
- Device information
  - Information on the place of operation (tag) and the current configuration of the measuring point
  - Management of the information in the device
  - Display on the verification report
- Calibration
  - Information on the calibration factor and zero point setting for the sensor
  - These values must correspond to those from the last calibration or repeat calibration in order to comply with factory specifications
- Verification information
  - The operating time and verification ID are used to uniquely assign the verification results for the traceable documentation of the verification
  - Storage and display of the manual date and time entry as well as the current operating time in the device
  - Verification mode: standard verification or extended verification
- Overall verification result
  Overall result of the verification passed if all of the individual results are passed

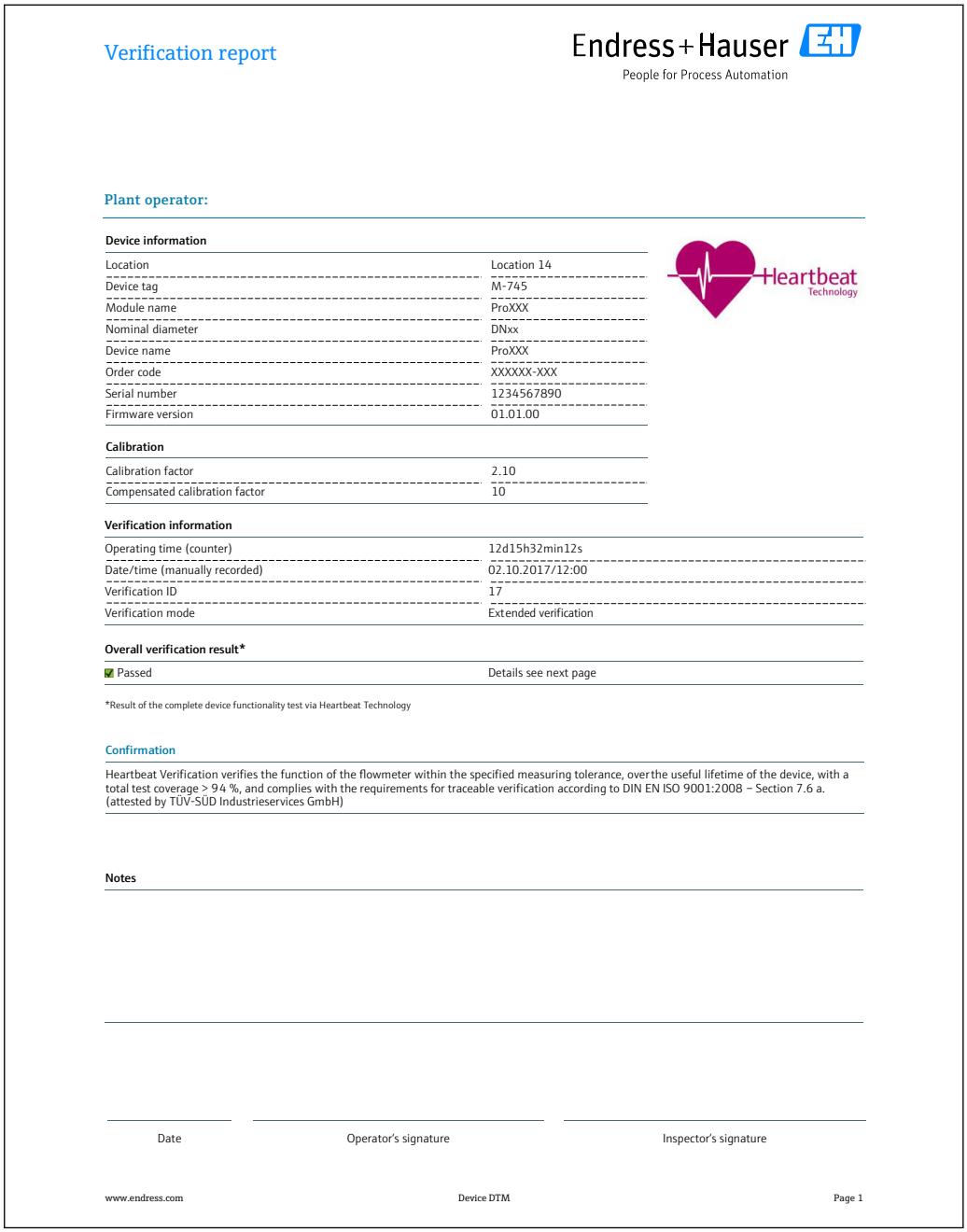
Second page: test results
Details on the individual results for all test groups:
- System operator
- Test groups → 35
  - Sensor
  - Sensor electronics module (ISEM)
  - System condition
  - I/O module

Third page (and subsequent pages): measured values and visualization
Numerical values and graphic presentation of all the values recorded:
- System operator
- Test object
- Unit
- Current: measured value
- Min.: lower limit
- Max.: upper limit
- Visualization: graphic presentation of the measured value, within the lower and upper limits.

Last page: process conditions
Information on the process conditions that applied during the verification:
- Volume flow
- Conductivity
- Electronics temperature
- Current potential difference
- Current potential of electrode 1

- Current potential of electrode 2
- Current potential of pipe GND electrode
- Build-up index value (only with the Heartbeat Verification + Monitoring application package)

As a prerequisite for the validity of the verification report, the **Heartbeat Verification** feature must be activated on the measuring device concerned and must have been performed by an operator tasked to carry out this job by the customer. Alternatively, an Endress+Hauser service technician or a service provider authorized by Endress+Hauser can be tasked with performing the verification.



Verification report

Endress+Hauser
People for Process Automation

Plant operator:

Device information

Location	Location 14
Device tag	M-745
Module name	ProXXX
Nominal diameter	DNxx
Device name	ProXXX
Order code	XXXXXX-XXX
Serial number	1234567890
Firmware version	01.01.00

Heartbeat Technology

Calibration

Calibration factor	2.10
Compensated calibration factor	10

Verification information

Operating time (counter)	12d15h32min12s
Date/time (manually recorded)	02.10.2017/12:00
Verification ID	17
Verification mode	Extended verification

Overall verification result*

☑ Passed	Details see next page

*Result of the complete device functionality test via Heartbeat Technology

Confirmation

Heartbeat Verification verifies the function of the flowmeter within the specified measuring tolerance, over the useful lifetime of the device, with a total test coverage > 94 %, and complies with the requirements for traceable verification according to DIN EN ISO 9001:2008 – Section 7.6 a. (attested by TÜV-SÜD Industrieservices GmbH)

Notes

Date | Operator's signature | Inspector's signature

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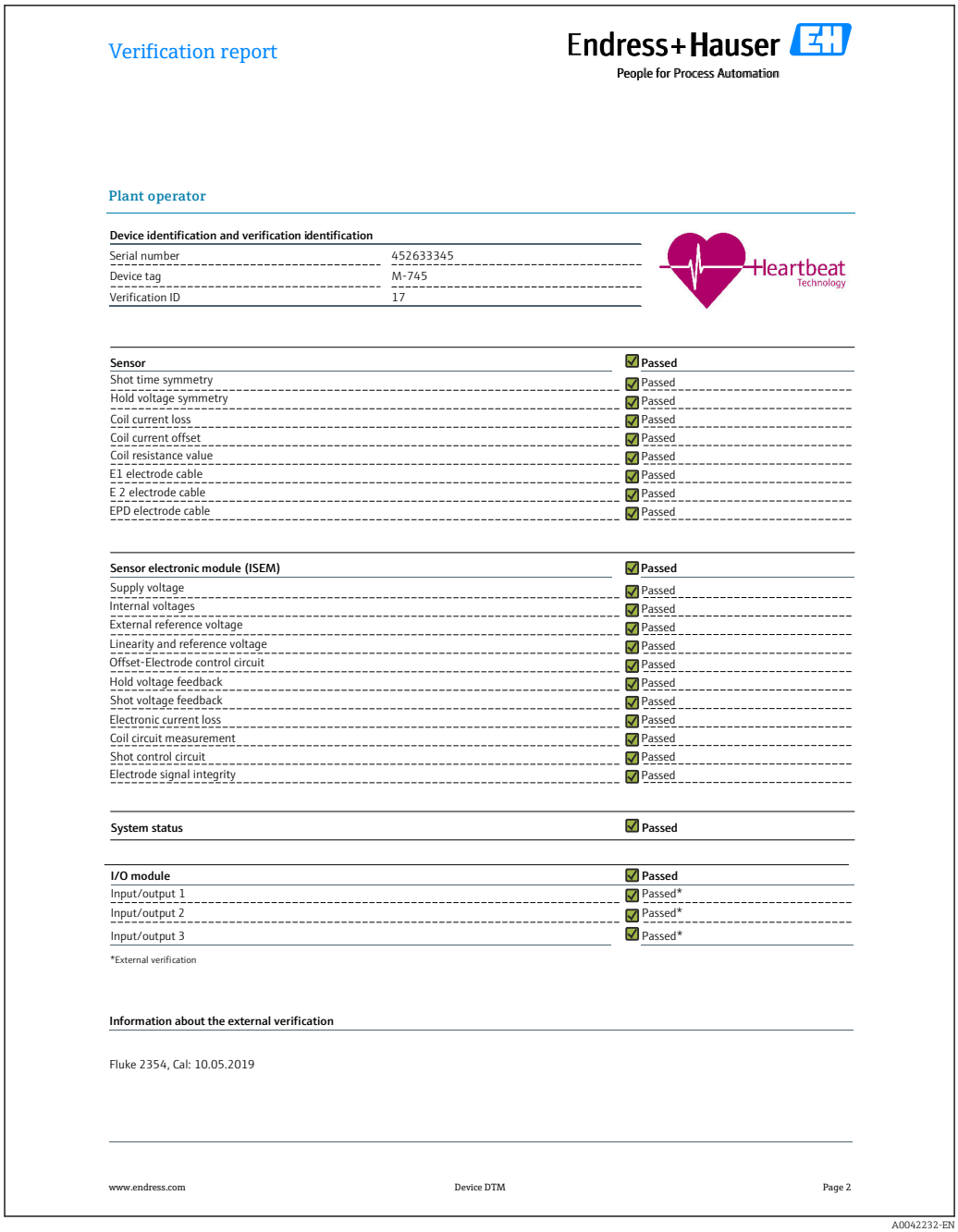
13 *Example of a verification report (Page 1: identification → 38)*

Individual test groups and description of individual tests: → 35



Verification report

Endress+Hauser
People for Process Automation

Plant operator

Device identification and verification identification

Serial number	452633345
Device tag	M-745
Verification ID	17

Heartbeat Technology

Sensor	**Passed**
Shot time symmetry	Passed
Hold voltage symmetry	Passed
Coil current loss	Passed
Coil current offset	Passed
Coil resistance value	Passed
E1 electrode cable	Passed
E 2 electrode cable	Passed
EPD electrode cable	Passed

Sensor electronic module (ISEM)	**Passed**
Supply voltage	Passed
Internal voltages	Passed
External reference voltage	Passed
Linearity and reference voltage	Passed
Offset-Electrode control circuit	Passed
Hold voltage feedback	Passed
Shot voltage feedback	Passed
Electronic current loss	Passed
Coil circuit measurement	Passed
Shot control circuit	Passed
Electrode signal integrity	Passed

System status	**Passed**

I/O module	**Passed**
Input/output 1	Passed*
Input/output 2	Passed*
Input/output 3	Passed*

*External verification

Information about the external verification

Fluke 2354, Cal: 10.05.2019

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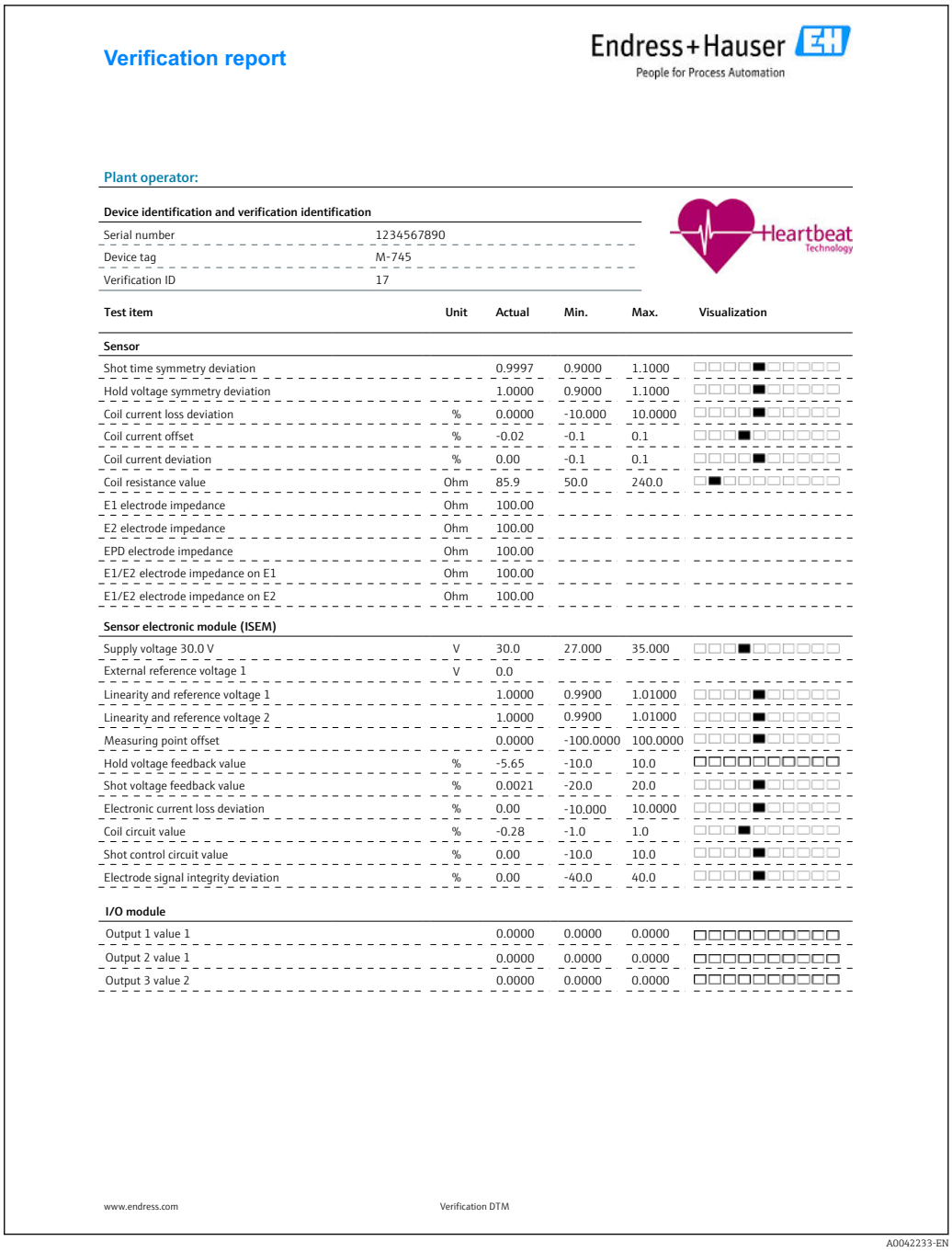
14 *Example of a verification report (Page 2: test results → 38)*

Comments from the person carrying out the verification appear in the "Information about the External Verification" field. It is also recommended for information on the type and serial number of the external testing device used to carry out the external verification.

Data administration with Web server and FieldCare (Flow Verification DTM): → 11



Verification report

Endress+Hauser
People for Process Automation

Plant operator:

Device identification and verification identification

Serial number	1234567890
Device tag	M-745
Verification ID	17

Heartbeat Technology

Test item	Unit	Actual	Min.	Max.	Visualization
Sensor					
Shot time symmetry deviation		0.9997	0.9000	1.1000	
Hold voltage symmetry deviation		1.0000	0.9000	1.1000	
Coil current loss deviation	%	0.0000	-10.000	10.0000	
Coil current offset	%	-0.02	-0.1	0.1	
Coil current deviation	%	0.00	-0.1	0.1	
Coil resistance value	Ohm	85.9	50.0	240.0	
E1 electrode impedance	Ohm	100.00			
E2 electrode impedance	Ohm	100.00			
EPD electrode impedance	Ohm	100.00			
E1/E2 electrode impedance on E1	Ohm	100.00			
E1/E2 electrode impedance on E2	Ohm	100.00			
Sensor electronic module (ISEM)					
Supply voltage 30.0 V	V	30.0	27.000	35.000	
External reference voltage 1	V	0.0			
Linearity and reference voltage 1		1.0000	0.9900	1.01000	
Linearity and reference voltage 2		1.0000	0.9900	1.01000	
Measuring point offset		0.0000	-100.0000	100.0000	
Hold voltage feedback value	%	-5.65	-10.0	10.0	
Shot voltage feedback value	%	0.0021	-20.0	20.0	
Electronic current loss deviation	%	0.00	-10.000	10.0000	
Coil circuit value	%	-0.28	-1.0	1.0	
Shot control circuit value	%	0.00	-10.0	10.0	
Electrode signal integrity deviation	%	0.00	-40.0	40.0	
I/O module					
Output 1 value 1		0.0000	0.0000	0.0000	
Output 2 value 1		0.0000	0.0000	0.0000	
Output 3 value 2		0.0000	0.0000	0.0000	

A0042233-EN

15 *Example of a verification report (Page 3: measured values and visualization → 38)*

5.3.7 Interpreting and using the verification results

Heartbeat Verification uses the self-monitoring function of the Proline flowmeters to check the measuring device functionality. During the verification process, the system checks whether the measuring device components comply with the factory specifications. Both the sensor and the electronics modules are included in the tests.

Compared to flow calibration, which incorporates the entire measuring device and assesses the flow measuring performance directly (primary measured variable), **Heartbeat Verification** checks the function of the measuring chain from the sensor to the outputs.

Here, the function checks device-internal parameters that are correlated with flow measurement (secondary measured variables, comparative values). The check is based on reference values that were recorded during the factory calibration.

If a verification is passed, this confirms that the comparison values that are checked are within the factory specification and that the measuring device is working correctly. At the same time, zero point and calibration factor of the sensor are documented and traceable in the verification report. To ensure that the measuring device complies with the factory specification, these values must match those of the last calibration or repeated calibration.

- Confirmation of compliance with the flow specifications with a total test coverage of 100 % is only possible by verifying the primary measured variable (flow) by recalibrating or by proving the value.
- **Heartbeat Verification** confirms the device function within the specified measuring tolerance on demand.

Recommended course of action if the result of a verification is "Failed"

If the result of a verification is **Failed**, it is advisable to begin by repeating the verification.

This applies in particular if the individual tests of the **Sensor** test group are concerned, as a process-related influence is then possible.

Ideally, ensure defined and stable process conditions in order to rule out process-specific influences as much as possible. When repeating the verification, it is advisable to compare the current process conditions to those of the previous verification in order to identify any deviations.

The process conditions of the previous verification are documented on the last page of the verification report or can be accessed using the Flow Verification DTM → 35.

Stabilize or stop flow, ensure that process temperature is stable, drain the sensor if possible.

Additional remedial measures if the result of a verification is "Failed"

- Calibrate the measuring device
  The calibration has the advantage that the "as found" measuring device state is recorded and the actual measured error is determined.
- Direct remedial measures
  Take remedial action on the basis of the verification results and the diagnostic information of the measuring device. Narrow down the possible cause of the error by identifying the test group that **failed** the verification.

For detailed information on diagnostics and troubleshooting and for diagnostic information and associated remedial measures, see the Operating Instructions → 6.

6 Heartbeat Monitoring

With Heartbeat Monitoring, additional measured values are output continuously and monitored in an external Condition Monitoring system so that changes to the measuring device and in the process can be detected at an early stage. The measured variables can be interpreted in a Condition Monitoring system. The information obtained in this way helps users to control measures concerning maintenance or process optimization. Possible applications of Condition Monitoring include the detection of the formation of build-up or wear as a result of corrosion.

6.1 Operation

The benefits of **Heartbeat Monitoring** are in direct correlation with the recorded data selection and their interpretation. Good data interpretation is critical for deciding whether a problem has occurred and when and how maintenance should be scheduled or performed (good knowledge of the application is required). The elimination of process effects that cause misleading warnings or interpretation must also be ensured. For this reason it is important to compare the recorded data against a process reference.

Heartbeat Monitoring enables additional monitoring values to be displayed in continuous operation mode.

focuses on measured variables which indicate a change in the performance of the measuring device brought about by process-related influences. There are two difference categories of process-specific influences:

- Temporary process-specific influences that impact the measuring function directly and therefore result in a higher level of measuring uncertainty than would normally be expected (e.g. measurement of multiphase fluids). These process-specific influences generally do not affect the integrity of the device but do impact measuring performance temporarily.
- Process-related influences which only impact the integrity of the sensor over the medium term but which also bring about a gradual change in the measuring performance (e.g. abrasion, corrosion or the formation of build-up in the sensor). These influences also affect the integrity of the device on the long term.

Devices with **Heartbeat Monitoring** offer a range of parameters that are particularly suitable for monitoring specific, application-related influences. These target applications are:

- Fluids containing magnetite
- Multi-phase fluids (gas content in liquid fluids)
- Applications in which the sensor is exposed to a programmed amount of wear
- Applications with cathodic protection systems
- Applications with pipes that are not grounded
- Applications in which build-up can form.

The results of must always be interpreted in the context of the application.

6.1.1 Overview of the monitoring parameters

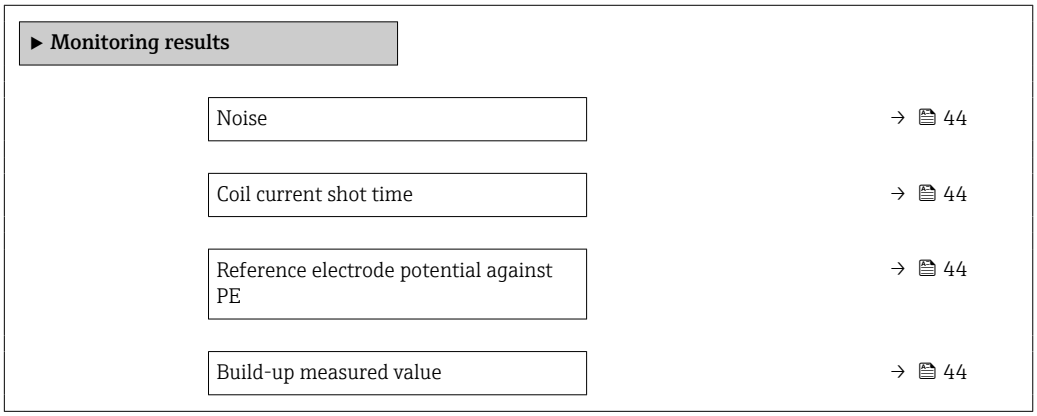
This section describes the interpretation of certain monitoring parameters in connection with the process and the application.

Monitoring parameter	Possible reasons for deviation
Noise	A change can be an indicator of multi-phase fluids (gas content in liquid fluids or a change in the solids content of the fluid) or changing electrical conductivity. This value allows conclusions to be drawn about the process.
Coil current shot time	At constant process temperatures, a change can indicate a possible build-up of magnetite or an increase in the magnetite content of the medium. Strong external magnetic fields influence this value too.

Monitoring parameter	Possible reasons for deviation
Reference electrode potential against PE	This diagnostic value describes the voltage between the fluid and the protective ground. This value is of significance if the measuring device with the reference electrode contacting the fluid is disconnected from the protective ground.
Build-up index value	Detection and monitoring of an even coating forming on the inside of the measuring tube.

Navigation

"Diagnostics" menu → Heartbeat → Monitoring results



Parameter overview with brief description

Parameter	Description	User interface	Factory setting
Noise	Indicates the degree to which the differential signal from both measuring electrodes is dispersed.	0 to 3.0 · 10^{+38} µV	–
Coil current shot time	Indicates the rise time of the coil current for the buildup of the magnetic field.	2 to 500 ms	–
Reference electrode potential against PE	Displays the voltage of the reference electrode in relation to the potential of the measuring tube.	−30 to +30 V	–
Build-up measured value	Shows current build-up measured value.	0.0 to 100.0 %	0.0 %

7 Build-up detection using the Build-up index

Build-up detection is only available:
- In conjunction with the Promag W sensor
- In the **compact version** of the device (transmitter and sensor form a single mechanical unit)
- For additional prerequisites for the optimum and reliable use of the build-up detection function, see → 47

Build-up detection is part of Heartbeat Monitoring. It is used to detect and monitor an even coating forming on the inside of the measuring tube.

Build-up detection makes it possible to:
- Draw conclusions regarding accuracy
- Avoid process disruptions
- Identify and control necessary cleaning intervals early on

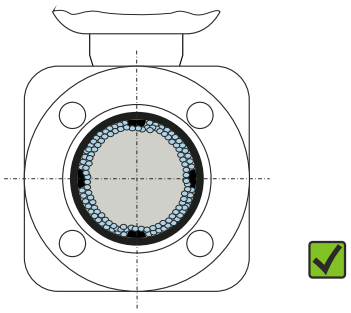
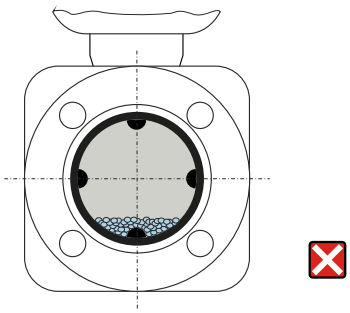
Build-up is understood to be an even coating that forms over the entire inner wall of the measuring tube and increases in the course of the process. The time required for build-up to form varies. Depending on the process and medium, build-up can form within just a few hours or only after a few months.

Build-up detection is particularly suitable for processes in which an even coating forms, e.g:
- Heating circuits with magnetite deposits
- Sugar refining processes with oxalates
- Dairy and food processing with protein or sugar deposits
- Iron clogging in drinking water and water processes

7.1 General principles

7.1.1 Build-up and deposits

The build-up detection function is designed to detect and monitor the formation of an even coating and **cannot** be used for the detection of deposits at the bottom of a measuring tube.

Coating (build-up)	Deposits
	
16 Build-up formed on the inside of the inner wall of the measuring tube	*17 Deposits on the bottom of the measuring tube*

7.1.2 Operating principle

The electrical conductivity values of the flowing medium and the build-up differ from one another. By analyzing the distribution of electrical conductivity within the measuring tube, it is possible to detect the formation of build-up.

The distribution of electrical conductivity in the cleaned measuring tube serves as the reference situation. In this state, a reference value is calibrated and the value of 0% is assigned to the Build-up index value before the device is delivered.

Build-up detection using the Build-up index assesses the difference between the conductivity of the flowing medium and the conductivity of the build-up. If the thickness of the build-up increases, the Build-up index value also increases. This effect is used to track the formation of build-up or cleaning progress.

Evaluation of build-up formation

For a comparative assessment, it is important to note that if build-up has already formed in the pipe, a change in the conductivity of the flowing medium can also cause a change in the Build-up index value. Build-up formation should therefore always be assessed at a constant medium conductivity.

Build-up index value

The formation of build-up is indicated as a percentage in the Build-up index value parameter. The higher the percentage value, the thicker the layer of build-up.

Build-up index value = 0%
- No build-up present
- Measuring tube as-delivered state (initial value)
- Measuring tube was cleaned thoroughly after formation of build-up

Build-up index value = 100%
- Value for the maximum measurable build-up thickness
- The thickness of the build-up at 100% varies depending on the process
- 100% does **not** indicate a clogged measuring tube

The percentage indicated in the Build-up index value parameter does not provide direct information about the absolute thickness or the composition of the build-up. Therefore, to make optimum use of the build-up detection function with the Build-up index, it is necessary to first compare the formation of build-up in the process, as known from experience, with the associated Build-up index value. The aim is to determine the Build-up index value at the time the cleaning is usually performed.

On the basis of the Build-up index value during cleaning, it is possible to make a valid assessment of the condition inside the measuring tube and to plan the cleaning using the Build-up limit and Build-up limit hysteresis parameters.

In addition, conclusions about possible effects on neighboring processes can be drawn from the Build-up index value.

Interval for build-up detection

The interval for recording the Build-up index value can be specified in the Build-up index parameter.
- If it is known, from experience, that build-up is formed quickly, a short interval should be selected (**Fast** option). This option is also suitable for cleaning processes with a short monitoring duration of approx. 5 to 20 minutes.
- A longer interval, e.g. one measurement per minute or less, suffices for build-up that forms slowly over several months (**Slow** option).

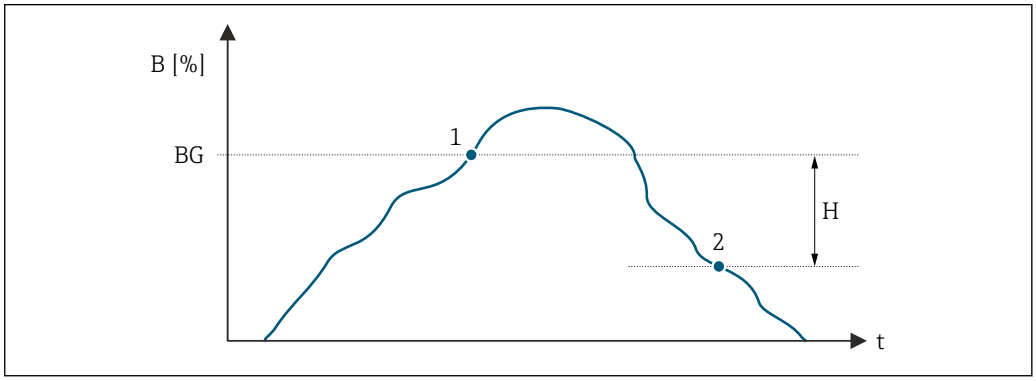
The Fast, Standard and Slow options each differ from one another by a time factor of 10.

Example for the measuring interval with DN 25 nominal diameter:
- **Fast** option: Every 6 seconds
- **Standard** option: Every 60 seconds
- **Slow** option: Every 600 seconds

Displaying the "Build-up detected" diagnostic information

Use the Build-up limit and Build-up limit hysteresis parameters to define a range for the thickness of the build-up in which the "Build-up detected" diagnostic information is output.

- If the value for the build-up detection hysteresis is higher than the Build-up limit, the "Build-up detected" diagnostic information is only reset once the measuring tube has been cleaned and the device is restarted.
- If the "Build-up detected" diagnostic information is displayed for an empty measuring tube, this can be avoided by activating empty pipe detection: Setup → Empty pipe detection



B Build-up index value [%]
t Time
BG Build-up limit [%]
1 Diagnostics information switch-on point
H Build-up limit hysteresis [%]
2 Diagnostics information switch-off point

7.1.3 Prerequisites

The following conditions must be met to ensure the optimum and reliable use of the build-up detection function.

Device version

Build-up detection is only available:
- In conjunction with the Promag W sensor
- In the **compact version** of the device (transmitter and sensor form a single mechanical unit)

Potential equalization

Potential equalization must be ensured in line with the operational environment of the measuring device in the plant.

For more information on ensuring potential equalization, see the Operating Instructions → 6.

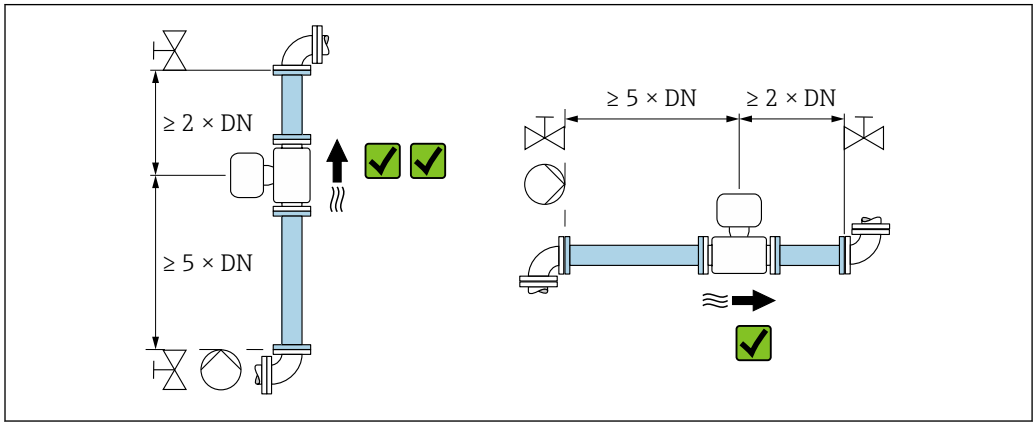
Conductivity measurement

Build-up detection is only available if conductivity measurement is activated: Expert → Sensor → Process parameters → Conductivity measurement

Installation

- Vertical orientation (preferable)
- Mount the device downstream of assemblies such as valves, T-sections or pumps
- Observe inlet and outlet runs

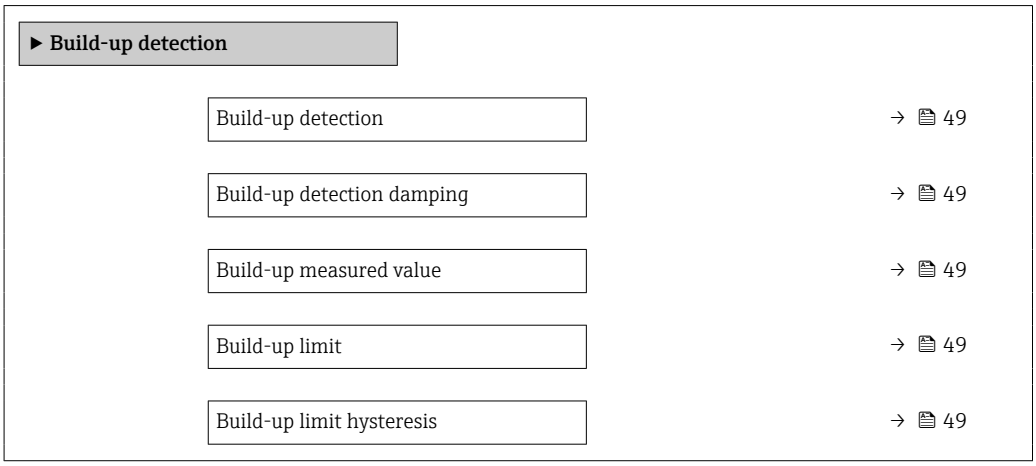
For devices with the order code for "Design", option C , H, I , no inlet or outlet runs need to be considered.



For more information on installation, see the Operating Instructions → 6.

7.2 Description of the Build-up index parameters

Navigation
"Expert" menu → Sensor → Process parameters → Build-up index



Parameter overview with brief description

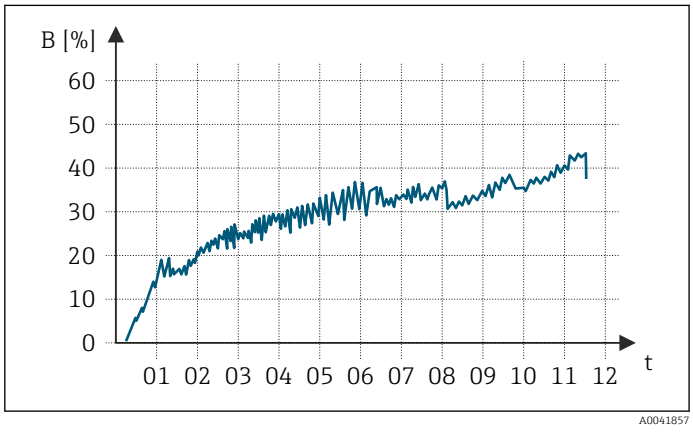
Parameter	Description	Selection / User entry / User interface	Factory setting
Build-up detection	Select mode for build-up detection.	▪ Off ▪ Slow ▪ Standard ▪ Fast	Off
Build-up detection damping	Enter damping value for build-up detection. Damping value: ▪ 0 = minimum damping ▪ 15 = maximum damping The damping value should only be increased if the measured value is unstable.	0 to 15	0
Build-up measured value	Shows current build-up measured value.	0.0 to 100.0 %	0.0 %
Build-up limit	Enter limit value for the build-up measured value.	0 to 100 %	50 %
Build-up limit hysteresis	Enter hysteresis for build-up detection. If the value for build-up detection hysteresis is higher than the Build-up limit, the "Build-up detected" diagnostic information is not reset until the measuring tube has been cleaned and a restart has been performed.	0 to 100 %	20 %

7.3 Application examples

The following application examples show how differently build-up forms in various processes. While the values indicated cannot be applied directly on a one-to-one basis, they do provide an indication of behavior in similar processes.

7.3.1 Water application

Application	Water supply
Type of build-up	Iron clogging
Monitoring duration	12 months
Build-up detection	Standard (one measurement per minute)
Nominal diameter of measuring tube	DN 100
Build-up formed	9 mm
Analysis	

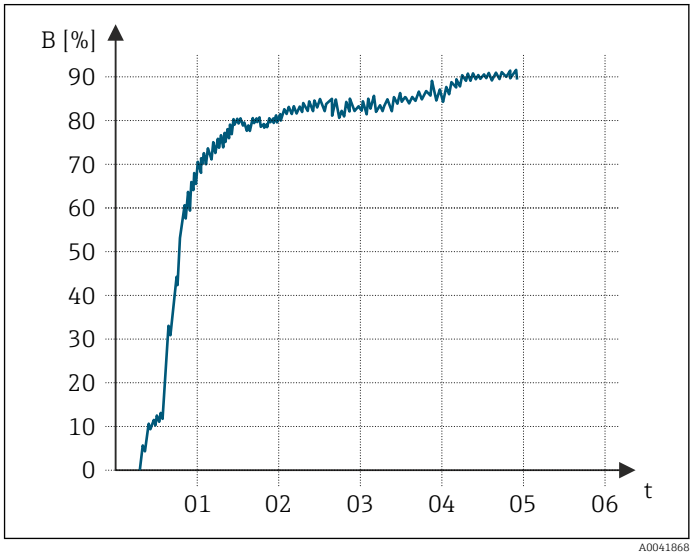


B *Build-up index value [%]*
t *Time [months]*

Build-up index value:
- 0 to 5% : no build-up present
- > 5% : build-up is detected

7.3.2 Application in the food industry: sugar

Application	Sugar refinery
Type of build-up	Oxalates in sugar beet juice
Monitoring duration	4 months
Build-up detection	Standard (one measurement per minute)
Nominal diameter of measuring tube	DN 100
Build-up formed	4 to 8 mm
Analysis	



B Build-up index value [%]
t Time [months]

Build-up index value:
- 0 to 5% : no build-up present
- > 5% : build-up is detected

7.3.3 Application in the food industry: whey protein

Application	Food processing facility
Type of build-up	Whey protein
Monitoring duration	1 day
Build-up detection	Standard (one measurement per minute)
Measuring tube nominal diameter	DN 25
Build-up formed	3-4 mm

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People for Process Automation

EA00070D/06/A2/15.20
71496843
2020-10-09

Installation Instructions
Installing ground disks

Promag 10, 23, 50, 51, 53, 55, 100, 200, 300, 500, 800, 400 Index C

EN Installation Instructions: EA00070D → 3

Endress+Hauser
People for Process Automation

Installation of ground disks

Promag, 10, 23, 50, 51, 53, 55, 100, 200, 300, 500, 800, 400 Index C

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2 Authorized installation personnel 4
3 Safety Instructions 4
4 Symbols used 5
5 Tools list 6
6 Installation of ground disks 6
7 Disposal 20

1 Overview of accessories

The Installation Instructions apply to the following accessories:

Order number	Original accessory
DK5GD-*****	1 × ground disk

2 Authorized installation personnel

Authorization to carry out installation depends on the measuring device's approval type. The table below shows the authorized group of people in each case.

Whoever carries out the installation has full responsibility to ensure that work is carried out safely and to the required quality standard. He/she must also guarantee the safety of the device following installation.

Measuring device approval	Personnel authorized to carry out installation [1)]
No approval	1, 2, 3
With approval (e.g. IECEx)	1, 2, 3
For custody transfer	4

1) 1 = Qualified specialist on customer side, 2 = Service technician authorized by Endress+Hauser,
3 = Endress+Hauser (return measuring device to manufacturer)
4 = Check with local approval center if installation/alteration must be performed under supervision.

3 Safety Instructions

- Only use original parts from Endress+Hauser.
- Comply with national regulations governing mounting, electrical installation, commissioning, maintenance and repair procedures.
- The following requirements must be met with regard to specialized technical staff for the mounting, electrical installation, commissioning, maintenance and repair of the measuring devices:
  - Specialized technical staff must be trained in instrument safety.
  - They must be familiar with the individual operating conditions of the devices.
  - In the case of Ex-certified measuring devices, they must also be trained in explosion protection.
- The measuring device is energized! Risk of fatal injury from electric shock. Open the measuring device only when the device is deenergized.
- For measuring devices intended for use in hazardous locations, please observe the guidelines in the Ex documentation (XA).

- When using measuring devices in safety-related applications in accordance with IEC 61508 or IEC 61511: following installation, re-commission the device in accordance with the Operating Instructions. Document the installation.
- Before removing the device: set the process to a safe state and purge the pipe of dangerous process substances.
- Hot surfaces! Risk of injury! Before commencing work: allow the system and measuring device to cool down to a touchable temperature.
- In the case of devices in custody transfer, the custody transfer status no longer applies once the seal has been removed.
- The Operating Instructions for the device must be followed.
- Risk of damaging the electronic components! Ensure you have a working environment protected from electrostatic discharge.
- After removal of the electronics compartment cover: risk of electrical shock due to missing touch protection!
  Turn instrument off before removing internal covers.
- Modifications to the measuring device are not permitted.
- Only open housing for a brief period. Avoid the penetration of foreign bodies, moisture or contaminants.
- Replace defective seals only with original seals from Endress+Hauser.
- If threads are damaged or defective, the measuring device must be repaired.
- Threads (e.g. of the electronics compartment cover and connection compartment cover) must be lubricated if an abrasion-proof dry lubricant is not available. Use acid-free, non-hardening lubricant.
- If, during installation, spacing is reduced or the dielectric strength of the measuring device cannot be guaranteed, perform a test on completion of the work (e.g. high-voltage test in accordance with the manufacturer's instructions).
- Service plug:
  - Do not connect in explosive atmospheres.
  - Only connect to Endress+Hauser service devices.
- Observe the instructions for transporting and returning the device outlined in the Operating Instructions.

If you have any questions, please contact your Endress+Hauser service organization.

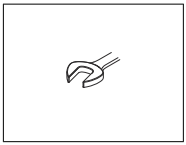
4 Symbols used

4.1 Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Forbidden Procedures, processes or actions that are forbidden.

Symbol	Meaning
	Tip Indicates additional information.
1., 2., 3...	Series of steps

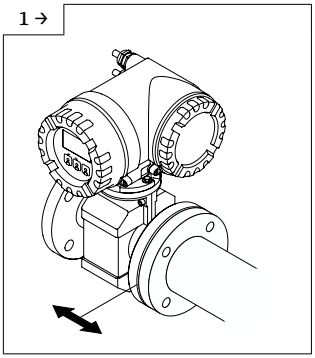
5 Tools list



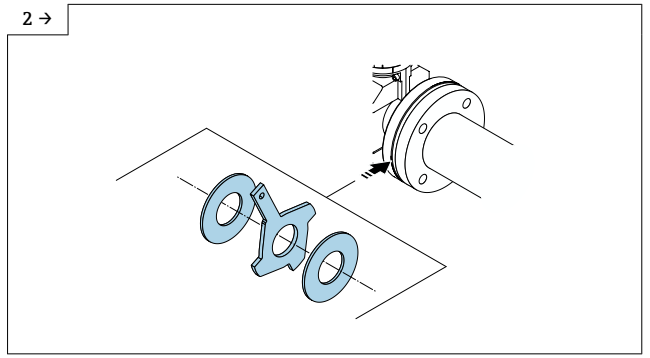
6 Installation of ground disks

Pay attention to the dimensions! The use of ground disks (incl. seals) increases the installed length!

1 →

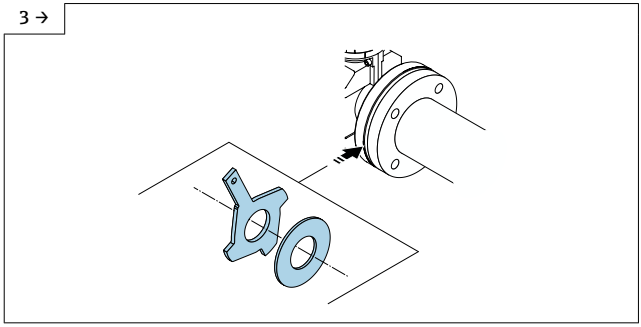


2 →

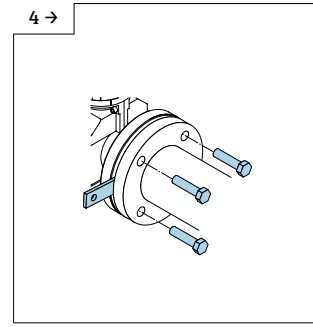


- **Seal installation**
- Lining: HR = hard rubber

3 →

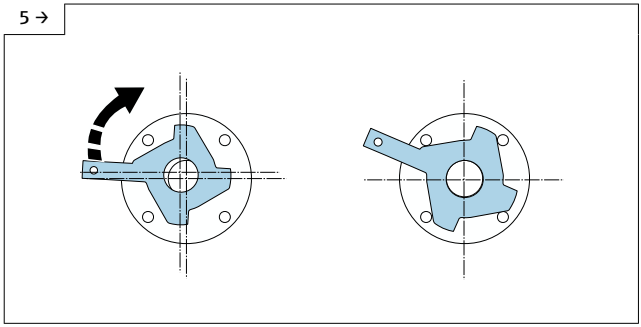


4 →

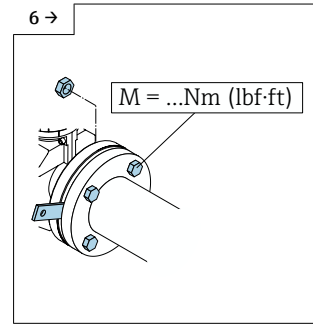


- **Seal installation**
- Lining: PUR = polyurethane, PTFE, PFA, NR = natural rubber

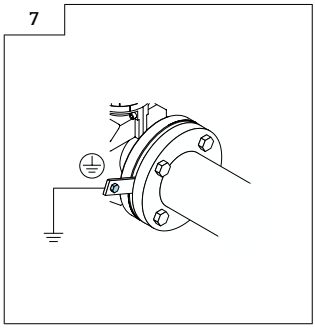
5 →



6 →



7

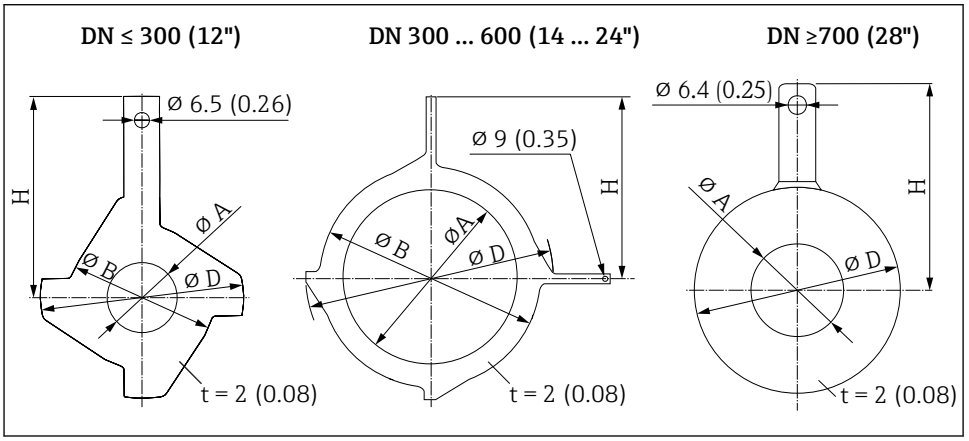


For detailed information on potential equalization, see the "Potential equalization" section of the Operating Instructions for the device.

For torques, see the following tables.

6.1 Dimensions

Ground disks for flange connections in accordance with EN (DIN)/ JIS/ AS/ ANSI



DN[1]		Pressure rating	A				B		D		H	
EN (DIN)/ JIS/ AS[4]	ANSI		PTFE, PFA, PUR[5], HR[5]		NR[5]							
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
15	½"	1)	16	0.63	–	–	43	1.69	61.5	2.42	73	2.87
25	1"	1)	26	1.02	–	–	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	–	–	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	–	–	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	–	–	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	53	2.09	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	66	2.60	131	5.16	154.5	6.08	135	5.31
100	4"	1)	104	4.09	91.5	3.60	156	6.14	186.5	7.34	153	6.02
125	5"	1)	130	5.12	117	4.61	187	7.36	206.5	8.13	160	6.30
150	6"	1)	158	6.22	143.5	5.65	217	8.54	256	10.08	184	7.24
200	8"	1)	206	8.11	192	7.56	267	10.51	288	11.34	205	8.07
250	10"	1)	260	10.2	245	9.65	328	12.91	359	14.13	240	9.45
300	12"	2)	312	12.3	294.5	11.59	375	14.76	413	16.26	273	10.75
		3)	310	12.2	–	–	375	14.76	404	15.91	268	10.55

DN[1]		Pressure rating	A				B		D		H	
EN (DIN) / JIS / AS [4]	ANSI		PTFE, PFA, PUR[5], HR[5]		NR [5]							
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
350	14"	PN 6	420	16.5	–	–	420	16.54	479	18.86	365	14.37
		PN 10			323.5	12.74						
		PN 16			–	–						
375	15"	PN 16	461	18.2	393	15.5	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	–	–	470	18.50	542	21.34	395	15.55
		PN 10			371	14.61						
		PN 16			–	–						
450	18"	PN 6	525	20.7	–	–	525	20.67	583	22.95	417	16.42
		PN 10			420	16.54						
		PN 16			–	–						
500	20"	PN 6	575	22.6	–	–	575	22.64	650	25.59	460	18.11
		PN 10			469	18.46						
		PN 16			–	–						
600	24"	PN 6	676	26.6	–	–	676	26.61	766	30.16	522	20.55
		PN 10			566	22.28						
		PN 16			–	–						
700	28"	PN 6	697	27.4	–	–	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	–	–	893	35.16	520	20.47
		PN10	795	31.3	–	–	–	–	920	36.22	540	21.26
		PN16	789	31.1	–	–	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	–	–	993	39.09	570	22.44
		PN 10	893	35.2	–	–	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	–	–	1048	41.26	615	24.21

DN[1]		Pressure rating	A				B		D		H	
EN (DIN)/ JIS/ AS[4]	ANSI		PTFE, PFA, PUR[5], HR[5]		NR[5]							
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
1000	40"	PN 6	999	39.3	–	–	–	–	1093	43.03	620	24.41
		PN10	995	39.2	–	–	–	–	1127	44.37	650	25.59
		PN16	988	38.9	–	–	–	–	1131	44.53	660	25.98
		Cl, D	995	39.2	–	–	–	–	1163	45.79	675	26.57
1100	42"	PN 6	1044	41.1	–	–	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	–	–	1310	51.57	733	28.86
		PN10	1196	47.1	–	–	–	–	1344	52.91	760	29.92
		PN16	1196	47.1	–	–	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	–	–	1345	52.95	775	30.51

[1] In the case of DN 15 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version
[2] PN 10/ 16, Cl. 150
[3] PN 25, JIS 10K/ 20K
[4] For flanges according to AS, only DN 25 and DN 50 are available.
[5] Abbreviations (liner): PUR = polyurethane, NR = natural rubber, HR = hard rubber

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
25	1"	[1]	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	[1]	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	[1]	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	[1]	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	[1]	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	[1]	80	3.15	131	5.16	154.5	6.08	135	5.31
100	4"	[1]	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	[1]	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	[1]	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	[1]	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	[1]	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

6.2 Torques

Abbreviations (lining): PUR = polyurethane, NR = natural rubber, HR = hard rubber

EN (DIN) (pressure rating in [bar])

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
Promag W, P, S							
15	40	4 × M12	-	-	11	-	–
25	40	4 × M12	-	15	26	20	–
32	40	4 × M16	-	24	41	35	–
40	40	4 × M16	-	31	52	47	–
50	40	4 × M16	48	40	65	59	–
65*	16	4 × M16	32	27	87	80	11
65	40	8 × M16	32	27	43	40	–
80	16	8 × M16	40	34	53	48	13
80	40	8 × M16	40	34	53	48	–
100	16	8 × M16	43	36	57	51	14
100	40	8 × M20	59	50	78	70	–
125	16	8 × M16	56	48	75	67	19
125	40	8 × M24	83	71	111	99	–
150	16	8 × M20	74	63	99	85	27

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
Promag W, P, S							
150	40	8 × M24	104	88	136	120	–
200	10	8 × M20	106	91	141	101	–
200	16	12 × M20	70	61	94	67	28
200	25	12 × M24	104	92	138	105	–
250	10	12 × M20	82	71	110	-	27
250	16	12 × M24	98	85	131	-	–
250	25	12 × M27	150	134	200	-	–
300	10	12 × M20	94	81	125	-	34
300	16	12 × M24	134	118	179	-	–
300	25	16 × M27	153	138	204	-	–
350	6	12 × M20	111	120	-	-	–
350	10	16 × M20	112	118	188	-	47
350	16	16 × M24	152	165	254	-	–
350	25	16 × M30	227	252	380	-	–
400	6	16 × M20	90	98	-	-	–
400	10	16 × M24	151	167	260	-	65
400	16	16 × M27	193	215	330	-	–
400	25	16 × M33	289	326	488	-	–
450	6	16 × M20	112	126	-	-	–
450	10	20 × M24	153	133	235	-	59
450	16	20 × M27	198	196	300	-	–
450	25	20 × M33	256	253	385	-	–
500	6	20 × M20	119	123	-	-	–
500	10	20 × M24	155	171	265	-	66
500	16	20 × M30	275	300	448	-	–
500	25	20 × M33	317	360	533	-	–
600	6	20 × M24	139	147	-	-	–
600	10	20 × M27	206	219	345	-	93
600*	16	20 × M33	415	443	658	-	–
600	25	20 × M36	431	516	731	-	–
700	6	24 × M24	148	139	-	-	-

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
Promag W, P, S							
700	10	24 × M27	246	246	-	-	-
700	16	24 × M33	278	318	-	-	-
700	25	24 × M39	449	507	-	-	-
800	6	24 × M27	206	182	-	-	-
800	10	24 × M30	331	316	-	-	-
800	16	24 × M36	369	385	-	-	-
800	25	24 × M45	664	721	-	-	-
900	6	24 × M27	230	637	-	-	-
900	10	28 × M30	316	307	-	-	-
900	16	28 × M36	353	398	-	-	-
900	25	28 × M45	690	716	-	-	-
1000	6	28 × M27	218	208	-	-	-
1000	10	28 × M33	402	405	-	-	-
1000	16	28 × M39	502	518	-	-	-
1000	25	28 × M52	970	971	-	-	-
1200	6	32 × M30	319	299	-	-	-
1200	10	32 × M36	564	568	-	-	-
1200	16	32 × M45	701	753	-	-	-
1400	6	36 × M33	430	398	-	-	-
1400	10	36 × M39	654	618	-	-	-
1400	16	36 × M45	729	762	-	-	-
1600	6	40 × M33	440	417	-	-	-
1600	10	40 × M45	946	893	-	-	-
1600	16	40 × M52	1007	1100	-	-	-
1800	6	44 × M36	547	521	-	-	-
1800	10	44 × M45	961	895	-	-	-
1800	16	44 × M52	1108	1003	-	-	-
2000	6	48 × M39	629	605	-	-	-
2000	10	48 × M45	1047	1092	-	-	-
2000	16	48 × M56	1324	1261	-	-	-

*Designed acc. to EN 1092-1 (not to DIN 2501)

EN (DIN) (pressure rating in [bar])

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
Promag L							
50	16	4 × M16	-	15	-	-	-
65*	16	8 × M16	-	10	-	-	-
80	16	8 × M16	-	15	-	-	-
100	16	8 × M16	-	20	-	-	-
125	16	8 × M16	-	30	-	-	-
150	16	8 × M20	-	50	-	-	-
200	10	8 × M20	-	65	-	-	-
250	10	12 × M20	-	50	-	-	-
300	10	12 × M20	-	55	-	-	-
*Designed acc. to EN 1092-1 (not to DIN 2501)							

AS 2129 (pressure rating Tab. E)

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
25	Tab. E	4 × M12	15	-	21	-	-
40	Tab. E	4 × M12	21	-	27	-	-
50	Tab. E	4 × M16	32	-	42	-	-
80	Tab. E	4 × M16	49	-	66	-	-
100	Tab. E	8 × M16	38	-	51	-	-
150	Tab. E	8 × M20	64	-	86	-	-
200	Tab. E	8 × M20	96	-	128	-	-
250	Tab. E	12 × M20	98	-	130	-	-
300	Tab. E	12 × M24	123	-	164	-	-
350	Tab. E	12 × M24	203	-	339	-	-
400	Tab. E	12 × M24	226	-	387	-	-
450	Tab. E	16 × M24	226	-	-	-	-
500	Tab. E	16 × M24	271	-	442	-	-
600	Tab. E	16 × M30	439	-	706	-	-
700	Tab. E	20 × M30	355	-	-	-	-
750	Tab. E	20 × M33	559	-	-	-	-

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
800	Tab. E	20 × M33	631	-	-	-	-
900	Tab. E	24 × M33	627	-	-	-	-
1000	Tab. E	24 × M36	634	-	-	-	-
1200	Tab. E	32 × M36	727	-	-	-	-

AS 4087 (pressure rating PN16)

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
25	PN16	-	-	-	-	-	-
40	PN16	-	-	-	-	-	-
50	PN16	4 × M16	32	-	42	-	-
80	PN16	4 × M16	49	-	66	-	-
100	PN16	4 × M16	76	-	101	-	-
150	PN16	8 × M16	52	-	69	-	-
200	PN16	8 × M16	77	-	103	-	-
250	PN16	8 × M20	147	-	195	-	-
300	PN16	12 × M20	103	-	137	-	-
350	PN16	12 × M24	203	-	339	-	-
375	PN16	12 × M24	137	-	-	-	-
400	PN16	12 × M24	226	-	387	-	-
450	PN16	12 × M24	301	-	-	-	-
500	PN16	16 × M24	271	-	442	-	-
600	PN16	16 × M27	393	-	632	-	-
700	PN16	20 × M27	330	-	-	-	-
750	PN16	20 × M30	529	-	-	-	-
800	PN16	20 × M33	631	-	-	-	-
900	PN16	24 × M33	627	-	-	-	-
1000	PN16	24 × M33	595	-	-	-	-
1200	PN16	32 × M33	703	-	-	-	-

JIS

Nominal diameter	Pressure rating	Screws	Max. tightening torque [Nm]				
			HR	PUR	PTFE	PFA	NR
15	10K	4 × M12	-	-	14	-	-
15	20K	4 × M12	-	-	14	-	-
25	10K	4 × M16	-	19	32	27	-
25	20K	4 × M16	-	19	32	27	-
32	10K	4 × M16	-	22	38	-	-
32	20K	4 × M16	-	22	38	-	-
40	10K	4 × M16	-	24	41	37	-
40	20K	4 × M16	-	24	41	37	-
50	10K	4 × M16	40	33	54	46	-
50	20K	8 × M16	20	17	27	23	-
65	10K	4 × M16	55	45	74	63	-
65	20K	8 × M16	28	23	37	31	-
80	10K	8 × M16	29	23	38	32	-
80	20K	8 × M20	42	35	57	46	-
100	10K	8 × M16	35	29	47	38	-
100	20K	8 × M20	56	48	75	58	-
125	10K	8 × M20	60	51	80	-	-
125	20K	8 × M22	91	79	121	-	-
150	10K	8 × M20	75	63	99	-	-
150	20K	12 × M22	81	72	108	-	-
200	10K	12 × M20	61	52	82	-	-
200	20K	12 × M22	91	80	121	-	-
250	10K	12 × M22	100	87	133	-	-
250	20K	12 × M24	159	144	212	-	-
300	10K	16 × M22	74	63	99	-	-
300	20K	16 × M24	138	124	183	-	-

ANSI

Nominal diameter		Pressure rating	Screws	Max. tightening torque							
				HR		PUR		PTFE		PFA	
Inch	mm			[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]
Promag W, P, S											
½"	15	Class 150	4 × ½"	-	-	-	-	4.4	6	-	-
		Class 300	4 × ½"	-	-	-	-	4.4	6	-	-
1"	25	Class 150	4 × ½"	-	-	5.2	7	8.1	11	7.4	10
		Class 300	4 × 5/8"	-	-	5.9	8	10	14	8.9	12
1½"	40	Class 150	4 × ½"	-	-	7.4	10	18	24	15	21
		Class 300	4 × ¾"	-	-	11	15	25	34	23	31
2"	50	Class 150	4 × 5/8"	26	35	16	22	35	47	32	44
		Class 300	8 × 5/8"	13	18	8.1	11	17	23	16	22
3"	80	Class 150	4 × 5/8"	44	60	32	43	58	79	49	67
		Class 300	8 × ¾"	28	38	19	26	35	47	31	42
4"	100	Class 150	8 × 5/8"	31	42	23	31	41	56	37	50
		Class 300	8 × ¾"	43	58	30	40	49	67	44	59
6"	150	Class 150	8 × ¾"	58	79	44	59	78	106	63	86
		Class 300	12 × ¾"	52	70	38	51	54	73	49	67
8"	200	Class 150	8 × ¾"	79	107	59	80	105	143	80	109
10"	250	Class 150	12 × 7/8"	75	101	55	75	100	135	-	-
12"	300	Class 150	12 × 7/8"	98	133	76	103	131	178	-	-
14"	350	Class 150	12 × 1"	100	135	117	158	192	260	-	-
16"	400	Class 150	16 × 1"	94	128	111	150	181	246	-	-
18"	450	Class 150	16 × 11/8"	150	204	173	234	274	371	-	-
20"	500	Class 150	20 × 11/8"	135	183	160	217	252	341	-	-
24"	600	Class 150	20 × 1¼"	198	268	226	307	352	477	-	-

Nominal diameter		Pressure rating	Screws	Max. tightening torque							
				HR		PUR		PTFE		PFA	
Inch	mm			[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]
Promag L											
2"	50	Class 150	4 × 5/8"	-	-	11	15	-	-	-	-
3"	80	Class 150	4 × 5/8"	-	-	18	25	-	-	-	-

Nominal diameter		Pressure rating	Screws	Max. tightening torque							
				HR		PUR		PTFE		PFA	
Inch	mm			[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]	[lbf ft]	[Nm]
Promag L											
4"	100	Class 150	8 × 5/8"	-	-	15	20	-	-	-	-
6"	150	Class 150	8 × ¾"	-	-	33	45	-	-	-	-
8"	200	Class 150	8 × ¾"	-	-	48	65	-	-	-	-
10"	250	Class 150	12 × 7/8"	-	-	41	55	-	-	-	-
12"	300	Class 150	12 × 7/8"	-	-	56	68	-	-	-	-

AWWA

Nominal diameter		Pressure rating	Screws	Max. tightening torque			
				HR		PUR	
Inch	mm			[lbf ft]	[Nm]	[lbf ft]	[Nm]
28"	700	Class D	28 × 1¼"	182	247	215	292
30"	750	Class D	28 × 1¼"	212	287	223	302
32"	800	Class D	28 × 1½"	291	394	311	422
36"	900	Class D	32 × 1½"	309	419	317	430
40"	1000	Class D	36 × 1½"	310	420	352	477
42"	1050	Class D	36 × 1½"	389	528	382	518
48"	1200	Class D	44 × 1½"	407	552	392	531
54"	1350	Class D	44 × 1¾"	538	730	467	633
60"	1500	Class D	52 × 1¾"	559	758	614	832
66"	1650	Class D	52 × 1¾"	698	946	704	955
72"	1800	Class D	60 × 1¾"	719	975	802	1087
78"	2000	Class D	64 × 2"	629	853	580	786

7 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to Endress+Hauser for disposal under the applicable conditions.

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Endress+Hauser

People for Process Automation

EA01191D/06/A2/05.23-00
71613730
2024-01-01

Installation Instructions
Weather Protection

Proline 400, 800, 500-digital

Endress+Hauser
People for Process Automation

Weather protection cover

Proline 400, 800, 500-digital

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2 Intended use 4
3 Authorized installation personnel 4
4 Safety instructions 5
5 Symbols 6
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7 Mounting of weather protection cover on wall 7
8 Mounting of weather protection cover on pipe 8
9 Disposal 8

1 Overview of accessories

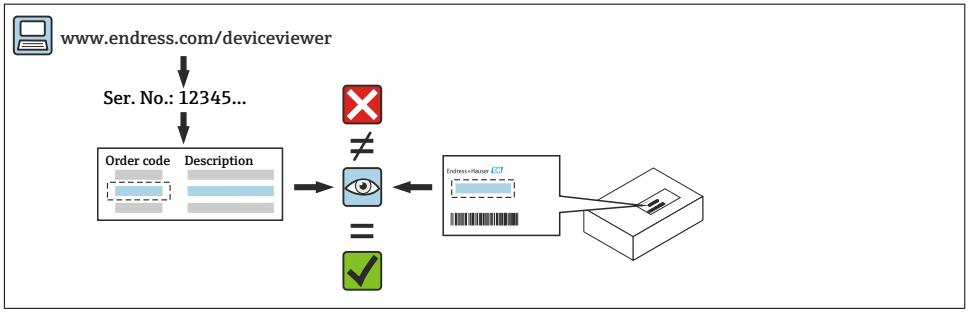
The Installation Instructions apply to the following accessories:

Order number	Original accessories	Contents
71343504	Weather protection cover set	1 × weather protection cover

- The order number of the accessory (on the product label on the package) can differ from the production number (on the label directly on the accessory)!
- You can find the order number of the relevant accessory by entering the production number of the accessory in the spare parts search tool.
- We recommend that you keep the Installation Instructions and packaging together at all times.

2 Intended use

- Accessories and installation instructions are used to upgrade certain functions of an Endress+Hauser measuring device.
- Only use original parts from Endress+Hauser.
- Check in the W@M Device Viewer if the accessory is suitable for the measuring device in question.



3 Authorized installation personnel

Authorization to carry out installation depends on the measuring device's approval type. The table below shows the authorized group of people in each case.

Whoever carries out the installation has full responsibility to ensure that work is carried out safely and to the required quality standard. He/she must also guarantee the safety of the device following installation.

Measuring device approval	Personnel authorized to carry out installation [1)]
No approval	1, 2, 3
With approval (e.g. IECEx)	1, 2, 3
For custody transfer	4

1) 1 = Qualified specialist on customer side, 2 = Service technician authorized by Endress+Hauser,
3 = Endress+Hauser (return measuring device to manufacturer)
4 = Check with local approval center if installation/alteration must be performed under supervision.

4 Safety instructions

- Only use original parts from Endress+Hauser.
- Comply with national regulations governing mounting, electrical installation, commissioning and maintenance.
- The specialized technical staff involved in the mounting, electrical installation, commissioning, maintenance and installation of the measuring devices must meet the following requirements:
  - Be trained in instrument safety.
  - Be familiar with the individual operating conditions of the devices.
  - In the case of Ex-certified measuring devices, they must also be trained in explosion protection.
- The measuring device is energized! Risk of fatal injury from electric shock. Open the measuring device only when the device is de-energized.
- For measuring devices intended for use in hazardous locations, please observe the guidelines in the Ex documentation (XA).
- When using measuring devices in safety-related applications in accordance with IEC 61508 or IEC 61511: following installation, re-commission the device in accordance with the Operating Instructions. Document the installation.
- Before removing the device: set the process to a safe state and purge the pipe of dangerous process substances.
- Burn hazard from hot surfaces! Before commencing work: allow the system and measuring device to cool to a touch-safe temperature.
- In the case of devices in custody transfer, the custody transfer status no longer applies once the seal has been removed.
- The Operating Instructions for the device must be followed.
- Risk of damage to electronic components! Ensure that the working environment is protected against electrostatic discharge.
- After removing the electronics compartment cover: risk of electric shock due to removal of contact protection!
  Turn off the measuring device before removing internal covers.
- Only open the housing for a brief period. Avoid ingress of foreign bodies, moisture or contaminants.
- Replace defective seals only with original seals from Endress+Hauser.
- If threads are defective, the measuring device must be repaired.

- Threads (e.g. of the electronics compartment cover and connection compartment cover) must be lubricated if an abrasion-proof dry lubricant is not available. Use acid-free, non-hardening lubricant.
- If, during installation, spacing is reduced or the dielectric strength of the measuring device cannot be guaranteed, perform a test on completion of the work (e.g. high-voltage test in accordance with the manufacturer's instructions).
- Service plug:
  - Do not connect in explosive atmospheres.
  - Only connect to Endress+Hauser service devices.
- Observe the instructions for transporting and returning the device outlined in the Operating Instructions.

If you have any questions, please contact your www.addresses.endress.com.

5 Symbols

5.1 Symbols for certain types of information

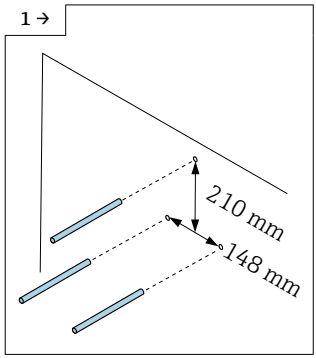
Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
1., 2., 3...	Series of steps

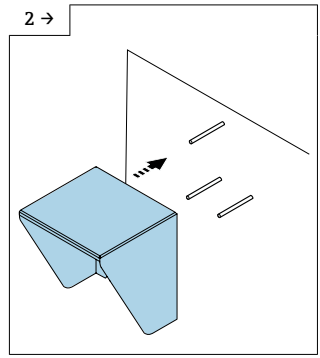
6 Tool list

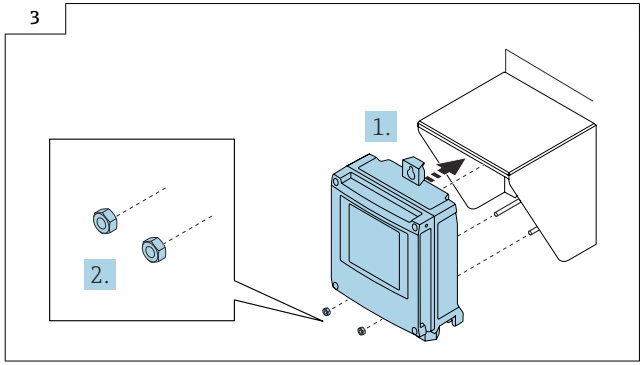
Allen key
4 mm

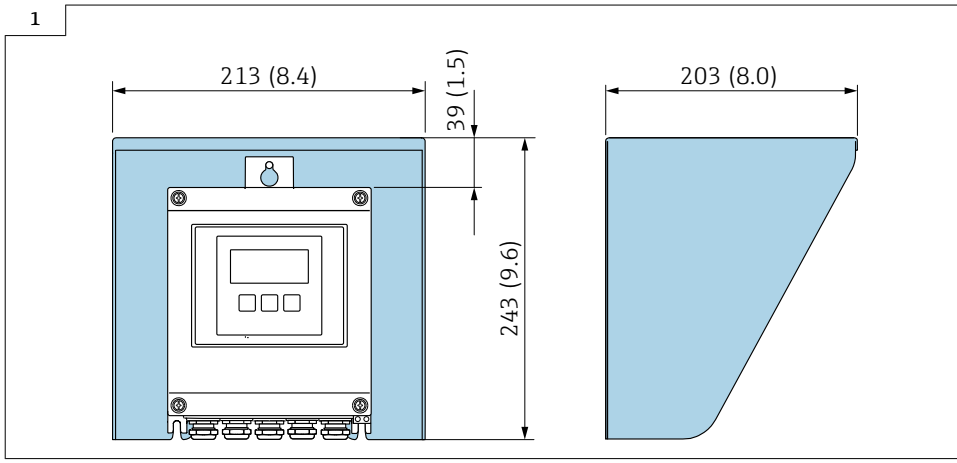
Torx screwdriver
T25

7 Mounting of weather protection cover on wall



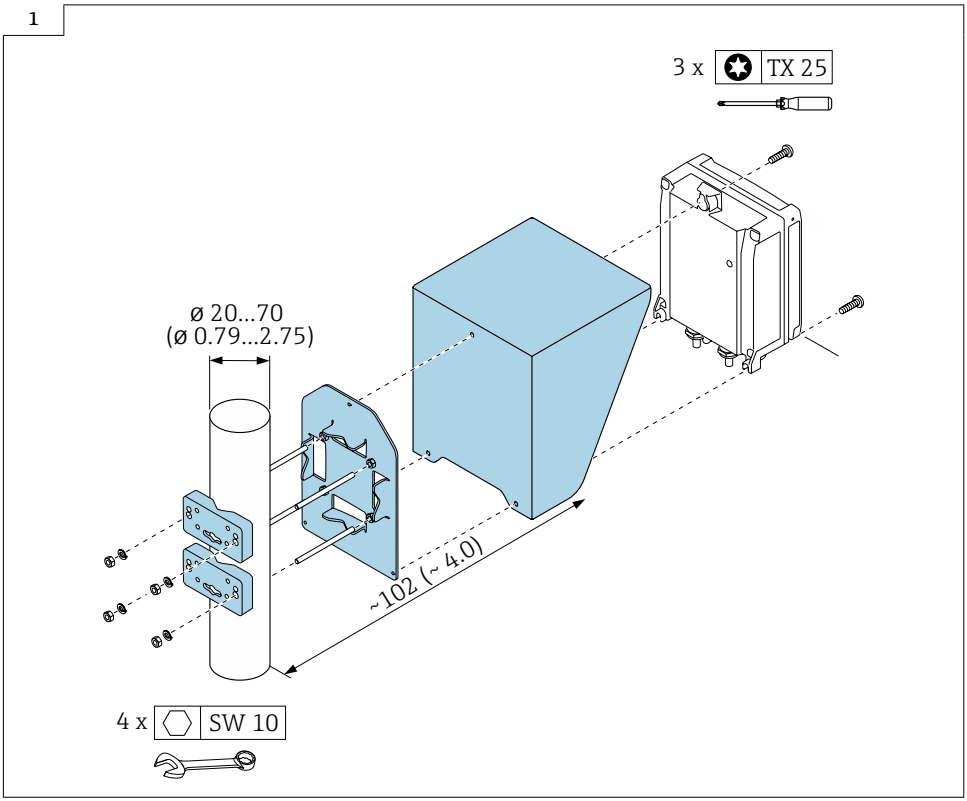






8 Mounting of weather protection cover on pipe

1



9 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

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Endress+Hauser

People for Process Automation

Certificate of Compliance

Certificate:	2551823	**Master Contract:**	160686
Project:	80224103	**Date Issued:**	2024-11-13

Issued to: **Endress+Hauser Flowtec AG**
Kagenstrasse 7
Reinach, Basel-Country 4153
Switzerland

Attention: Daniel Bosshard

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Issued by: *Anil Sodhi*
Anil Sodhi, P. Eng.

PRODUCTS

Class 2258 03 PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non - Incendive Systems - For Hazardous Locations
Class 2258 83 PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non-Incendive Systems-For Hazardous Locations-Certified to U.S. Standards

Class I, Division 2, Groups A, B, C and D:

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Certificate: 2551823 **Master Contract**: 160686

Project: 80224103 **Date Issued**: 2024-11-13

Product	**Proline Promag 400 Magnetic-inductive flow measuring system; compact version** providing exciter coil circuits and non-incendive electrode circuits to Integral Sensor Model Promag W, L, D. Proline Promag W 400, Model 5W4Cbb-ccdLfA/M/Q/Rhiklllmn+#**# and O5W4Cbb-ccdLfA/M/Q/Rhiklllmnpp + #**# Proline Promag L 400, Model 5L4Cbb-ccLfA/M/Q/Rhiklllmn+#**# and O5L4Cbb-ccLfA/M/Q/Rhiklllmnpp + #**# Proline Promag D 400, Model 5D4Cbb-ccLfA/M/Q/Rhiklllmn+#**# and O5D4Cbb-ccLfA/M/Q/Rhiklllmnpp + #**# Note: Must be installed as per control drawing FES0196*
Electrical Rating	Rated input: 100-240 V AC, 50/60Hz (+/- 4Hz), 30VA 24 V AC, 50/60Hz (+/- 4Hz), 10VA 24 V DC, 8.0W
Enclosure rating	Type 4X, IP 66/67
Temp. code and ambient temperature	T4 (-40°C to + 60°C)
Process temperature and MWP	Max process temperature: +90°C Maximum Working Pressure (MWP): 160bar (Sensors W, L), 25bar (sensor D)

Product	**Proline Promag 400 Magnetic-inductive flow measuring system; remote version** providing exciter coil circuits and non-incendive electrode circuits to Remote Sensor, Model Promag W, L, D. Proline Promag W 400, Model 5W4Cbb-ccdLfN/Phiklllmn+#**# and O5W4Cbb-ccdLfN/Phiklllmnpp + #**# Proline Promag L 400, Model 5L4Cbb-ccLfN/Phiklllmn+#**# and O5L4Cbb-ccLfN/Phiklllmnpp + #**# Proline Promag D 400, Model 5D4Cbb-ccLfN/Phiklllmn+#**# and O5D4Cbb-ccLfN/Phiklllmnpp + #**# Note: Must be installed as per control drawing FES0196*
Electrical Rating	Rated input: 100-240 V AC, 50/60Hz (+/- 4Hz), 30VA 24 V AC, 50/60Hz (+/- 4Hz), 10VA 24 V DC, 8.0W
Enclosure rating	Transmitter Housing: Type 4X, IP 66/67 Sensor Housing: Type 4X, 6P, IP 66/68
Temp. code and ambient temperature	Transmitter Housing: T4 (-40°C to + 60°C) Sensor Housing: T6 or T5 (-40°C to + 60°C)

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Certificate: 2551823 **Master Contract**: 160686

Project: 80224103 **Date Issued**: 2024-11-13

Process temperature and MWP	Max process temperature: +90°C Maximum Working Pressure (MWP): 160bar (Sensors W, L), 25bar (sensor D)

Order Code Structure:

Proline Promag W 400

5a4obb-ccdefghiklllmn + ##**
O5a4obb-ccdefghiklllmnpp + ##**

Proline Promag 400 - replacement transmitter
5X4oXX-ccdgefhi + ##**
O5X4oXX-ccdgefhipp + ##**

a = Type of sensor
W = Promag W
o = Generation Index
C = modular version
bb = Size (nominal tube diameter)
any double number or letter
cc = Approval
C6 = CSA C/US NI CL.I Div.2 Gr. ABCD
d = Design
(options for length of tube)
any single number or letter
e = Power Supply (and sensor only option)
L = 24-240V AC/DC
(modular version only)
X = sensor only (For customers ordering a replacement sensor.)
f = Output/Input
H,I,J = 4-20mA HART + configurable ports
L = PROFIBUS DP
M = Modbus RS485
N = Ethernet/IP
O, P = Modbus/PFS/IOUT
X = sensor only (For customers ordering a replacement sensor.)
g = Housing of Transmitter
A = Compact, Alu
M = Compact, Polymeric
N = Remote, Polymeric
P = Remote, Alu
Q = Compact, Polymeric, 22.5° angle
R = Compact, Alu, 22.5° angle
h = Cable, Remote Version (options for

Proline Promag L 400, Proline Promag D 400

5a4obb-ccefghiklllmn + ##**
O5a4obb-ccefghiklllmnpp + ##**

a = Type of sensor
L = Promag L
D = Promag D
o = Generation Index
C = modular version
bb = Size (nominal tube diameter)
any double number or letter
cc = Approval
C6 = CSA C/US NI CL.I Div.2 Gr. ABCD
e = Power Supply (and sensor only option)
L = 24-240V AC/DC
(modular version only)
X = sensor only (For customers ordering a replacement sensor.)
f = Output/Input
H,I,J = 4-20mA HART + configurable ports
L = PROFIBUS DP
M = Modbus RS485
N = Ethernet/IP
O, P = Modbus/PFS/IOUT
X = sensor only (For customers ordering a replacement sensor.)
g = Housing of Transmitter
A = Compact, Alu
M = Compact, Polymeric
N = Remote, Polymeric
P = Remote, Alu
Q = Compact, Polymeric, 22.5° angle
R = Compact, Alu, 22.5° angle
h = Cable, Remote Version (options for length and quality of cable)
any single number or letter
i = Cable Glands
D = Thread NPT1/2”
L = Thread NPT1/2” + M12x1 receptacle

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length and quality of cable)
any single number or letter
i = Cable Glands
D = Thread NPT1/2”
L = Thread NPT1/2” + M12x1 receptacle for ethernet
k = Liner Material (covers the inside of measurement tube)
any single number or letter
lll = Process Connection (= flange)
any triple number or letter
m = Electrodes (shape and material of electrodes contacting the fluid)
any single number or letter
n = Calibration Flow
any single number or letter
pp = Customer version
any double number or letter

** = Option in two digits (none, two or multiple of two digits); any combination of number or letter

+, # = Signs used as indicator for optional abbreviation of extended order code

for ethernet
k = Liner Material (covers the inside of measurement tube)
any single number or letter
lll = Process Connection (= flange)
any triple number or letter
m = Electrodes (shape and material of electrodes contacting the fluid)
any single number or letter
n = Calibration Flow
any single number or letter
pp = Customer version
any double number or letter

** = Option in two digits (none, two or multiple of two digits); any combination of number or letter

+, # = Signs used as indicator for optional abbreviation of extended order code

Product	**Proline Prosonic Flow ultrasonic flow measuring system; remote version** providing non incendive circuits to sensors Prosonic Flow W and Prosonic Flow I. Proline Prosonic W 400, Model 9W4Bcc-ddefghikklmmnnpp + #**# and O9W4Bcc-ddefghikklmmnnppqq + #**# Proline Prosonic I 400, Model 9I4Bcc-ddefghikklmmnnoopp + #**# and O9I4Bcc-ddefghikklmmnnooppqq + #**# Note: Must be installed as per control drawing FES0233*
Electrical Rating	Rated input: 100-240 V AC, 50/60Hz (+/- 4Hz), 30VA 24 V AC, 50/60Hz (+/- 4Hz), 10VA 24 V DC, 8.0W
Enclosure rating	Transmitter Housing: Type 4X, IP 66/67 Sensor: Type 4X/ 6P/ IP 66/68
Temp. code and ambient temperature	Transmitter Housing: T4 (-40°C to + 60°C) Sensor Housing: T6-T1, see control drawing FES0233*
Process temperature and MWP	See control drawing FES0233*

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Order Code Structure:

Proline Prosonic Flow W 400
9W4Bcc-ddefghikklmmnnpp + #**#
O9W4Bcc-ddefghikklmmnnppqq + #**#

Proline Prosonic Flow I 400
9I4Bcc-ddefghikklmmnnoopp + #**#
O9I4Bcc-ddefghikklmmnnooppqq + #**#

Proline Prosonic Flow 400 - replacement transmitter
9X4BXX-ddefghipp + #**#
O9X4BXX-ddefghippqq + #**#

cc	**Number of Sensorsets** any double number or letter
dd	**Approval** C6 = CSA C/US NI CL.I Div.2 Gr. ABCD
e	**Power Supply** L = 100..240 VAC or 24V AC/DC X = Sensor only (Not for replacement transmitter)
f	**Output/Input** H,I = 4-20mA HART + configurable ports L = Profibus DP M = Modbus RS485 N = Ethernet/IP O,P = Modbus/PFS/IOUT X = Sensor only (Not for replacement transmitter)
g	**Display/Operation** F = Display module G = Display module with WLAN X = Sensor only (Not for replacement transmitter)
h	**Housing of Transmitter** N = Remote, Polymeric enclosure P = Remote, Aluminum enclosure X = Sensor only (Not for replacement transmitter)
i	**Cable Entries** D = Thread NPT1/2” L = Thread NPT1/2” + M12x1 receptacle for Ethernet X = Sensor only (Not for replacement transmitter)
kk	**Sensor Version** any double number or letter
l	**Process Temperature** any single number or letter
mm	**Cable** any double number or letter
nn	**Installation Set** any double number or letter

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oo	**Sensor Holder** any double number or letter
pp	**Device Model** any double number or letter
qq	**Customer Version** any double number or letter
+, #	Signs used as indicator for optional abbreviation of extended order code
**	Option in two digits (none, two or multiple of two digits); any combination of number or letter

Proline Prosonic Flow 400 sensor set

DK9018-ddkkl00

dd	**Approval** C6 = CSA C/US NI CL.I Div.2 Gr. ABCD
kk	**Sensor Version** any double number or letter
l	**Process Temperature** any single number or letter
00	**Reserved for future use**

Note:
Optionally an antenna bushing is available for the connection of an external antenna.

Conditions of Acceptability:

1. Final installation shall be as per Canadian Electrical Code (CEC) or National Electrical Code (NEC). Refer to control drawing FES0196 and FES0233 for safe instructions.
2. For polymeric enclosures: Do not remove the reinforcement plate. This ensures grounding and mechanical stability of the conduit entries and the optional antenna bushing.
3. Antenna supplied by Endress+Hauser shall be used only. As an alternate, any passive omni-directional RF antenna with or without cable is permitted to be connected when meeting the following parameters:
    a. The antenna shall have an impedance of at least 50Ω.
    b. The rated frequency range of the antenna shall not exceed 1710MHz … 6000MHz.
    c. The RF antenna or the RF antenna cable shall be fitted with a Type N connector plug (male).
4. The antenna bushing type H337 shall be mounted wrench tight to the transmitter enclosure to maintain the ingress protection of the enclosure.
5. The coupling nut of the Type N plug connector shall be hand tightened only.
6. The metal enclosure of the Antenna Bushing H337 shall be securely connected to local earth, typically via the enclosure to which it is connected.

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APPLICABLE REQUIREMENTS

CSA C22.2 No. 213-17+Upd.1+Upd.2+Upd.3(Third Edition) - Nonincendive electrical equipment for use in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations - Third Edition; Update No. 1: August 2018; Update No. 2: August 2019; Update No. 3: April 2021

CSA C22.2 No. 61010-1-12, UPD1:2015, UPD2:2016 AMD1:2018 - Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements...

CSA C22.2 No. 94.2:15 - Second Edition - Enclosures for electrical equipment, environmental considerations

ANSI/UL 121201-2021 Ninth Edition - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

ANSI/UL 61010-1:2012 - Third Edition - Including revisions through June 6, 2023 - Safety Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements

UL 50E:2015 - Second Edition - UL Standard for Safety Enclosures for Electrical Equipment, Environmental Considerations

FM 3600:2022 - Electrical Equipment for Use in Hazardous (Classified) Locations - General Requirements

FM 3611:2021 - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

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Certificate: 2551823 **Master Contract**: 160686

Project: 80224103 **Date Issued**: 2024-11-13

Notes:

Products certified under Class(es) C225803, C225883 have been certified under CSA's ISO/IEC 17065 accreditation with the Standards Council of Canada (SCC). www.scc.ca

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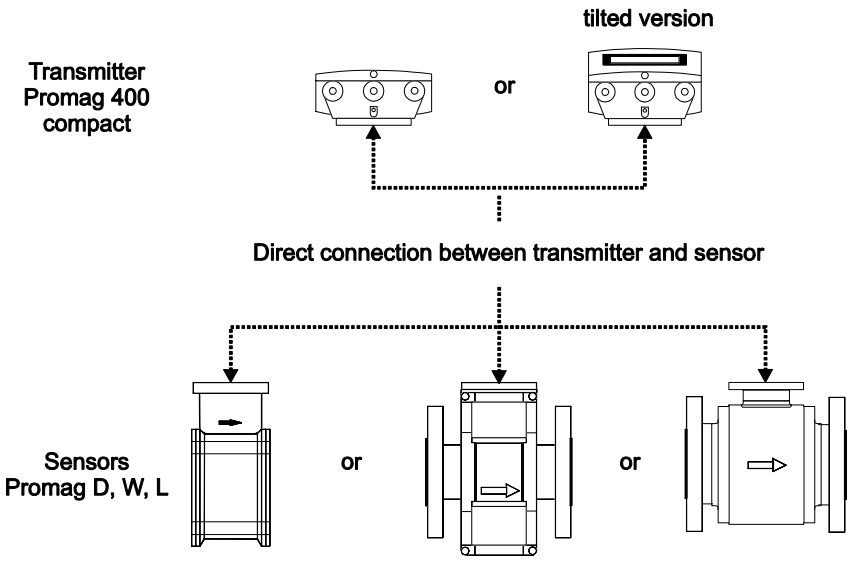
§

Hazardous Locations
Cl. I. Div. 2, Gps A,B,C,D



PROMAG W/D/L 400 - Compact version

Notes:

1) Install according to Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70.
2) Tightening torque for transmitter cover screws:

Metallic enclosure	Polymeric enclosure, flat version	Polymeric enclosure, tilted version
2.5 Nm	2.5 Nm	1.3 Nm

3) For polymeric enclosures: Do not remove the reinforcement plate. This ensures grounding and mechanical stability of the conduit entries and the optional antenna bushing.
4) Suitable for outdoor use.
5) Open housing for brief periods only. Avoid the ingression of foreign objects, moisture or contaminants.
   Logement ouvert pour de brèves périodes seulement. Éviter la pénétration de corps étrangers, d'humidité ou de contaminants
6) The maximally allowed medium temperature T_m depends on the liner material used for the sensor. Refer to the sensor name plate.

7) Additional temperature restriction depending on temperature classes:

Max. ambient temperature	Max. medium temperature						
	T6 80°C	T5 95°C	T4A 115°C	T4 130°C	T3C 155°C	T2 290°C	T1 440°C
60°C/140°F *)	---	---	---	90°C / 194°F *)	90°C / 194°F	90°C / 194°F	90°C / 194°F

*) Exception for Sensor Promag D: Max. ambient temperature = 40°C /104°F, Max. medium temperature = 40°C /104°F

Minimally allowed ambient temperature depending on the material of the sensor flanges:
- stainless steel flanges: -40°C/ -40°F
- carbon steel flanges: -10°C/14°F

8) WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
   AVERTISSEMENT – RISQUE D'EXPLOSION – LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATÉRIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2;

9) WARNING - EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS;
   AVERTISSEMENT – RISQUE D'EXPLOSION – AVANT DE DÉCONNECTER L'EQUIPMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX;

Aenderungen:					Ersteller: FES / **ID 1528** FILE: M:\ZEICHNG\FES0196\G\FES0196G.doc
	A	29.10.12/BDA	F	12.04.24/BDA	
	B	05.11.13/BDA	G	08.10.24/BDA	
	C	03.03.14/BDA	H		
	D	15.02.19/BDA	J		
	E	27.07.21/BDA	K		

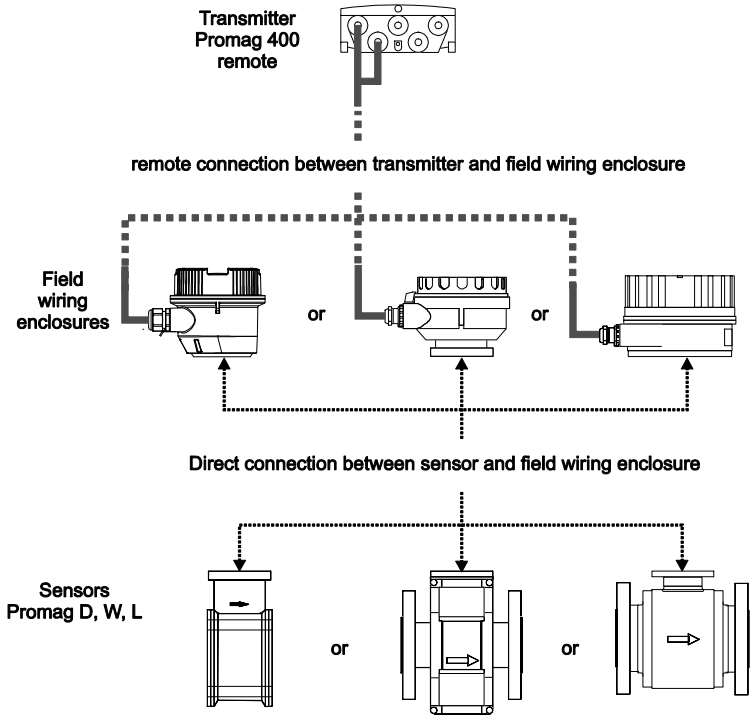
$_{C}$CSA$_{US}$ Control Drawing Class I Division 2 Compact version PROMAG W/D/L 400	Gezeichnet	29.10.2012	BDA
	Geprüft		
	Ex-geprüft	08.10.2024	BDA
	Gesehen		

Endress+Hauser
People for Process Automation

Flowtec AG, Kaegenstrasse 7, CH-4153 Reinach BL1, Postfach

FES0196G

Hazardous Locations
Cl. I. Div. 2, Gps A,B,C,D



PROMAG W/D/L 400 - Remote version

Notes:

1. Install according to Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70.
2. Tightening torque for transmitter cover screws: 2.5 Nm
3. For polymeric enclosures: Do not remove the reinforcement plate. This ensures grounding and mechanical stability of the conduit entries and the optional antenna bushing.
4. Suitable for outdoor use.
5. Open housing for brief periods only. Avoid the ingression of foreign objects, moisture or contaminants
   Logement ouvert pour de brèves périodes seulement. Éviter la pénétration de corps étrangers, d'humidité ou de contaminants
6. The maximally allowed medium temperature T_m depends on the liner material used for the sensor. Refer to the sensor name plate.
7. Additional temperature restriction depending on temperature classes
   Sensor:

Max. ambient temperature	Max. medium temperature						
	T6	T5	T4A	T4	T3C	T2	T1
60°C/140°F	80°C / 176°F	90°C / 194°F	90°C / 194°F	90°C / 194°F	90°C / 194°F	90°C / 194°F	90°C / 194°F

Minimally allowed ambient temperature depending on the material of the sensor flanges:
- stainless steel flanges: -40°C / -40°F
- carbon steel flanges: -10°C / 14°F

Transmitter:
Temperature class for transmitter in remote version is T4 at 60°C / 140°F ambient temperature.
The minimum ambient temperature is –40°C/-40°F

8. WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
   AVERTISSEMENT – RISQUE D'EXPLOSION – LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATÉRIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2;

9. WARNING - EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS;
   AVERTISSEMENT – RISQUE D'EXPLOSION – AVANT DE DÉCONNECTER L'EQUIPMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX;

Aenderungen:					Ersteller: FES / **ID 1528** FILE: M:\ZEICHNG\FES0196\G\FES0196G.doc
	A	29.10.12/BDA	F	12.04.24/BDA	
	B	05.11.13/BDA	G	08.10.24/BDA	
	C	03.03.14/BDA	H		
	D	15.02.19/BDA	J		
	E	27.07.21/BDA	K		

$_{C}$CSA$_{US}$ Control Drawing Class I Division 2 Remote version PROMAG W/D/L 400	Gezeichnet	29.10.2012	BDA
	Geprüft		
	Ex-geprüft	08.10.2024	BDA
	Gesehen		

Endress+Hauser
People for Process Automation

Flowtec AG, Kaegenstrasse 7, CH-4153 Reinach BL1, Postfach

FES0196G

PROMAG W/D/L 400 - Wiring Options

1) Cl. I. Div. 2, Gps A,B,C,D

a) Threaded Cable Entries NPT1/2":

- Install per Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70 and use supply wires suitable for 20 °C above ambient temperature.

b) Receptacle (plug-in connector) with thread M12x1, approved for Cl. I. Div.2:

- Install per Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70.
- The M12 mating connector which is sourced by the customer must also be approved for Cl. I. Div.2 and must be suitable for Type 4X, IP66/67.
  It must provide additional mechanical security to prevent accidental disconnection.

2) Non-hazardous classified areas

a) Threaded Cable Entries (e.g. NPT1/2" or M20x1.5):

- Install per Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70 and use supply wires suitable for 20 °C above ambient temperature.

b) Receptacle (plug-in connector) with thread M12x1:

- Install per Canadian Electrical Code (CEC) or National Electrical Code (NEC) ANSI/NFPA 70.
- The M12 mating connector which is sourced by the customer must be suitable for Type 4X, IP66/67.

3) Notes for External Antenna

a) Antenna supplied by Endress+Hauser shall be used only. As an alternate, any passive omni-directional RF antenna with or without cable is permitted to be connected when meeting the following parameters:
i) The antenna shall have an impedance of at least 50Ω
ii) The rated frequency range of the antenna shall not exceed 1710MHz … 6000MHz
iii) The RF antenna or the RF antenna cable shall be fitted with a Type N connector plug (male)

b) The antenna bushing type H337 shall be mounted wrench tight to the transmitter enclosure to maintain the ingress protection of the enclosure.

c) The coupling nut of the Series N plug connector shall be hand tightened only.

d) The metal enclosure of the Antenna Bushing H337 shall be securely connected to local earth, typically via the enclosure to which it is connected

Aenderungen:				
	A	29.10.12/BDA	F	12.04.24/BDA
	B	05.11.13/BDA	G	08.10.24/BDA
	C	03.03.14/BDA	H	
	D	15.02.19/BDA	J	
	E	27.07.21/BDA	K	

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$_{C}$CSA$_{US}$ Control Drawing

Compact version + Remote version

PROMAG W/D/L 400

Gezeichnet	29.10.2012	BDA
Geprüft		
Ex-geprüft	08.10.2024	BDA
Gesehen		

Endress+Hauser
People for Process Automation

Flowtec AG, Kaegenstrasse 7, CH-4153 Reinach BL1, Postfach

FES0196G

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Endress+Hauser
People for Process Automation

Flow Calibration with Adjustment

30677416-7090509

3004225783	FCP-8.B
Purchase order number	Calibration rig
US-3007698249-10 / Endress+Hauser Flow	404.1832 gal/min (us) (≙ 100 %)
Order N°/Manufacturer	Calibrated full scale
5W4C1H-347E4/0	Service interface
Order code	Calibrated output
Promag W 400 4"	1.2771
Sensor/Transmitter	Calibration factor
W906EC16000	-0.3
Serial N°	Zero point
C35FET3131	85.1 °F
Tag N°	Water temperature

Flow [%]	Flow [gal/min (us)]	Duration [s]	V target [gal (us)]	V meas. [gal (us)]	Δ o.r.* [%]	Outp.** [mA]
61.7	249.464	35.1	145.787	145.800	0.01	13.88
61.8	249.713	35.1	145.920	145.896	-0.02	13.88
99.5	402.054	35.1	234.951	234.832	-0.05	19.91
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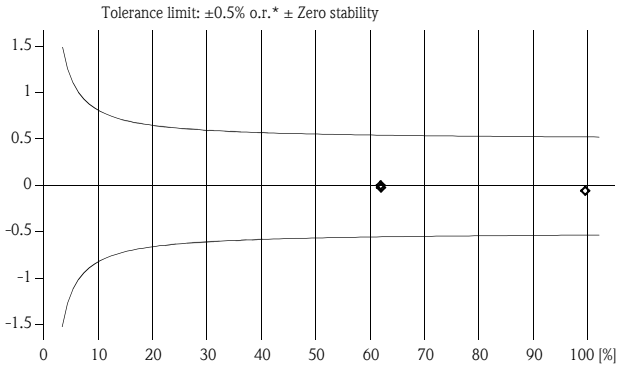
*o.r.: of reading

**Calculated value (4 - 20 mA)

Measured error % o.r.



For detailed data concerning output specifications of the unit under test, see Technical Information (TI), chapter Performance characteristics.

The calibration is traceable to the N.I.S.T. through standards certified at preset intervals.

Endress+Hauser Flowtec operates ISO/IEC 17025 accredited calibration facilities in Reinach (CH), Cernay (FR), Greenwood (USA), Aurangabad (IN), Suzhou (CN) and Itatiba (BR).

09-20-2024
Date of calibration

Adam Servies
Operator

Endress+Hauser Flow USA, Inc.
2330 Endress Place
Greenwood, IN 46143

Certified acc. to
ISO 9001, Reg.-N° 030502.2
ISO 14001, Reg.-N° EMS561046

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Endress+Hauser
People for Process Automation

Flow Calibration with Adjustment

30678904-7105460

3004225783	FCP-7.1.B
Purchase order number	Calibration rig
US-3007698249-30 / Endress+Hauser Flow	3170.065 gal/min (us) (≙ 100 %)
Order N°/Manufacturer	Calibrated full scale
5W4C2F-1TLM0/0	Service interface
Order code	Calibrated output
Promag W 400 10"	1.2617
Sensor/Transmitter	Calibration factor
W90DEC16000	-1.1
Serial N°	Zero point
C35FET3214	80.4 °F
Tag N°	Water temperature

Flow [%]	Flow [gal/min (us)]	Duration [s]	V target [gal (us)]	V meas. [gal (us)]	Δ o.r.* [%]	Outp.** [mA]
48.6	1541.72	58.5	1502.11	1501.84	-0.02	11.78
48.6	1541.52	58.5	1501.93	1502.17	0.02	11.78
100.5	3187.05	58.5	3105.64	3104.18	-0.05	20.08
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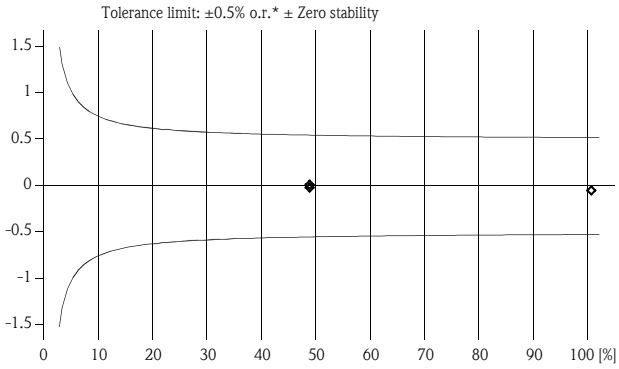
*o.r.: of reading

**Calculated value (4 - 20 mA)

Measured error % o.r.



For detailed data concerning output specifications of the unit under test, see Technical Information (TI), chapter Performance characteristics.

The calibration is traceable to the N.I.S.T. through standards certified at preset intervals.

Endress+Hauser Flowtec operates ISO/IEC 17025 accredited calibration facilities in Reinach (CH), Cernay (FR), Greenwood (USA), Aurangabad (IN), Suzhou (CN) and Itatiba (BR).

10-02-2024
Date of calibration

Steven Wilson
Operator

Endress+Hauser Flow USA, Inc.
2330 Endress Place
Greenwood, IN 46143

Certified acc. to
ISO 9001, Reg.-N° 030502.2
ISO 14001, Reg.-N° EMS561046

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Endress+Hauser
People for Process Automation

Flow Calibration with Adjustment

30677647-7090510

3004225783	FCP-8.B
Purchase order number	Calibration rig
US-3007698249-10 / Endress+Hauser Flow	404.1832 gal/min (us) (≙ 100 %)
Order N°/Manufacturer	Calibrated full scale
5W4C1H-347E4/0	Service interface
Order code	Calibrated output
Promag W 400 4"	1.2765
Sensor/Transmitter	Calibration factor
W906ED16000	-1.5
Serial N°	Zero point
C35FET3231	81.6 °F
Tag N°	Water temperature

Flow [%]	Flow [gal/min (us)]	Duration [s]	V target [gal (us)]	V meas. [gal (us)]	Δ o.r.* [%]	Outp.** [mA]
61.7	249.455	35.1	145.784	145.788	0.00	13.88
61.8	249.567	35.1	145.842	145.829	-0.01	13.88
99.4	401.932	35.1	234.864	234.863	0.00	19.91
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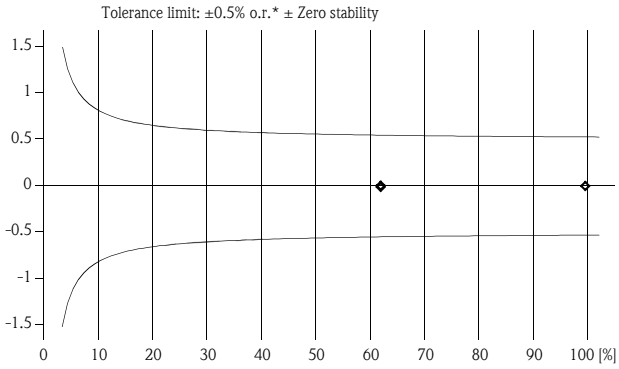
*o.r.: of reading

**Calculated value (4 - 20 mA)

Measured error % o.r.



For detailed data concerning output specifications of the unit under test, see Technical Information (TI), chapter Performance characteristics.

The calibration is traceable to the N.I.S.T. through standards certified at preset intervals.

Endress+Hauser Flowtec operates ISO/IEC 17025 accredited calibration facilities in Reinach (CH), Cernay (FR), Greenwood (USA), Aurangabad (IN), Suzhou (CN) and Itatiba (BR).

09-23-2024
Date of calibration

Bill Brown
Operator

Endress+Hauser Flow USA, Inc.
2330 Endress Place
Greenwood, IN 46143

Certified acc. to
ISO 9001, Reg.-N° 030502.2
ISO 14001, Reg.-N° EMS561046

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Endress+Hauser
People for Process Automation

Flow Calibration with Adjustment

30677391-7090511

3004225783	FCP-8.B
Purchase order number	Calibration rig
US-3007698249-10 / Endress+Hauser Flow	404.1832 gal/min (us) (≙ 100 %)
Order N°/Manufacturer	Calibrated full scale
5W4C1H-347E4/0	Service interface
Order code	Calibrated output
Promag W 400 4"	1.3325
Sensor/Transmitter	Calibration factor
W906EE16000	1.2
Serial N°	Zero point
C40FET1301	85.4 °F
Tag N°	Water temperature

Flow [%]	Flow [gal/min (us)]	Duration [s]	V target [gal (us)]	V meas. [gal (us)]	Δ o.r.* [%]	Outp.** [mA]
61.7	249.545	35.1	145.813	145.812	0.00	13.88
61.8	249.624	35.1	145.866	145.871	0.00	13.88
100.4	405.642	35.1	237.071	236.964	-0.04	20.05
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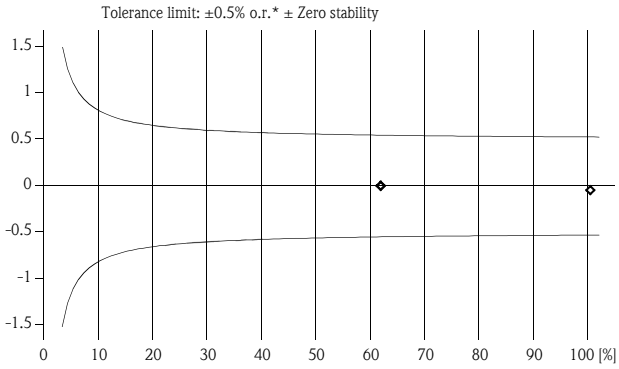
*o.r.: of reading

**Calculated value (4 - 20 mA)

Measured error % o.r.



For detailed data concerning output specifications of the unit under test, see Technical Information (TI), chapter Performance characteristics.

The calibration is traceable to the N.I.S.T. through standards certified at preset intervals.

Endress+Hauser Flowtec operates ISO/IEC 17025 accredited calibration facilities in Reinach (CH), Cernay (FR), Greenwood (USA), Aurangabad (IN), Suzhou (CN) and Itatiba (BR).

09-20-2024
Date of calibration

Adam Servies
Operator

Endress+Hauser Flow USA, Inc.
2330 Endress Place
Greenwood, IN 46143

Certified acc. to
ISO 9001, Reg.-N° 030502.2
ISO 14001, Reg.-N° EMS561046

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People for Process Automation

Parameter Settings

Order information	
Customer	OPTIMAL CONTROL SYSTEMS INC US-97322-9701 ALBANY
Customer purchase order	24-0403
Sales order number / Item	3004225783
Internal order number / Item	US-3007698249-10

Device information	
Description	Promag W 400 4"
TAG	C35FET3131
Serial number	W906EC16000
Order code	5W4C1H-347E4/0
Extended order code	5W4C1H-C6ELHP2DUA1KGA+AAEBI7PBZ1

Device	
Device software	02.01.03
Communication type	HART
Device revision	Dev.Rev.: 9
Application package code	6362958
MAC Address 1	00-07-05-78-25-30
Bus address	0

Expert → Sensor → System units	
Volume flow unit	gal/min (us)
Volume unit	gal (us)
Mass flow unit	lb/min
Mass unit	lb
Density unit	kg/l
Temperature unit	°F
Conductiv. unit	µS/cm

Expert → Sensor → Process param. → Low flow cut off	
On value	4 gal/min (us)

Expert → Sensor → Sensor adjustm.	
Install. direct.	In arrow direct.

Operator
Greenwood, 2024-20-09, Andrea Haines

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Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C35FET3131
Serial number	W906EC16000

Expert → System → Display	
Display language	English
Format display	1 value, max.
Value 1 display	Volume flow
Value 2 display	None
Value 3 display	None
Value 4 display	None
Display damping	0 s

Expert → Application → Totalizer 1	
Assign variable	Volume flow
Unit totalizer1	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 2	
Assign variable	Volume flow
Unit totalizer2	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 3	
Assign variable	Volume flow
Unit totalizer3	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Output → Curr.output 1	
Assign curr. 1	Volume flow
Current span	4...20 mA US
0/4 mA value	0 gal/min (us)
20 mA value	300 gal/min (us)
Failure mode	Max.
Damping out. 1	1 s

Endress+Hauser
People for Process Automation

Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C35FET3131
Serial number	W906EC16000

Expert → Output → PFS output 1	
Assign pulse 1	Volume flow
Pulse scaling	2 gal (us)
Pulse width	100 ms
Failure mode	No pulses

Expert → Output → PFS output 2	
Switch out funct	Off

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Parameter Settings

Order information	
Customer	OPTIMAL CONTROL SYSTEMS INC US-97322-9701 ALBANY
Customer purchase order	24-0403
Sales order number / Item	3004225783
Internal order number / Item	US-3007698249-30

Device information	
Description	Promag W 400 10"
TAG	C35FET3214
Serial number	W90DEC16000
Order code	5W4C2F-1TLM0/0
Extended order code	5W4C2F-C6ELHP2DUA1KGA+AAEBI7PBZ1

Device	
Device software	02.01.03
Communication type	HART
Device revision	Dev.Rev.: 9
Application package code	4893049
MAC Address 1	00-07-05-78-3B-34
Bus address	0

Expert → Sensor → System units	
Volume flow unit	gal/min (us)
Volume unit	gal (us)
Mass flow unit	lb/min
Mass unit	lb
Density unit	kg/l
Temperature unit	°F
Conductiv. unit	µS/cm

Expert → Sensor → Process param. → Low flow cut off	
On value	30 gal/min (us)

Expert → Sensor → Sensor adjustm.	
Install. direct.	In arrow direct.

Operator
Greenwood, 2024-01-10, David Coomer

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Parameter Settings

Device information	
Description	Promag W 400 10"
TAG	C35FET3214
Serial number	W90DEC16000

Expert → System → Display	
Display language	English
Format display	1 value, max.
Value 1 display	Volume flow
Value 2 display	None
Value 3 display	None
Value 4 display	None
Display damping	0 s

Expert → Application → Totalizer 1	
Assign variable	Volume flow
Unit totalizer1	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 2	
Assign variable	Volume flow
Unit totalizer2	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 3	
Assign variable	Volume flow
Unit totalizer3	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Output → Curr.output 1	
Assign curr. 1	Volume flow
Current span	4...20 mA US
0/4 mA value	0 gal/min (us)
20 mA value	1500 gal/min (us)
Failure mode	Max.
Damping out. 1	1 s

Endress+Hauser
People for Process Automation

Parameter Settings

Device information	
Description	Promag W 400 10"
TAG	C35FET3214
Serial number	W90DEC16000

Expert → Output → PFS output 1	
Assign pulse 1	Volume flow
Pulse scaling	15 gal (us)
Pulse width	100 ms
Failure mode	No pulses

Expert → Output → PFS output 2	
Switch out funct	Off

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Parameter Settings

Order information	
Customer	OPTIMAL CONTROL SYSTEMS INC US-97322-9701 ALBANY
Customer purchase order	24-0403
Sales order number / Item	3004225783
Internal order number / Item	US-3007698249-10

Device information	
Description	Promag W 400 4"
TAG	C35FET3231
Serial number	W906ED16000
Order code	5W4C1H-347E4/0
Extended order code	5W4C1H-C6ELHP2DUA1KGA+AAEBI7PBZ1

Device	
Device software	02.01.03
Communication type	HART
Device revision	Dev.Rev.: 9
Application package code	66821744
MAC Address 1	00-07-05-78-25-3E
Bus address	0

Expert → Sensor → System units	
Volume flow unit	gal/min (us)
Volume unit	gal (us)
Mass flow unit	lb/min
Mass unit	lb
Density unit	kg/l
Temperature unit	°F
Conductiv. unit	µS/cm

Expert → Sensor → Process param. → Low flow cut off	
On value	4 gal/min (us)

Expert → Sensor → Sensor adjustm.	
Install. direct.	In arrow direct.

Operator
Greenwood, 2024-23-09, Tyler Rector

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Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C35FET3231
Serial number	W906ED16000

Expert → System → Display	
Display language	English
Format display	1 value, max.
Value 1 display	Volume flow
Value 2 display	None
Value 3 display	None
Value 4 display	None
Display damping	0 s

Expert → Application → Totalizer 1	
Assign variable	Volume flow
Unit totalizer1	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 2	
Assign variable	Volume flow
Unit totalizer2	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 3	
Assign variable	Volume flow
Unit totalizer3	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Output → Curr.output 1	
Assign curr. 1	Volume flow
Current span	4...20 mA US
0/4 mA value	0 gal/min (us)
20 mA value	300 gal/min (us)
Failure mode	Max.
Damping out. 1	1 s

Endress+Hauser
People for Process Automation

Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C35FET3231
Serial number	W906ED16000

Expert → Output → PFS output 1	
Assign pulse 1	Volume flow
Pulse scaling	2 gal (us)
Pulse width	100 ms
Failure mode	No pulses

Expert → Output → PFS output 2	
Switch out funct	Off

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Parameter Settings

Order information	
Customer	OPTIMAL CONTROL SYSTEMS INC US-97322-9701 ALBANY
Customer purchase order	24-0403
Sales order number / Item	3004225783
Internal order number / Item	US-3007698249-10

Device information	
Description	Promag W 400 4"
TAG	C40FET1301
Serial number	W906EE16000
Order code	5W4C1H-347E4/0
Extended order code	5W4C1H-C6ELHP2DUA1KGA+AAEBI7PBZ1

Device	
Device software	02.01.03
Communication type	HART
Device revision	Dev.Rev.: 9
Application package code	65344127
MAC Address 1	00-07-05-78-0A-59
Bus address	0

Expert → Sensor → System units	
Volume flow unit	gal/min (us)
Volume unit	gal (us)
Mass flow unit	lb/min
Mass unit	lb
Density unit	kg/l
Temperature unit	°F
Conductiv. unit	µS/cm

Expert → Sensor → Process param. → Low flow cut off	
On value	4 gal/min (us)

Expert → Sensor → Sensor adjustm.	
Install. direct.	In arrow direct.

Operator
Greenwood, 2024-20-09, Andrea Haines

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Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C40FET1301
Serial number	W906EE16000

Expert → System → Display	
Display language	English
Format display	1 value, max.
Value 1 display	Volume flow
Value 2 display	None
Value 3 display	None
Value 4 display	None
Display damping	0 s

Expert → Application → Totalizer 1	
Assign variable	Volume flow
Unit totalizer1	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 2	
Assign variable	Volume flow
Unit totalizer2	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Application → Totalizer 3	
Assign variable	Volume flow
Unit totalizer3	gal (us)
Operation mode	Net flow total
Failure mode	Stop

Expert → Output → Curr.output 1	
Assign curr. 1	Volume flow
Current span	4...20 mA US
0/4 mA value	0 gal/min (us)
20 mA value	300 gal/min (us)
Failure mode	Max.
Damping out. 1	1 s

Endress+Hauser
People for Process Automation

Parameter Settings

Device information	
Description	Promag W 400 4"
TAG	C40FET1301
Serial number	W906EE16000

Expert → Output → PFS output 1	
Assign pulse 1	Volume flow
Pulse scaling	2 gal (us)
Pulse width	100 ms
Failure mode	No pulses

Expert → Output → PFS output 2	
Switch out funct	Off

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

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(Check Applicable)

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☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

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Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C40(FI/FSL)0501	Glass Tube Variable Area Flow Meter, Sho-Rate Series	Brooks	1350GAM3DBNV1BAA	Section 40 91 00	09-I-005, 09-I-105
002	1	C40(FI/FSL)0502	Glass Tube Variable Area Flow Meter, Sho-Rate Series	Brooks	1350GAM3DBNV1BAA	Section 40 91 00	09-I-005, 09-I-105
003	1	C40(FI/FSL)0601	Glass Tube Variable Area Flow Meter, Sho-Rate Series	Brooks	1350GAM3DBNV1BAA	Section 40 91 00	09-I-005, 09-I-105
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BROOKS® INSTRUMENT

Beyond Measure

Sho-Rate™ Models 1350G & 1355G

Glass Tube Variable Area Flowmeters (Rotameters) for Low Flow Rates

Sho-Rate™ Series glass tube variable area flowmeters have been the industry standard for decades. Ideal for a variety of low flow gas and liquid applications, these flowmeters are particularly suited for purge applications. The base configuration uses a borosilicate glass tube installed in an aluminum frame with 316SS end blocks, adaptors, and valve. Additional material options, valve options, and flow controllers are available to provide the appropriate configuration for a wide variety of applications.

Features	Benefits
Standard Direct Read Scales on Tube and Millimeter Scales with Flow Data for All Fluids and Fluid Conditions	Tube and float options to meet exact customer process conditions
Multiple Connection Fittings, Adapters, and Approval Certifications	Suits a wide range of world area applications and requirements
Clear Polycarbonate Face Shield with Built-In Magnifier	Easier float and scale reading
Heavy Wall, Precision Bore Borosilicate Glass Metering Tube	Resistant to thermal shock and corrosive gasses and fluids
Integrated Alarm Option with Single or Double Inductive Ring Sensor/Switch with Intrinsically Safe Relay	Ideal for hazardous environments and applications where process conditions are critical
Interchangeable Tubes and Floats with Integral Float Stops	Easy in-situ maintenance. Prevents loss of float during tube removal
Compatible with Cartridge and Precision Control Valve (Inlet & Outlet) and Integral Flow Controller (Upstream & Downstream)	Meets a wider range of customer requirements where flow control is necessary

Product Specifications

	1350G	1355G
Performance		
Accuracy	±5% at reference conditions*	±3% at reference conditions*
Repeatability	0.25% F.S.	
Pressure / Temperature	200 psig (33°F - 250°F) / 13.8 bar (1°C - 121°C)	
Materials of Construction	Borosilicate glass, Brass, Aluminum, 316 Stainless Steel, Clear Polycarbonate, Milk White Polycarbonate, Teflon®	
End Block Options	Stainless Steel and Brass	
Elastomer Seals	Viton® fluoroelastomers, Teflon®, Buna, Kalrez® per fluoroelastomers	
Float Materials	Glass, Sapphire, Stainless Steel, Carboloy®, Tantalum	
Connection Materials	Stainless Steel	
Connection Options	1/8" NPT (w/wo locknuts) 1/4" NPT (w/wo locknuts) 1/8" Compression (w/wo locknuts) 1/4" Compression (w/wo locknuts) 6 mm Compression (w/wo locknuts) 1/4" RC (w/wo locknuts) 3/8" RC (w/wo locknuts) 1/4" VCR® 1/4" ID Hose	
Dimensions	See Dimension Drawings	
Alarm Availability	1 Inductive Ring Sensor/Switch 2 Inductive Ring Sensor(s)/Switch(es) Inductive Ring Sensor(s)/Switch(es) with Relay Options	
Valve Options	Cartridge III Valve and NRS™	
Valve Materials	Stainless Steel	
Flow Controller	Yes	
Certifications	International Calibration Certificate (ICC) CRN Pressure Equipment Directive (97/23/EC) RoHS (II) REACH Materials (2.1)	

* Reference conditions apply to air or water at 14.7 psia and 70 Degrees F/1.01 Bar and 21.1 Degrees C.

Capacities - Rib Guide Tubes, Spherical Floats for use with 1350G Series Only

			Full Scale - Water		Full Scale - Air	
Meter Size	Tube No.	Float Material	GPH	LPH	SCFH[1]	NLPH[2]
2	R-2-65-A G	Glass	0.010	0.041	0.12	3.2
		Sapphire	0.021	0.079	0.19	5.0
		Stainless Steel	0.049	0.18	0.37	9.8
		Carboloy	0.10	0.36	0.65	17
		Tantalum	0.10	0.40	0.71	18
	R-2-65-B G	Glass	0.014	0.06	0.16	4.4
		Sapphire	0.028	0.10	0.25	6.7
		Stainless Steel	0.07	0.25	0.48	12
		Carboloy	0.12	0.48	0.80	21
		Tantalum	0.14	0.53	0.87	22
	R-2-65-C G	Glass	0.12	0.47	0.99	26
		Sapphire	0.22	0.83	1.3	35
		Stainless Steel	0.41	1.5	2.1	55
		Carboloy	0.65	2.4	3.1	81
		Tantalum	0.70	2.6	3.3	87
	R-2-65-D G	Glass	0.68	2.5	3.9	100
		Sapphire	0.99	3.7	5.1	130
		Stainless Steel	1.6	6.3	7.9	200
		Carboloy	2.5	9.5	11	290
		Tantalum	2.7	10.0	12	310
6	R-6-65-A G	Glass	2.2	8.5	13	340
		Sapphire	3.3	12	17	440
		Stainless Steel	5.6	21	25	660
		Carboloy	8.3	31	36	940
		Tantalum	8.8	33	38	1000
	R-6-65-B G	Glass	8.7	33	46	1200
		Sapphire	12	47	59	1500
		Stainless Steel	20	76	86	2200
		Carboloy	29	100	110	3100
		Tantalum	30	110	120	3300

[1] Air flow rates in standard units are at 70°F & 14.7 PSIA. Reference conditions 70°F latm.
[2] Air flow rates in normal units are at 20°C & 1.013 bar. Reference conditions 0°C latm.

Product Specifications

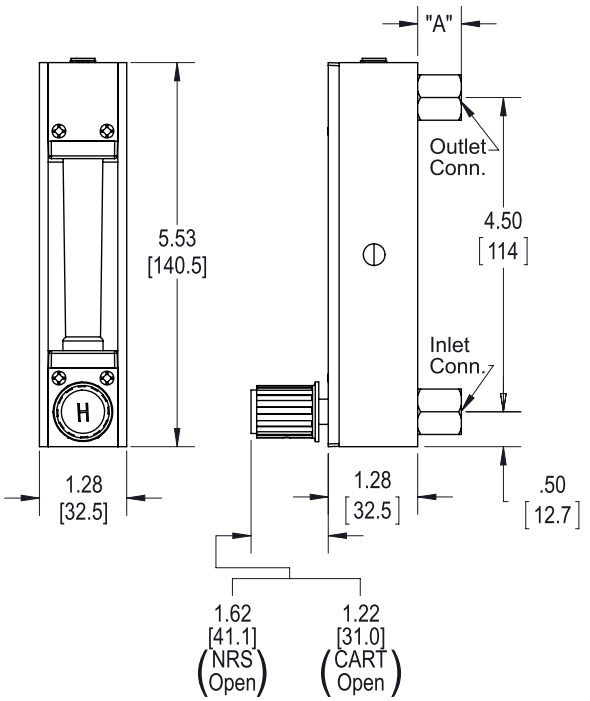
Capacities - Rib Guide Tubes, Spherical Floats for use with 1355G Series Only

			Full Scale Flow	
Meter Size	Tube No.	Float Material	Water (CC/Min)	Air[1]
2	R-2-15-AAAA G	Glass	0.59	50 SCC/M
		Sapphire	1.1	79 SCC/M
		Stainless Steel	2.6	150 SCC/M
		Carboloy	5.2	280 SCC/M
		Tantalum	5.8	310 SCC/M
	R-2-15-D G	Glass	5.5	370 SCC/M
		Sapphire	10	520 SCC/M
		Stainless Steel	20	830 SCC/M
		Carboloy	34	1200 SCC/M
		Tantalum	36	1300 SCC/M
	R-2-15-A G	Glass	17	0.82 SLPM
		Sapphire	26	1.0 SLPM
		Stainless Steel	46	1.6 SLPM
		Carboloy	70	2.4 SLPM
		Tantalum	75	2.5 SLPM
	R-2-15-B G	Glass	53	2.3 SLPM
		Sapphire	80	3.0 SLPM
		Stainless Steel	130	4.6 SLPM
		Carboloy	200	6.7 SLPM
		Tantalum	210	7.1 SLPM
	R-2-15-C G	Glass	90	4.0 SLPM
		Sapphire	130	5.2 SLPM
		Stainless Steel	220	7.9 SLPM
		Carboloy	340	11 SLPM
		Tantalum	360	11 SLPM
6	R-6-15-A G	Glass	210	9.5 SLPM
		Sapphire	320	12 SLPM
		Stainless Steel	540	18 SLPM
		Carboloy	790	25 SLPM
		Tantalum	840	26 SLPM
	R-6-15-B G	Glass	560	23 SLPM
		Sapphire	820	29 SLPM
		Stainless Steel	1300	43 SLPM
		Carboloy	1900	60 SLPM
		Tantalum	2000	63 SLPM

[1] Air flow rates in standard units are at 70°F & 14.7 PSIA. Reference conditions 70°F latm.

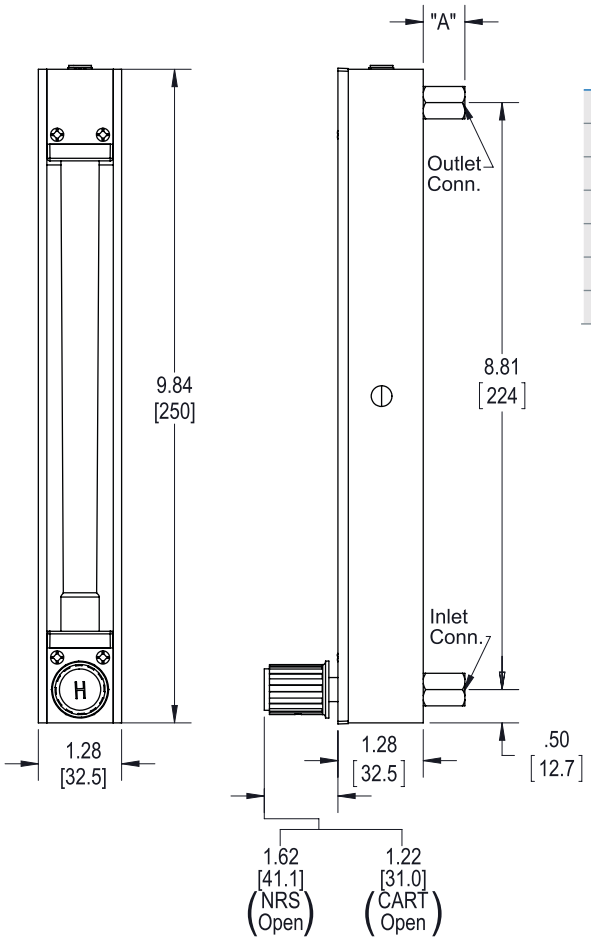
Product Dimensions

Model 1350G



Dimension "A" Connection Adapter	
1/8" NPT	0.625 [15.9]
1/4" NPT	0.625 [15.9]
1/8" Compression	1.59 [40.3]
1/4" Compression	1.78 [45.1]
1/4" ID Hose	0.72 [18.3]
1/4" RC	0.895 [22.7]
3/8" RC	0.895 [22.7]

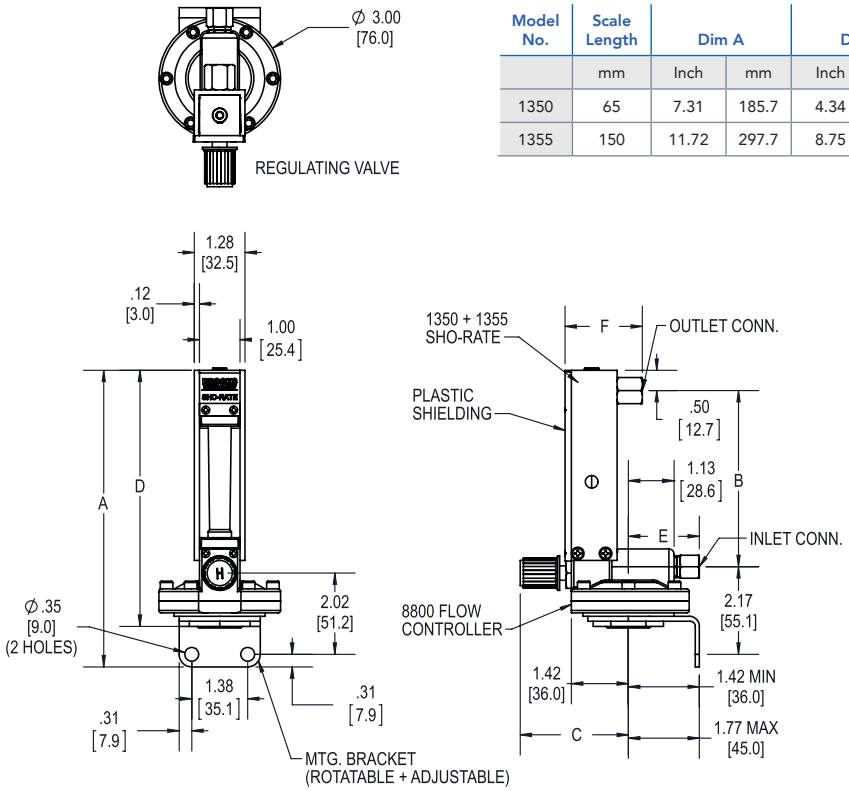
Model 1355G



Dimension "A" Connection Adapter	
1/8" NPT	0.625 [15.9]
1/4" NPT	0.625 [15.9]
1/8" Compression	1.59 [40.3]
1/4" Compression	1.78 [45.1]
1/4" ID Hose	0.72 [18.3]
1/4" RC	0.895 [22.7]
3/8" RC	0.895 [22.7]

Product Dimensions

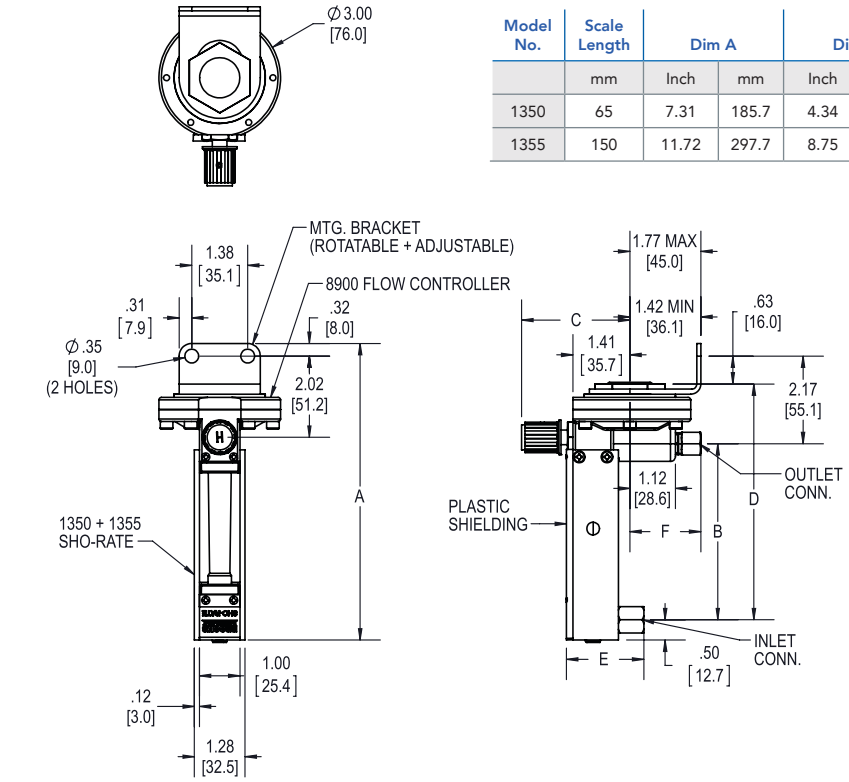
Model 1350G/1355G with Model 8800 Flow Controller on Inlet



Model No.	Scale Length	Dim A		Dim B		Dim C (Open)		Dim C (Closed)		Dim D	
	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1350	65	7.31	185.7	4.34	110.3	2.79	70.8	2.65	67.2	6.38	162.0
1355	150	11.72	297.7	8.75	222.2	2.79	70.8	2.65	67.2	10.78	273.8

Conn. Size	Inlet Connection E		Outlet Connection F	
	Inch	mm	Inch	mm
1/8 NPT	1.85	46.9	1.91	48.4
1/4 NPT	1.13	28.6	1.91	48.4
1/8 Comp.	2.19	55.6	2.87	72.8
1/4 Comp.	2.28	57.8	3.06	77.6
1/4 ID Hose	2.44	61.9	2.00	50.8
1/4 VCR (M)	N/A	N/A	2.19	55.6
1/4 RC	2.10	53.3	2.18	55.3
3/8 RC	2.60	66.1	2.18	55.3

Model 1350G/1355G with Model 8900 Flow Controller on Outlet



Model No.	Scale Length	Dim A		Dim B		Dim C (Open)		Dim C (Closed)		Dim D	
	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1350	65	7.31	185.7	4.34	110.3	2.79	70.8	2.65	67.2	6.38	162.0
1355	150	11.72	297.7	8.75	222.2	2.79	70.8	2.65	67.2	10.78	273.8

Conn. Size	Inlet Connection E		Outlet Connection F	
	Inch	mm	Inch	mm
1/8 NPT	1.91	48.4	1.85	46.9
1/4 NPT	1.91	48.4	1.13	28.6
1/8 Comp.	2.87	72.8	2.19	55.6
1/4 Comp.	3.06	77.6	2.28	57.8
1/4 ID Hose	2.00	50.8	2.44	61.9
1/4 VCR (M)	2.19	55.6	N/A	N/A
1/4 RC	2.18	55.3	2.10	53.3
3/8 RC	2.18	55.3	2.60	66.1

Product Approvals

Declaration	Mark	Meter Options Inductive Alarm	Standards/Directives/Marking	Status/Certificate
EU Declaration of Conformity	CE	✓	EMC Directive (2014/30/EU)	Declaration
		✓	RoHS Directive (2011/65/EU)	Declaration
		✓	Pressure Equipment Directive (2014/68/EU)	Declaration
		✓	EMC Directive (2014/30/EU)	Declaration
Explosion safety "Intrinsic Safety (ia)"		✓	Inductive Ring Sensor Pepperl + Fuchs Model: RC10-14-N3-Y53478 Pepperl + Fuchs Model: RC15-14-N3-Y53479 <u>Non-Hazardous Locations</u> Power Supply: Nominal Voltage 8V Operating Voltage 5...25V Current consumption: Active area clear : 3mA (at 8V) Active area obscured: 0.5...0.95mA (at 8V) Ambient Temperature: 0°C to 40°C	
	Ex	✓	<u>Hazardous Location</u> ATEX: II 2 G Ex ia IIC T6…T1 Gb IP67 Refer to ATEX Certificate for: Input parameters, Max Ambient Temperature, Special conditions for use	Pepperl + Fuchs PTB 99 ATEX 2128 X
		✓	FM Approvals: Class I, Division 1, Group A, B, C, Class II, Division Group E, F, G, Class III, Division 1 Class I, Zone 0, Group IIC T6	Pepperl + Fuchs Control Drawing:116-0165G
		✓	Canadian Registration Number (CRN)	CRN

Model Code

Code Description	Code Option	Option Description
I-IV. Basic Model Number	1350	65mm Sho-Rate Size 1-6 Flow Indicator
	1355	150mm Sho-Rate Size 1-6 Flow Indicator
V. Model Revision Level	G	Revision G
VI. End Block Material	A	316 stainless steel
	B	Brass

VII. Tube		1350	1355
	A	---	R-2-15-A G
	B	---	R-2-15-B G
	C	---	R-2-15-C G
	D	---	R-2-15-D G
	E	---	R-6-15-A G
	F	---	R-6-15-B G
	G	R-2-65-A G	R-2-15-AAAA G
	H	R-2-65-B G	---
	J	R-2-65-C G	---
	K	R-2-65-D G	---
	L	R-6-65-A G	---
	M	R-6-65-B G	---
	N[1]	No Tube	No Tube

VIII-IX. Float & Direct Read Scale Selection		Float	Accuracy	Scale Inscription
	ZZ[3]	None	N/A	N/A
	1A	[2]GLASS	STD-50(10%), 55(5%)	MM
	1B	[2]ST.STL	STD-50(10%), 55(5%)	MM
	1C	[2]SAPPHIRE	STD-50(10%), 55(5%)	MM
	1D	[2]CARBOLOY	STD-50(10%), 55(5%)	MM
	1E	[2]TANTALUM	STD-50(10%), 55(5%)	MM
	1G	GLASS	CALIB-50(5%), 55(3%)	MM
	1H	ST.STL	CALIB-50(5%), 55(3%)	MM
	1J	SAPPHIRE	CALIB-50(5%), 55(3%)	MM
	1K	CARBOLOY	CALIB-50(5%), 55(3%)	MM
	1L	TANTALUM	CALIB-50(5%), 55(3%)	MM
	2A	[2]GLASS	STD-50(10%), 55(5%)	LINEAR
	2B	[2]ST.STL	STD-50(10%), 55(5%)	LINEAR
	2C	[2]SAPPHIRE	STD-50(10%), 55(5%)	LINEAR
	2D	[2]CARBOLOY	STD-50(10%), 55(5%)	LINEAR
	2E	[2]TANTALUM	STD-50(10%), 55(5%)	LINEAR
	2G	GLASS	CALIB-50(5%), 55(3%)	LINEAR
	2H	ST.STL	CALIB-50(5%), 55(3%)	LINEAR
	2J	SAPPHIRE	CALIB-50(5%), 55(3%)	LINEAR
	2K	CARBOLOY	CALIB-50(5%), 55(3%)	LINEAR
	2L	TANTALUM	CALIB-50(5%), 55(3%)	LINEAR
	3A	[2]GLASS	STD-50(10%), 55(5%)	CUSTOM DECAL
	3B	[2]ST.STL	STD-50(10%), 55(5%)	CUSTOM DECAL
	3C	[2]SAPPHIRE	STD-50(10%), 55(5%)	CUSTOM DECAL
	3D	[2]CARBOLOY	STD-50(10%), 55(5%)	CUSTOM DECAL
	3E	[2]TANTALUM	STD-50(10%), 55(5%)	CUSTOM DECAL
	3G	GLASS	CALIB-50(5%), 55(3%)	CUSTOM DECAL
	3H	ST.STL	CALIB-50(5%), 55(3%)	CUSTOM DECAL
	3J	SAPPHIRE	CALIB-50(5%), 55(3%)	CUSTOM DECAL
	3K	CARBOLOY	CALIB-50(5%), 55(3%)	CUSTOM DECAL
	3L	TANTALUM	CALIB-50(5%), 55(3%)	CUSTOM DECAL
	4A	[2]GLASS	STD-50(10%), 55(5%)	PERCENT SCALE
	4B	[2]ST.STL	STD-50(10%), 55(5%)	PERCENT SCALE
	4C	[2]SAPPHIRE	STD-50(10%), 55(5%)	PERCENT SCALE
	4D	[2]CARBOLOY	STD-50(10%), 55(5%)	PERCENT SCALE
	4E	[2]TANTALUM	STD-50(10%), 55(5%)	PERCENT SCALE
	4G	GLASS	CALIB-50(5%), 55(3%)	PERCENT SCALE
	4H	ST.STL	CALIB-50(5%), 55(3%)	PERCENT SCALE
	4J	SAPPHIRE	CALIB-50(5%), 55(3%)	PERCENT SCALE
	4K	CARBOLOY	CALIB-50(5%), 55(3%)	PERCENT SCALE
	4L	TANTALUM	CALIB-50(5%), 55(3%)	PERCENT SCALE

Code Description	Code Option	Option Description	
X. Tube Packing and O-ring Materials Note: If valve assy is not required for a specific model number, select the proper code for the O-ring material of the Sho-Rate.		Tube Packing	O-ring Meter/Valve
	A	Buna	Buna
	B	Viton	Viton
	D	Viton	EPR
	E	Viton	Kalrez
	F	Teflon	Buna
	G	Teflon	Viton
	J	Teflon	EPR
	K	Teflon	Kalrez
	L	EPR	EPR
	N	No Packing	Buna
	P	No Packing	Viton
	R	No Packing	EPR
	S	No Packing	Kalrez
	T	No Packing	Butyl
XI. End Fitting Material, Connection Size & Type		Fitting Material	Connection Size and Type
	C	316SS	1/8" NPT
	F	316SS	1/8" NPT Thd.W/Locknut
	J	316SS	1/4" NPT
	N	316SS	1/4" NPT Thd.W/Locknut
	R	316SS	1/8" Compression
	U	316SS	1/8" Compression w/locknut (2 pc design)
	W	316SS	1/4" F-Rc Thd w/Locknut
	X	316SS	1/4" Compression
	1	316SS	1/4" Compression w/locknut (2 pc design)
	3	316SS	3/8" F-Rc Thd w/Locknut
	4[1]	316SS	1/4" I.D. Hose
	5[1]	316SS	1/4" I.D. Hose w/Locknut
	6	316SS	Integral 5/16-24 thd.
	7	316SS	1/4" VCR
	8[1]	316SS	6mm Compression
XII. Valve Type	A	Valve Plug	
	B	NRS-316SS #1	
	C	NRS-316SS #2	
	D	NRS-316SS #3	
	E	NRS-316SS #4	
	F	NRS-316SS #5	
	G	NRS-316SS #6	
	N	To Integrally Mounted 88/8900 316SS Flow Controller - Cartridge II/III Valve - Teflon Diaphragm	
	P	To Integrally Mounted 88/8940 316SS Flow Controller - NRS Valve - Teflon Diaphragm	
	Q	To Integrally Mounted 88/8900 Brass Flow Controller - Cartridge II/III Valve - Buna Diaphragm	
	R	To Integrally Mounted 88/8940 Brass Flow Controller - NRS Valve - Buna Diaphragm	
	S	Std. Valve Cavity - no valve assy or plug	
	T	Cartridge III Valve - Low Flow - 316SS	
	U	Cartridge III Valve - Med Flow - 316SS	
	V	Cartridge III Valve - HighFlow - 316SS	

Code Description	Code Option	Option Description		
XIII. Valve Cavity/Controller Location & Connection Orientation		Valve/Controller Location	Connection Orientation	
			Inlet	Outlet
	1	Inlet	Back	Back
	5	Outlet	Back	Back

XIV. Alarms	A	None
	B	1 Inductive Ring Sensor/Switch
Note: Alarm options not available with the following:	C	2 Inductive Ring Sensors/Switches
	D	1 Inductive Ring Sensor/Switch w/I.S. Relay 120V (bistable)
- Glass, Sapphire, or Tantalum Floats	E	1 Inductive Ring Sensor/Switch w/I.S. Relay 240V (bistable)
- Stainless Steel Frame Option	F	2 Inductive Ring Sensors/Switches with I.S. Double Relays 120V (bistable)
- Valve Type Option: Flow Controllers	G	2 Inductive Ring Sensors/Switches with I.S. Double Relays 240V (bistable)

XV. Options	A	None
	B	316 Stainless Steel Frame
	C	Baseplate (Plastic Triangle Base with Aluminum Bracket)
	D	No Brooks Identification
	E	316SS Frame & No Brooks ID
	F	Baseplate & No Brooks ID
	G	316SS Frame & Baseplate
	H	316SS Frame & Baseplate & No Brooks ID
	J	Stainless Steel Tag & 316SS Frame
	K	Stainless Steel Tag & Baseplate (Aluminum)
	L	Stainless Steel Tag & no Brooks ID
	M	Stainless Steel Tag & 316SS Frame & No Brooks ID
	N	Stainless Steel Tag & Baseplate & No Brooks ID
	P	Stainless Steel Tag & 316SS Frame & Baseplate
	Q	Stainless Steel Tag & 316SS Frame & Baseplate & No Brooks ID
	R	Stainless Steel Tag
	S	Stainless Steel Float Stops
	T	Open Alarm Frame
	U	316SS Frame & Stainless Steel Float Stops

XVI. Certifications	A	None
	B	CRN Certification
	C	International Calibration Certification (5%-1350, 3%-1355)
	D	Degrease for Oxygen Service (not MIL Spec)
	E	CRN Cert & ICC
	F	CRN Cert & Degrease for O_2
	G	Degrease for O_2 & ICC
	H	CRN Cert, ICC & Degrease for O_2

[1] The options indicated are not available with a CRN certification. Not valid for controllers.

[2] Accuracy for air and water in the preceding capacity tables will be STD-50(5%), 55(3%).

[3] Use this code (ZZ) only when Tube Code above is "N"

Sample Standard Model Code

I-IV	V	VI	VII	VIII-IX	X	XI	XII	XIII	XIV	XV	XVI
1350	G	A	G	1B	E	C	A	1	A	A	A

Service and Support

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users, and maintenance persons. Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement to four products, all specifications are subject to change without notice.

TRADEMARKS

Brooks, NRS, Sho-Rate..... Brooks Instrument, LLC
All other trademarks are the property of their respective owners.

ISO 9001 QUALITY SYSTEM

Data-Sheet-1350G-EN/2025-01

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BROOKS® INSTRUMENT
Beyond Measure

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Installation & Operation Manual

Sho-Rate™ Series
Models 1350G/1355G
Variable Area Flow Meters

BROOKS® INSTRUMENT

Beyond Measure

Essential Instructions
Read before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. These products must be properly installed, operated and maintained to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, operating and maintaining Brooks Instrument products.

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.

⚠ **WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.**

- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.

⚠ **WARNING: Prior to installation ensure this instrument has the required approval ratings to meet local and national codes. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.**

- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid flow surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.

⚠ **WARNING: For liquid flow devices, if the inlet and outlet valves adjacent to the devices are to be closed for any reason, the devices must be completely drained. Failure to do so may result in thermal expansion of the liquid that can rupture the device and may cause personal injury.**

European Pressure Equipment Directive (PED)

All pressure equipment with an internal pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED).

- The Specifications Section of this manual contains instructions related to the PED directive.
- Products described in this manual are in compliance with EN directive 2014/34/EU.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Products larger than 25mm or 1" (inch) are in compliance with PED category I, II or III.
- Products of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2014/30/EU).
Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks Instrument supplies high quality cable(s) which meets the specifications for CE certification.
If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.
"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.
The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.
The shield should be terminated to an earth ground.
Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.
The shield should be terminated to an earth ground.
For pin configuration : Please refer to the enclosed Instruction Manual.

ESD (Electrostatic Discharge)

⚠ **CAUTION: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.**

Handling Procedure:

1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

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Description

The Sho-Rate Flowmeters are variable area, glass tube, flow rate indicating meters. The basic elements are a tapered glass metering tube and a metering float. Features include quick and simple removal or installation of the tube and float while the meter remains in the process piping.

Specifications

(Reference Tables 1-1 through 1-5)

⚠ WARNING

Do not operate this instrument in excess of the specifications listed below. Failure to heed this warning can result in serious personal injury and/or damage to the equipment.

⚠ WARNING

Glass metering tubes are designed for operation up to the maximum operating pressures and temperatures as specified herein. Due to the inherent brittle characteristics of glass and conditions beyond our control, tube breakage could result even within specified operating conditions. Do not use glass tube meters with fluids that are toxic, or chemically react with glass such as water above 140°F (60°C), steam, alkalis, fluorine, hydrofluoric acid, or molten metal. Failure to heed this warning can result in serious personal injury and/or damage to the equipment.

⚠ CAUTION

It is the user's responsibility to select and approve all materials of construction. Careful attention to metallurgy, engineered materials and elastomeric materials is critical to safe operation.

Table 1-1 Specifications for Sho-Rate Models 1350G and 1355G

	1350G	1355G
Performance		
Accuracy	±5% at reference conditions*	±3% at reference conditions*
Repeatability	0.25% F.S.	
Pressure / Temperature	200 psig (33°F - 250°F) / 13.8 bar (1°C - 121°C)	
Materials of Construction	Borosilicate glass, Brass, Aluminum, 316 Stainless Steel, Clear Polycarbonate, Milk White Polycarbonate, Teflon®	
End Block Options	Stainless Steel and Brass	
Elastomer Seals	Viton® fluoroelastomers, Teflon®, Buna, Kalrez® per fluoroelastomers	
Float Materials	Glass, Sapphire, Stainless Steel, Carboloy®, Tantalum	
Connection Materials	Stainless Steel	
Connection Options	1/8" NPT (w/wo locknuts) 1/4" NPT (w/wo locknuts) 1/8" Compression (w/wo locknuts) 1/4" Compression (w/wo locknuts) 6 mm Compression (w/wo locknuts) 1/4" RC (w/wo locknuts) 3/8" RC (w/wo locknuts) 1/4" VCR® 1/4" ID Hose	
Dimensions	See Dimension Drawings	
Alarm Availability	1 Inductive Ring Sensor/Switch 2 Inductive Ring Sensor(s)/Switch(es) Inductive Ring Sensor(s)/Switch(es) with Relay Options	
Valve Options	Cartridge III Valve and NRS™	
Valve Materials	Stainless Steel	
Flow Controller	Yes	
Certifications	International Calibration Certificate (ICC) CRN Pressure Equipment Directive (97/23/EC) RoHS (II) REACH Materials (2.1)	

* Reference conditions apply to air or water at 14.7 psia and 70 Degrees F/1.01 Bar and 21.1 Degrees C.

Table 1-2 Capacities - Rib Guide Tubes, Spherical Floats for use with 1350G Series Only

			Full Scale - Water		Full Scale - Air	
Meter Size	Tube No.	Float Material	GPH	LPH	SCFH[1]	NLPH[2]
2	R-2-65-A G	Glass	0.010	0.041	0.12	3.2
		Sapphire	0.021	0.079	0.19	5.0
		Stainless Steel	0.049	0.18	0.37	9.8
		Carboloy	0.10	0.36	0.65	17
		Tantalum	0.10	0.40	0.71	18
	R-2-65-B G	Glass	0.014	0.06	0.16	4.4
		Sapphire	0.028	0.10	0.25	6.7
		Stainless Steel	0.07	0.25	0.48	12
		Carboloy	0.12	0.48	0.80	21
		Tantalum	0.14	0.53	0.87	22
	R-2-65-C G	Glass	0.12	0.47	0.99	26
		Sapphire	0.22	0.83	1.3	35
		Stainless Steel	0.41	1.5	2.1	55
		Carboloy	0.65	2.4	3.1	81
		Tantalum	0.70	2.6	3.3	87
	R-2-65-D G	Glass	0.68	2.5	3.9	100
		Sapphire	0.99	3.7	5.1	130
		Stainless Steel	1.6	6.3	7.9	200
		Carboloy	2.5	9.5	11	290
		Tantalum	2.7	10.0	12	310
6	R-6-65-A G	Glass	2.2	8.5	13	340
		Sapphire	3.3	12	17	440
		Stainless Steel	5.6	21	25	660
		Carboloy	8.3	31	36	940
		Tantalum	8.8	33	38	1000
	R-6-65-B G	Glass	8.7	33	46	1200
		Sapphire	12	47	59	1500
		Stainless Steel	20	76	86	2200
		Carboloy	29	100	110	3100
		Tantalum	30	110	120	3300

[1] Air flow rates in standard units are at 70°F & 14.7 PSIA. Reference conditions 70°F latm.
[2] Air flow rates in normal units are at 20°C & 1.013 bar. Reference conditions 0°C latm.

Table 1-3 Tube and Float Code - Seventh Digit in Model Code for Scale Configuration

Code	Model 1350 Tube	Model 1355 Tube
A	---	R-2-15-A G
B	---	R-2-15-B G
C	---	R-2-15-C G
D	---	R-2-15-D G
F	---	R-6-15-B G
G	R-2-65-A G	R-2-15-AAAA G
H	R-2-65-B G	---
J	R-2-65-C G	---
K	R-2-65-D G	---
L	R-6-65-A G	---
M	R-6-65-B G	---
N	No Tube	No Tube

Table 1-4 Tube and Float Code - Eighth and Ninth Digit in Model Code for Scale Configuration

		Decal Scale Inscription			
Meter Accuracy	Float Material	MM Scale	Linear Scale	Custom Decal	Percent Scale
Standard (1350-10%) (1355-5%)	Glass	1A	2A	3A	4A
	Stainless Steel	1B	2B	3B	4B
	Sapphire	1C	2C	3C	4C
	Carboloy	1D	2D	3D	4D
	Tantalum	1E	2E	3E	4E
Calibrated (1350-5%) (1355-2%	Glass	1G	2G	3G	4G
	Stainless Steel	1H	2H	3H	4H
	Sapphire	1J	2J	3J	4J
	Carboloy	1K	2K	3K	4K
	Tantalum	1L	2L	3L	4L

*Note: Code for No Float/No Scale = "ZZ"

Table 1-5 Capacities - Rib Guide Tubes, Spherical Floats for use with 1355G Series Only

			Full Scale Flow	
Meter Size	Tube No.	Float Material	Water (CC/Min)	Air[1]
2	R-2-15-AAAA G	Glass	0.59	50 SCC/M
		Sapphire	1.1	79 SCC/M
		Stainless Steel	2.6	150 SCC/M
		Carboloy	5.2	280 SCC/M
		Tantalum	5.8	310 SCC/M
	R-2-15-D G	Glass	5.5	370 SCC/M
		Sapphire	10	520 SCC/M
		Stainless Steel	20	830 SCC/M
		Carboloy	34	1200 SCC/M
		Tantalum	36	1300 SCC/M
	R-2-15-A G	Glass	17	0.82 SLPM
		Sapphire	26	1.0 SLPM
		Stainless Steel	46	1.6 SLPM
		Carboloy	70	2.4 SLPM
		Tantalum	75	2.5 SLPM
	R-2-15-B G	Glass	53	2.3 SLPM
		Sapphire	80	3.0 SLPM
		Stainless Steel	130	4.6 SLPM
		Carboloy	200	6.7 SLPM
		Tantalum	210	7.1 SLPM
	R-2-15-C G	Glass	90	4.0 SLPM
		Sapphire	130	5.2 SLPM
		Stainless Steel	220	7.9 SLPM
		Carboloy	340	11 SLPM
		Tantalum	360	11 SLPM
6	R-6-15-A G	Glass	210	9.5 SLPM
		Sapphire	320	12 SLPM
		Stainless Steel	540	18 SLPM
		Carboloy	790	25 SLPM
		Tantalum	840	26 SLPM
	R-6-15-B G	Glass	560	23 SLPM
		Sapphire	820	29 SLPM
		Stainless Steel	1300	43 SLPM
		Carboloy	1900	60 SLPM
		Tantalum	2000	63 SLPM

[1] Air flow rates in standard units are at 70°F & 14.7 PSIA. Reference conditions 70°F latm.

Optional Equipment

Standard Needle Valve

The standard needle valve can be supplied integrally mounted to the inlet or outlet of the instrument. For more details on the needle valve go to our website: BrooksInstrument.com, select Documentation, Precision Valves & Flow Controllers, select Brooks-Line IV, CART, 8503 or 8504 valves.

Flow Controllers

Flow controllers can be supplied integrally mounted to the inlet or outlet of the instrument. For the flow controller's complete instruction manual go to our website: BrooksInstrument.com, select Documentation, Precision Valves & Flow Controllers, select FC8800, or FC8900.

General

This section provides installation instructions for the Brooks® Sho-Rate

Models 1350G/1355G Flowmeters. Refer to Section 1 of this manual for connections.

Receipt of Equipment

When the equipment is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability. A report should be submitted to the nearest Brooks Instrument location listed on the Global Service Network page on our website:

BrooksInstrument.com/GlobalSupportCenters

Remove the envelope containing the packing list. Carefully remove the instrument from the packing case. Make sure spare parts are not discarded with the packing materials. Inspect for damaged or missing parts.

Unpacking

Carefully unpack the meter and inspect it for any damage that may have occurred during shipment. The flowmeters are shipped completely assembled and tested. It should not be necessary to tighten or adjust any of the parts when it is received.

Return Shipment

Prior to returning any instrument to the factory for any reason, visit our website for instructions on how to obtain a Return Materials Authorization Number (RMA #) and complete a Decontamination Statement to accompany it: BrooksInstrument.com/Service. All instruments returned to Brooks also require a Material Safety Data Sheet (MSDS) for the fluid(s) used in the instrument. Failure to provide this information will delay processing of the instrument.

Instrument must have been purged in accordance with the following:

⚠ WARNING

Before returning the device, purge thoroughly with a dry inert gas such as Nitrogen before disconnecting process connections. Failure to correctly purge the instrument could result in fire, explosion or death. Corrosion or contamination may occur upon exposure to air.

Recommended Storage Practice

If intermediate or long term storage is required for equipment, as supplied by Brooks Instrument, it is recommended that said equipment be stored in accordance with the following:

- Within the original shipping container.
- Stored in a sheltered area, preferably a warm, dry heated warehouse.
- Ambient temperature: 70°F (21.0°C) nominal, 110°F (43°C) maximum, 45°F (7.1°C) minimum.
- Relative humidity 45% nominal, 60% maximum, 25% minimum.

Upon removal from storage, a visual inspection should be conducted to verify the condition of equipment is “as received”. If the equipment has been in storage for an excess of two (2) years or in conditions in excess of those recommended, all pressure boundary seals should be replaced and the device subject to a hydrostatic/pneumatic pressure test to 150% of rated pressure.

Installation

The flowmeter should be mounted within 6° of true vertical. The inlet connection to the flowmeter is in the bottom end fitting. The connections are normally horizontal, female NPT. Be sure the piping is adequately supported to prevent undue strain on the meter.

⚠ WARNING

If the inlet and outlet valves adjacent to the flowmeter are to be closed for any reason, the flowmeter must be completely drained. Failure to do so may result in thermal expansion of the liquid which can cause rupture of the meter and possible personal injury.

⚠ CAUTION

Care must be taken in the system piping to this instrument to prevent sudden excessive pressure or flow surges. Protective devices should be installed upstream from this instrument, such as flow controllers, pressure regulators, pressure snubbers and rupture discs.

⚠ CAUTION

Any sudden change in system pressure may cause mechanical damage to elastomer materials. Damage can occur when there is a rapid expansion of fluid that has permeated elastomer materials. The user must take the necessary precautions to avoid such conditions.

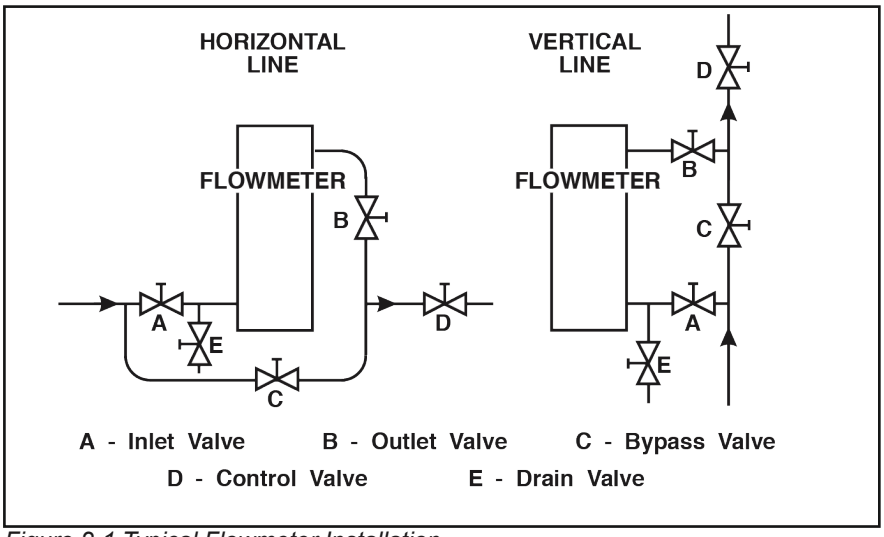
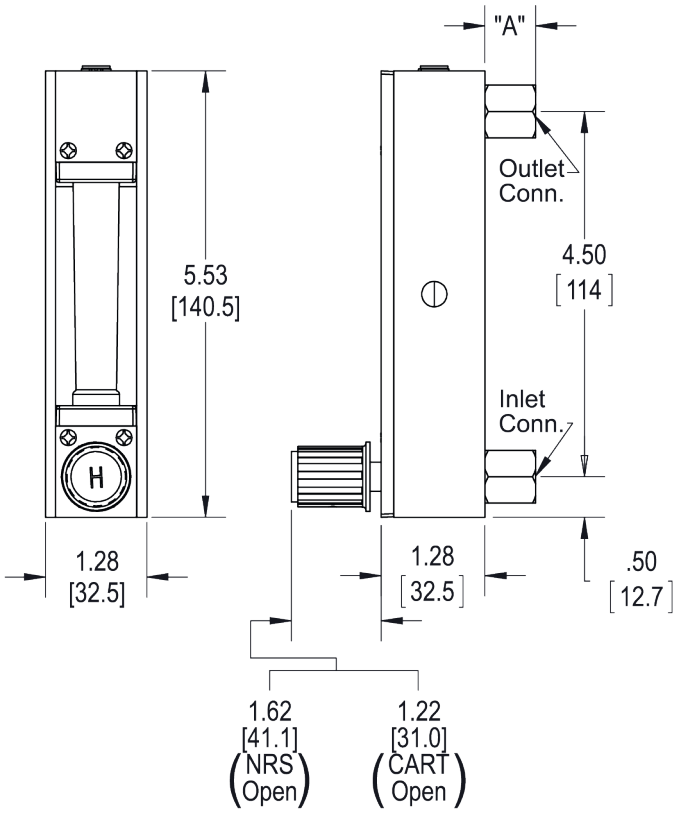


Figure 2-1 Typical Flowmeter Installation

It is recommended that a final leak test of the system plumbing and meter be performed before subjecting it to process fluid.

(See “4-2 Reassembly Procedure” on p. 4-2, step 6)



Dimension "A" Connection Adapter	
1/8" NPT	.625 [15.9]
1/4" NPT	.625 [15.9]
1/8" Compression	1.59 [40.3]
1/4" Compression	1.78 [45.1]
1/4" ID Hose	.72 [18.3]
1/4" Rc	.895 [22.7]
3/8" Rc	.895 [22.7]

Figure 2-2 Dimensions - Sho-Rate 1350G

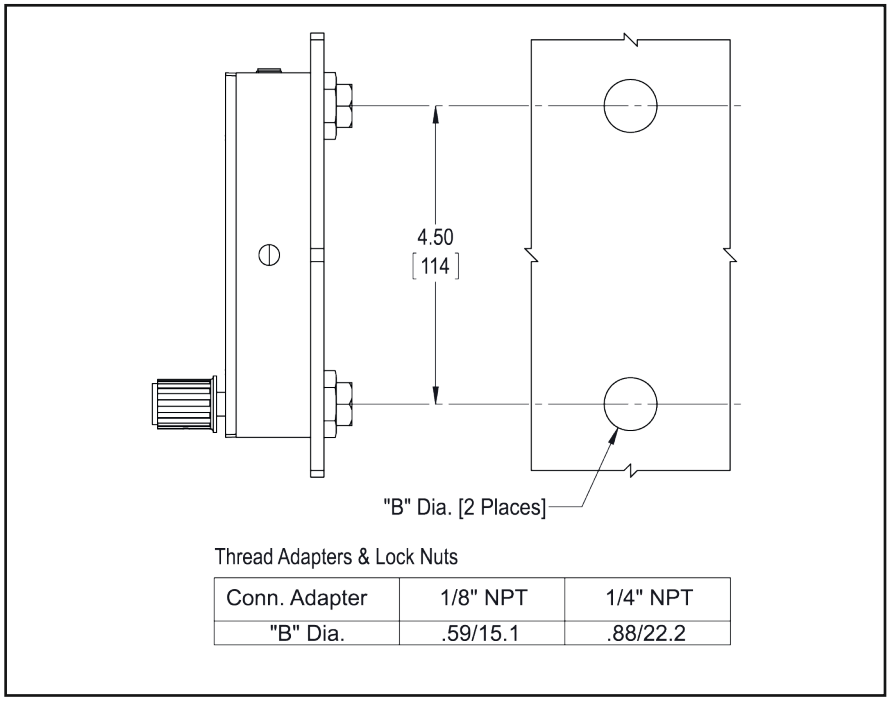


Figure 2-3 Dimensions - Sho-Rate 1350G Panel Mount

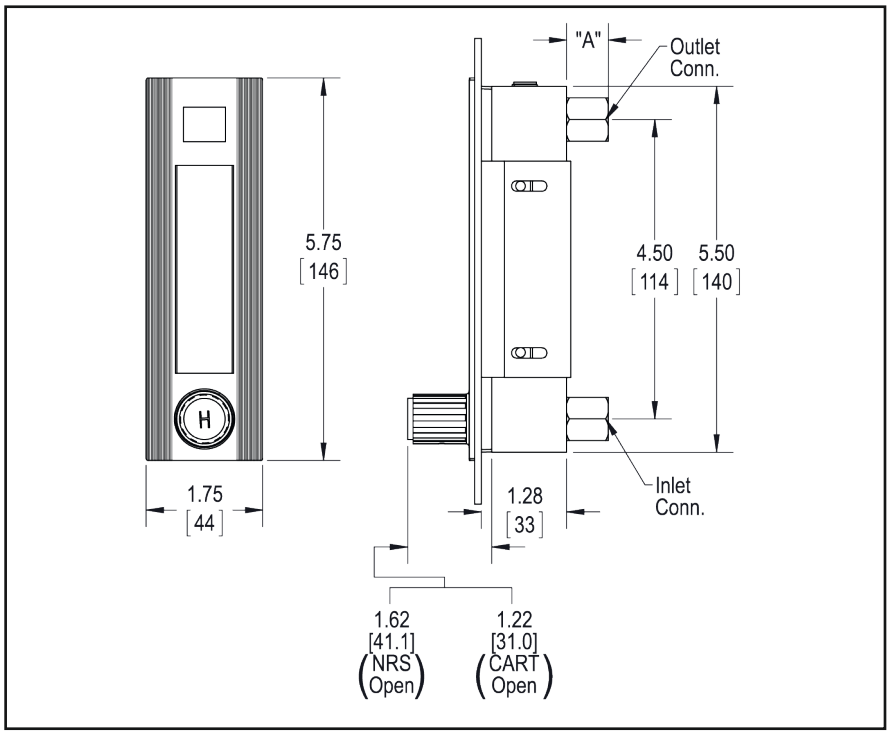
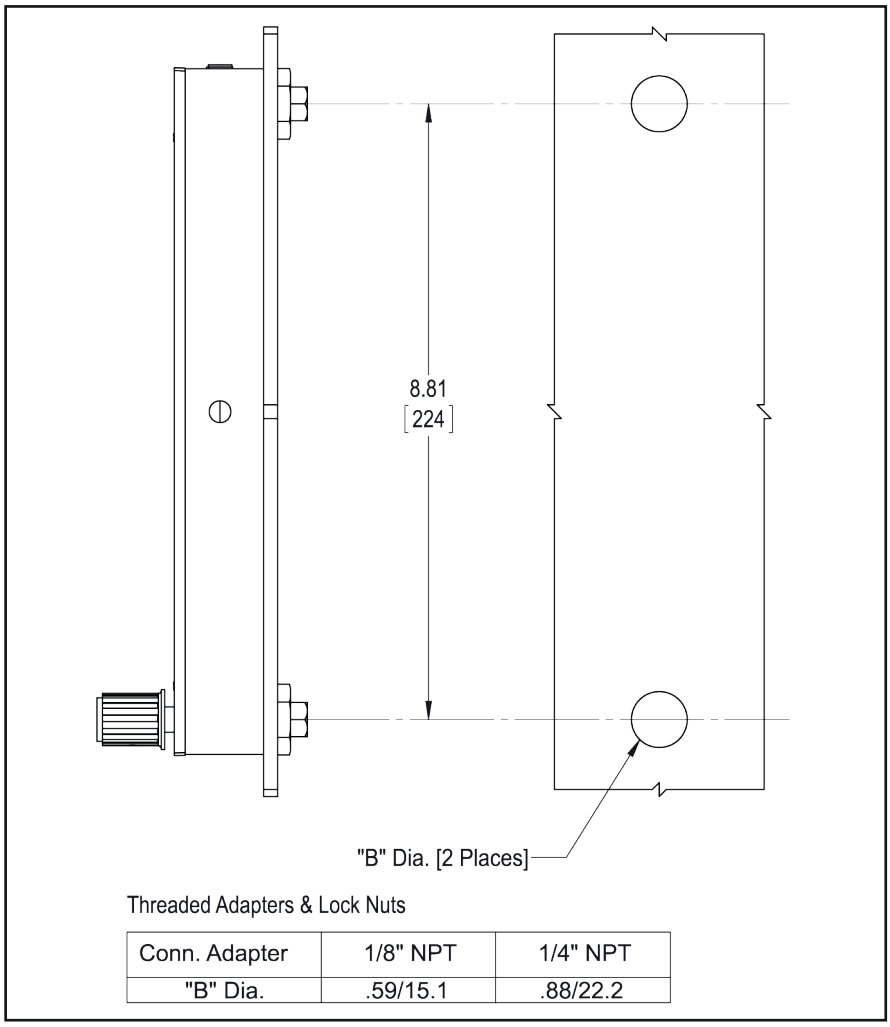


Figure 2-4 Dimensions - Sho-Rate 1350G Bezel



Threaded Adapters & Lock Nuts

Conn. Adapter	1/8" NPT	1/4" NPT
"B" Dia.	.59/15.1	.88/22.2

Figure 2-5 Dimensions - Sho-Rate 1355G Panel Mount

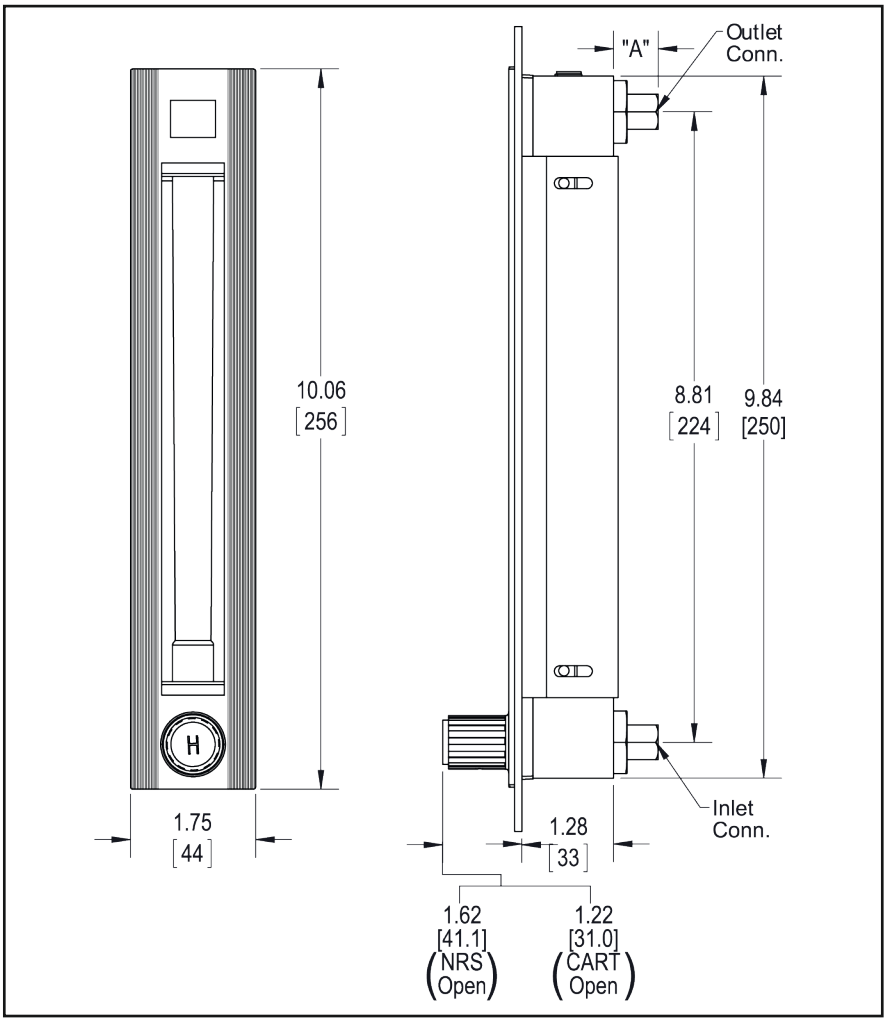
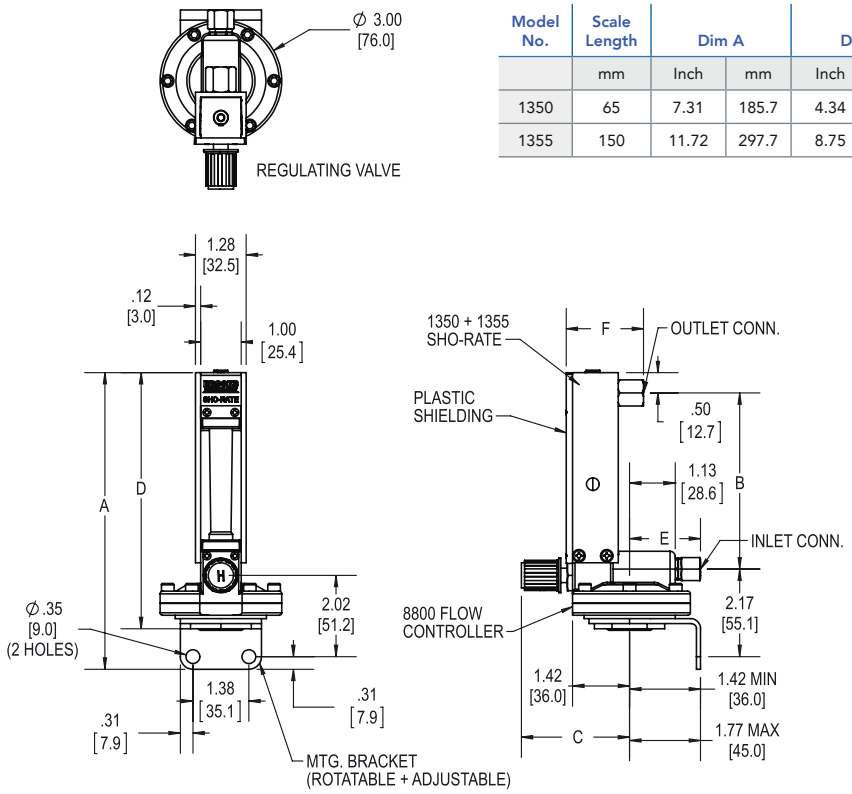


Figure 2-6 Dimensions - Sho-Rate 1355G Bezel

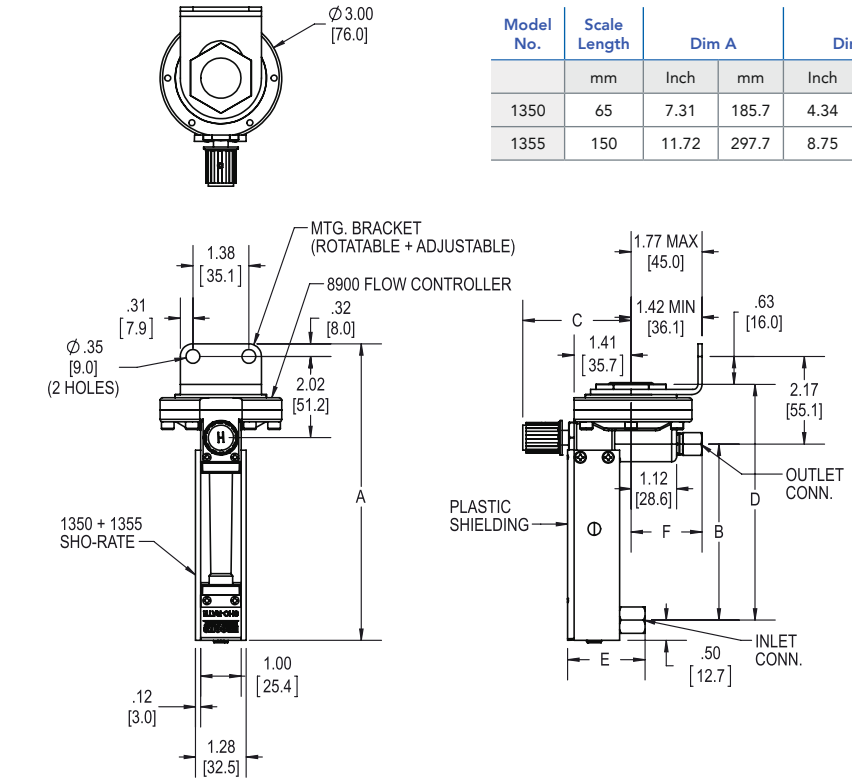
Model 1350G/1355G with Model 8800 Flow Controller on Inlet



Model No.	Scale Length	Dim A		Dim B		Dim C (Open)		Dim C (Closed)		Dim D	
	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1350	65	7.31	185.7	4.34	110.3	2.79	70.8	2.65	67.2	6.38	162.0
1355	150	11.72	297.7	8.75	222.2	2.79	70.8	2.65	67.2	10.78	273.8

Conn. Size	Inlet Connection E		Outlet Connection F	
	Inch	mm	Inch	mm
1/8 NPT	1.85	46.9	1.91	48.4
1/4 NPT	1.13	28.6	1.91	48.4
1/8 Comp.	2.19	55.6	2.87	72.8
1/4 Comp.	2.28	57.8	3.06	77.6
1/4 ID Hose	2.44	61.9	2.00	50.8
1/4 VCR (M)	N/A	N/A	2.19	55.6
1/4 RC	2.10	53.3	2.18	55.3
3/8 RC	2.60	66.1	2.18	55.3

Model 1350G/1355G with Model 8900 Flow Controller on Outlet



Model No.	Scale Length	Dim A		Dim B		Dim C (Open)		Dim C (Closed)		Dim D	
	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1350	65	7.31	185.7	4.34	110.3	2.79	70.8	2.65	67.2	6.38	162.0
1355	150	11.72	297.7	8.75	222.2	2.79	70.8	2.65	67.2	10.78	273.8

Conn. Size	Inlet Connection E		Outlet Connection F	
	Inch	mm	Inch	mm
1/8 NPT	1.91	48.4	1.85	46.9
1/4 NPT	1.91	48.4	1.13	28.6
1/8 Comp.	2.87	72.8	2.19	55.6
1/4 Comp.	3.06	77.6	2.28	57.8
1/4 ID Hose	2.00	50.8	2.44	61.9
1/4 VCR (M)	2.19	55.6	N/A	N/A
1/4 RC	2.18	55.3	2.10	53.3
3/8 RC	2.18	55.3	2.60	66.1

Figure 2-7 Dimensions - Model 1350G/1355G with Flow Controller

After the flowmeter has been installed in the flow system, it is ready for operation. An optional built-in needle control valve may be provided to control the flow through the flowmeter. These control valves are designed for fine control. Excessive tightening may damage the valve seat and limit its effectiveness as a control valve. If tight shut-off is required, it is recommended that a separate shut-off valve should be installed in the line immediately before the flowmeter.

Flow indication is measured using the center of the spherical float as the reference point.

Description

The Brooks bistable limit switches are inductive ring initiators designed to be slipped over the glass tube. The switch operates as a coil that is inductively actuated by a 316 Stainless Steel or Carboloy ball float. The limit switches can be set to any desired limit values, by sliding the switch along the metering tube. The Brooks ring initiators create a highly sensitive, stable latching signaling on high or low flows, or deviations from a controlled flow.

Technical Data Limit Switch

Switch Type	**Inductive**
Function	Bistable (Latching)
Repeatability	≤ 0.5 mm
Input Voltage	8Vdc nominal
Current Consumption	≤ 1 mA (direction A to B) ≥ 3 mA (direction B to A)
Max. float speed	10 m/s
Ambient temperature	0°C to 40°C
Protection to IEC 60529	IP67
Cable Specification	2 conductor, 2m PVC-covered
Conductor cross section	0,14 mm^2 (#23 AWG)
Housing material	Crastin (PBT)

Hazardous Area for Size 2 Tube

Ring Initiator	**RC 10-14-N3 (size 2 tube)**
PTB 99ATEX2128 X	⟨Ex⟩ II 2 G EExia IIC T6
EMC to	EN 60947-5-2
In compliance with	EN 50227
Self inductance	Limax = 70 µH
Self Capacitance	Cimax = 90 nF

Hazardous Area for Size 6 Tubes

Ring Initiator	**RC 15-14-N3 (size 6 tube)**
PTB 99ATEX2128 X	⟨Ex⟩ II 2 G EExia IIC T6
EMC to	EN 60947-5-2
In compliance with	EN 50227
Self inductance	Limax = 120 µH
Self Capacitance	Cimax = 90 nF

Power Supply/Relay Unit

Proximity switches may only be connected to a power supply/relay unit certified EEx ia IIB or EEx ia IIC, EEx ib IIB or EEx ib IIC. The switch adopts the same classification as the power supply/ relay unit. The power supply/relay unit must fulfill NAMUR requirement, EN 50227 (DIN 19234).

Maximum Operating Temperature

The maximum fluid temperature for the Sho-Rate series with the inductive switches is 70°C.

Recommended Spares

Model	Size	Description	Part number
Sho-Rate	Size 2	Bistable alarm incl. mounting parts	273-G-006-ZZZ
Sho-Rate	Size 6	Bistable alarm incl. mounting parts	273-G-007-ZZZ

Pressure Equipment Directive (PED)97/23/EC

Flow meter complies under Sound Engineering Practices (SEP)

Alarm Settings

The minimum setting distance of a switch and a fitting is 8 mm, and the minimum setting distance between 2 switches is approx. 30 mm, see figure 1. The standard alarm function is a bistable (latching) function, see figure 2. Once the ball float moves inside the inductive switch, the alarm function is activated, it remains activated, even if the float continues to move towards the alarm zone, thus leaving the inductive switch. The relay will drop out as soon as the float crosses the switch from the opposite direction, and moves back the alarm from the alarm zone into the normal operating range. The actual float position above or below the alarm switch is precisely indicated. Figure 3 displays low and high flow alarm settings.

The intrinsically safe power supply/relay unit from Pepperl+Fuchs (KF series) gives the customer the ability to switch over the alarm function in “Normally open” or “Normally closed”.

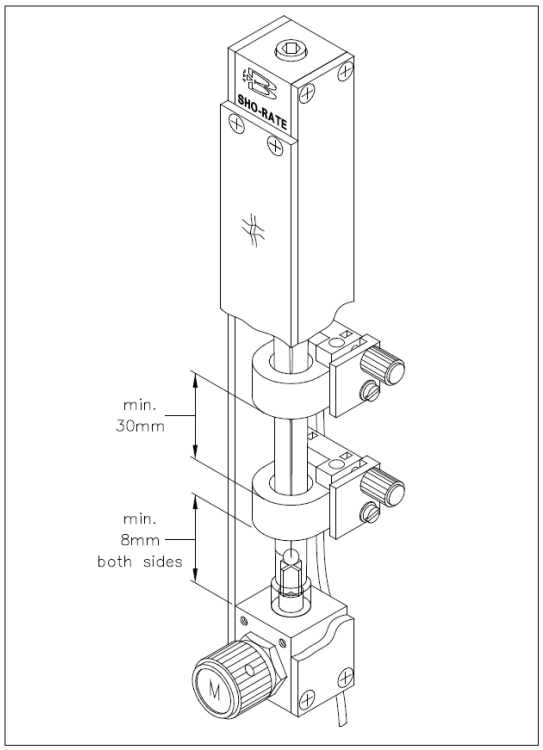


Figure 5-1: Alarm settings

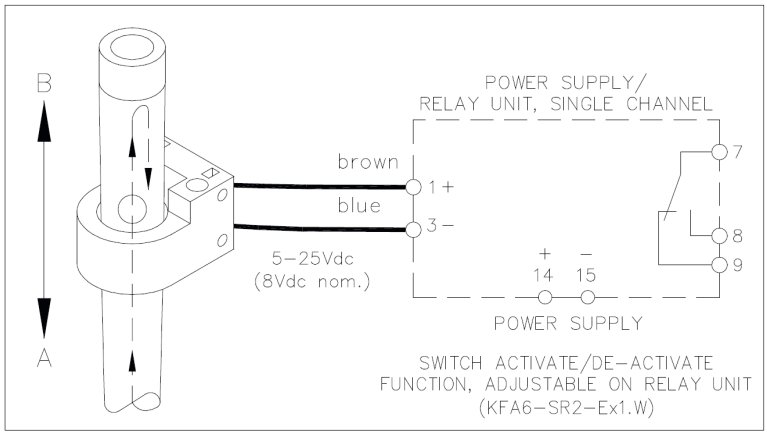


Figure 5-2: Standard bistable alarm

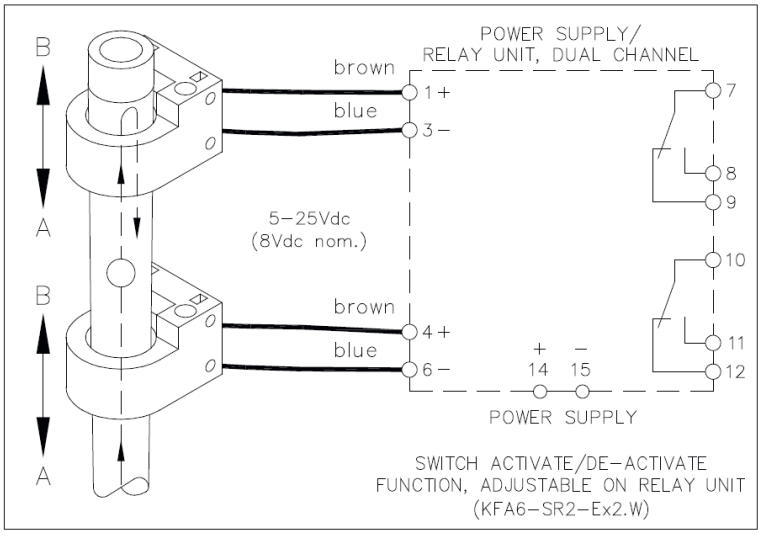
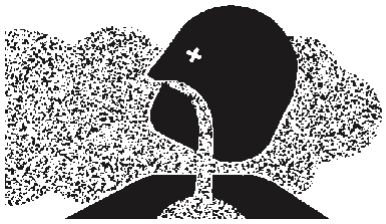


Figure 5-3: Bistable low and high flow alarm

Disassembly and Cleaning



⚠ WARNING

METER/CONTROLLER SEAL COMPATIBILITY

Products in this manual may contain metal or elastomeric seals, gaskets, O-rings or valve seats. It is the "user's" responsibility to select materials that are compatible with their process and process conditions. Using materials that are not compatible with the process or process conditions could result in the Meter or Controller leaking process fluid outside the pressure boundary of the device, resulting in personnel injury or death.

It is recommended that the user check the Meter or Controller on a regular schedule to ensure that it is leak free as both metal and elastomeric seals, gaskets, O-rings and valve seats may change with age, exposure to process fluid, temperature, and /or pressure.

It is recommended the user periodically inspect the tube and float, and clean if necessary. Dirt or foreign materials adhering to the tube and float may cause inaccuracy and sticking of the float. The metering tube (Borosilicate glass) and related parts may be cleaned with any solvent which does not attack glass. To disassemble use the following procedures:

1. Remove the front shield.

2. Loosen the jack screw by turning it counterclockwise with a 5/32” hex wrench. The tube may now be removed from the meter housing.

3. On meter sizes 1 through 6, the tube, float and float stops may be cleaned as an assembly or may be disassembled for cleaning. Using a small hook, remove either Teflon® float stop from the metering tube and remove the float. Be careful not to chip the tube.

4. Packing seats may now be removed.

5. The needle control valve assembly may be removed by turning the valve body counterclockwise. The valve seat, stem and packing then may be removed easily from the valve body for cleaning or replacement.

Reassembly Procedure

1. Use the reverse of Steps 1 through 5 of the disassembly procedure to reassemble the meter.

2. Prior to installing the needle control valve assembly make certain that the valve stem is turned completely counterclockwise (full open position) to prevent damage to the valve seat. Packing seats should be examined for damage or deterioration and replaced if necessary.

3. Make sure that the tube seats firmly on the packing seats and does not overlap onto the end block.

4. The jack screw and plug serve to axially compress the tube seat gasket and exert a uniform pressure on the metering tube to prevent any possibility of leakage. Do not overtighten the jack screw.

5. After the flowmeter has been reassembled, it is important that it be leak tested with air at a minimum pressure of 15 psig at room temperature.

6. To detect leaks, brush soapy water around all possible leak points (tube packing, connections, and seal spindle) and check if bubbles are being formed. Should a leak be detected, tighten that particular joint to see if the leak can be stopped. If the leak persists, disassemble the area involved and check for dirt or damaged elastomer. Clean and replace elastomer.

General

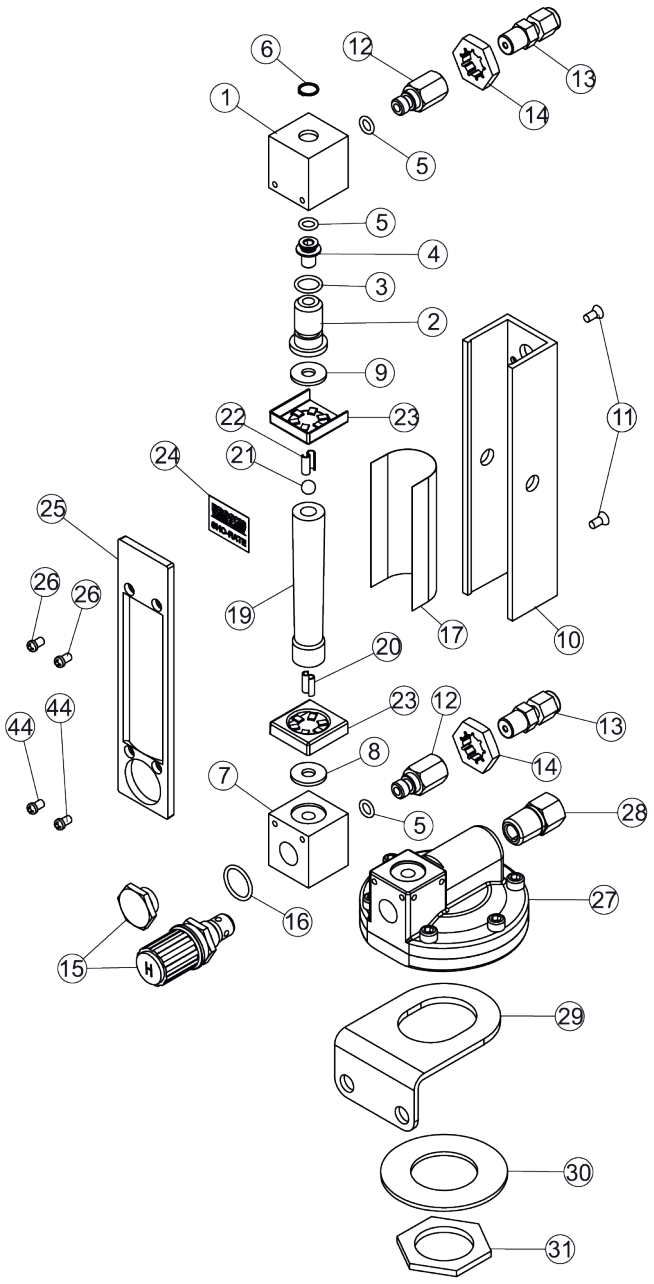
When ordering parts please specify:

Brooks Serial Number

Model Number Part Number

Description and Quantity

(Refer to Figure 5-1 and Table 5-1)



ITEM NO.	PART NUMBER
1	SEAL END FITTING
2	JACK PLUG
3	O-RING (JACK PLUG)
4	JACK SCREW
5	O-RING (JACK SCREW, ADAPTERS)
6	RETAINING RING
7	VALVE END FITTING
8	INLET TUBE PACKING
9	OUTLET TUBE PACKING
10	FRAME
11	SCREWS (BACK OF METER)
12	ADAPTERS
13	2ND ADAPTER
14	LOCKNUTS
15	VALVE PLUG / VALVE ASSY
16	O-RING FOR VALVE PLUG
17	BACKGROUND LABEL
19	TUBE
20	INLET FLOAT STOP
21	FLOAT
22	OUTLET FLOAT STOP
23	ALIGNMENT BLOCK
24	LOGO LABEL
25	FRONT WINDOW
26	SCREWS (FRONT WINDOW) TOP
27	FLOW CONTROLLER SUB-ASSY
28	ADAPTER (FLOW CONTROLLER)
29	BRACKET (FLOW CONTROLLER)
30	SPACER (FLOW CONTROLLER)
31	NUT(FLOW CONTROLLER)
32	ALARM*
33	BASE PLATE*
34	SCREW (BASE PLATE)*
36	SUPPORT BRACKET*
37	ADJUSTMENT SCREWS*
38	PANEL MOUNTING SCREWS*
39	ALUMINUM BEZEL*
40	BRACKET (BEZEL)*
41	SCREWS (BEZEL)*
42	WASHERS (BEZEL)*
43	LABEL SET*
44	SCREW (FRONT WINDOW) BOTTOM

*PART NOT SHOWN

CONTACT FACTORY IF REPLACEMENT PARTS ARE NEEDED.

GT1350001 REV C

Figure 7-1 Parts Drawing Sho-Rate Models 1350G and 1355G

Table 7-1 Sho-Rate 1350G/1355G Parts List

	PART DESCRIPTION			QTY.	COMPONENT PART NUMBER for 1350G	COMPONENT PART NUMBER for 1355G
1	**SEAL END FITTING**			1		
		BRASS			325A110GGJ	325A110GGJ
		SS/STEEL	Std Mat'l		325A109BMA	325A109BMA
2	**JACK PLUG**			1		
		SS	Std Mat'l		817A088BMA	817A088BMA
3	**O RING (Jack Plug)**		Viton	1	375B012QTA	375B012QTA
			Buna		375B012SUA	375B012SUA
			Butyl		375B012SAA	375B012SAA
			EPR		375B012SYA	375B012SYA
			Kalrez		375B012TTA	375B012TTA
4	**JACK SCREW**			1		
		SS	Std Mat'l		817A087BMA	817A087BMA
5	**O RING (Jack Screw and Adapters)**		Viton	3	375B009QTA	375B009QTA
			Buna		375B009SUA	375B009SUA
			Teflon		375B009QMA	375B009QMA
			Buty		375B009SAA	375B009SAA
			EPR		375B009SYA	375B009SYA
			Kalrez		375B009TTA	375B009TTA
6	**RETAINING RING**	SS		1		
			Std Mat'l		724Z438AAA	724Z438AAA
7	**VALVE END FITTING**			1		
		BRASS			325B120GGJ	325B120GGJ
		SS/STEEL	Std Mat'l		325B119BMA	325B119BMA
8	**INLET TUBE PACKING**			1		
		ALL R-2-65- TUBES	Buna		589B308SUA	589B308SUA
		ALL R-2-15- TUBES	Viton		589B308QTA	589B308QTA
			Teflon		589B310QMA	589B310QMA
			Butyl		589B308SAA	589B308SAA
			EPR		589B308SYA	589B308SYA
		ALL R-6-65- TUBES	Buna		589B309SUA	589B309SUA
		ALL R-6-15- TUBES	Viton		589B309QTA	589B309QTA
			Teflon		589B311QMA	589B311QMA
			Butyl		589B309SAA	589B309SAA
			EPR		589B309SYA	589B309SYA
9	**OUTLET TUBE PACKING**			1		
		ALL R-2-65- TUBES	Buna		589B308SUA	589B308SUA
		ALL R-2-15- TUBES	Viton		589B308QTA	589B308QTA
			Teflon		589B310QMA	589B310QMA
			Butyl		589B308SAA	589B308SAA
			EPR		589B308SYA	589B308SYA
		ALL R-6-65- TUBES	Buna		589B309SUA	589B309SUA
		ALL R-6-15- TUBES	Viton		589B309QTA	589B309QTA
			Teflon		589B311QMA	589B311QMA
			Butyl		589B309SAA	589B309SAA
			EPR		589B309SYA	589B309SYA
10	**Frame**			1		
		Standard	Alum		614A179EAJ	614B239EAJ
			SS		614A182BMA	614B242BMA
		w/Alarm	Alum	1	614A181EAJ	614B241EAJ
		w/Flow Controller	Alum		614A180EAJ	614B240EAJ
			SS		614A183BMA	614B243BMA
11	**SCREWS (BACK OF METER)**					
	W/O FLOW CONTROLLER, ALUM FRAME		316 SST 6-32 x 5/16" Lg Phillips Flat Hd	2	753Z221BMZ	753Z221BMZ
	W/ FLOW CONTROLLER, ALUM FRAME		316 SST 6-32 x 5/16" Lg Phillips Flat Hd	5	753Z221BMZ	753Z221BMZ
	W/O FLOW CONTROLLER, SS FRAME		316 SST 6-32 x 5/16" Lg Phillips Flat Hd	2	753C267BMA	753C267BMA
	W/ FLOW CONTROLLER SS FRAME		316 SST 6-32 x 5/16" Lg Phillips Flat Hd	5	753C267BMA	753C267BMA

Table 7-1 Sho-Rate 1350G/1355G Parts List (Continued)

	PART DESCRIPTION		QTY.	COMPONENT PART NUMBER for 1350G	COMPONENT PART NUMBER for 1355G
12	**ADAPTERS** from End Fitting (to 5/16-24 UNF)	**2 if no FCA, 1 if with FCA	2 of 1		
	NONE (integral 5/16-24 UNF Thds)			NO PART	NO PART
	TH'D - 1/8" (F) NPT also use for 1/8" Compression				
	SS			014C363BMA	014C363BMA
	TH'D - 1/4" (F) NPT also use for 1/4" Compression				
	SS			014C364BMA	014C364BMA
	5/16-24 to 1/4" Compression	no FCA	2	014B283BMA	014B283BMA
	SS	with FCA	1	014B283BMA	014B283BMA
	TH"D - 1/4" Rc				
	SS			014C365BMA	014C365BMA
	TH"D - 3/8" Rc				
	SS			014C366BMA	014C366BMA
	1/4 I.D. HOSE				
	SS			014H236BMA	014H236BMA
	1/4" VCR	SS		014C367BMA	014C367BMA
13	**2nd ADAPTER -** required for Compression Ftg & Locknut option	**2 for compression fittings, 1 if FCA			
	1/8" M-NPT to 1/8" Compression	no FCA	2	320B016BMA	320B016BMA
	SS	with FCA	1	320B016BMA	320B016BMA
	1/4" M-NPT to 1/4" Compression	no FCA	2	320B001BMA	320B001BMA
	SS	with FCA	1	320B001BMA	320B001BMA
	1/4" M-NPT to 6mm Compression	no FCA	2	014Z387BMA	014Z387BMA
	SS	with FCA	1	014Z387BMA	014Z387BMA
	1/4' NPT to 1/4 I.D. HOSE	no FCA	2	318Z068BMA	318Z068BMA
	SS	with FCA	1	318Z068BMA	318Z068BMA
14	**LOCKNUTS**				
	for 1/8" ADAPTER		2	573Z260AAA	573Z260AAA
	for 1/4" ADAPTER		2	573Z004GGJ	573Z004GGJ
	for 3/8" RC ADAPTER		2	573B018AC0	573B018AC0
15	**VALVE PLUG or VALVE ASSEMBLY**		1		
	Plug				
	SS			618J019BNA	618J019BNA
	Valve Assembly			See Valve assembly Tab for Cart III & NRS	
16	**O RING** for VALVE PLUG only		1		
	Viton			375B015QTA	375B015QTA
	Buna			375B015SUA	375B015SUA
	Teflon			375B015QMA	375B015QMA
	Buty			375B015SAA	375B015SAA
	EPR			375B015SYA	375B015SYA
	Kalrez			375B015TTA	375B015TTA
17	**Background Label**		1		
	Std			502Y939AAA	502Y940AAA
	w/Flow Controller			502Y939AAA	502Y940AAA
	Only for Alarm Configurations (RELEASE TBD)		2	502Y942AAA	502Y943AAA
19	**TUBE DIRECT READ**		1		
		R-2-65-AG		925R799WA8	
		R-2-65-BG		925R800WA8	
		R-2-65-CG		925R801WA8	
		R-2-65-DG		925R802WA8	
		R-6-65-AG		925X903WA8	
		R-6-65-BG		925X904WA8	
		R-2-15-AAAAG			925R807WA8
		R-2-15-AG			925R803WA8
		R-2-15-BG			925R790WA8
		R-2-15-CG			925R804WA8
		R-2-15-DG			925R805WA8
		R-6-15-AG			925X905WA8
		R-6-15-BG			925X906WA8
	MILLIMETER	R-2-65-AG		925R813WA8	
		R-2-65-BG		925R814WA8	
		R-2-65-CG		925R815WA8	
		R-2-65-DG		925R816WA8	
		R-6-65-AG		925X909WA8	
		R-6-65-BG		925X910WA8	
		R-2-15-AAAAG			925R812WA8
		R-2-15-AG			925R808WA8
		R-2-15-BG			925R809WA8
		R-2-15-CG			925R810WA8
		R-2-15-DG			925R811WA8
		R-6-15-AG			925X907WA8
		R-6-15-BG			925X908WA8

Table 7-1 Sho-Rate 1350G/1355G Parts List (Continued)

	PART DESCRIPTION			QTY.	COMPONENT PART NUMBER for 1350G	COMPONENT PART NUMBER for 1355G
20	**INLET FLOAT STOP**			1		
		R-2-65-AG,BG,CG	Std Teflon		846B141QMA	
		R-2-65-DG	Std Teflon		846B144QMA	
		R-6-65-AG	Std Teflon		846B147QMA	
		R-6-65-BG	Std Teflon		846B150QMA	
		R-2-15AAAAG,AG,DG	Std Teflon			846B143QMA
		R-2-15-BG,CG	Std Teflon			846B146QMA
		R-6-15-AG	Std Teflon			846B149QMA
		R-6-15-BG	Std Teflon			846B152QMA
21	**FLOAT**			1		
		1/8”	Glass		345C054WYA	345C054WYA
			SS		345C067BMA	345C067BMA
			Sapphire		345C068VGA	345C068VGA
			Carboloy		345C069CKA	345C069CKA
			Tantalum		345C051JNA	345C051JNA
		1/4”	Glass		345G055WYA	345G055WYA
			SS		345G072BMA	345G072BMA
			Sapphire		345G071VGA	345G071VGA
			Carboloy		345G073CKA	345G073CKA
			Tantalum		345G051JNA	345G051JNA
22	**OUTLET FLOAT STOP**			1		
		R-2-65-AG,BG,CG	Std Teflon		846B142QMA	
		R-2-65-DG	Std Teflon		846B145QMA	
		R-6-65-AG	Std Teflon		846B148QMA	
		R-6-65-BG	Std Teflon		846B151QMA	
		R-2-15-AAAAG,AG,DG	Std Teflon			846B142QMA
		R-2-15-BG,CG	Std Teflon			846B145QMA
		R-6-15-AG	Std Teflon			846B153QMA
		R-6-15-BG	Std Teflon			846B153QMA
23	**ALIGNMENT BLOCK**			2		
		R-2-65-AG,BG,CG,DG			079C117AAA	
		R-2-15-AAAAG,AG,BG,CG,DG				079C117AAA
		R-6-65-AG			079C118AAA	
		R-6-15-AG				079C118AAA
		R-6-65-BG			079C119AAA	
		R-6-15-BG				079C119AAA
24	**LOGO LABEL** for Front Window			1		
			Std Brooks		502C635AAA	502C635AAA
			No Logo		NO PART	NO PART
25	**FRONT WINDOW**	Std		1	794A299NZA	794B083NZA
		w/Flow Controller			794A407NZA	794B088NZA
		w/Bezel			794A408NZA	794B089NZA
26	**SCREWS** - for Front Window (TOP)			2		
		Std	#6-32 X 1/4” Lg Phillips Fillister Hd		753N265AWA	753N265AWA
		w/Flow Controller	1/8” Lg Phillips Fillister Hd		753N261AWA	753N261AWA
27	**FLOW CONTROLLER SUB-ASSY**			1		
			w/o Flow Controller		NO PART	NO PART
	8800	Brass Body	Buna Diaphragm		211B028FIA	211B028FIA
			Viton Diaphragm		211B028HIA	211B028HIA
		S/S Body	Viton Diaphragm		211B028DAA	211B028DAA
			Teflon Diaphragm		211B028FUA	211B028FUA
	8840	Brass Body	Buna Diaphragm & Quad		211E027FIA	211E027FIA
			Viton Diaphragm & Quad		211E027HIA	211E027HIA
		S/S Body	Viton Diaphragm & Quad		211E027DAA	211E027DAA
			Teflon Diaph/ Viton Quad		211E027FUA	211E027FUA
			Teflon Diaph/ Buna Quad		211E028FUA	211E028FUA
			Teflon Diaph/ EPR Quad		211E029FUA	211E029FUA
	8900	Brass Body	Buna Diaphragm		211G027FIA	211G027FIA
			Viton Diaphragm		211G027HIA	211G027HIA
		S/S Body	Viton Diaphragm		211G027DAA	211G027DAA
			Teflon Diaphragm		211G027FUA	211G027FUA
	8940	Brass Body	Buna Diaphragm		211J027FIA	211J027FIA
			Viton Diaphragm		211J027HIA	211J027HIA
		S/S Body	Viton Diaphragm		211J027DAA	211J027DAA
			Teflon Diaphragm		211J027FUA	211J027FUA

Table 7-1 Sho-Rate 1350G/1355G Parts List (Continued)

				COMPONENT PART NUMBER for	
	PART DESCRIPTION		**QTY.**	1350G	1355G
28	**ADAPTER: Flow Controller to Cust Connection** (1/4" M-NPT to)		1		
	1/8" (F) NPT	SS		315T050BMA	315T050BMA
	1/4" (F) NPT	SS		NO PART	NO PART
	1/8" Compression	SS		320B209BMA	320B209BMA
	1/4" Compression	SS		320B001BMA	320B001BMA
	6mm Compression	SS		014Z387BMA	014Z387BMA
	1/4" Rc	SS		014B102BNA	014B102BNA
	3/8" Rc	SS		014B271BMA	014B271BMA
	1/4 I.D. HOSE	SS		318Z068BMA	318Z068BMA
29	**BRACKET** for Panel Mounting of FC		1		
		Steel		106Z032AC0	106Z032AC0
		S/S		106Z032BFA	106Z032BFA
30	**SPACER** for FC Panel Mounting Bracket		1		
		Steel		810Z038AC0	810Z038AC0
		S/S		810Z038BFA	810Z038BFA
31	**NUT** for FC Panel Mounting Bracket				
		Steel		573Z015AC0	573Z015AC0
		S/S		573Z015BMA	573Z015BMA
32	**ALARM**	(RELEASE TBD)			
		BISTABLE INITIATOR+MNTG KIT #2		273-G-006-ZZZ	273-G-006-ZZZ
		BISTABLE INITIATOR+MNTG KIT #6		273-G-007-ZZZ	273-G-007-ZZZ
33	**BASE PLATE**	Base Plate Assembly	1	ASM163	ASM163
		Tripod Base Plate		PLA010	PLA010
		Bubble Level		PHW064	PHW064
34	**SCREW** - Bracket to Base Plate		1	PHW094	PHW094
36	**SUPPORT BRACKET**		1	106Y554ADD	106Y554ADD
37	**ADJUSTMENT SCREWS** - Corners of Base Plate		3	PHW065	PHW065
38	**PANEL MOUNTING SCREWS**	6-32 x .5" LG	4	754Z033AC0	754Z033AC0
39	**ALUMINUM BEZEL**				
	w/ Valve		1	075B032FEG	075D041FEG
	w/o Valve		1	075B031FEG	075D040FEG
40	**BRACKET for bezel**		2	106Y665FEG	106Y666FEG
41	**SCREWS** - Bracket to Bezel		4	751C263AWA	751C263AWA
42	**WASHERS** - Bezel		4	962A006AWA	962A006AWA
43	**LABEL SET**		1	502Y799AAA	502Y799AAA
44	**SCREWS** - for Front Window (BOTTOM)		2		
	Std	#6-32 X 1/4" Lg Phillips Fillister Hd		753N265AWA	753N265AWA
	w/Flow Controller	1/8" Lg Phillips Fillister Hd		753N261AWA	753N261AWA
45	**Decal Paper**		0.1		
		All Models		998E150AAA	998E150AAA
46	**Decal Overcoat**		0.1		
		All Models		998E151AAA	998E151AAA
REF1	**FINAL ASSEMBLY DRAWING**			GT1350001	
REF2	**OUTLINE DRAWINGS**				
	Valve on inlet			GT1350002	GT1355002
	Valve on outlet			GT1350003	GT1355003
	No Valve			GT1350004	GT1355004
	with 8800			GT1350005	GT1355005
	with 8900			GT1350006	GT1355006
REF3	**LABEL PRINTING INSTRUCTIONS**			502Y805	502Y805

Table 7-1 Sho-Rate 1350G/1355G Parts List (Continued)

VALVE		O-RING MATERIAL						
TYPE	**SIZE**	**BUNA**	**VITON**	**KALREZ**	**EPR/EPM**	**KALREZ/TEFLON**	**BUTYL**	
CARTRIDGE 3 SS	LOW	947N091BMA	947N092BMA	947N095BMA	947N094BMA	947N096BMA	947N093BMA	
	MED	947N097BMA	947N098BMA	947N101BMA	947N100BMA	947N102BMA	947N099BMA	
	HIGH	947N103BMA	947N104BMA	947N107BMA	947N106BMA	947N108BMA	947N105BMA	
CARTRIDGE 2 SS	LOW	947N063BNA	947N060BNA	947N064BNA	947N065BNA	**INVALID**	**INVALID**	
	MED	947N069BNA	947N061BNA	947N070BNA	947N071BNA	**INVALID**	**INVALID**	**Existing valve, using for initial release
	HIGH	947N077BNA	947N062BNA	947N078BNA	947N079BNA	**INVALID**	**INVALID**	**CART II valve no longer being offered
NRS SS	1	947L301BMA	947L302BMA	947L305BMA	947L304BMA	947L306BMA	947L303BMA	
	2	947L307BMA	947L308BMA	947L311BMA	947L310BMA	947L312BMA	947L309BMA	
	3	947L313BMA	947L314BMA	947L317BMA	947L316BMA	947L318BMA	947L315BMA	
	4	947L319BMA	947L320BMA	947L323BMA	947L322BMA	947L324BMA	947L321BMA	
	5	947L325BMA	947L326BMA	947L329BMA	947L328BMA	947L330BMA	947L327BMA	
	6	947L331BMA	947L332BMA	947L335BMA	947L334BMA	947L336BMA	947L333BMA	
	7	947L337BMA	947L338BMA	947L341BMA	947L340BMA	947L342BMA	947L339BMA	**Size 7 no longer being offered

*Sizing Based on Sizing Tab

Table 7-1 Sho-Rate 1350G/1355G Parts List (Continued)

Sho-Rate G Valve Sizing - AIR					Sho-Rate G Valve Sizing - WATER			
Tube/Float Combo	Max Flow (SCCM Air @ STP) Sho-Rate G	Recommended Valve (CART) (10 PISG inlet Pressure	Recommended Valve (NRS) (10 PISG inlet Pressure)		Tube/Float Combo	Max Flow (SCCM Water @ STP) Sho-Rate G	Recommended Valve (CART) (10 PISG inlet Pressure	Recommended Valve (NRS) (10 PISG inlet Pressure)
R-2-65-AG					R-2-65-AG			
Glass	59	Low	#1		**Glass**	0.68	Low	#1
Ruby	91	Low	#1		**Ruby**	1.3	Low	#1
Stainless	170	Low	#2		**Stainless**	3.1	Low	#1
Tungsten	300	Low	#2		**Tungsten**	6	Low	#2
Tantalum	330	Low	#2		**Tantalum**	6.7	Low	#2
R-2-65-BG					R-2-65-BG			
Glass	80	Low	#1		**Glass**	0.93	Low	#1
Ruby	120	Low	#1		**Ruby**	1.8	Low	#1
Stainless	220	Low	#2		**Stainless**	4.2	Low	#2
Tungsten	370	Low	#3		**Tungsten**	8	Low	#2
Tantalum	410	Low	#3		**Tantalum**	8.8	Low	#2
R-2-65-CG					R-2-65-CG			
Glass	460	Low	#3		**Glass**	7.9	Low	#2
Ruby	630	Low	#4		**Ruby**	13	Low	#3
Stainless	990	Low	#4		**Stainless**	26	Low	#4
Tungsten	1400	Low	#4		**Tungsten**	41	Low	#4
Tantalum	1500	Low	#4		**Tantalum**	44	Low	#4
R-2-65-DG					R-2-65-DG			
Glass	1800	Low	#4		**Glass**	43	Low	#4
Ruby	2400	Low	#4		**Ruby**	62	Low	#4
Stainless	3700	Low	#5		**Stainless**	100	Low	#5
Tungsten	5300	Med	#5		**Tungsten**	150	Low	#5
Tantalum	5600	Med	#5		**Tantalum**	170	Low	#5
R-2-15-AG					R-2-15-AG			
Glass	820	Low	#4		**Glass**	17	Low	#3
Ruby	1000	Low	#4		**Ruby**	26	Low	#4
Stainless	1600	Low	#4		**Stainless**	46	Low	#4
Tungsten	2400	Low	#5		**Tungsten**	70	Low	#4
Tantalum	2500	Low	#5		**Tantalum**	75	Low	#4
R-2-15-BG					R-2-15-BG			
Glass	2300	Low	#4		**Glass**	53	Low	#4
Ruby	3000	Low	#5		**Ruby**	80	Low	#4
Stainless	4600	Med	#5		**Stainless**	130	Low	#5
Tungsten	6700	Med	#5		**Tungsten**	200	Med	#5
Tantalum	7100	Med	#6		**Tantalum**	210	Med	#6
R-2-15-CG					R-2-15-CG			
Glass	4000	Med	#5		**Glass**	90	Low	#5
Ruby	5200	Med	#5		**Ruby**	130	Low	#5
Stainless	7900	Med	#6		**Stainless**	220	Med	#6
Tungsten	11000	Med	#6		**Tungsten**	340	Med	#6
Tantalum	11000	Med	#6		**Tantalum**	360	Med	#6
R-2-15-DG					R-2-15-DG			
Glass	370	Low	#3		**Glass**	5.5	Low	#2
Ruby	520	Low	#3		**Ruby**	10	Low	#2
Stainless	830	Low	#4		**Stainless**	20	Low	#3
Tungsten	1200	Low	#4		**Tungsten**	34	Low	#4
Tantalum	1300	Low	#4		**Tantalum**	36	Low	#4
R-2-15-AAAAG					R-2-15-AAAAG			
Glass	50	Low	#1		**Glass**	0.59	Low	#1
Ruby	79	Low	#1		**Ruby**	1.1	Low	#1
Stainless	150	Low	#1		**Stainless**	2.6	Low	#1
Tungsten	280	Low	#2		**Tungsten**	5.5	Low	#2
Tantalum	310	Low	#2		**Tantalum**	5.8	Low	#2
R-6-65-AG					R-6-65-AG			
Glass	6600	Med	#5		**Glass**	150	Low	#5
Ruby	8600	Med	#6		**Ruby**	220	Med	#6
Stainless	12000	Med	#6		**Stainless**	380	Med	#6
Tungsten	18000	Med	#6		**Tungsten**	560	Med	#6
Tantalum	19000	High	#6		**Tantalum**	600	Med	#6
R-6-65-BG					R-6-65-BG			
Glass	22000	High	Use Cart Valve High		**Glass**	550	Med	#6
Ruby	28000	High	Use Cart Valve High		**Ruby**	790	High	Use Cart Valve High
Stainless	40000	High	Use Cart Valve High		**Stainless**	1200	High	Use Cart Valve High
Tungsten	56000	High	Use Cart Valve High		**Tungsten**	1800	High	Use Cart Valve High
Tantalum	59000	High	Use Cart Valve High		**Tantalum**	1900	High	Use Cart Valve High
R-6-15-AG					R-6-15-AG			
Glass	9500	Med	#6		**Glass**	210	Med	#6
Ruby	12000	Med	#6		**Ruby**	320	Med	#6
Stainless	18000	Med	#6		**Stainless**	540	Med	#6
Tungsten	25000	High	Use Cart Valve High		**Tungsten**	790	High	Use Cart Valv High
Tantalum	26000	High	Use Cart Valve High		**Tantalum**	840	High	Use Cart Valv High
R-6-15-BG					R-6-15-BG			
Glass	23000	High	Use Cart Valve High		**Glass**	560	Med	#6
Ruby	29000	High	Use Cart Valve High		**Ruby**	820	High	Use Cart Valve High
Stainless	43000	High	Use Cart Valve High		**Stainless**	1300	High	Use Cart Valve High
Tungsten	60000	High	Use Cart Valve High		**Tungsten**	1900	High	Use Cart Valve High
Tantalum	63000	High	Use Cart Valve High		**Tantalum**	2000	High	Use Cart Valve High

SCCM AIR, 10 PSIG INLET

CART		NRS	
Low	3700	1	150
Med	18000	2	350
High	75000	3	600
		4	2400
		5	6800
		6	12200

SCCM WATER, 10 PSIG INLET

CART		NRS	
Low	175	1	4
Med	687	2	10
High	1984	3	20
		4	80
		5	200
		6	650

LIMITED WARRANTY

Visit www.BrooksInstrument.com for the terms and conditions of our limited warranty.

BROOKS SERVICE AND SUPPORT

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users and maintenance persons.

Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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Installation-Manual-1350G-EN/541B205AAG/2025-09

ISO 9001 QUALITY SYSTEM

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A list of all Brooks Instrument locations and contact details can be found at www.BrooksInstrument.com

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BROOKS® INSTRUMENT
Beyond Measure

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35FE3215	FLUXUS F601 Ultrasonic Flow Meter	Flexim	DE6-F601GP-NNNNN-2PG3-NN.CS2.BO1	Section 40 91 00	09-I-004
002	1	"	F601 Clamp-On Transducer	Flexim	TRD-FSK-NNNN-NNNL-009	Section 40 91 00	09-I-004
003							
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FLEXIM AMERICAS Corporation
Headquarters
250-V Executive Drive
Edgewood, NY 11717
Phone: (631) 492-2300
Fax: (631) 492-2117
Toll Free: 1-888-852-PIPE
www.flexim.com

Price Overview:

Pos.	Description	Amount	Single price	Total Price
1	**Transmitter** DE6-F601GP-NNNNN-2PG3-NN.CS2.BO1 FLUXUS F601 [F] FLUXUS for the measurement of: liquids [601] Type: 601 [GP] General purpose [NN] No explosion protection [N] Non-intrinsically safe [NN] No certificates [2] Measuring channels: 2 [PG] Housing: polyamide glass [3] Power supply: 10.5...15 V DC [NN] No communication module Outputs [CS2] 2 x current output, switchable, active/passive, 4...20 mA [BO1] 1 x binary output (optorelay) status, pulse	1		
1.1	**Operating instruction** Operating instruction FLUXUS F601 English and electronic operating instructions in different languages on USB stick	1		
1.2	**Carrying case** Transport case for FLUXUS F/G601 dimensions: 19.1 x 15.4 x 7.6 in	1		
1.3	**Pipe mounting kit** Pipe mounting fixture QuickFix for x60x	1		
1.4	**Power supply units** Charging and power supply unit FLUXUS x601.2 110...240 V AC, 50/60 Hz, without mains cable	1		
1.5	**Power cable** Mains cable for charging and power supply unit (USA)	1		
1.6	**Data transmission kit** Data transmission kit for x60x	1		

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Pos.	Description	Amount	Single price	Total Price
1.7	**Measuring tape** Measuring tape FLEXIM, length: 9 ft scale: meter, inch, foot	1		
1.8	**Output adapter AO5** AO5 –signal output adapter for x601.2	1		
2	**Clamp-On Transducer** TRD-FSK-LNNN-NNKL-006/H68 CDK1LI7 Flow calibration of a transducer with the corresponding transmitter or a master transmitter (7 measuring points), without adjustment, including calibration certificate (recalibration). [F] For the measurement of: liquids [S] Typ: Shear wave [K] Transducer frequency K – 0.5 MHz Inner pipe diameter: 7.9…185 in [L] Temperature range: -40…+212 °F [NN] No explosion protection [NN] No certificates [KL] Connection system: LEMO-3K connector [006] Cable length: 19 ft [H68] Degree of protection IP68	1		
2.1	**Coupling compound** Coupling compound: -22…+392 °F, FLEXIM, tube 0.03 gal	1		
	Accessories			
3	**Ladder chains** Ladder chain brackets for K, G, and H transducers	1		
4	**Ladder chains** Set of ladder chains (2 x 1m)	1		
	Packing			
5	VH	1		

FLEXIM

Precise, flexible and versatile

FLUXUS® F/G60X Series

Portable ultrasonic flow measurement of liquids, thermal energy, gases, compressed air and steam

Oil & Gas

Chemical & Petrochemical

Water & Wastewater

Power Generation

HVAC

Pharmaceutical

Food & Beverage

Semiconductor

Mining

General Production

FLEXIM
when measuring matters

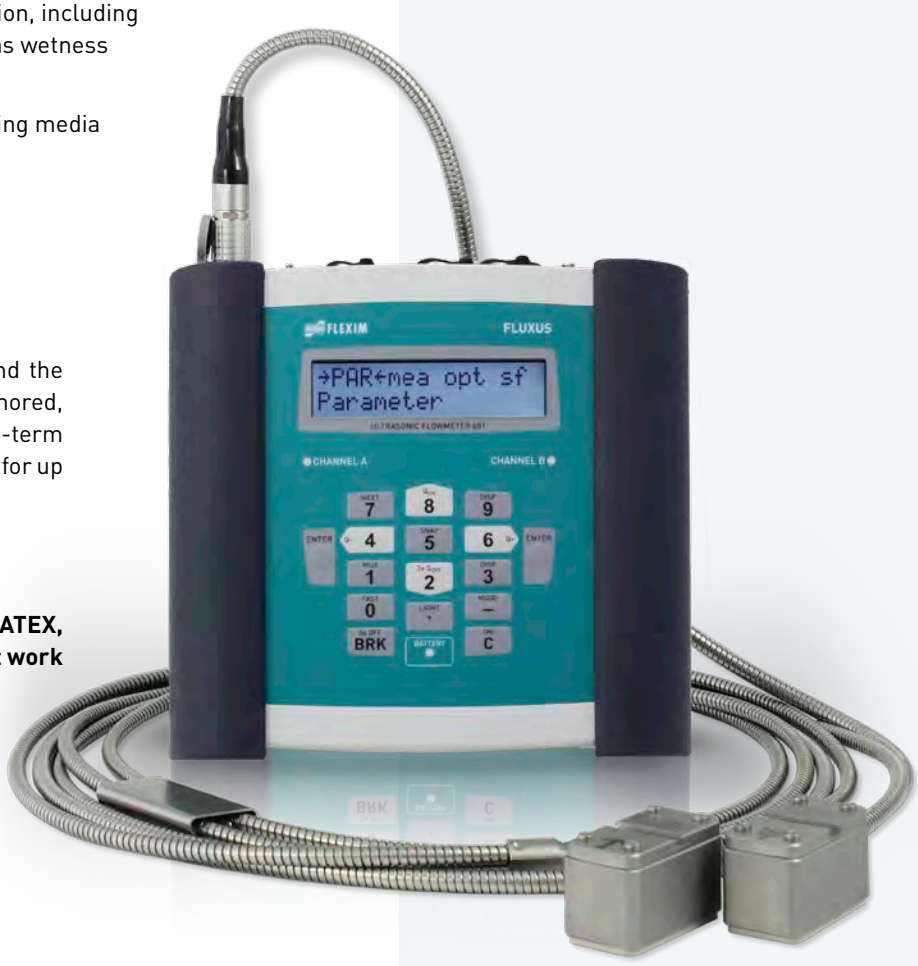
Flow Measurement on the go

FLUXUS® F/G60X Series

Welcome to the most versatile and industry-proven portable flow meter

The FLUXUS® F/G60X portable flow meter series is the instrumentation standard in many industries, ranging from the Oil & Gas and Chemical Industry to HVAC, Water & Wastewater, Food & Beverage, Pharma and many more. Independent of the environment and pipe conditions, it accurately and reliably measures:

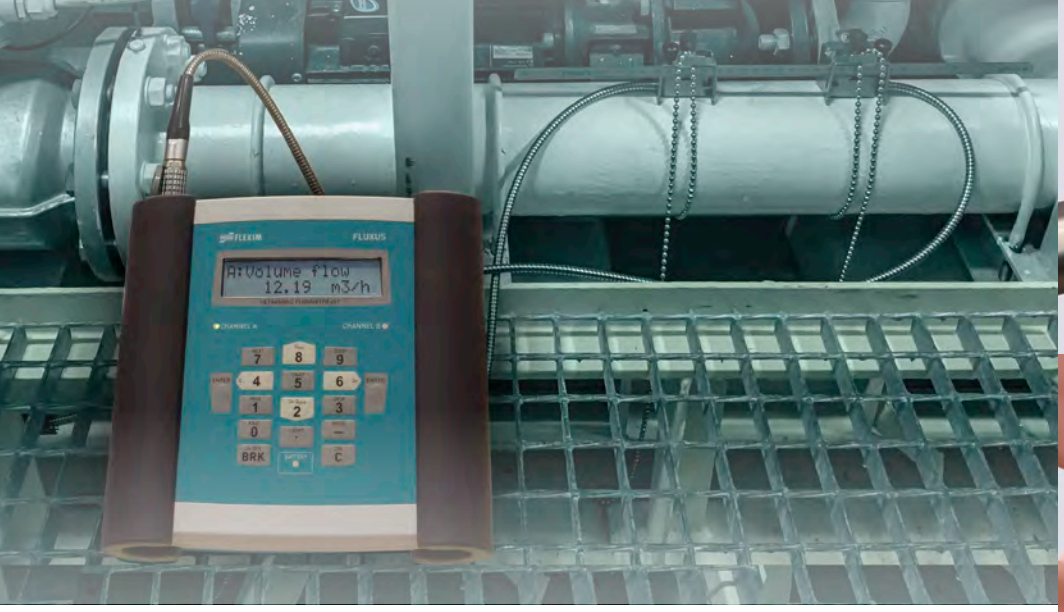
- virtually any liquid – independent of viscosity and temperature (from as low as -310 °F up to +1100 °F) and even with solid or gaseous entrainments
- virtually any gas – independent of the pressurization, including compressed air and steam, and not affected by gas wetness (up to LVF of 5%) as well as
- thermal energy flow rates of liquid heat transferring media (water, heat transfer oils, etc.)



Fit for industrial purpose

With the transmitter residing in a sturdy housing and the transducers and cables being stainless steel armored, FLUXUS® F/G60X offers unrivalled durability for long-term stable flow measurements. Its internal battery allows for up to 25 hrs. of autonomous measurement.

Moreover, based on special FM Class I, Div. 2 and ATEX, IECEx Zone 2 certified variants, time consuming hot work permits are a thing of the past.



Safe and efficient by principle

As the ultrasonic clamp-on transducers are simply mounted onto the pipe wall outside, the measurement does not require any pipe modifications and does not impair plant availability. With no direct media contact any potential for leaks can be ruled out, offering highest operational safety.

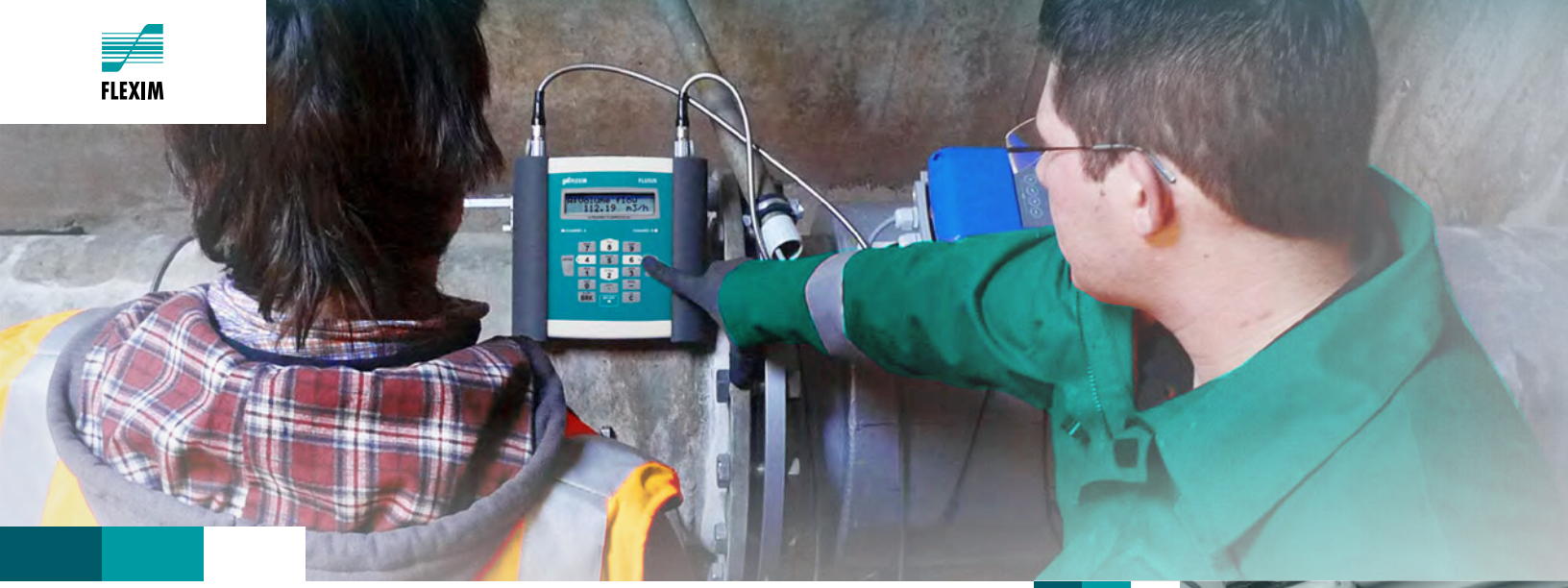
Measurement data you can rely on

With 30 years of engineering experience, FLEXIM sets standards in the field of clamp-on flow measurement:

- → Benchmarking digital signal processing and evaluation capabilities (up to 1000 measurement signals per second)
- → Separately calibrated transmitters and transducer pairs based on patented aperture calibration for highest possible accuracy of the measuring system
- → Matched and paired transducers ensuring zero offset and superior low flow performance
- → Integrated transducer temperature compensation (acc. to ANSI/ASME MFC-5.1-2011 regulations), for stable measurements independent of changing ambient temperatures
- → Two channels for reliable measurements at challenging applications or simultaneous measurement at two pipes
- → Built-in Noise Trek® Mode for accurate and reliable measurements of liquids with entrained solids or gases as well as internal wet gas compensation (up to LVF of 5%)

Data evaluation made easy

In connection with FLEXIM's elaborated FluxDiag Software, efficient measurement data evaluation, interpretation and recommendation is as easy as it can get. By downloading measurement data from the meter, FluxDiag offers statistical data analysis and extensive graphical visualization helping to gain an in-depth understanding of the process.
With its excellent reporting options, it is the ideal tool to comply with industry standards for regular verification of existing meters and plant wide flow audits.



Solutions for any flow metering application

The FLUXUS® F/G60X portable flow meters are available in various variants, starting as a liquid flow meter up to a multifunctional meter for non-invasive measurement of liquids, heat flow rates and gases – even including compressed air and steam.

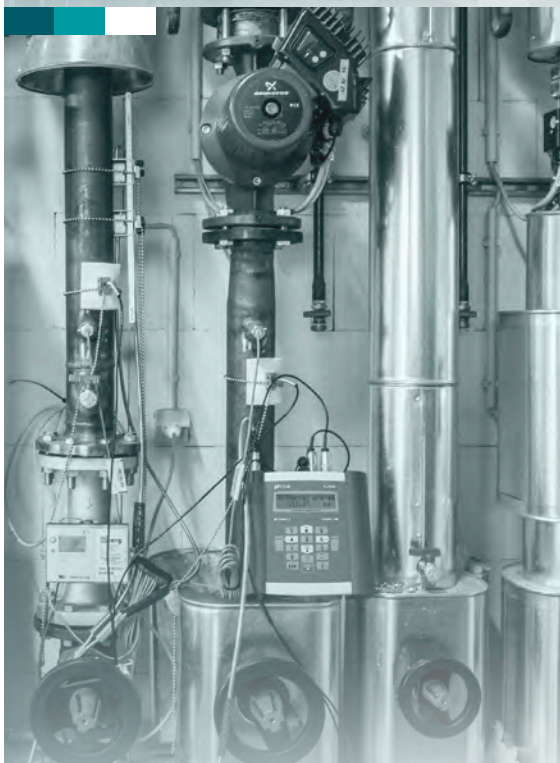
Whereas the FLUXUS® F/G601 meter series is designed for non-hazardous area related applications, the FLUXUS® F/G608 meter series is ATEX, IECEx Zone 2 (1) and FM Class I, Div. 2 (1) certified, making them the world's only portable flow meters with hazardous area approval.

The FLUXUS® F/G60X portable flow meters are the ideal tool for:

- Spot metering for continuous process optimization
- Check metering of existing stationary meters
- Temporary replacement of existing meters
- Plant wide flow and thermal energy audits
- Consumption monitoring
- Efficiency determination of pumps, heat exchangers, etc.

For liquids: FLUXUS® F60X

The standard FLUXUS® F60X portable liquid flow meter allows for the measurement of virtually any liquid media – from water over high viscosity oils to chemicals such as acids and caustics and up to slurries. In conjunction with the WaveInjector® transducer mounting, the meter can even measure at extreme pipe wall temperatures from as low -310 °F up to +1100 °F.



For liquids and thermal energy flows: FLUXUS® F60X Energy

The FLUXUS® F60X Energy is the portable meter of choice for monitoring of thermal energy flow rates e.g. balancing of chillers / heaters, optimization of heat exchangers, etc., making it a standard flow metering tool for HVAC applications as well as energy efficiency tasks in any kind of industrial environment.
In terms of media and applicable pipe wall temperature it offers the same possibilities as the standard FLUXUS® F60X portable meter.

FLEXIM's range of FLUXUS® G60X portable gas flow meters not only covers virtually any gaseous medium, they also include all liquid flow metering capabilities of the FLUXUS® F60X series meter series making them a truly comprehensive tool.

For liquids and gases: FLUXUS® G60X

When measuring gas filled pipes, the FLUXUS® G60X portable flow meter is the system of choice. Independent of the pipe's pressurization and with virtually no limitation in terms of measurable media – even wet gas isn't a challenge – it is the perfect measuring solution for the oil & gas and chemical industry.

For liquids, thermal energy, gases and compressed air: FLUXUS® G60X CA Energy

Equipped with temperature and current inputs, the product variant FLUXUS® G60X CA Energy is the most versatile multi-tool for various measuring tasks:
From monitoring liquid and thermal energy streams up to gas flow rates – including compressed air – it is the ideal portable measuring system for usage within the framework of plant wide industrial energy audits.

One for all – including steam: FLUXUS® G601 ST

As the world's only portable steam flow meter, the FLUXUS® G601 ST is the benchmark of non-invasive clamp-on ultrasonic flow measurement. Engineered for low pressure and low steam temperature applications, it is an ideal companion in various industries ranging from food & beverage to the pharmaceutical and chemical sector. Additionally, it also measures thermal energy and flow rates of virtually any liquid or gaseous medium.

FLEXIM

Technical Data

Portable liquid flow meters		
	FLUXUS® F60X	**FLUXUS® F60X Energy**
Measurement of:	Volumetric flow rate, mass flow rate, flow velocity	Volumetric flow rate, mass flow rate, flow velocity, heat flow rate
Measurement uncertainty:	±1% of reading ±0.02 ft/s	
Reproducibility:	0.15% of reading ±0.02 ft/s	
Flow velocities:	0.03 to 82 ft/s	
Outputs:	2 x 4-20 mA (active/passive), 2 x binary	
Inputs:	-	4 x Temp. Pt100 / Pt1000 RTD
Communication:	Modbus RTU	
Pipe size range (I.D.):	0.23 inch to 22 ft	
Temperature range:	-40 °F to +460 °F (with WaveInjector® mounting: -310 °F to +1100 °F)	
Hazardous area protection:	F608 product variant: FM Class I, Div. 2 and ATEX, IECEx Zone 2 certified; Connected transducers up to FM Class I, Div. 1 and ATEX, IECEx Zone 1	

Portable gas and liquid flow meters			
	FLUXUS® G60X	**FLUXUS® G60X CA (Compressed Air) Energy**	**FLUXUS® G601 ST – Steam flow meter**
Measurement of:	Volumetric flow rate, mass flow rate, flow velocity	Volumetric flow rate, mass flow rate, flow velocity, heat flow rate	Volumetric flow rate, mass flow rate, flow velocity, heat flow rate
Measurement uncertainty: Gases & Steam: Liquids:	 ±1 to 3% of reading ±0.02 ft/s ±1% of reading ±0.02 ft/s		
Reproducibility:	0.15% of reading ±0.02 ft/s		
Flow velocities:	0.03 to 115 ft/s (dependent on pipe diameter); Steam: 0.03 to 180 ft/s		
Outputs:	2 x 4-20 mA (active/passive), 2 x binary		
Inputs:	-	2 x Temp. Pt100 / Pt1000 RTD, 2 x 4-20 mA passive (G601 CA Energy only)	2 x Temp. Pt100 / Pt1000 RTD, 2 x 4-20 mA passive
Communication:	Modbus RTU		
Pipe size range (I.D.): Gases: Liquids: Steam:	 0.28 inch to 63 inches 0.23 inch to 22 ft		 1.77 inch to 15.75 inches *
Temperature range: Gases and Steam: Liquids:	 -40 °F to +460 °F; Steam: +275 °F to +355 °F -40 °F to +460 °F (with WaveInjector® mounting: -310 °F to +1100 °F)		
Hazardous area protection:	G608 product variants: FM Class I, Div. 2 and ATEX, IECEx Zone 2 certified; Connected transducers up to FM Class I, Div. 1 and ATEX, IECEx Zone 1		

** Please have your specific application tested for feasibility.*
This is especially recommended for pipe diameters smaller 4 inch.

FLEXIM AMERICAS
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Phone: (631) 492-2300

FLEXIM has offices located throughout North America.

Please have a look for your local representative at:

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Technical specification

FLUXUS F601

Portable ultrasonic flow measurement of liquids

Portable instrument for non-invasive, quick flow and energy measurement with clamp-on technology for all types of piping

Features

- Transmitterconfigurable for flow and thermal energy measurement
  - Flow measurement for all acoustically penetrable fluids
  - Integrated thermal energy measurement for a typical heat and refrigerating agents
  - Temperature range -40 to+392 °F, with WaveInjector max. +1166 °F
- Precise bidirectional and highly dynamic flow measurement with the non-invasive clamp-on technology
- Calibrated transducers and transmitters with traceable certificates
- Automatic loading of calibration data and transducer detection for a fast and easy set-up (less than 5 min), providing precise and long-term stable results
- High precision at fast and slow flow rates, high temperature and zero point stability
- Portable, easy-to-use flow transmitter with 2 flow channels, multiple inputs/outputs, an integrated data logger with a serial interface
- Integrated wall thickness measurement with connectable wall thickness probe
- The transmitter is water and dust-tight (NEMA 4), resistant against oil, many liquids and dirt
- Robust, water-tight (NEMA 4) transport case with comprehensive accessories
- Li-Ion battery provides up to 25 hours of measurement operation
- User-friendly design
- QuickFix for a simple and fast transmitter fixation, e.g., on pipes

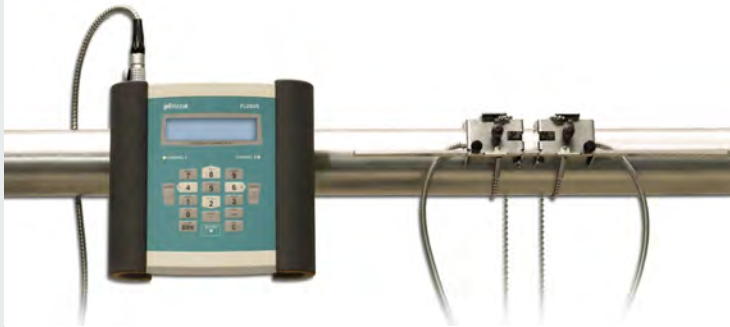
Applications

Designed for harsh environments and applicable in all areas such as drinking water and sewerage industry, power plants, producing industry, food industry and many more

Example applications:

- Operation measurements
- Data gathering in energy management and certifications according to ISO 50001
- Survey of pump performances
- Hydraulic balancing
- Verification of installed measuring systems
- Supervision of permanently installed meters, service and maintenance

FLUXUS F601



Measurement with transducers mounted with mounting frames and flow transmitter fixed to the pipe with the QuickFix pipe mounting fixture

Measurement equipment in transport case

Function . . . 3
Measurement principle . . . 3
Calculation of volumetric flow rate . . . 3
Number of sound paths . . . 4
Typical measurement setup . . . 5

Transmitter . . . 6
Technical data . . . 6
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Transducer mounting fixture . . . 14

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Clamp-on temperature probe (optional) . . . 19
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Fixation . . . 20

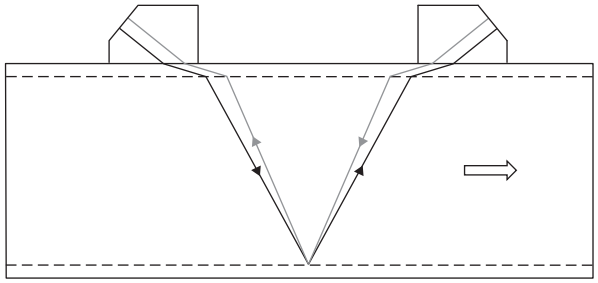
Wall thickness measurement (optional) . . . 21
Technical data . . . 21

Function

Measurement principle

The transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are emitted alternately by a transducer and received by the other. The physical quantities are determined from the transit times of the ultrasonic signals.

Path of the ultrasonic signal in the flowing fluid



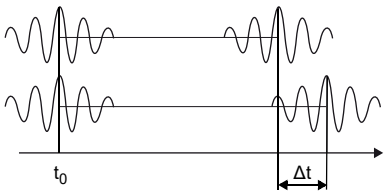
Transit time difference principle

As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

The transit time difference Δt is measured and allows the flowmeter to determine the average flow velocity along the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area averaged flow velocity, which is proportional to the volumetric flow rate.

The integrated microprocessors control the entire measuring cycle. The received ultrasonic signals are checked for measurement usability and evaluated for their reliability. Noise signals are eliminated.

Transit time difference Δt



HybridTrek

If the gaseous or solid content in the fluid increases occasionally during measurement, a measurement with the transit time difference principle may no longer be possible. NoiseTrek mode will then be selected by the flowmeter. This measurement method allows the flowmeter to achieve a stable measurement even with high gaseous or solid content.

The transmitter can switch automatically between transit time and NoiseTrek mode without any changes to the measurement setup.

Calculation of volumetric flow rate

$$\dot{V} = k_{Re} \cdot A \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_\gamma}$$

where

- $\dot{V}$ - volumetric flow rate
- k_{Re} - fluid mechanics calibration factor
- A - cross-sectional pipe area
- k_a - acoustical calibration factor
- Δt - transit time difference
- t_γ - average of transit times in the fluid

Number of sound paths

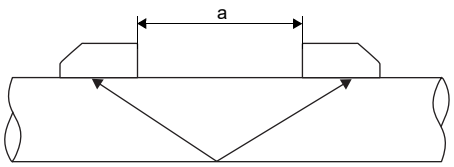
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **reflect arrangement**
  The number of sound paths is even. The transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easier.
- **diagonal arrangement**
  The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe.
- **direct mode**
  Diagonal arrangement with 1 sound path. This should be used in the case of a high signal attenuation by the fluid, pipe or coatings.

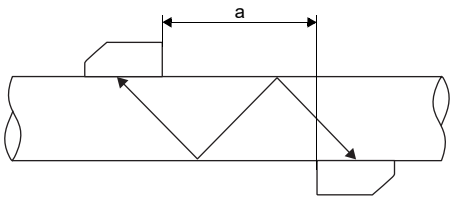
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the transmitter.

As the transducers can be mounted with the transducer mounting fixture in reflect arrangement or diagonal arrangement, the number of sound paths can be adjusted optimally for the application.

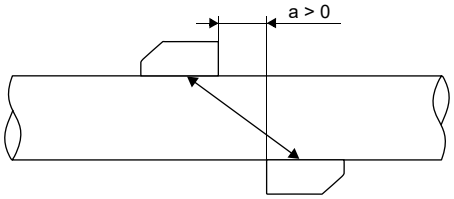
Reflect arrangement, number of sound paths: 2



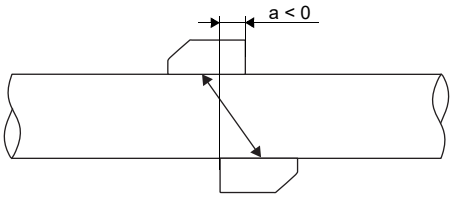
Diagonal arrangement, number of sound paths: 3



Direct mode, number of sound paths: 1



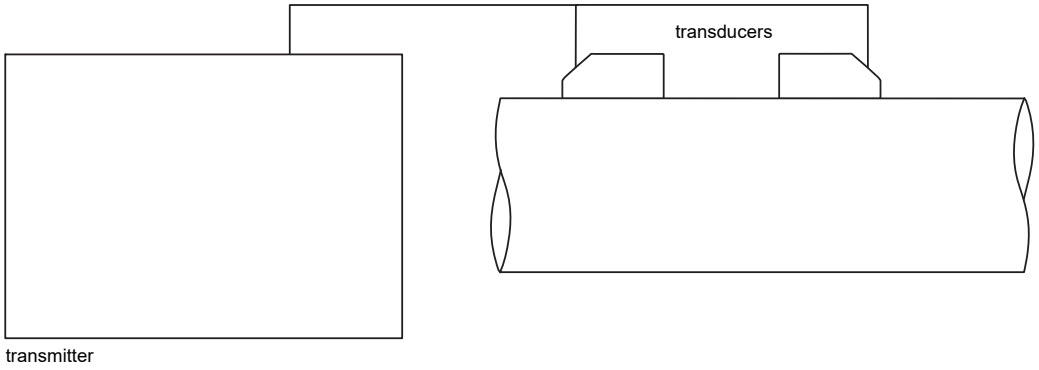
Direct mode, number of sound paths: 1, negative transducer distance



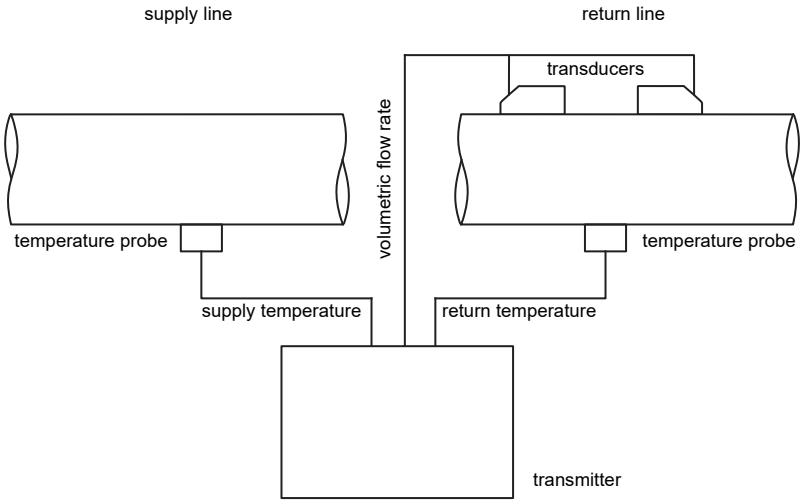
a - transducer distance

Typical measurement setup

Example of a reflect arrangement



Example of a thermal energy rate measurement measuring the volumetric flow rate in the return line



Transmitter

Technical data

		FLUXUS F601
design		portable
measurement		
measurement principle		transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	ft/s	0.03 to 82
repeatability		0.15 % of reading ±0.02 ft/s
fluid		all acoustically conductive liquids with < 10 % gaseous or solid content in volume (transit time difference principle)
temperature compensation		corresponding to the recommendations in ANSI/ASME MFC-5.1-2011
measurement uncertainty (volumetric flow rate)		
measurement uncertainty of measuring system[1]		±0.3 % of reading ±0.02 ft/s includes calibration certificate traceable to NIST
measurement uncertainty at the measuring point[2]		±1 % of reading ±0.02 ft/s
transmitter		
power supply		• 100 to 230 V/50 to 60 Hz (power supply unit: IP40, 32 to 104 °F) • 10.5 to 15 V DC (socket at transmitter) • integrated battery
integrated battery • operating time	 h	Li-Ion, 7.2 V/6.2 Ah • > 14 (without outputs, inputs and backlight) • > 25 (1 measuring channel, ambient temperature > 50 °F, without outputs, inputs and backlight)
power consumption	W	< 6 (with outputs, inputs and backlight), charging: 18
number of measuring channels		2
damping	s	0 to 100 (adjustable)
measuring cycle	Hz	100 to 1000 (1 channel)
response time	s	1 (1 channel), option: 0.07
housing material		PA, TPE, AutoTex, stainless steel
degree of protection		NEMA 4
dimensions	in	see dimensional drawing
weight	lb	4.6
fixation		QuickFix pipe mounting fixture
ambient temperature	°F	14 to 140
display		2 x 16 characters, dot matrix, backlight
menu language		English, German, French, Dutch, Spanish
measuring functions		
physical quantities		volumetric flow rate, mass flow rate, flow velocity, thermal energy rate (if temperature inputs are installed)
totalizer		volume, mass, optional: thermal energy
calculation functions		average, difference, sum
diagnostic functions		sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times
communication interfaces		
service interfaces		• RS232 • USB (with adapter)
process interfaces		• Modbus RTU (optional)
accessories		
serial data kit • cable • adapter	 	 RS232 RS232 - USB
software		• FluxDiagReader: download of measured values and parameters, graphical presentation • FluxDiag (optional): download of measurement data, graphical presentation, report generation
adapter		AO5, AO6, AO7, AO8, AI1, AI2
transport case		dimensions: 19.7 x 15.7 x 7.5 in
data logger		
loggable values		all physical quantities, totalized values and diagnostic values
capacity		> 100 000 measured values

[1] with aperture calibration of the transducers

[2] for transit time difference principle and reference conditions

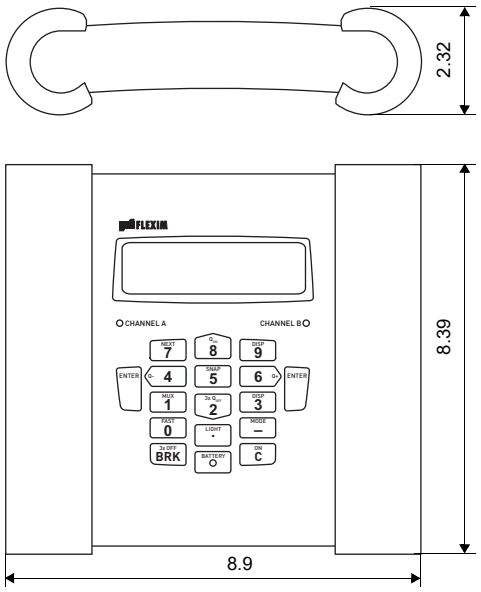
		FLUXUS F601
outputs		
		The outputs are galvanically isolated from the transmitter.
number		see standard scope of supply, max. on request
• switchable current output		
		The switchable current outputs are menu selectable all together as passive or active.
range	mA	4 to 20 (3.2 to 24)
accuracy		0.04 % of reading ±3 µA
active output		U_{int} = 24 V, R_{ext} < 500 Ω
passive output		U_{ext} = 8 to 30 V, depending on R_{ext} (R_{ext} < 900 Ω at 30 V)
• frequency output		
range	kHz	0 to 5
open collector		24 V/4 mA
• binary output		
optorelay		26 V/100 mA
binary output as alarm output		
• functions		limit, change of flow direction or error
binary output as pulse output		
• functions		mainly for totalizing
• pulse value	units	0.01 to 1000
• pulse width	ms	1 to 1000
inputs		
		The inputs are galvanically isolated from the transmitter.
number		see standard scope of supply, max. 4
• temperature input		
type		Pt100/Pt1000
connection		4-wire
range	°F	-238 to +1040
resolution	K	0.01
accuracy		±0.01 % of reading ±0.03 K
• current input		
accuracy		0.1 % of reading ±10 µA
passive input		R_{int} = 50 Ω, P_{int} < 0.3 W
• range	mA	-20 to +20
• voltage input		
range	V	0 to 1
accuracy		0.1 % of reading ±1 mV
internal resistance		R_{int} = 1 MΩ

[1] with aperture calibration of the transducers

[2] for transit time difference principle and reference conditions

Dimensions

60



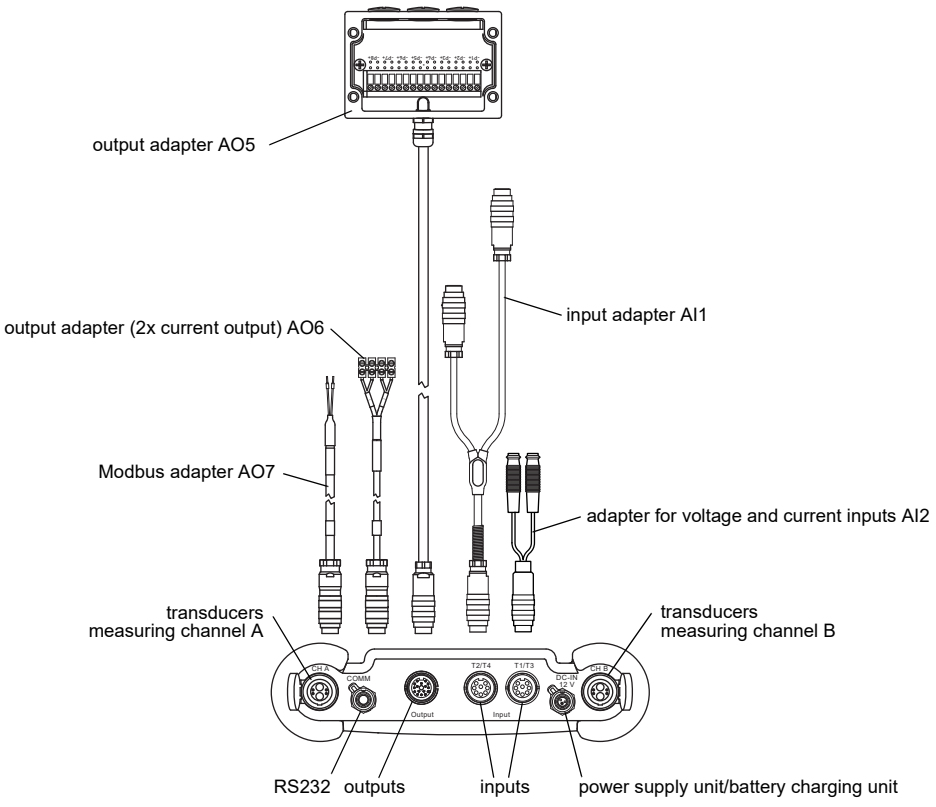
in inch

Standard scope of supply

	F601 Basic	F601 Energy
application	flow measurement of liquids	
	2 independent measuring channels, 2 calculation channels	
	wall thickness measurement (wall thickness probe to be ordered separately)	
		integrated thermal energy computer
		simultaneous monitoring of 2 energy flows
		temperature-compensated calculation of mass flow rate
outputs		
switchable current output	2	2
inputs		
temperature input	-	4
accessories		
transport case	x	x
power supply unit, mains cable	x	x
battery	x	x
adapter	AO6	AO6, AI1
QuickFix pipe mounting fixture for transmitter	x	x
serial data kit	x	x
measuring tape	x	x
user manual, Quick start guide	x	x

Adapters

***601**

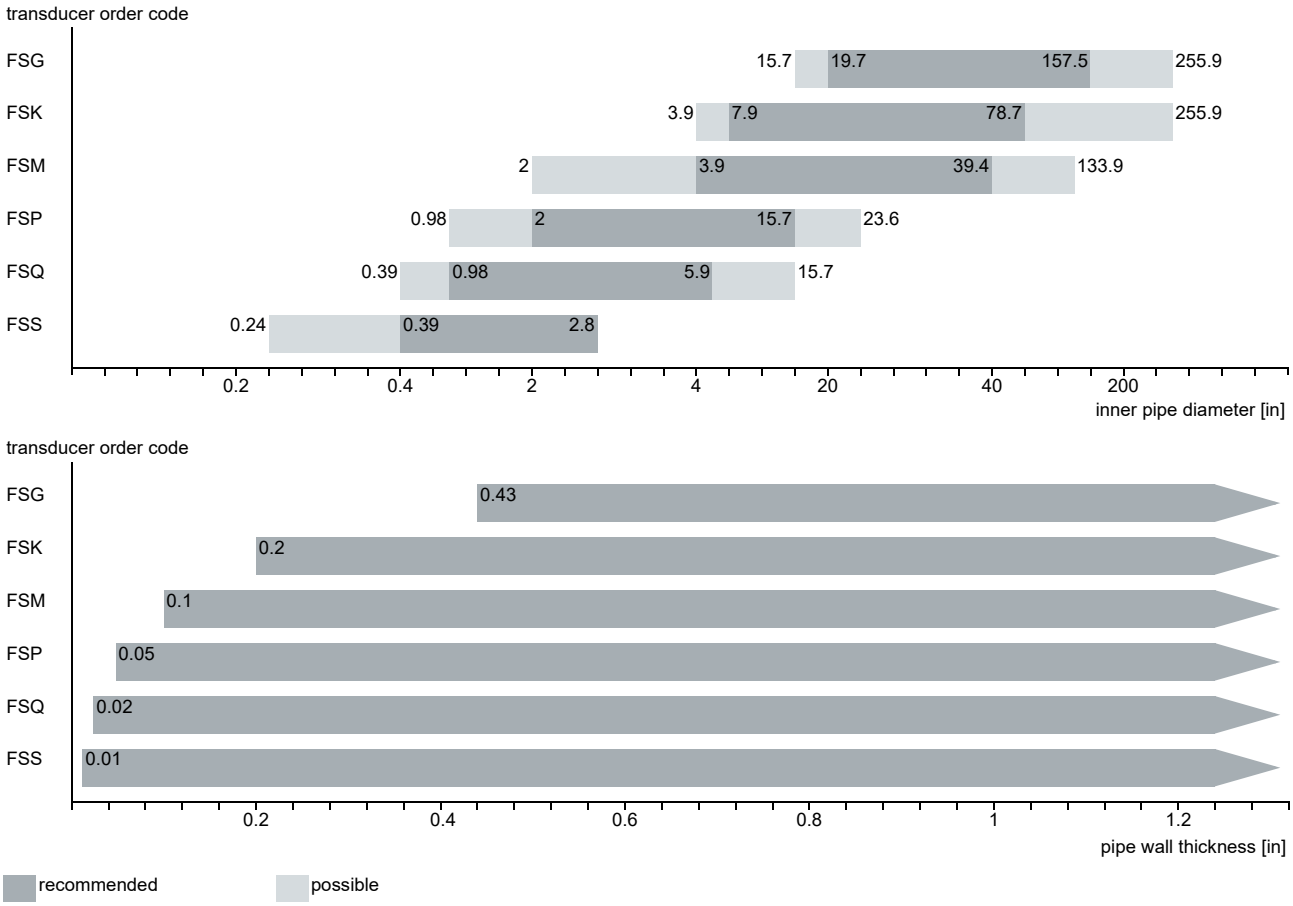


Example for the equipment of a transport case

F601

Transducers

Transducer selection

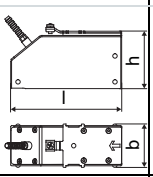
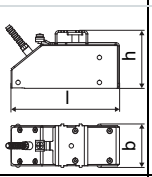
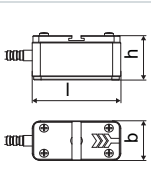
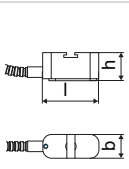
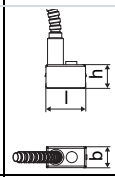


Transducer order code

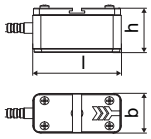
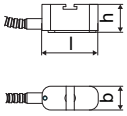
1, 2	3		4	5, 6	7, 8		9 to 11			no. of character
transducer	**transducer frequency**	**-**	**ambient temperature**	**explosion protection**	**connection system**	**-**	**extension cable**	**/**	**option**	**description**
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	G									0.2 MHz
	K									0.5 MHz
	M									1 MHz
	P									2 MHz
	Q									4 MHz
	S									8 MHz
			N							normal temperature range
			E							extended temperature range
				NN						not explosion proof
					NL					with Lemo connector
							XXX			0 m: without extension cable > 0 m: with extension cable
									LC	long transducer cable

Technical data

Shear wave transducers (nonEx, NL)

order code		FSG-NNNNL/**	FSK-NNNNL/**	FSM-NNNNL/**	FSP-NNNNL/**	FSQ-NNNNL/**	FSS-NNNNL/**
technical type		C(DL)G1NZ7	C(DL)K1NZ7	C(DL)M1NZ7	C(DL)P1NZ7	C(DL)Q1NZ7	CDS1NZ7
transducer frequency	MHz	0.2	0.5	1	2	4	8
inner pipe diameter d							
min. extended	in	15.7	3.9	2	0.98	0.39	0.24
min. recommended	in	19.7	7.9	3.9	2	0.98	0.39
max. recommended	in	157.5	78.7	39.4	15.7	5.9	2.8
max. extended	in	255.9	255.9	133.9	23.6	15.7	2.8
pipe wall thickness							
min.	in	0.43	0.2	0.1	0.05	0.02	0.01
material							
housing		PEEK with stainless steel cap 304		stainless steel 304			stainless steel 304
contact surface		PEEK		PEEK			PEI
degree of protection		NEMA 6					NEMA 4
transducer cable							
type		1699					
length	ft	16		13		9	6
length (***-*****/LC)	ft	29					-
dimensions							
length l	in	5.1	4.98	2.36		1.67	0.98
width b	in	2.01	2.01	1.18		0.71	0.51
height h	in	2.64	2.66	1.32		0.85	0.67
dimensional drawing							
weight (without cable)	lb	1	0.79	0.08		0.03	0.01
pipe surface temperature							
min.	°F	-40					-22
max.	°F	+266					+266
ambient temperature							
min.	°F	-40					-22
max.	°F	+266					+266
temperature compensation		x					

Shear wave transducers (nonEx, NL, extended temperature range)

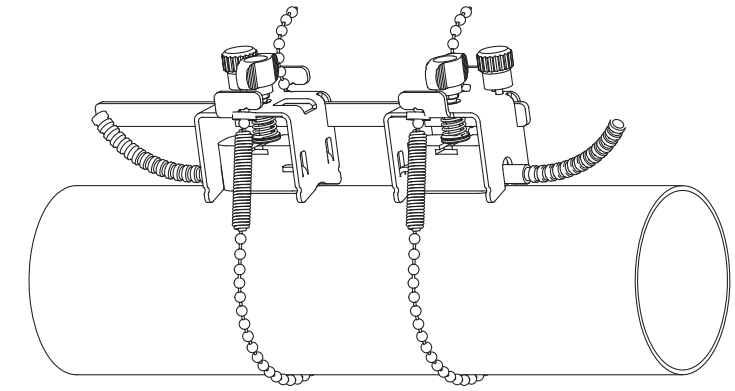
order code		FSM-ENNNL/**	FSP-ENNNL/**	FSQ-ENNNL/**
technical type		C(DL)M1EZ7	C(DL)P1EZ7	C(DL)Q1EZ7
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	133.9	23.6	15.7
pipe wall thickness				
min.	in	0.1	0.05	0.02
material				
housing		stainless steel 304		
contact surface		Sintimid		
degree of protection		NEMA 4		
transducer cable				
type		1699		
length	ft	13		9
length (***-*****/LC)	ft	29		
dimensions				
length l	in	2.36		1.67
width b	in	1.18		0.71
height h	in	1.32		0.85
dimensional drawing				
weight (without cable)	lb	0.09		0.02
pipe surface temperature				
min.	°F	-22		
max.	°F	+392		
ambient temperature				
min.	°F	-22		
max.	°F	+392		
temperature compensation		x		

Transducer mounting fixture

Order code

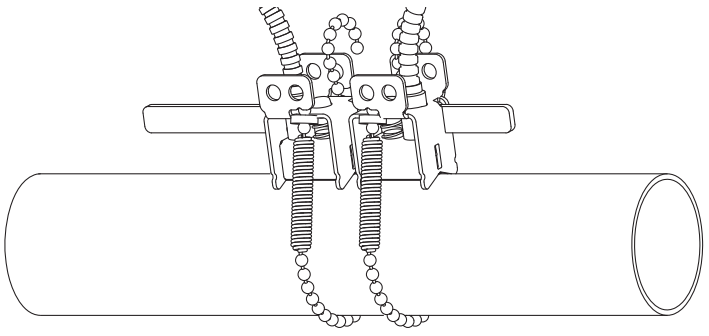
1, 2	3		4	5		6	7 to 9	no. of character
transducer mounting fixture	**transducer**	**-**	**measurement arrange-ment**	**size**	**-**	**fixation**	**outer pipe diameter**	**description**
FS								mounting frames
LM								ladder chain mounting accessory
VP								portable Variofix
TB								tension belts
WL								transducer box for WaveInjector
	A							all transducers
	K							transducers with transducer frequency G, K
	M							transducers with transducer frequency M, P
	Q							transducers with transducer frequency Q
	S							transducers with transducer frequency S
			D					reflect arrangement or diagonal arrangement/direct mode
			R					reflect arrangement
				S				small
				M				medium
						C		chains
						N		without fixation
							L08	0.5 to 8 in
							L22	0.5 to 22 in
							010	0.39 to 3.9 in
							025	0.39 to 9.8 in
							055	0.39 to 21.7 in
							150	2 to 59.1 in
							210	2 to 82.7 in

mounting frames FS and chains



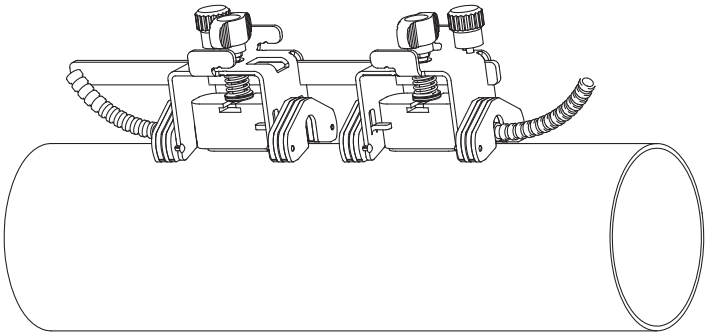
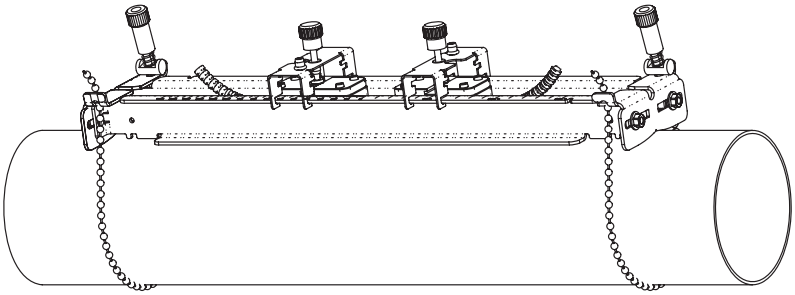
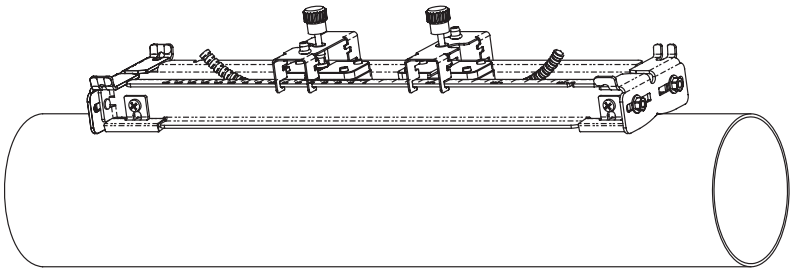
transducer frequency: M, P, Q

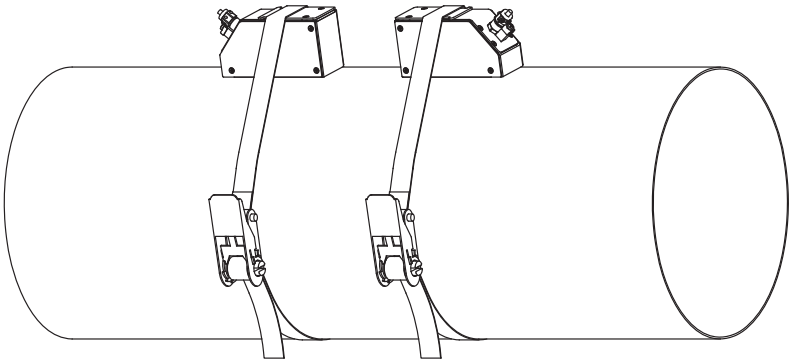
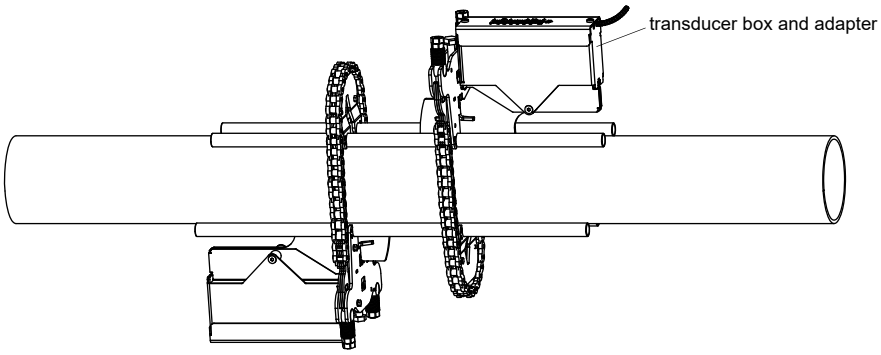
material: stainless steel 304, 301, 303
dimensions:
M, P: 16.54 x 1.89 x 2.68 in
Q: 16.54 x 1.69 x 2.28 in
chain length: 1/3/6 ft
outer pipe diameter:
max. 5.9/12.2/23.6 in



transducer frequency: S

material: stainless steel 304, 301, 303
dimensions:
8.27 x 1.26 x 1.73 in
chain length: 1 ft
outer pipe diameter:
max. 5.9 in

mounting frames FS and magnet (optional) 	material: stainless steel 304, 301, 303 dimensions: M, P: 16.54 x 1.89 x 2.68 in Q: 16.54 x 1.69 x 2.28 in
ladder chain mounting accessory LM 	transducer frequency: M, P, Q chain length: 30/78 in outer pipe diameter: max. 24 in
portable Variofix VP and chains (optional) 	material: stainless steel 304, 301, 303 dimensions: 16.3 x 3.7 x 2.99 in chain length: 6 ft
portable Variofix VP and magnet (optional) 	material: stainless steel 304, 301, 303 dimensions: 16.3 x 3.7 x 1.57 in

tension belts TB 	transducer frequency: G, K material: steel, powder coated and textile tension belt length: 16/22 ft ambient temperature: max. 140 °F outer pipe diameter: max. 59.1/82.7 in
transducer box WL for WaveInjector 	see Technical specification TSWaveInjectorVx-x

Coupling materials for transducers

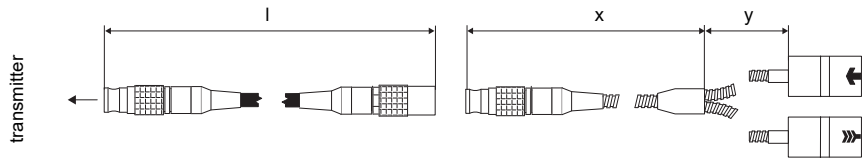
normal temperature range (4th character of transducer order code = N)		**extended temperature range (4th character of transducer order code = E)**		**WaveInjector**	
< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 1166 °F
coupling compound type N	coupling compound type E	coupling compound type E	coupling compound type E or H	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT

Technical data

type	**ambient temperature** °F
coupling compound type N	-22 to +266
coupling compound type E	-22 to +392
coupling compound type H	-22 to +482
coupling pad type A	max. 536
coupling pad type B	536 to 1166
coupling pad type VT	14 to +392

coupling pad not to be used for transducer mounting fixture with magnets

Connection systems

connection system NL	
direct connection/connection with extension cable	transducers technical type
	*****Z7

Cable

transducer cable		
type		**1699**
weight	lb/ft	0.06
ambient temperature	°F	-67 to +392
cable jacket		
material		PTFE
outer diameter	in	0.11
thickness	in	0.01
color		brown
shield		x
sheath		
material		stainless steel 304
outer diameter	in	0.31

extension cable			
type		**1750**	**2551**
standard length	ft	16 32	-
max. length	ft	32	see table below
weight	lb/ft	0.08	0.06
ambient temperature	°F	< 144	-13 to +176
cable jacket			
material		PE	TPE-O
outer diameter	in	0.24	0.31
thickness	in	0.02	
color		black	black
shield		x	x
sheath			
material		stainless steel 304	-
outer diameter	in	0.35	-
remark		optional	

Cable length

transducer frequency		F, G, H, K			M, P			Q			S		
connection system NL													
transducers technical type		x	y	l	x	y	l	x	y	l	x	y	l
*D***Z7[1]	ft	6	9	≤ 82	6	6	≤ 82	6	3	≤ 82	3	3	≤ 65
option LC: *L***Z7[1]	ft	6	22	≤ 82	22	6	≤ 82	26	3	≤ 82	-	-	-

[1] l > 82 to 328 ft on request

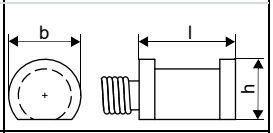
x, y = transducer cable length

l = max. length of extension cable

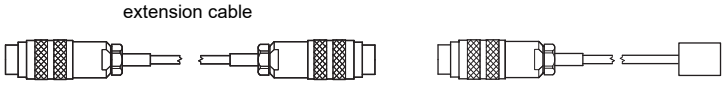
Clamp-on temperature probe (optional)

Technical data

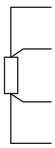
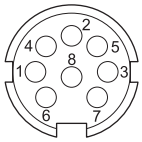
PT13N

design		clamp-on with connector
type		Pt1000
connection		4-wire
measuring range	°F	-40 to +392
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		≤ 0.03 °F (at 50 °F)
housing material		360 brass alloy
degree of protection		NEMA 4
dimensions		
length l	in	0.79
width b	in	0.59
height h	in	0.49
dimensional drawing		
weight	lb	0.437 (without connector)
accessories		
thermal conductivity foil 482 °F		x

Connection system

direct connection/connection with extension cable


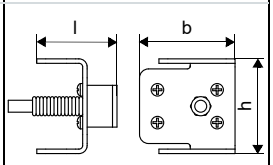
Connection

	temperature probe	extension cable	connector pin	
	red	black	2	
	red	green	6	
	white	white	1	
	white	red	7	

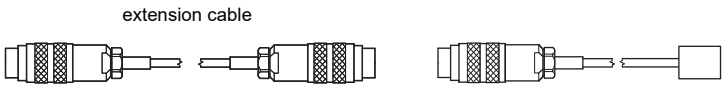
Cable

		temperature probe	extension cable
type		4 x 24 AWG	4 x 18 AWG
standard length	ft	20	-
max. length	ft	-	656
cable jacket		PTFE	LS PVC

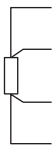
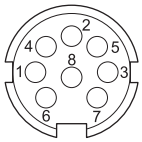
PT13F

design		clamp-on short response time, with connector
type		Pt1000
connection		4-wire
measuring range	°F	-58 to +482
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		≤ 0.1 K (3 K < ΔT < 6 K), more corresponding to EN 1434-1
response time	s	8 (t50, T1 = 25 °C, T2 = 60 °C)
housing material		PEEK, stainless steel 304, copper
degree of protection		IP54
dimensions		
length l	in	0.55
width b	in	1.18
height h	in	1.06
dimensional drawing		
weight	lb	0.7 (without connector)
accessories		
thermal conductivity paste 392 °F		x
thermal conductivity foil 482 °F		x
plastic protection plate, insulation foam		x

Connection system

direct connection/connection with extension cable


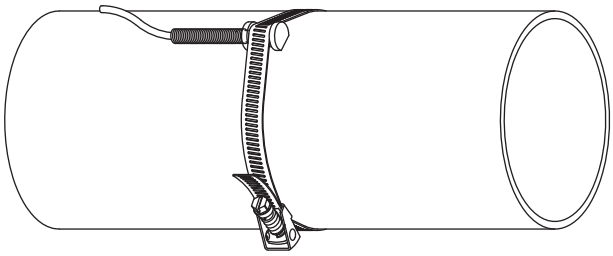
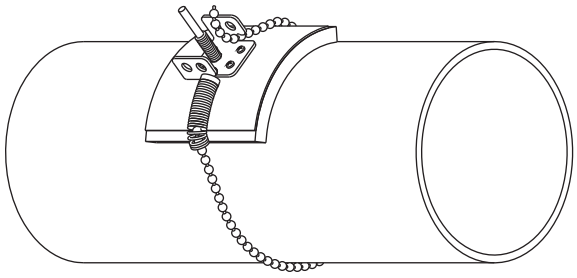
Connection

	temperature probe	extension cable	connector pin	
	red	black	2	
	red/blue	green	6	
	white/blue	white	1	
	white	red	7	

Cable

		temperature probe	extension cable
type		4 x 0.22 mm^2	4 x 18 AWG
standard length	ft	9	-
max. length	ft	-	656
ambient temperature	°F	-58 to +482	
min. bend radius	in	1.06	
cable jacket			
material		PFA	LS PVC
outer diameter	in	0.15 ±0.01	
color		black	

Fixation

tension strap PT13N 	material: stainless steel 301, 410 thermal insulation necessary
ball chain PT13F 	material: stainless steel 316L length: 3 ft

Wall thickness measurement (optional)

The pipe wall thickness is an important pipe parameter which has to be determined exactly for a good measurement. However, the pipe wall thickness often is unknown.

The wall thickness probe can be connected to the transmitter instead of the flow transducers and the wall thickness measurement mode is activated automatically.

Acoustic coupling compound is applied to the wall thickness probe which then is placed firmly on the pipe. The wall thickness is displayed and can be stored directly in the transmitter.

Technical data

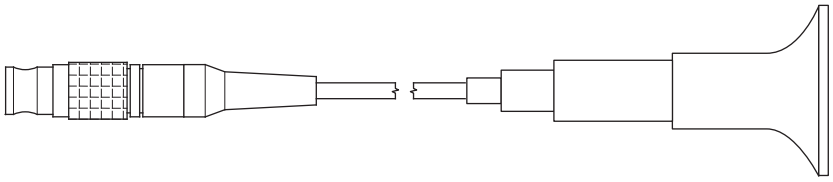
		DWR1NZ7
order code		ACC-PO-G601-/W6
measuring range[1]	in	0.04 to 9.8
resolution	in	0.0004
accuracy		1 % ±0.004 in
fluid temperature	°F	-4 to +392, short-time peak max. 932
cable		
type		2616
length	ft	4

[1] The measuring range depends on the attenuation of the ultrasonic signal in the pipe. For strongly attenuating plastics (e.g., PFA, PTFE, PP) the measuring range is smaller.

Cable

		2616
ambient temperature	°F	<392
cable jacket		
material		FEP
outer diameter	in	0.2
color		black
shield		x

DWR1NZ7



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2022-06-16, TSFLUXUS_F601V2-4-3US_Lus

Connection of the Transducers to the Transmitter FLUXUS *60x

Attention!	Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS_608).

Installation of the Transmitter

Note!	The recommended distances to disturbance sources have to be observed when selecting the measuring point (see chapter "Selection of the Measuring Point" in the operating instruction).

Place the transmitter within cable reach of the measuring point.
Use an extension cable, if necessary.

placement

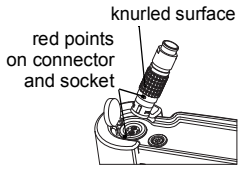
installation on a pipe

hanging

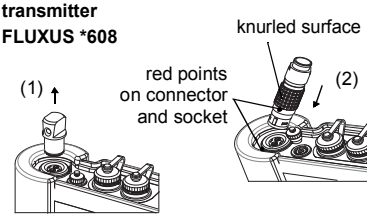
Connection of the Transducers

The red point on the connector must align with the red marking on the socket. Remove the connector by pulling at the knurled surface.

transmitter FLUXUS *601



transmitter FLUXUS *608



Keyboard Layout

- switch on transmitter: key C
- vertical selection: key 2 and 8
- horizontal selection: key 4 and 6
- return to main menu: key BRK
- delete: key C
- switch off transmitter: 3x key BRK

Parameter Input

```
>PAR< mea opt sf
Parameter
```

Select the program branch. ↵

```
Parameter          ↕
for Channel       A:
```

Select the measuring channel. ↵

```
Outer Diameter
       100.0       mm
```

Enter the outer pipe diameter. ↵

```
Wall Thickness
        3.0        mm
```

Enter the pipe wall thickness. ↵

```
Pipe Material      ↕
Carbon Steel
```

Select the pipe material. ↵

```
Lining
 >NO<              yes
```

Is pipe lining present? ↵

```
Roughness
        0.4        mm
```

Enter the roughness. ↵

```
Medium             ↕
Water
```

Select the medium. ↵

```
Medium Temperat.
       20.0         C
```

Enter the temperature. ↵

```
>PAR< mea opt sf
Parameter
```

Return to the main menu.

Output Options

```
par mea >OPT< sf
Output Options
```

Select the program branch. ↵

```
Output Options      ↕
for Channel        A:
```

Select the measuring channel. ↵

```
Physic. Quant.      ↕
Volume flow
```

Select the physical quantity.

```
Volume in:          ↕
m3/h
```

Select the measurement unit. ↵

Press ENTER unil the following display is indicated:

```
Store Meas.Data
no                >YES<
```

Store measured values? ↵

```
Serial Output
>NO<               yes
```

Output via serial interface? ↵

```
Storage Rate        ↕
Once per 10 sec.
```

Select the storage rate. ↵

```
Current Loop
I1: >NO<           yes
```

Activate or deactivate the output. ↵

```
par mea >OPT< sf
Output Options
```

Return to the main menu.

Measuring

```
par >MEA< opt sf
Measuring
```

Select the program branch. ↵

```
CHANN: >A< B Y Z
MEASUR  ✓  . - .
```

Select and activate the measuring channel. ↵

```
A: Sound Path
        2          NUM
```

Confirm the value.

```
Transd. Distance
A:53.9 mm Reflex
```

The recommended transducer distance is indicated. ↵

Mount the transducers on the pipe (see "Notes on the Transducer Mounting" on the right side).

```
S=■■■■■■
A:■<    >■=54mm
```

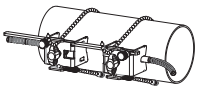
Shift the transducers until the LED lights green. ↵

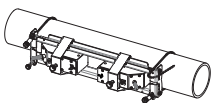
```
Transd. Distance
        54 mm
```

Measure and enter the adjusted transducer distance. ↵

```
A: Volume flow
        31.82     m3/h
```

Measurement





Measuring Channel

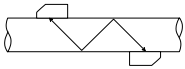
√ : measuring channel is activated
– : measuring channel is deactivated
· : no parameters

select measuring channel: key 4 and 6
activate measuring channel: key 2 and 8

Sound Path

- sound path (even number):
The transducers are mounted on the same side of the pipe.

- sound path (odd number):
The transducers are mounted on opposite sides of the pipe.

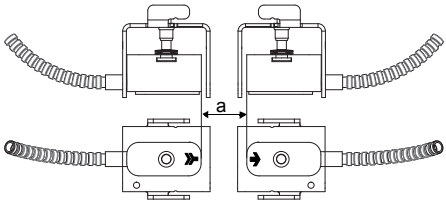


Notes on the Transducer Mounting

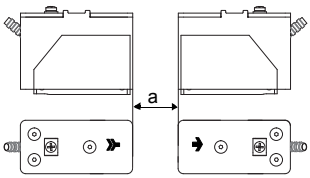
- Observe the recommended distance between the measuring point and the disturbance point.
- Clean the pipe.
- Use coupling foil or apply coupling compound.
- Mount the transducers on the pipe at the recommended transducer distance (see fig. below).
- Fix the transducers on the sides of the pipe, if possible.
- When the transducers are mounted correctly, the engravings on the transducers form an arrow (see fig. below).

Transducer Distance a

- Transducers for the connection to the transmitter FLUXUS *601 (in the fastening shoe):



- Transducers for the connection to the transmitter FLUXUS *608:



Operating instruction

FLUXUS F60x

UMFLUXUS_F60xV5-3EN

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Operating instruction for
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1 Introduction

This operating instruction has been written for users operating the ultrasonic flowmeter FLUXUS. It contains important information about the measuring equipment, how to handle it correctly, and how to avoid damages. Read the safety instructions carefully. Make sure you have read and understood this operating instruction before using the measuring equipment.

Any work on the measuring equipment has to be carried out by authorized and qualified personnel in order to detect and avoid possible risks and dangers.

Presentation of warnings

This operating instruction contains warnings marked as follows:

Danger!

Type and source of danger

danger with high level of risk, which if not avoided, can lead to death or serious injuries

→ measures of prevention

Warning!

Type and source of danger

danger with medium level of risk, which if not avoided, can lead to death or serious injuries

→ measures of prevention

Caution!

Type and source of danger

danger with low level of risk, which if not avoided, can lead to minor or moderate injuries

→ measures of prevention

Important!

This text contains important information which should be observed to avoid material damage.

Notice!

This text contains important information about the handling of the measuring equipment.

Storage of the operational manual

The operating instruction must permanently be available at the place where the measuring equipment is used. It must always be available to the user.

User comments

All reasonable effort has been made to ensure the correctness of the content of this operating instruction. If you however find some erroneous information or miss information, please inform us.

We will be grateful for any suggestions and comments regarding the concept and your experience working with the measuring equipment. If you have any suggestions about improving the documentation and particularly this operating instruction, please let us know so that we can consider your comments for future reprints.

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2 Safety instructions

2.1 General safety instructions

Prior to any work, read the operating instruction carefully and in full.

Failure to comply with the instructions, in particular with the safety instructions, poses a risk to health and can lead to material damages. For further information, contact FLEXIM.

During installation and operation of the measuring equipment, observe the ambient and installation conditions specified in the documentation.

Do not carry out any work on the measuring point during the operation and installation work must be concluded.

The measuring equipment has to be checked for proper condition and operational safety before each use. If troubles or damages have occurred during installation or operation of the measuring equipment, please inform FLEXIM.

It is not allowed to make unauthorized modifications or alterations to the measuring equipment.

The personnel has to be suitably trained and experienced for the work.

If the measuring point is within an explosive atmosphere, the danger zone and present explosive atmosphere have to be determined. The transmitter, transducers and accessories have to be appropriate and approved for the conditions within the corresponding zone.

Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608. Observe the instructions for hazardous substances and the respective safety data sheets. Observe the regulations for the disposal of electrical equipment.

2.2 Intended use

The measuring equipment is intended for the measurement of fluid properties in closed pipes. By means of connected transducers, the transit times of the ultrasonic signals in the fluid and the pipe as well as other related properties, such as temperature and pressure, are measured and evaluated.

The transmitter uses these values to calculate the sought physical quantities, e.g., volumetric flow rate, mass flow rate, thermal energy, density and concentration. Through comparison with the values stored in the transmitter further physical quantities can be determined. The physical quantities are provided via configurable outputs and the display.

- All instructions of this operating instruction have to be observed to ensure intended use.
- Any use beyond or other than the intended use is not covered by warranty and can present a danger. Any damage arising from not intended use shall be solely the liability of the operator or user.
- The measurement is carried out without direct contact to the fluid in the pipe. The flow profile is not influenced.
- The transducers are fixed to the pipe using the supplied transducer mounting fixture.
- Observe the operating conditions, e.g., environment, voltage ranges. For the technical data of the transmitter, transducers and accessories, see technical specification.

2.3 Not intended use

Not intended use in terms of a misuse means:

- any work on the measuring equipment without observing all instructions in this operating instruction
- use of transmitter, transducer and accessories combinations not intended by FLEXIM
- installation of the transmitter, transducers and accessories in explosive atmospheres they are not approved for
- any work on the measuring equipment (e.g., installation, dismounting, connection, start-up, operation, service and maintenance) carried out by unauthorized and untrained personnel
- storage, installation and operation of the measuring equipment outside the specified ambient conditions, see technical specification

2.4 Safety instructions for the user

Any work on the transmitter has to be carried out by authorized and qualified personnel. Observe the safety instructions in the operating instruction. For the technical data of the transmitter, transducers and accessories, see technical specification.

- Observe the safety and accident prevention regulations applicable on the site of operation.
- Only use the supplied mounting fixtures and transducers as well as the intended accessories.
- Always wear the required personal protective equipment.

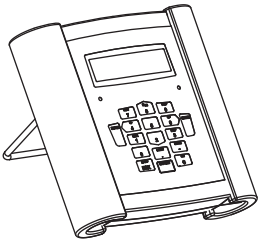
2.5 Safety instructions for the operator

- The operator shall qualify the personnel to perform their assigned tasks. The operator shall provide the required personal protective equipment and oblige the personnel to wear it. It is recommended to risk assess the workplace.
- Besides the safety instructions in this operating instruction, the health, safety and environment regulations applicable for the range of application of the transmitter, transducers and accessories have to be observed.
- With the exceptions stated in chapter 11, the measuring equipment is maintenance-free. Any components and spare parts may only be replaced by FLEXIM. The operator shall carry out periodic checks for changes or damages that can present a danger. For further information, contact FLEXIM.
- Observe the specifications for the installation and connection of the transmitter, transducers and accessories, see chapter 6 and 7.

2.6 Safety instructions for electrical work

- Electrical work may only be carried out if there is enough space.
- The degree of protection of the transmitter is only ensured if all unused connections are covered.
- Housing protection of measuring equipment or accessories with cable glands is only given if cable glands are firmly tighten and all cables fit tightly.
- The condition and tight fit of the electrical connections have to be checked at regular intervals.
- The power supply unit for charging the battery may only be connected to networks up to overvoltage category II. Use only the supplied power supply unit. For the power supply via power cable and power adapter, observe the safety instructions in chapter 7, sections 7.1.2 (FLUXUS *601) and 7.2.2 (FLUXUS *608).
- The transmitter and the power supply unit must not be disassembled, see Fig. 2.1. The transmitter does not contain any components to be maintained by the user. For repair and service work, please contact FLEXIM.
- Observe the safety and accident prevention regulations for electrical systems and equipment.

Fig. 2.1: Transmitter



2.7 Safety instructions for transport

- If you detect a transport damage when unpacking the delivery, please contact the supplier or FLEXIM immediately.
- The transmitter is a sensitive electronic measuring instrument. Avoid shocks or impacts.
- Handle the transducer cable with care. Avoid excessive bending or buckling. Observe the ambient conditions.
- Select a solid surface to put the transmitter, transducers and accessories on.
- The transmitter, transducers and accessories have to be properly packed for transport:
  - Use, if possible, the original packaging by FLEXIM or an equivalent cardboard box.
  - Position the transmitter, transducers and accessories in the middle of the cardboard box.
  - Fill any voids with appropriate packaging material (e.g., paper, foam, bubble wrap).
  - Protect the cardboard box against humidity.

2.8 Recommended procedure in hazardous situations

Fire fighting measures

- If possible, disconnect the transmitter from the power supply.
- Prior to extinguishing, protect any electrical parts that are not affected by the fire (e.g., using a cover).
- Select a suitable extinguishing agent. Avoid, if possible, conductive extinguishing agents.
- Observe the applicable minimum distances. The minimum distances differ depending on the used extinguishing agent.

3 General principles

In the ultrasonic flow measurement, the flow velocity of the fluid in a pipe is determined. Further physical quantities are derived from the flow velocity and from additional physical quantities, if necessary.

3.1 Measurement principle

The flow velocity of the fluid is measured in the TransitTime mode using the ultrasonic-transit time difference correlation principle. When measuring with a high proportion of gas or solid particles, the transmitter can toggle into the NoiseTrek mode.

3.1.1 Terms

Flow profile

Distribution of flow velocities over the cross-sectional pipe area. For an optimal measurement, the flow profile has to be fully developed and axisymmetrical. The shape of the flow profile depends on whether the flow is laminar or turbulent and is influenced by the conditions at the inlet of the measuring point.

Reynolds number Re

Coefficient describing the turbulence behavior of a fluid in the pipe. The Reynolds number Re is calculated from the flow velocity, the kinematic viscosity of the fluid and the inner pipe diameter.

If the Reynolds number exceeds a critical value (usually approx. 2300, if the fluid flows in a pipe), a transition from a laminar flow to a turbulent flow takes place.

Laminar flow

A flow without any turbulence. There is no mixing between the parallel flowing layers of the fluid.

Turbulent flow

A flow with turbulences (swirling of the fluid). In technical applications, the flow in the pipe is mostly turbulent.

Transition range

The flow is partly laminar and partly turbulent.

Sound speed c

Speed of the propagating sound. The sound speed depends on the mechanical properties of the fluid or the pipe material. In pipe materials and other solid materials, a distinction is made between the longitudinal and transversal sound speed. For the sound speed of some fluids and materials, see annex C.

Flow velocity v

Average value of all flow velocities of the fluid over the cross-sectional pipe area.

Acoustic calibration factor k_a

$$k_a = \frac{c_\alpha}{\sin\alpha}$$

The acoustic calibration factor k_a is a transducer parameter which results from the sound speed c within the transducer and the angle of incidence. According to Snell's law of refraction, the angle of propagation in the adjoining fluid or pipe material is:

$$k_a = \frac{c_\alpha}{\sin\alpha} = \frac{c_\beta}{\sin\beta} = \frac{c_\gamma}{\sin\gamma}$$

Fluid mechanics correction factor k_{Re}

With the fluid mechanics calibration factor k_{Re}, the measured value of the flow velocity in the area of the sound beam is converted into the value of the flow velocity across the whole cross-sectional pipe area. In case of a fully developed flow profile, the fluid mechanics calibration factor only depends on the Reynolds number and the roughness of the inner pipe wall. The fluid mechanics calibration factor is recalculated by the transmitter for each new measurement.

Volumetric flow rate $\dot{V}$

$$\dot{V} = v \cdot A$$

The volume of the fluid that passes through the pipe per unit time. The volumetric flow rate is calculated from the product of the flow velocity v and the cross-sectional pipe area A.

Mass flow rate $\dot{m}$

$$\dot{m} = \dot{V} \cdot \rho$$

The mass of the fluid that passes through the pipe per unit time. The mass flow rate is calculated from the product of the volumetric flow rate $\dot{V}$ and the density ρ.

Heat flow Φ

The heat quantity that is transferred per unit time. For the calculation of the heat flow see chapter 21.

3.1.2 Measurement of the flow velocity in the TransitTime mode

The signals are emitted and received by 2 transducers alternatively in and against the flow direction. If the fluid is flowing, the signals propagating in the fluid are displaced with the flow.

Caused by this displacement, the sound path of the signal in flow direction is reduced and the signal against the flow direction is increased, see Fig. 3.1 and Fig. 3.2.

This causes a change in the transit times. The transit time of the signal in flow direction is shorter than the transit time against the flow direction. The transit time difference is proportional to the average flow velocity.

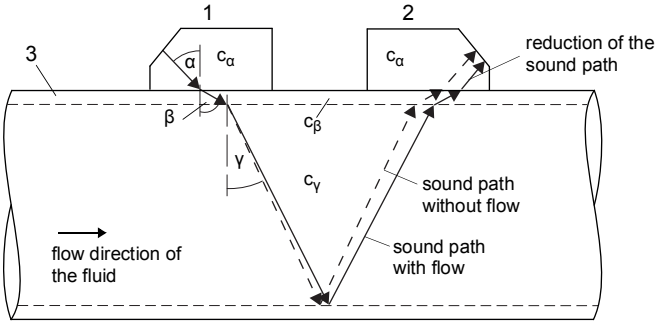
The average flow velocity of the fluid is calculated as follows:

$$v = k_{Re} \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_\gamma}$$

where

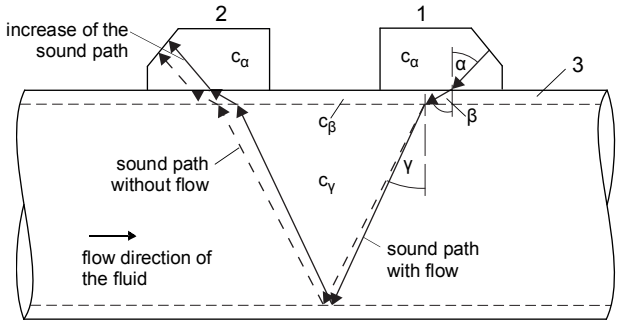
- v – average flow velocity of the fluid
- k_{Re} – fluid mechanics calibration factor
- k_a – acoustic calibration factor
- Δt – transit time difference
- t_γ – transit time in the fluid

Fig. 3.1: Sound path of the signal in the flow direction



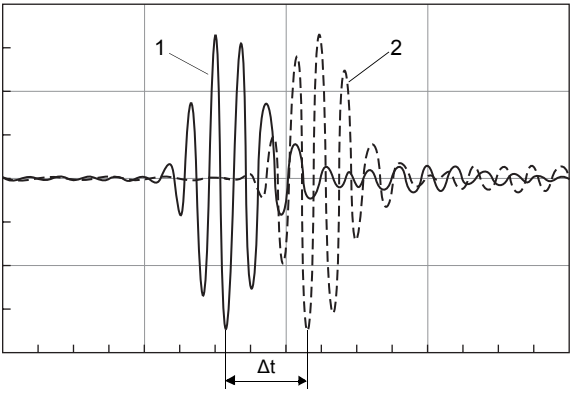
c – sound speed
1 – transducer (emitter)
2 – transducer (receiver)
3 – pipe wall

Fig. 3.2: Sound path of the signal against the flow direction



c – sound speed
1 – transducer (emitter)
2 – transducer (receiver)
3 – pipe wall

Fig. 3.3: Transit time difference Δt



1 – signal in the flow direction
2 – signal against the flow direction

3.1.3 Measurement of the flow velocity in the NoiseTrek mode

If the proportion of gas or solids in the fluid is high, the damping of the ultrasonic signal can be so high that the complete propagation of the fluid and therefore a measurement in TransitTime mode is not possible anymore. In this case the NoiseTrek mode has to be used.

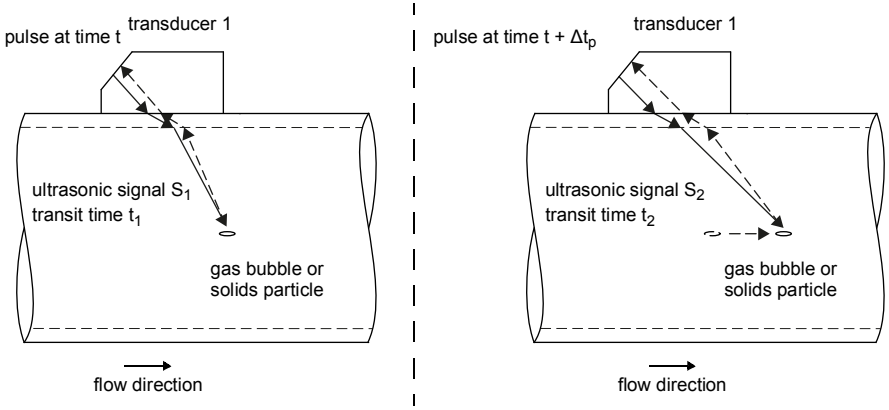
The NoiseTrek mode uses the presence of gas bubbles and/or solid particles in the fluid.

Ultrasonic signals are sent from a transducer into the fluid at short intervals, reflected by the gas bubbles and/or the solids particles and again received by the same transducer.

The measurement arrangement used in the TransitTime mode does not need to be changed.

The transit time difference Δt of 2 consecutive ultrasonic signals is determined. It behaves proportionately to the distance the gas bubble/solid particle is covering between 2 consecutive pulses and thus, to the average flow velocity of the fluid, see Fig. 3.4.

Fig. 3.4: Measurement of the flow velocity in the NoiseTrek mode



The average flow velocity of the fluid is calculated as follows:

$$v = k_{Re} \cdot k_a \cdot \frac{\Delta t}{2 \cdot \Delta t_p}$$

where

- v – average flow velocity of the fluid
- k_{Re} – fluid mechanics calibration factor
- k_a – acoustic calibration factor
- Δt_p – time difference between 2 consecutive pulses
- Δt – transit time difference of ultrasonic signals S_1 and S_2 ($\Delta t = t_2 - t_1$)

Depending on the attenuation of the ultrasonic signal, the error of measurement in the NoiseTrek mode can be greater than in the TransitTime mode.

3.1.4 Measurement of the flow velocity in the HybridTrek mode

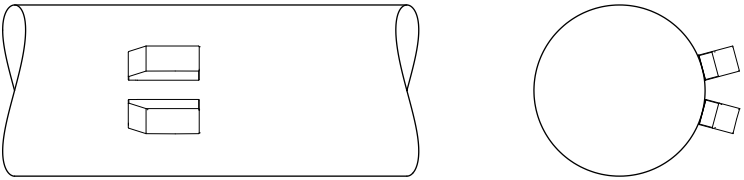
The HybridTrek mode combines the TransitTime and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime and the NoiseTrek mode depending on the gaseous or solid content. The measurement arrangement is identical to the one in the TransitTime mode.

3.1.5 Measurement of the flow velocity in the NoiseTrek parallel beam mode

Pipes with a small pipe diameter or fluids which strongly attenuate the ultrasonic signal can cause a reduction of the transit time in the fluid with the result that the signal quality is no longer sufficient. In this case the NoiseTrek parallel beam mode has to be used.

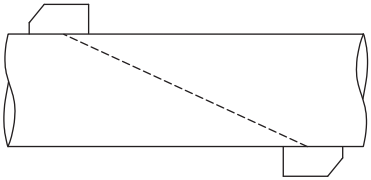
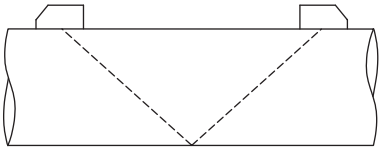
The NoiseTrek parallel beam mode works the same way the NoiseTrek mode does, the only difference is that the sending and receiving process do not occur in the same transducer. This leads to a better signal quality. The transducers are mounted in parallel on the pipe at a small distance, see Fig. 3.5. A measurement in TransitTime mode is not possible when working with this measurement arrangement.

Fig. 3.5: Measurement arrangement in the NoiseTrek parallel beam mode



3.2 Measurement arrangements

3.2.1 Terms

diagonal arrangement	reflection arrangement
The transducers are mounted on opposite sides of the pipe.	The transducers are mounted on the same side of the pipe.
	

Sound path

The distance covered by the ultrasonic signal after crossing the pipe once. The number of the sound paths is:

- odd if the measurement is carried out in diagonal arrangement
- even if the measurement is carried out in reflection arrangement

Beam

The path covered by the ultrasonic signal between the transducers, i.e., the transducer emitting the ultrasonic signal and the transducer receiving it. One beam consists of 1 or several sound paths.

Fig. 3.6: Diagonal arrangement with 2 beams and 3 sound paths

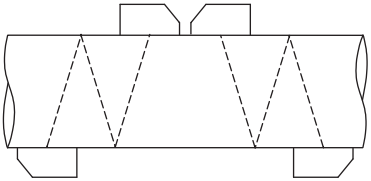
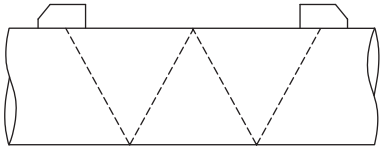


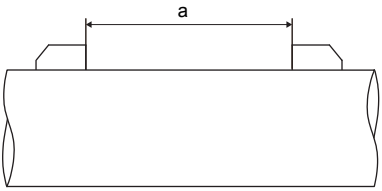
Fig. 3.7: Reflection arrangement with 1 beam and 4 sound paths



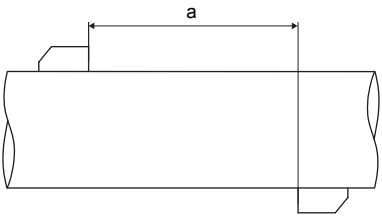
Transducer distance

The transducer distance is measured between the inner edges of the transducers.

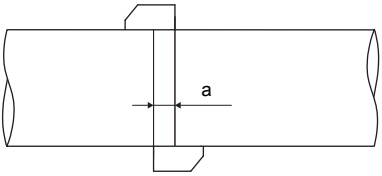
reflection arrangement



diagonal arrangement
(positive transducer distance)



diagonal arrangement
(negative transducer distance)



a – transducer distance

Sound beam plane

Plane containing 1 or several sound paths or beams

Fig. 3.8: 2 beams in 1 plane

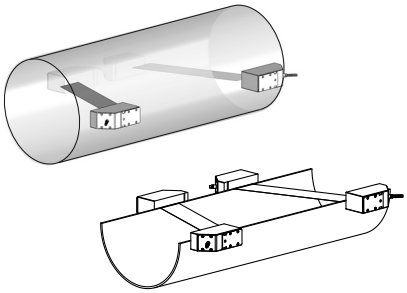
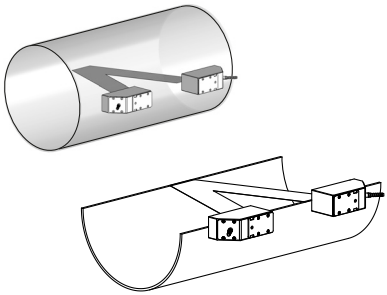
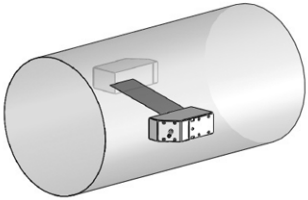
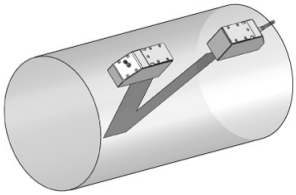
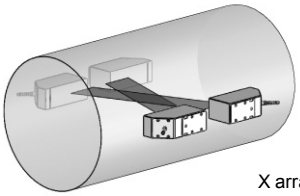
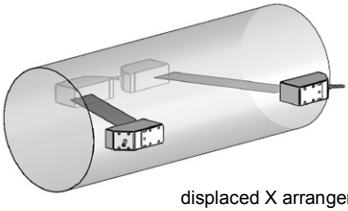
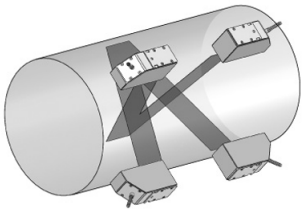


Fig. 3.9: 2 sound paths in 1 plane



3.2.2 Examples

diagonal arrangement with 1 beam	reflection arrangement with 1 beam
1 transducer pair 1 sound path 1 beam 1 plane 	1 transducer pair 2 sound paths 1 beam 1 plane 
diagonal arrangement with 2 beams	**reflection arrangement with 2 beams and 2 planes**
2 transducer pairs 2 sound paths 2 beams 1 plane  X arrangement  displaced X arrangement	2 transducer pairs 4 sound paths 2 beams 2 planes 

3.3 Acoustic penetration

The pipe has to be acoustically penetrable at the measuring point. The acoustic penetration is given when pipe and fluid do not attenuate the sound signal so strongly that it is completely absorbed before reaching the second transducer.

The attenuation caused by the pipe and the fluid depends on:

- kinematic viscosity of the fluid
- proportion of gas bubbles and solids in the fluid
- deposits on the inner pipe wall
- pipe material

The following requirements have to be met at the measuring point:

- the pipe is always completely filled
- no solid deposits in the pipe
- no bubble formation in the pipe

Notice!

Even bubble-free fluids can form gas bubbles when the fluid expands, e.g., before pumps and after great cross-section extensions.

Observe the following notes on the selection of the measuring point:

Horizontal pipe

Select a measuring point where the transducers can be mounted laterally on the pipe, allowing the sound waves to propagate horizontally in the pipe. Thus, solids on the bottom of the pipe or gas bubbles in the pipe's upper part are prevented from influencing the propagation of the signal, see Fig. 3.10 and Fig. 3.11.

Fig. 3.10: Recommended transducer mounting position

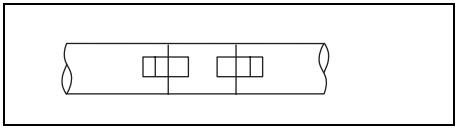
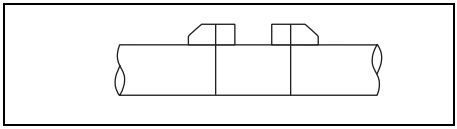


Fig. 3.11: Disadvantageous transducer mounting position



Vertical pipe

Select the measuring point at a pipe location where the fluid flows upward. The pipe has to be completely filled, see Fig. 3.12 and Fig. 3.13.

Fig. 3.12: Recommended transducer mounting position

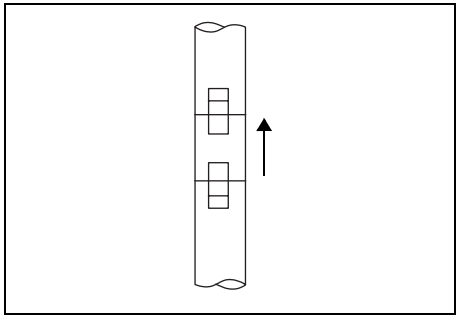
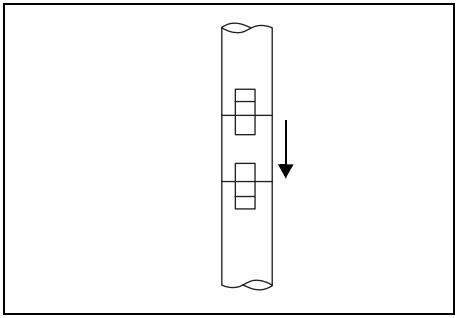


Fig. 3.13: Disadvantageous transducer mounting position



Free inlet or outlet pipe section

Select the measuring point at a pipe section where the pipe cannot run empty, see Fig. 3.14 and Fig. 3.15.

Fig. 3.14: Recommended transducer mounting position

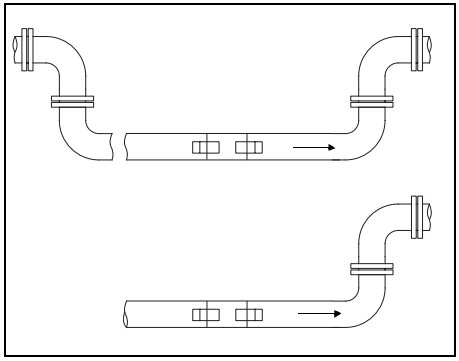
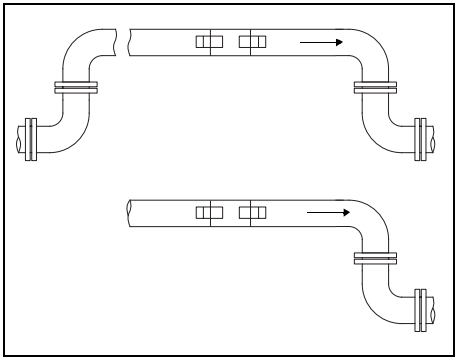


Fig. 3.15: Disadvantageous transducer mounting position



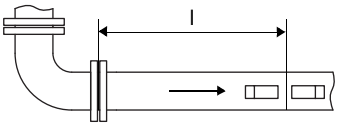
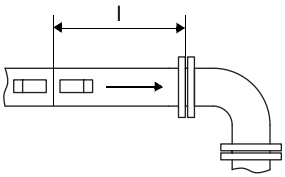
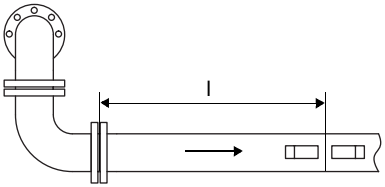
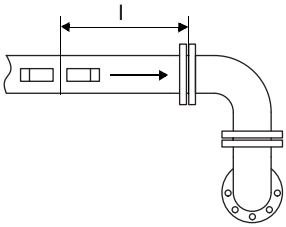
3.4 Undisturbed flow profile

Some flow elements (e.g., elbows, valves, pumps, reducers) distort the flow profile in their vicinity. The axisymmetrical flow profile in the pipe needed for correct measurement is no longer given. A careful selection of the measuring point helps to reduce the impact of disturbance sources.

It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources cannot be met for practical reasons.

The recommended straight inlet and outlet pipe lengths for different types of flow disturbance sources are shown in the examples in Tab. 3.1.

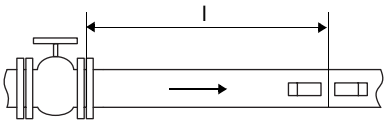
Tab. 3.1: Recommended distance from disturbance sources
D – nominal pipe diameter at the measuring point
l – recommended distance between disturbance source and transducer position

disturbance source: 90° elbow	
inlet: l ≥ 10 D	outlet: l ≥ 5 D
	
disturbance source: 2 × 90° elbows on different planes	
inlet: l ≥ 40 D	outlet: l ≥ 5 D
	

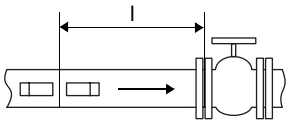
Tab. 3.1: Recommended distance from disturbance sources
D – nominal pipe diameter at the measuring point
l – recommended distance between disturbance source and transducer position

disturbance source: valve

inlet: l ≥ 40 D

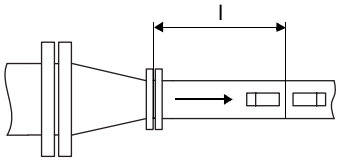


outlet: l ≥ 5 D

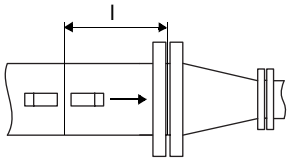


disturbance source: reducer

inlet: l ≥ 10 D

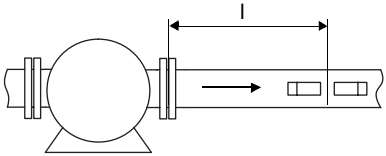


outlet: l ≥ 5 D



disturbance source: pump

inlet: l ≥ 20 D

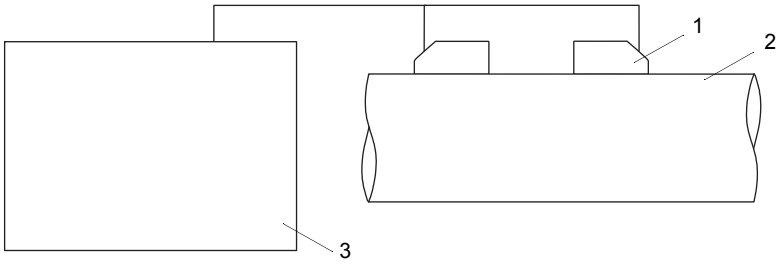


4 Product description

4.1 Measuring system

The measurement system consists of a transmitter, the ultrasonic transducers and the pipe on which the measurement is carried out, see Fig. 4.1.

Fig. 4.1: Example for a measurement arrangement



1 – transducer
2 – pipe
3 – transmitter

The ultrasonic transducers are mounted on the pipe. They send and receive ultrasonic signals through the fluid.

The transmitter controls the measuring cycle, eliminates noise signals and analyzes useful signals. The measured values can be displayed, used for calculations and transmitted by the transmitter.

4.2 Handling concept

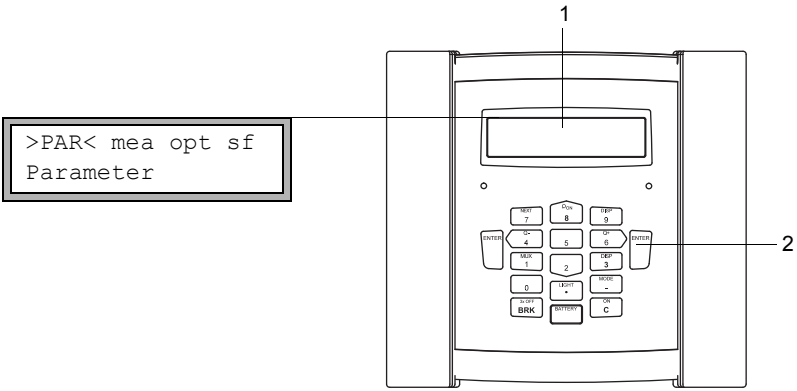
The transmitter is operated via the keyboard.

The selected program branch is displayed in angle brackets and capital letters, see Fig. 4.2. The complete name of the selected program branch is displayed in the lower line.

Select a program branch with key 〈4〉 and 〈6〉. Press ENTER.

- `par` (`Parameter`)
- `mea` (`Measuring`)
- `opt` (`Output Options`)
- `sf` (`Special Funct.`)

Fig. 4.2: Command panel of the transmitter



1 – display
2 – keyboard

For a description of the individual program branches, see Tab. 4.1.

Tab. 4.1: Description of the program branches

program branch	description
`Parameter`	Before starting a measurement, the transducer, pipe and fluid parameters have to be entered in the program branch `Parameter`.
`Measuring`	After activating the measuring channels and the input of the transducer distance, the measurement is started in the program branch `Measuring`.
`Output Options`	Channel-related settings such as determination of the physical quantity, unit of measurement and parameters for the transmission of measured values are set in the program branch `Output Options`.
`Special Funct.`	Includes global settings which are not directly related to the measurement.

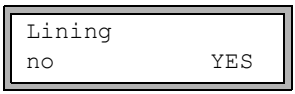
4.3 Navigation

4.3.1 Scroll lists

If a vertical arrow ↕ is displayed, the menu item contains a scroll list. The current list item is displayed in the lower line.

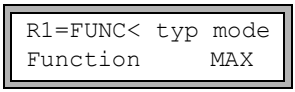
- Press key 8 and 2 to scroll and select a list item in the lower line.
- Press ENTER.

Some menu item contain a horizontal scroll list in the lower line. The selected list item is displayed in angle brackets and capital letters.



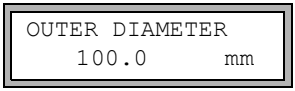
- Press key 4 and 6 to scroll and select a list item in the lower line.
- Press ENTER.

Some menu items contain a horizontal scroll list in the upper line. The selected list item is displayed in angle brackets and capital letters. The current value of the list item is displayed in the lower line.



- Press key 4 and 6 to scroll and select a list item in the upper line.
- Press key 8 and 2 to scroll and to select a value for the selected list item in the lower line.
- Press ENTER.

4.3.2 Input fields



- Enter a value via the numerical keys of the keyboard, see Tab. 4.4.
- Press ENTER.

4.4 Keyboard

The keyboard has 15 keys, including 3 function keys: ENTER, BRK and C.

Some key have multiple functions. They can be used to enter data, to navigate through scroll lists as well as to execute special functions (e.g., reset of totalizers).

Tab. 4.2: General functions

C	switching on the transmitter
LIGHT	switching on/off the display backlight
ENTER	confirmation of selection or input
BRK + C + ENTER	Reset: press these 3 keys simultaneously to correct a malfunction. The reset has the same effect as a restart of the transmitter. Stored data are not affected.
BRK	interruption of the measurement and selection of the main menu Be careful not to stop a current measurement by inadvertently pressing key BRK.
BRK	switching off the transmitter by pressing key BRK 3 times

Tab. 4.3: Navigation

BRK	selection of the main menu
4 6	scroll to the left/right through a scroll list
8 2	scroll upwards/downwards through a scroll list
ENTER	confirmation of a menu item of the program branch

Tab. 4.4: Input of numbers

0 … 9	input of the number pictured on the key
–	sign for the input of negative values
.	decimal marker
C	deletion of values After the value has been deleted, the previous value will be displayed.
ENTER	confirmation of the input

Tab. 4.5: Input of text

4 6	positioning of the cursor
9	"A" is displayed and capitalization is activated
3	"Z" is displayed and capitalization is activated
5	toggling between upper and lower case
8 2	selection of the previous/next character
0	deletion of a character and insertion of a blank
7 1	Automatic scrolling up or down through the limited ASCII character set. The character changes every second. The scrolling is stopped by pressing any other key.
ENTER	confirmation of the input

5 Transport and storage

Caution!

When packaging, the transmitter can fall down.

There is a danger of crushing body parts or damaging the measuring equipment.

→ Secure the transmitter against falling during packaging.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

Caution!

When lifting, the center of gravity of the transmitter can be displaced within the cardboard box. The transmitter can fall down.

There is a danger of crushing body parts or damaging the measuring equipment.

→ Secure the transmitter against falling during transport.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

5.1 Transport

The measuring equipment must be packaged properly for transport, see section 2.7. For weight indications of the transmitter and the transducers, see technical specification.

5.2 Storage

The transmitter and the transducers have to be stored in a dry place.

6 Installation

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

Caution!

Touching hot or cold surfaces

This may result in injuries (e.g., thermal damages).

→ Observe the ambient conditions at the measuring point during installation.

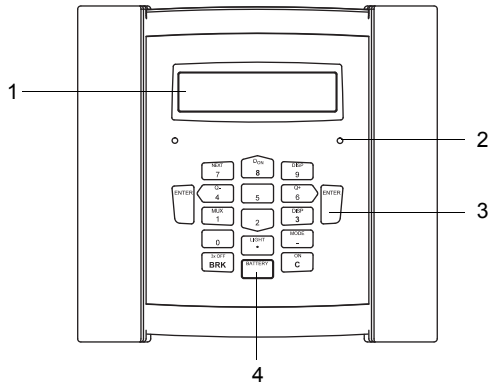
→ Wear the required personal protective equipment.

→ Observe the applicable rules.

6.1 Transmitter

6.1.1 Transmitter structure

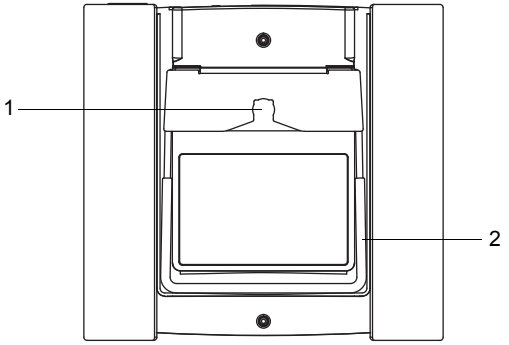
Fig. 6.1: Command panel of the transmitter



1 – display, 2 × 16-digit (backlight)
2 – status indication "SIGNAL"
3 – keyboard
4 – state indicator "BATTERY"

A handle is mounted on the rear side of the transmitter, see Fig. 6.2. The handle can also be used as support. The opening in the support plate is used to fasten the transmitter to the pipe, see section 6.1.2.3.

Fig. 6.2: Rear side of the transmitter



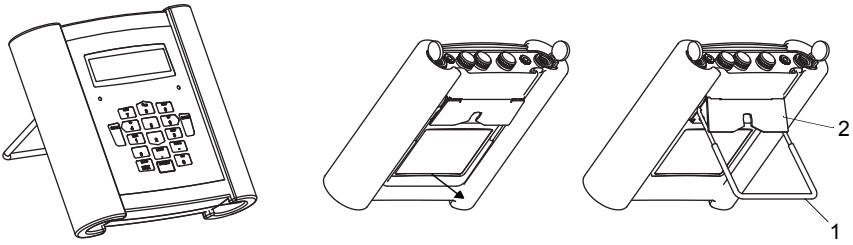
1 – opening in the support plate for button
2 – handle/support

6.1.2 Installation of the transmitter

6.1.2.1 Placement

Pull the support back to the stop of the support plate, see Fig. 6.3.

Fig. 6.3: Placement of the transmitter

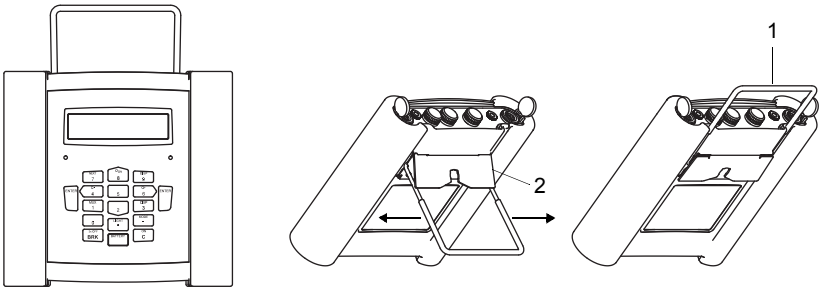


1 – handle
2 – support plate

6.1.2.2 Suspension

Press both ends of the handle outwards and pass them past the support plate. Turn the handle upwards.

Fig. 6.4: Suspension of the transmitter



1 – handle
2 – support plate

6.1.2.3 Pipe installation

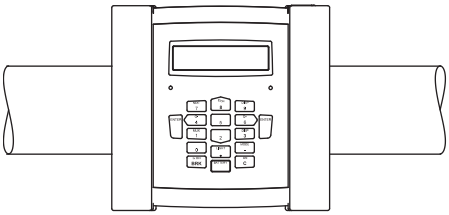
Important!
The pipe temperature must not exceed the operating temperature of the transmitter.

Fix the tension belt with the button to the pipe. Tighten the belt using the ratchet. Insert the button into the opening in the support plate on the rear side of the transmitter, see Fig. 6.5 and Fig. 6.6.

Fig. 6.5: Pipe installation

1 – ratchet
2 – button on the pipe
3 – opening in the support plate

Fig. 6.6: Transmitter on the pipe



6.2 Transducers

6.2.1 Preparation

6.2.1.1 Measuring point selection

The correct selection of the measuring point is crucial for achieving reliable measurement results and a high measurement accuracy.

A measurement on a pipe is possible if:

• the ultrasound propagates with a sufficiently high amplitude

• the flow profile is fully developed

The correct selection of the measuring point and the correct transducer positioning guarantee that the sound signal will be received under optimum conditions and evaluated correctly.

Because of the variety of applications and the different factors that influence the measurement, there is no standard solution for the transducer positioning.

The measurement is influenced by the following factors:

– diameter, material, lining, wall thickness and shape of the pipe

– fluid

– gas bubbles in the fluid

• Avoid measuring points in the vicinity of distorted or defective areas of the pipe or in the vicinity of welds.

• Avoid measuring points with deposit formation in the pipe.

• Make sure the pipe surface at the selected measuring point is even.

• Select the location of the transmitter within the transducer cable range.

• The ambient temperature at the measuring point has to be within the operating temperature range of the transmitter and the transducers, see technical specification.

If the measuring point is within an explosive atmosphere, possibly present danger zones and gases have to be determined. The transducers and the transmitter have to be appropriate for these conditions.

6.2.1.2 Pipe preparation

Caution!

Contact with grinding dust

This may result in injuries (e.g., breathing difficulties, skin reactions, eye irritations).

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

Important!

The pipe has to be sufficiently stable to withstand the pressure exerted by the transducers and the tension straps.

Notice!

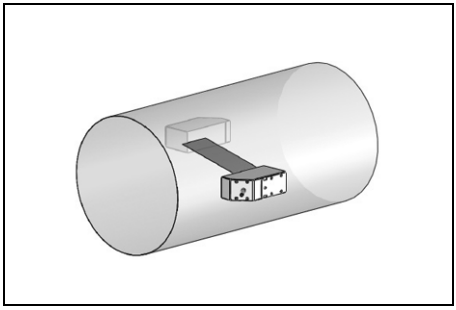
Observe the selection criteria of pipe and measuring point.

Rust, paint or deposits on the pipe absorb the sound signal. A good acoustic contact between the pipe and the transducers is obtained as follows:

- Clean the pipe at the selected measuring point.
  - If present, the paint layer has to be smoothed by grinding. The paint does not need to be removed completely.
  - Remove rust or loose paint.
- Use coupling foil or apply a bead of acoustic coupling compound along the center line of the contact surface of the transducers.
- Observe that there must be no air pockets between the transducer contact surface and the pipe wall.

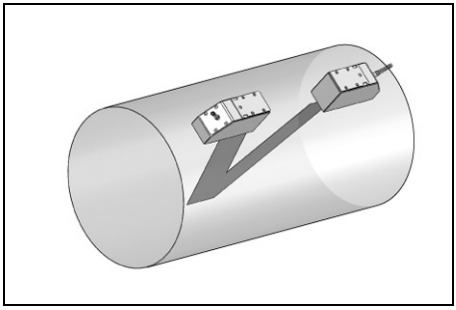
6.2.1.3 Selection of the measurement arrangement

Diagonal arrangement with 1 beam



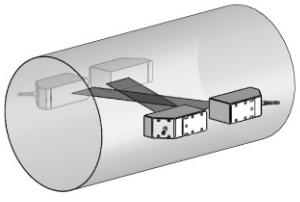
- wider flow velocity and sound speed range compared to the reflection arrangement
- use in the presence of deposits on the inner pipe wall or with strongly attenuating gases or liquids (only 1 sound path)

Reflection arrangement with 1 beam

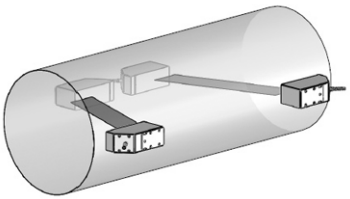


- smaller flow velocity and sound speed range compared to the diagonal arrangement
- transverse flow effects are compensated because the beam crosses the pipe in 2 directions
- higher accuracy of measurement because the accuracy increases with the number of sound paths

Diagonal arrangement with 2 beams



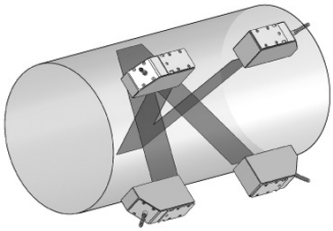
X arrangement



displaced X arrangement

- same characteristics as diagonal arrangement with 1 beam
- additional characteristic:
  transverse flow effects are compensated because the measurement is conducted with 2 beams

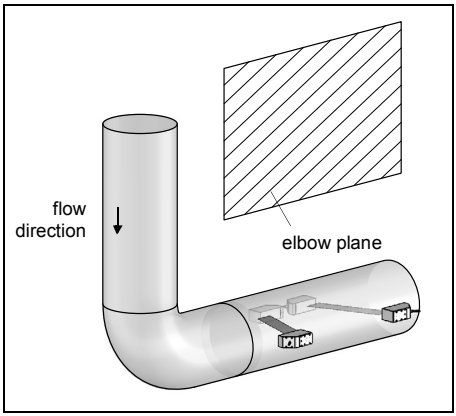
Reflection arrangement with 2 beams and 2 planes



- same characteristics as reflection arrangement with 1 beam
- additional characteristic:
  influences of the flow profile are compensated because the measurement takes place in 2 planes

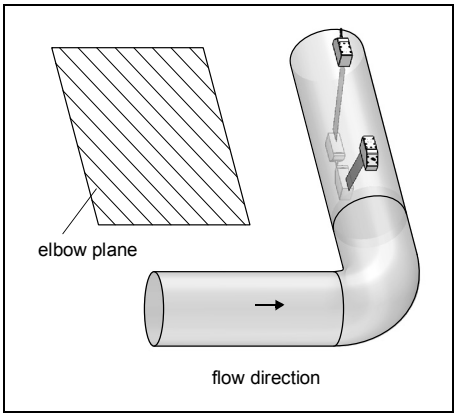
If the measuring point is situated near an elbow, the following measurement arrangements are recommended for the selection of the sound beam plane.

Vertical pipes



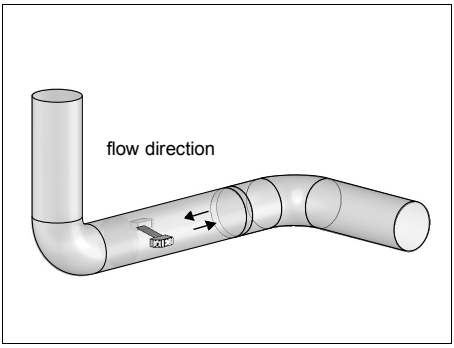
- The sound beam plan is selected in an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

Horizontal pipes



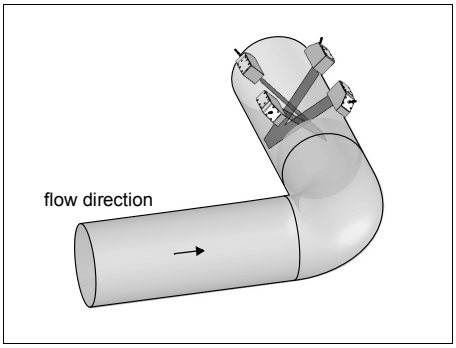
- The sound beam plane is selected in an angle of 90° ± 45° to the elbow plane. The elbow is upstream of the measuring point.

Bidirectional measurements



- The sound beam plane is selected according to the nearest elbow (horizontal or vertical, depending on the pipe orientation, see above).

Measurements in reflection arrangement with 2 beams and 2 planes



- The 2 sound beam planes are selected in an angle of 45° to the elbow plane. The elbow is upstream of the measuring point.
- On horizontal pipes, the transducers are mounted on the upper half of the pipe.

6.2.2 Installation of the transducers

Important!

Handle the transducers with care. Do not let the transducers hang on their cables.

Important!

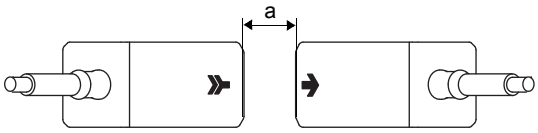
Handle the cables with care. Avoid excessive bending or buckling, especially at simultaneous strain.

6.2.2.1 Orientation of the transducers and determination of the transducer distance

Observe the orientation of the transducers. If the transducers have been mounted properly, the engravings on the transducers form an arrow, see Fig. 6.7. The transducer cables show in opposite directions.

The transducer distance is measured between the inner edges of the transducers.

Fig. 6.7: Orientation of the transducers and transducer distance



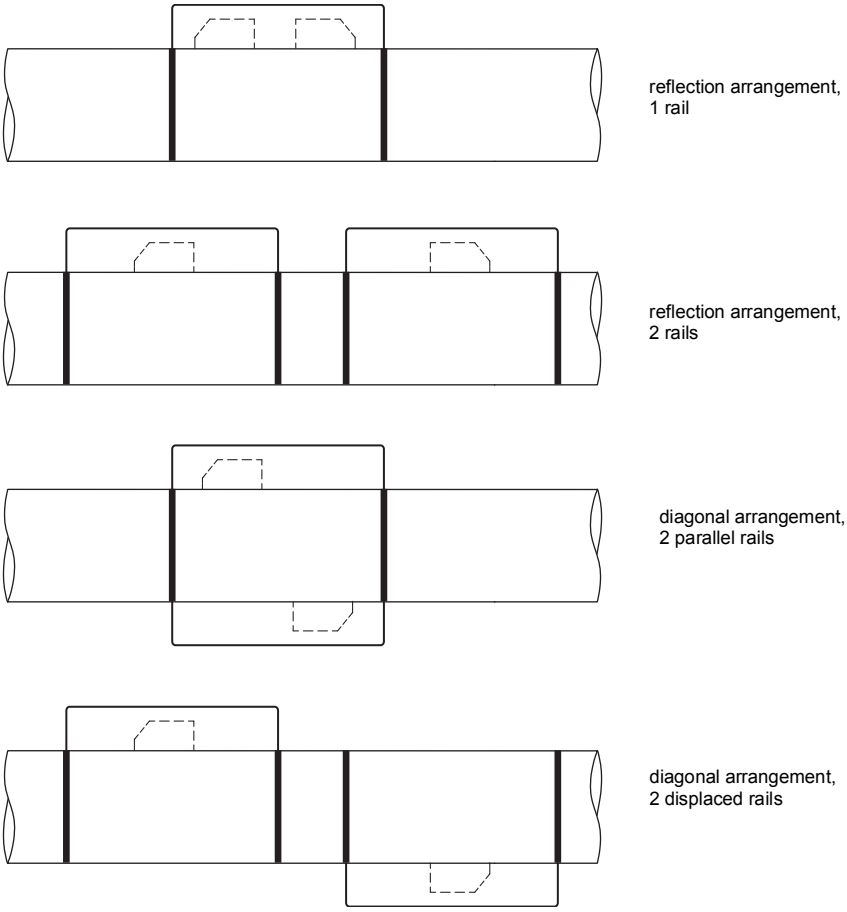
a – transducer distance

- Select the installation instructions that correspond to the supplied transducer mounting fixture.

6.2.2.2 Transducer arrangement

The transducer mounting with mounting rails can have various arrangements:

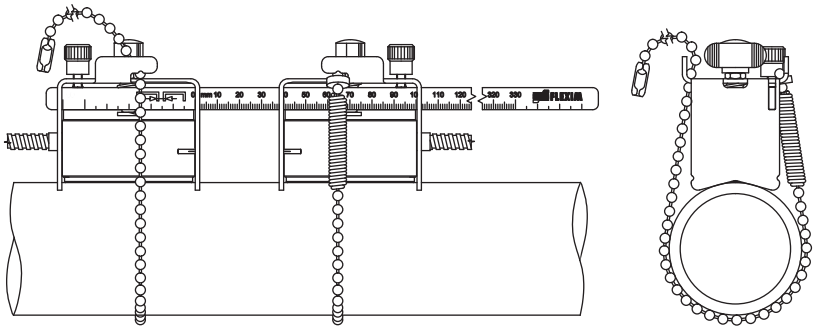
Fig. 6.8: Transducer arrangement in mounting rails



6.2.2.3 Installation of transducers with fastening shoes and chains

- Insert the transducers into the fastening shoes.
- Turn the screw on the upper side of the fastening shoes by 90° in order to engage and lock its extremity in the groove on top of the inserted transducer.
- Insert the ruler into the lateral slot of the fastening shoes.
- Adjust the displayed transducer distance, see section 9.3.
- Fix the transducers with the plastic screws on the transducer cable side of the fastening shoes.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point.
- Insert the last ball into the slot on the upper side of one of the fastening shoe.
- Place the chain around the pipe.
- Tighten the chain and insert it into the other slot of the fastening shoe.

Fig. 6.9: Installation of the transducers with fastening shoes and chains



Extension of the ball chain

In order to extend the chain, insert the last ball of the extension into the fastening clip of the ball chain. The spare fastening clips supplied with the chain can be used to repair a broken chain.

Notice!

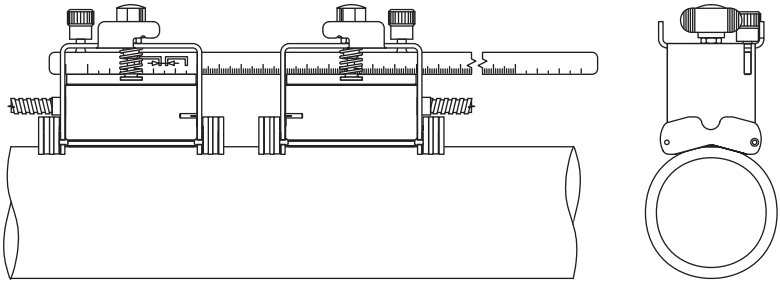
When using fastening shoes, the reflection arrangement is to be preferred. The ruler can be used as mounting aid.

In case the mounting has to be carried out in diagonal arrangement (without ruler), contact FLEXIM for further support.

6.2.2.4 Installation of the transducers with magnetic fastening shoes

- Insert the transducers into the fastening shoes.
- Turn the screw on the upper side of the fastening shoes by 90° in order to engage and lock its extremity in the groove on top of the inserted transducer.
- Apply some coupling compound to the contact surface of the transducers.
- Insert the ruler into the lateral slot of the fastening shoes.
- Adjust the displayed transducer distance, see section 9.3.
- Fix the transducers with the plastic screws on the transducer cable side of the fastening shoes.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point. There must be no air pockets between pipe wall and contact surface of the transducer.

Fig. 6.10: Installation of the transducers with magnetic fastening shoes



Notice!

When using fastening shoes, the reflection arrangement is to be preferred. The ruler can be used as mounting aid.

In case the mounting has to be carried out in diagonal arrangement (without ruler), contact FLEXIM for further support.

6.2.2.5 Installation of the transducers with portable Variofix rail and chains

Normally, each transducer is mounted in its own Variofix rail. If the transducer distance is small and both transducers are on the same side of the pipe (reflection arrangement), both transducers can be fixed in one Variofix rail.

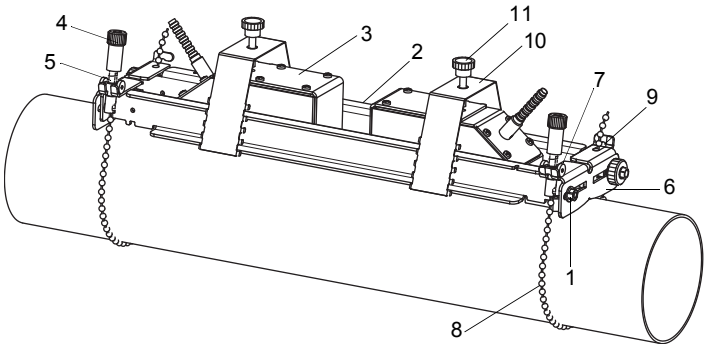
Installation of the Variofix rail

- Adjustment of the Variofix rail to transducer width:
  - Loosen the 4 screws (1) for the adjustment of the rails (2) with an M8 wrench, see Fig. 6.11.
  - Place one transducer (3) in the center of the rails.
  - Press the two rails (2) together and tighten the 4 screws (1). The transducer can be shifted and removed.
  - Remove the transducer.
- Loosen the chain tensioner (4), but do not unscrew it completely.
- If the chain has not been mounted in the rail support (6) yet:
  Compress the spring of the chain tensioner (4) with the cylinder (7) while pushing the chain tensioner (4) in the horizontal groove (5) of the rail support (6).
- Place the Variofix rail on the pipe. Both rail supports (6) have to be completely supported by the pipe.
- Lay the ball chain (8) around the pipe (if the pipe is vertical, start with the upper ball chain).
- Press the chain tensioner (4) inside completely and push the ball chain (8) into the other groove (9) of the rail support.
- Fix the second ball chain (8) in the same way.
- Tension the ball chains (8) by tightening the chain tensioners (4).
- Repeat the steps if the second transducer is fixed to its own Variofix rail.

Installation of the transducer

- Force the legs of the spring clip (10) apart and clamp it over the outer side of the rails (2). The height where the spring clip will snap in depends on the height of the transducer.
- Apply some coupling compound to the contact surface of the transducer.
- Place the transducer between the rails (2).
- Observe the mounting direction, see Fig. 6.11.
- Push the spring clip (10) over the transducer until the knurled screw (11) is positioned over the blind hole of the transducer.
- Fix the transducer by tightening the knurled screw by hand (11).
- Repeat the steps for fixing the second transducer.
- Adjust the transducer distance by loosening the knurled screw (11) of a spring clip (10) and shifting the transducer.

Fig. 6.11: Variofix rail with chains



1 – screw
2 – rail
3 – transducer
4 – chain tensioner
5 – horizontal groove
6 – rail support
7 – cylinder
8 – ball chain
9 – groove
10 – spring clip
11 – knurled screw

6.3 Temperature probe

6.3.1 Pipe preparation

Caution!

Contact with grinding dust

This may result in injuries (e.g., breathing difficulties, skin reactions, eye irritations).

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

Important!

The pipe has to be sufficiently stable to withstand the pressure exerted by the temperature probe.

Rust, paint or deposits on the pipe isolate the temperature at the measuring point. A good thermal contact between the pipe and the temperature probe is obtained as follows:

- Clean the pipe at the selected measuring point.
  - Remove any insulation material, rust or loose paint.
  - If present, the paint layer has to be smoothed by grinding. The paint does not need to be removed completely.
- Use coupling foil or apply a layer of thermal conductivity paste or coupling compound on the contact surface of the temperature probe.
- Observe the corresponding operating temperature range.
- Observe that there must be no air pockets between the contact surface of the temperature probe and the pipe wall.

6.3.2 Installation of the temperature probe (response time 50 s)

Notice!

The temperature probe has to be thermally insulated.

6.3.2.1 Installation with clasp

Caution!

The edge of the tension strap is very sharp.

Risk of injury!

→ Debur sharp edges.

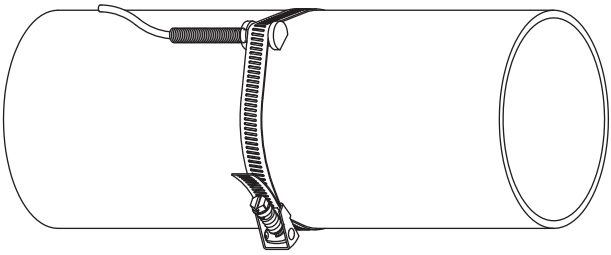
→ Wear the required personal protective equipment.

→ Observe the applicable rules.

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Make sure that part (2) of the clasp is on top of part (1), see Fig. 6.12 a. The hooks of part (2) have to be on the outer side of the clasp.
- Pull approx. 20 mm of the tension strap through the slot of the clasp to fix the clasp to the tension strap, see Fig. 6.12 b.
- Bend the end of the tension strap.
- Position the temperature probe on the pipe, see Fig. 6.13.
- Place the tension strap around the temperature probe and the pipe.
- Insert the tension strap through the parts (2) and (1) of the clasp.
- Tighten the tension strap and engage it in the inner hook of the clasp.
- Tighten the screw of the clasp.

Fig. 6.12: Clasp

Fig. 6.13: Temperature probe on the pipe



6.3.2.2 Installation with FLEXIM clasp

Caution!

The edge of the tension strap is very sharp.

Risk of injury!

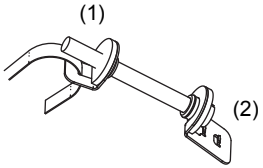
→ Debur sharp edges.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Insert approx. 20 mm of the tension strap into the slot of the clasp, see Fig. 6.14.
- Bend the end of the tension strap.
- Position the temperature probe on the pipe, see Fig. 6.13.
- Place the tension strap around the temperature probe and the pipe.
- Insert the tension strap through the parts (2) and (1) of the clasp.
- Pull the tension strap firmly and engage it in the inner hooks of the clasp.
- Tighten the screw of the clasp.

Fig. 6.14: FLEXIM clasp



6.3.2.3 Installation with quick release clasp

Caution!

The edge of the tension strap is very sharp.
Risk of injury!
→ Debur sharp edges.
→ Wear the required personal protective equipment.
→ Observe the applicable rules.

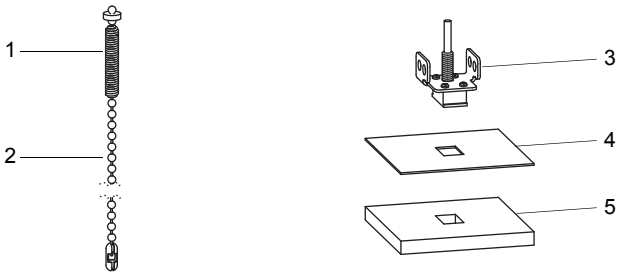
- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Position the temperature probe on the pipe, see Fig. 6.13.
- Place the tension strap around the temperature probe and the pipe.
- Insert the tension strap into the clasp, see Fig. 6.15.
- Tighten the tension strap.
- Tighten the screw of the clasp.

Fig. 6.15: Quick release clasp

6.3.3 Installation of the temperature probe (response time 8 s)

- Fix the protection plate and the insulation foam to the temperature probe, see Fig. 6.16.
- Take the spring end of the chain and insert the first ball into one of the slots on the upper side of the temperature probe, see Fig. 6.17.
- Place the chain around the pipe. Tighten the chain and insert it into the other slot of the temperature probe.

Fig. 6.16: Temperature probe

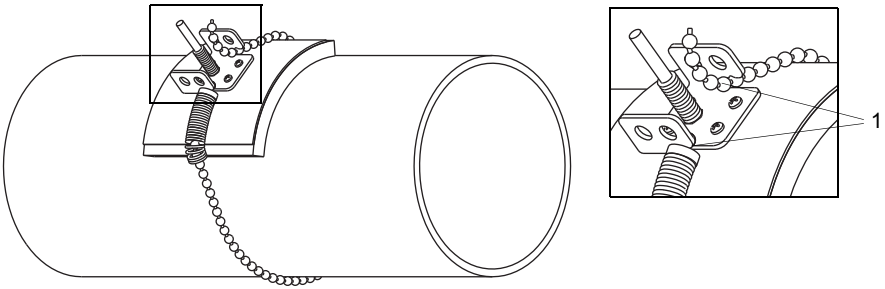


1 – spring end
2 – chain
3 – temperature probe
4 – protection plate
5 – insulation foam

Notice!

The entire contact surface of the temperature probe always has to rest on the pipe. In case of very small pipes, the protection plate and the insulation foam have to be cut to size, if necessary.

Fig. 6.17: Temperature probe on the pipe



1 – slots on the upper side of the temperature probe

7 Connection

7.1 FLUXUS *601

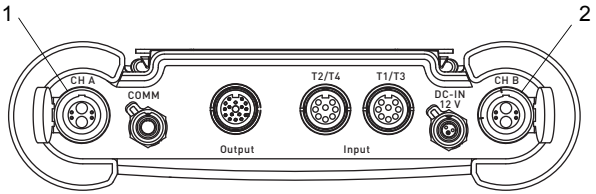
7.1.1 Transducers

It is recommended to run the cables from the measuring point to the transmitter before connecting the transducers to avoid load on the connectors.

The connections are on the upper side of the transmitter, see Fig. 7.1.

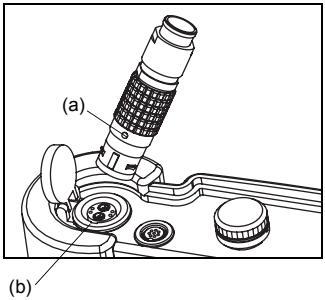
- Pull up the socket cover, see Fig. 7.2.
- Insert the connector of the transducer cable into the socket of the transmitter. The red point (a) on the connector has to be aligned with the red marking (b) on the socket.

Fig. 7.1: Connections on the transmitter



1 – transducers (measuring channel A)
2 – transducers (measuring channel B)

Fig. 7.2: Transducer connection



7.1.2 Power supply

The transmitter can be operated with the integrated battery, the power supply unit or the power pack PP026NN, see document QSPowerPack_PP026.

7.1.2.1 Battery operation

The transmitter has a Li-ion battery and can therefore be operated independently. When delivered, the battery is charged with approx. 30 %. The battery does not need to be fully charged before it is used for the first time.

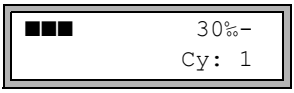
Notice!

The specified battery life, see technical specification, can only be reached if unused current output are uninstalled.

The battery charge can be displayed during the measurement, see section 9.4.3 and in the program branch `Special Funct.`:

```
Special Funct.\Battery status
```

- Select the menu item `Special Funct.\Battery status`.
- Press ENTER.



The current battery charge is displayed (here: 30 %).

The minus sign (`-`) indicates that the transmitter is in battery mode and is being discharged.

The number of cycles the battery has passed is displayed after `Cy`. A cycle corresponds to a charging and discharging process. The life time of the battery can be derived by means of this value.

If `RELEARN` is displayed in the lower line and a question mark (`?`) is displayed after the current battery charge, a relearn cycle has to be started, see section "Maintenance" (relearn cycle) on the following page.

This message will be displayed if the battery is almost empty:

```
LOW BATTERY !
```

The capacity is sufficient for the display and storing of the current parameter record. A measurement is impossible.

Charging the battery

Connect the power supply to the transmitter, see section 7.1.2.2. Switch on the transmitter. The charging starts automatically. The LED "BATTERY" flashes green while charging. The max. charging time is approx. 8 h.

During the charging process, the ambient temperature should be in the range of 0...45 °C.

A measurement can be made during the charging. Charging will be stopped automatically when the battery is fully charged. The LED "BATTERY" lights green then.

Notice!
The battery will only be charged if the transmitter is switched on.

Battery storage

The battery remains in the transmitter. After storage, the transmitter can immediately be operated with the battery.

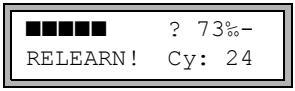
- battery charge: > 30 %
- storing temperature: 12...25 °C

Maintenance (relearn cycle)

The accuracy of the displayed value for the charge state of the battery is improved by executing a relearn cycle. The ambient temperature during a relearn cycle should be in the range of 12...30 °C.

```
Special Funct.\Battery status
```

- Select the menu item `Special Funct.\Battery status`.
- Press ENTER.



The charge state of the battery is displayed (here: 73 %).

The "`?`" and `RELEARN` indicate that the displayed charge state is not reliable. A relearn cycle is recommended.

- Charge the battery completely. The LED "BATTERY" lights green when charging is finished.
- Remove the power supply unit from the transmitter. Discharge the battery completely. In order to deactivate the automatic power-off during discharging, start a measurement. Discharging takes min. 14 h. The LED "BATTERY" will flash red afterwards.

Automatic power-off

In battery mode, the transmitter has an automatic power-off. The transmitter will be switched off if

• no measurement is being made and no key is pressed within 10 min or

• the battery is empty.

```
POWER OFF IN
      10      s
```

This message will be displayed before the transmitter is switched off automatically. A countdown with an acoustic signal will be started. The countdown can be stopped by pressing any key.

```
■ LOW BATTERY
WHILE POWER OFF
```

If this message is displayed when the transmitter is switched on, the transmitter has been switched off automatically due to a too low battery charge.

7.1.2.2 Power supply operation

Important!

→ Use only the supplied power supply unit.

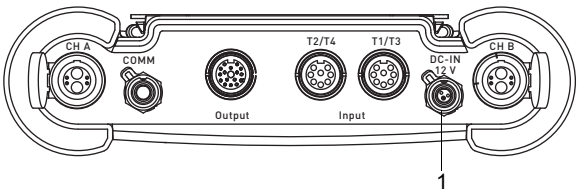
→ The power supply is not protected against moisture. Use it only in dry rooms.

→ The voltage indicated on the power supply unit must not be exceeded.

→ Do not connect a defective power supply unit to the transmitter.

• Connect the power supply unit to the socket on the upper side of the transmitter, see Fig. 7.3.

Fig. 7.3: Connection of the power supply unit to the transmitter



1 – power supply unit/battery charging unit

7.1.3 Outputs

Warning!

Danger in presence of conductive pollution

Open the box of the adapter in safe ambient conditions only (e.g., air humidity < 90 %, no conductive pollution, no explosive atmosphere).

Notice!

For the connection, observe the specifications regarding the assignment of the outputs given on the nameplate on the rear side of the transmitter.

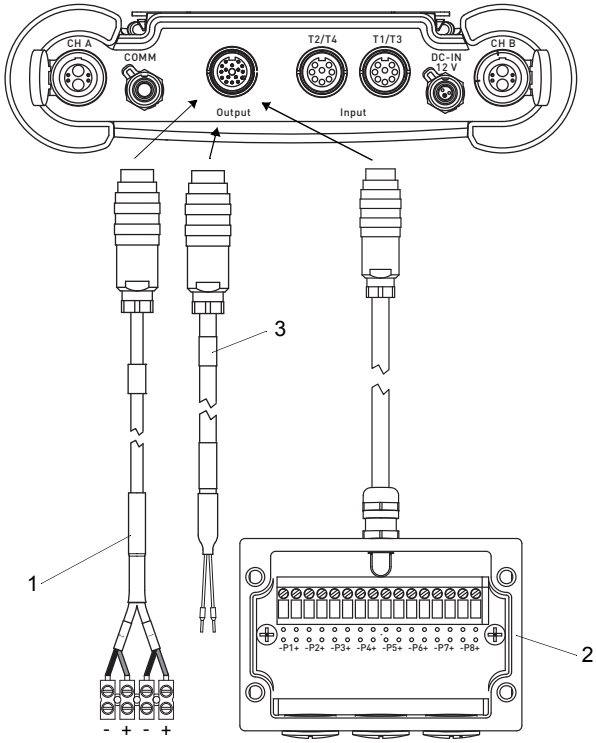
Important!

The max. voltage between the outputs and the internal power supply of the transmitter is 42 V DC (permanent).

Connection of an output adapter

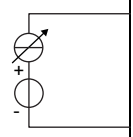
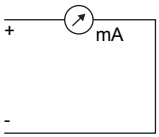
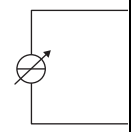
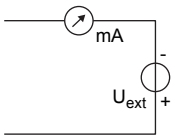
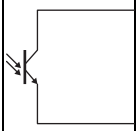
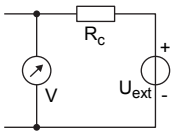
All available outputs are connected via the output adapter, see Fig. 7.4. For the connection of the outputs, see Fig. 7.4 and Tab. 7.1. If several outputs are required, the Modbus adapter or the output adapter can be used for 2 current outputs.

Fig. 7.4: Connection of the output adapter to the transmitter



1 – output adapter for 2 current outputs (red (+), black (-))
2 – output adapter
3 – Modbus adapter

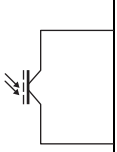
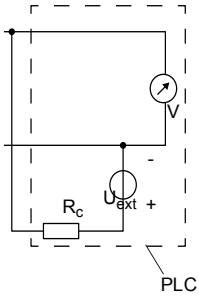
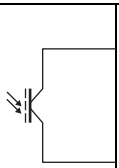
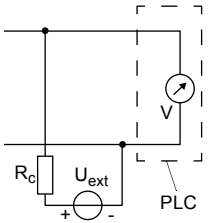
Tab. 7.1: Circuit of the outputs

output	transmitter		external circuit	remark
	internal circuit	**connection**		
switchable current output (1)	active current output			
		Px+ Px-		R_{ext} < 350 Ω U_{max} = 28 V ($R_{ext} \rightarrow \infty$) U_{int} = 24 V ± 2.4 V
	passive current output			
		Px+ Px-		U_{ext} = 8…30 V U_{ext} > 0.024 A · R_{ext} [Ω] + 8 V example: U_{ext} = 12 V R_{ext} ≤ 160 Ω
frequency output (open collector)		Px+ Px-		U_{ext} = 5…24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1…4 mA

The number, type and the connections of the outputs depend on the order.
R_{ext} is the sum of all ohmic resistances in the circuit (e.g., resistance of the conductors, resistance of the ammeter/voltmeter).

(1) All switchable current outputs are jointly switched to active and passive in the menu item `Special Version\SYSTEM settings\Proc. outputs`.

Tab. 7.1: Circuit of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
binary output (optorelay)	circuit 1			$U_{ext} \leq 26$ V $I_c \leq 100$ mA R_c [kΩ] = U_{ext}/I_c [mA]
		Px+ Px-		
	circuit 2			
		Px+ Px-		

The number, type and the connections of the outputs depend on the order.
R_{ext} is the sum of all ohmic resistances in the circuit (e.g., resistance of the conductors, resistance of the ammeter/voltmeter).
(1) All switchable current outputs are jointly switched to active and passive in the menu item `Special Version\SYSTEM settings\Proc. outputs`.

7.1.4 Inputs

Notice!

For the connection, observe the specifications regarding the assignment of the inputs given on the nameplate on the rear side of the transmitter.

Important!

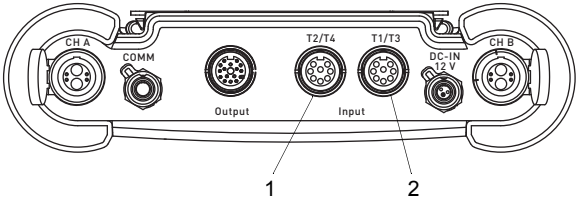
The max. voltage between the inputs and the internal power supply of the transmitter is 42 V DC (permanent).

7.1.4.1 Input adapter

The transmitter is equipped with max. 4 inputs (T1...T4). The type and number of inputs are stated on the nameplate.

It is possible to connect temperature probes, voltage and current sources to the inputs T1...T4. The inputs T1, T3 and T2, T4 are connected to their corresponding socket (T1/T3 and T2/T4), see Fig. 7.5.

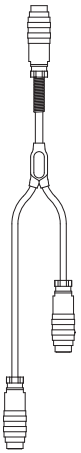
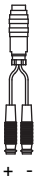
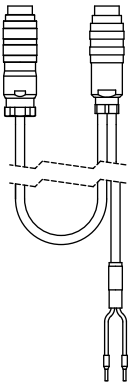
Fig. 7.5: Inputs of the transmitter



1 – socket T2/T4
2 – socket T1/T3

For the connection, adapters may be required.

Tab. 7.2: Adapter overview

input adapter	adapter for voltage and current inputs	adapter for the active current input
		
• when using T1 and T3 • when using T2 and T4 • when using T3 • when using T4	• for a current input • for a voltage input	• for power supply via an active current output

7.1.4.2 Temperature input

It is possible to connect temperature probes Pt100/Pt1000 (4-wire) to the inputs of the transmitter (option), see Fig. 7.5.

For the assignment and the activation of the temperature inputs, see chapter 14.

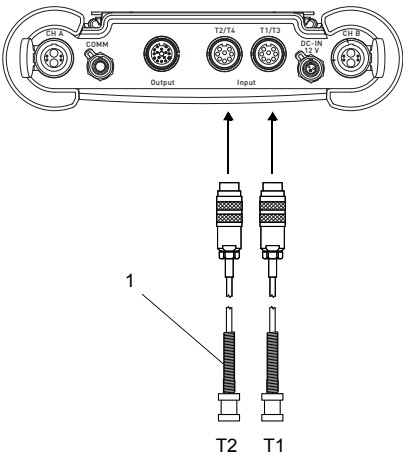
If the transmitter has only 1 or 2 temperature inputs, the temperature probes are connected directly to the socket T1/T3 or T2/T4, see Fig. 7.6.

If the transmitter has 3 or 4 temperature inputs, the temperature probes are connected to the socket T1/T3 or T2/T4 via an input adapter, see Fig. 7.7.

Notice!

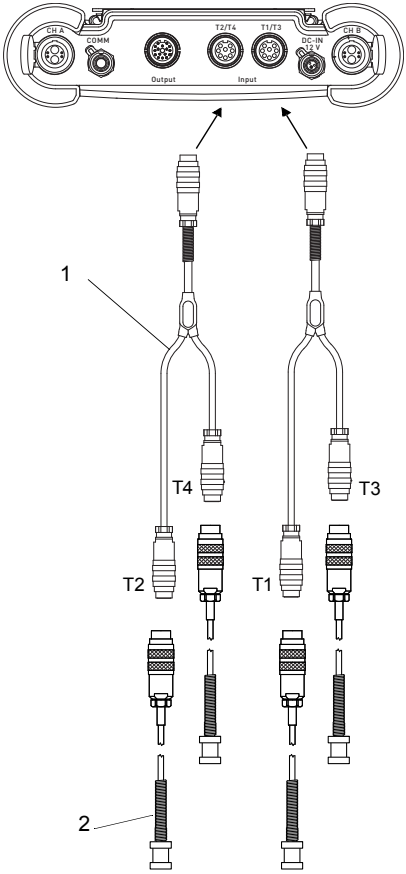
It is not necessary to connect the input adapter if only the input T1 or T2 is used, see Fig. 7.6.

Fig. 7.6: Connection of 1 or 2 temperature probes



1 – temperature probe

Fig. 7.7: Connection of 3 or 4 temperature probes



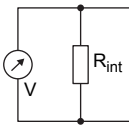
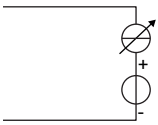
1 – input adapter
2 – temperature probe

The temperature probes are connected to the input adapter according to the information given on the nameplate.

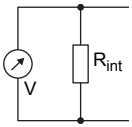
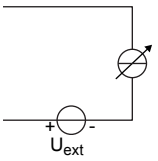
7.1.4.3 Current input

It is possible to connect an active current source or a passive current sink with an external power supply to a passive current input.

Tab. 7.3: Connection of an active current source

input	transmitter		external circuit	remark
	internal circuit	connection		
passive current input		+ -		permanent over-current max. 40 mA

Tab. 7.4: Connection of a passive current sink

input	transmitter		external circuit	remark
	internal circuit	connection		
passive current input		+ -		permanent over-current max. 40 mA

An external voltage source U_{ext} is necessary. It has to provide a current of min. 20 mA and

- supply sufficient power for the requirements of the passive current sink and
- cover the voltage drop at the input resistor (1 V at 20 mA) and
- cover all other voltage drops (e.g., cable resistance) in the circuit.

If the transmitter has an active output, the output can be used as power supply by means of an adapter, see section 7.1.4.4.

Example

A passive current sink with an external power supply (e.g., a pressure transmitter) is to be connected to a passive current input.

Technical data of the pressure transmitter:

U_S = 11...30 V DC
I_a = 4...20 mA ($I_{a\,max}$ = 22 mA)

U_{ext} required for the operation of the passive pressure transmitter is:

$U_{ext\,min} = U_{S\,min} + I_{a\,max} \cdot R_i + I_{a\,max} \cdot R_c$
$U_{ext\,min}$ = 11 V + 22 mA · 50 Ω + 22 mA · 2 Ω
$U_{ext\,min}$ = 12.14 V

$U_{ext\,max} = U_{S\,max}$
$U_{ext\,max}$ = 30 V

U_s – operating voltage of the pressure sensor

I_a – output current

R_i – input resistance

R_c – cable resistance

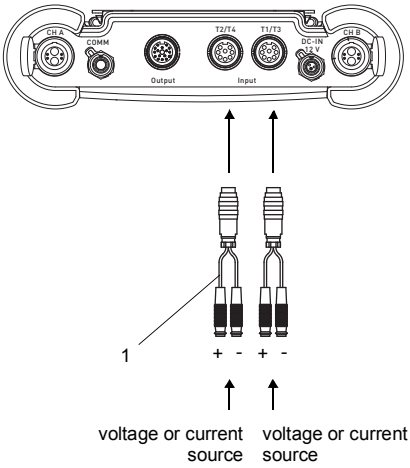
If the transmitter has 1 or 2 voltage or current inputs, the voltage and current sources are connected to the socket T1/T3 or T2/T4 via an adapter, see Fig. 7.8.

If the transmitter has 3 or 4 inputs, the adapters for the voltage and current inputs are connected to the sockets T1/T3 and T2/T4 via input adapters, see Fig. 7.7.

Notice!

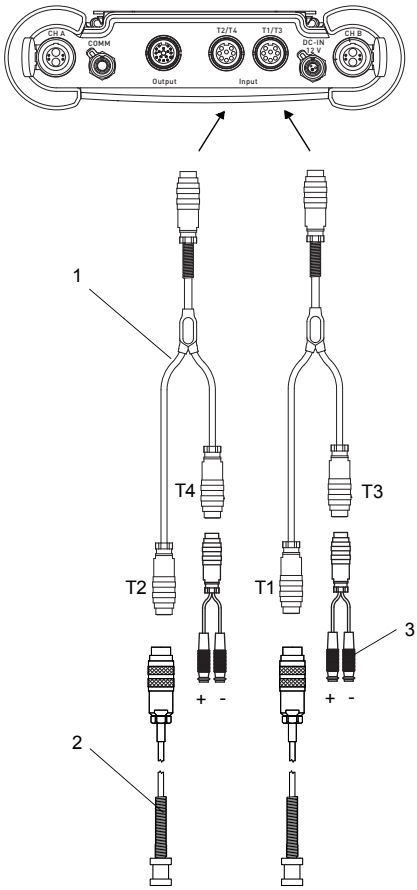
It is not necessary to connect the input adapter if only the inputs T1 or T2 are used, see Fig. 7.8.

Fig. 7.8: Connection of 1 or 2 voltage and current sources



1 – adapter for voltage and current inputs

Fig. 7.9: Combination of temperature, voltage and current measurement (example)



1 – input adapter
2 – temperature probe
3 – adapter for voltage and current inputs

The temperature probes, voltage or current sources are connected to the input adapter according to the information given on the nameplate.

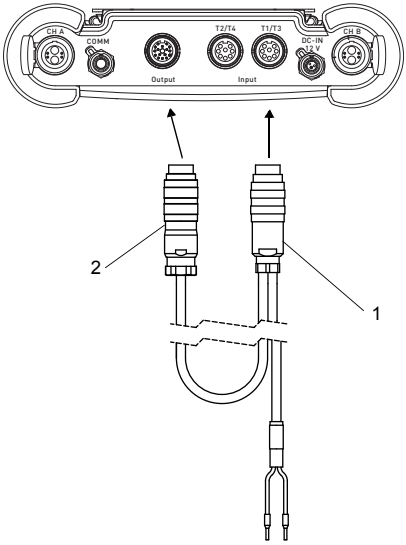
7.1.4.4 Connection of a passive current sink to a passive current input

For the connection of a passive current sink (e.g., pressure transmitter) to a passive current input, an external power supply has to be provided.

If the transmitter has an active current output, the output can be used as power supply by means of the adapter for the active current input. The adapter is connected to the T1/T3 or T2/T4 socket and to the output socket, see Fig. 7.10 and Tab. 7.1. The adapter connects the active current output with the passive current input and the passive current sink with the transmitter.

If 2 passive current sinks are to be fed via the transmitter, the active current outputs can be connected with the passive current inputs via the output adapter. In this case the adapter for the active current input cannot be used.

Fig. 7.10: Connection of the adapter for the active current input

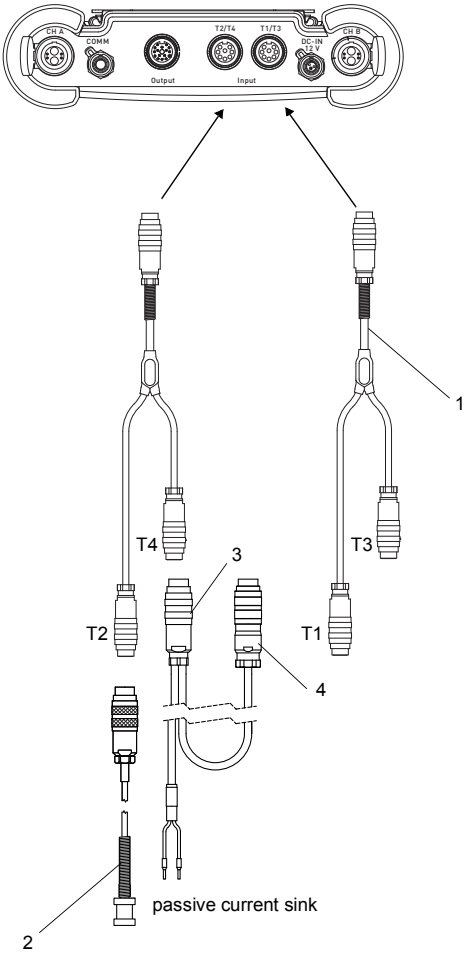


1 – connector for the connection to the current input
2 – connector for the connection to the current output

If the transmitter has 3 or 4 inputs, the adapter for the active current input is connected to the transmitter via an input adapter. The input adapter is connected whether to the T1/T3 or T2/T4 socket, see Fig. 7.11.

The temperature probes, voltage or current sources are connected to the adapters according to the information given on the nameplate.

Fig. 7.11: Combination of temperature, voltage and current measurement (example)



1 – input adapter
2 – temperature probe
3 – adapter for the active current input
4 – connector for the connection of an active current output

For the configuration of an output see section 13.1.

7.1.5 Serial interface

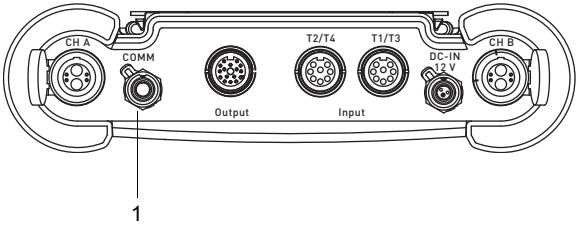
- Connect the RS232 cable to the transmitter, see Fig. 7.12, and to the serial interface of the PC.
- Use the RS232 adapter for the connection of the RS232 cable to the transmitter. If the RS232 cable cannot be connected to the PC, use the RS232/USB adapter.

The RS232 adapter, the RS232 cable and the RS232/USB adapter are part of the serial data kit (optional).

Notice!

If a problem occurs when using the RS232/USB adapter for connection, contact your system administrator.

Fig. 7.12: Connection of the serial interface



1 – serial interface

7.2 FLUXUS *608

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

7.2.1 Transducers

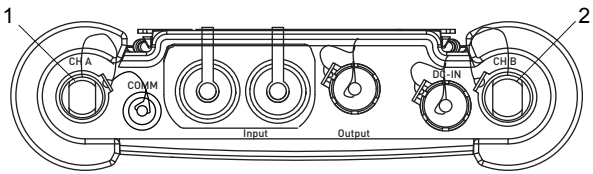
It is recommended to run the cables from the measuring point to the transmitter before connecting the transducers to avoid load on the connectors.

FLUXUS *608-A2**

The connections are on the upper side of the transmitter, see Fig. 7.13.

- Remove the blind plug, see Fig. 7.14.
- Insert the connector of the transducer cable into the socket of the transmitter. The red point (a) on the connector has to be aligned with the red marking (b) on the socket, see Fig. 7.15.

Fig. 7.13: Connection of the transducers to the transmitter



1 – transducers (measuring channel A)
2 – transducers (measuring channel B)

Fig. 7.14: Removal of the blind plug

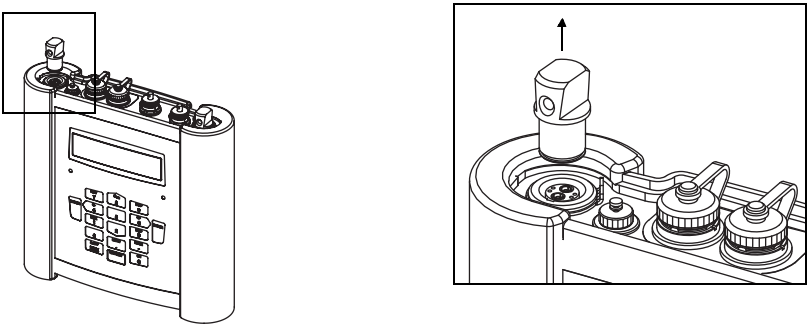
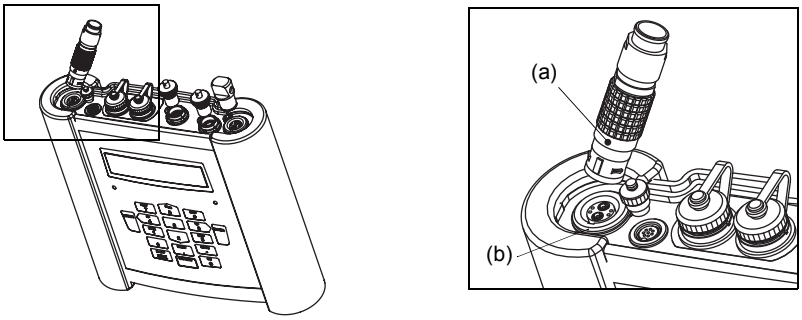


Fig. 7.15: Connection of the transducers

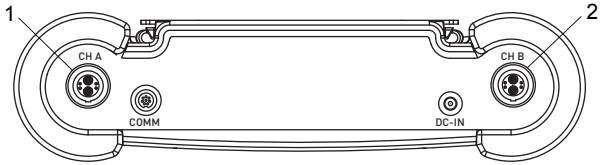


FLUXUS *608-F2**

The connections are on the upper side of the transmitter, see Fig. 7.16.

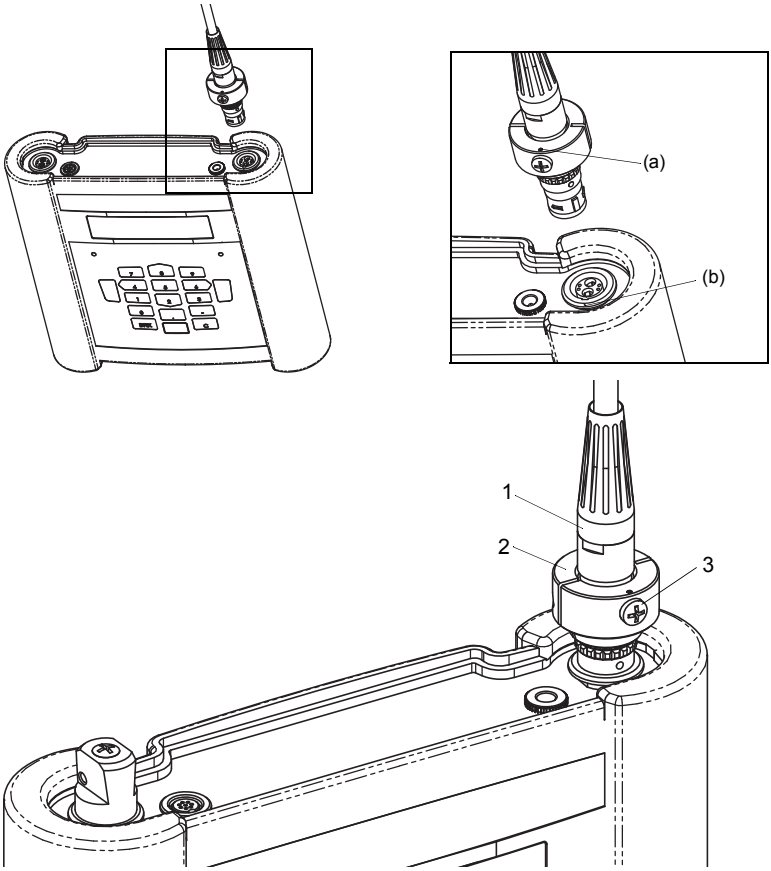
- Remove the blind plug, if present.
- Insert the connector of the transducer cable into the socket of the transmitter. The red point (a) on the connector has to be aligned with the red marking (b) on the socket, see Fig. 7.17.
- Secure the connector with of the locking ring by tightening the locking screw.
- If a socket for transducer connection is not used, close it with a blind plug. Secure the blind plug by tightening the locking screw.

Fig. 7.16: Connection of the transducers to the transmitter



1 – transducers (measuring channel A)
2 – transducers (measuring channel B)

Fig. 7.17: Connection of the transducers



1 – transducer connector
2 – locking ring
3 – locking screw

7.2.2 Power supply

The transmitter can be operated with the integrated battery, the power cable with power adapter (FLUXUS *608**-A2) or the power supply unit (FLUXUS *608**-F2).

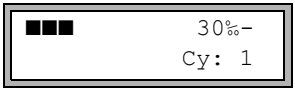
7.2.2.1 Battery operation

The transmitter has a Li-ion battery and can therefore be operated independently. When delivered, the battery is charged with approx. 30 %. The battery does not need to be fully charged before it is used for the first time.

The battery charge can be displayed during the measurement, see section 9.4.3 and in the program branch `Special Funct.`:

```
Special Funct.\Battery status
```

- Select the menu item `Special Funct.\Battery status`.
- Press ENTER.



The current battery charge is displayed (here: 30 %).

The minus sign (`-`) indicates that the transmitter is in battery mode and is being discharged.

The number of cycles the battery has passed is displayed after `Cy`. A cycle corresponds to a charging and discharging process. The life time of the battery can be derived by means of this value.

If `RELEARN` is displayed in the lower line and a question mark (`?`) is displayed after the current battery charge, a relearn cycle has to be started, see section "Maintenance" (relearn cycle) on the following page.

This message will be displayed if the battery is almost empty:

```
LOW BATTERY !
```

The capacity is sufficient for the display and storing of the current parameter record. A measurement is impossible.

Charging the battery

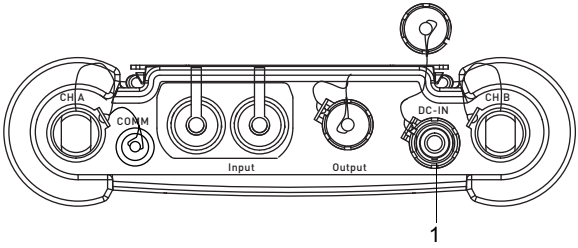
Connect the power supply to the transmitter, see Fig. 7.18 (FLUXUS *608**-A2) or Fig. 7.19 (FLUXUS *608**-F2). Switch on the transmitter. The charging starts automatically. The LED "BATTERY" flashes green while charging. The max. charging time is approx. 8 h.

During the charging process, the ambient temperature should be in the range of 0...45 °C.

A measurement can be made during the charging. Charging will be stopped automatically when the battery is fully charged. The LED "BATTERY" lights green then.

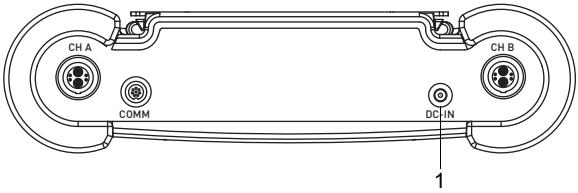
Notice!
The battery will only be charged if the transmitter is switched on.

Fig. 7.18: Connection of the power supply unit to the transmitter FLUXUS *608**-A2



1 – power supply unit/battery charging unit

Fig. 7.19: Connection of the power supply unit to the transmitter FLUXUS *608**-F2



1 – power supply unit/battery charging unit

Battery storage

The battery remains in the transmitter. After storage, the transmitter can immediately be operated with the battery.

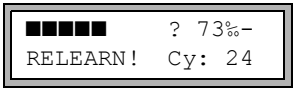
- battery charge: > 30 %
- storing temperature: 12...25 °C

Maintenance (relearn cycle)

The accuracy of the displayed value for the charge state of the battery is improved by executing a relearn cycle. The ambient temperature during a relearn cycle should be in the range of 12...30 °C.

```
Special Funct.\Battery status
```

- Select the menu item `Special Funct.\Battery status`.
- Press ENTER.



The charge state of the battery is displayed (here: 73 %).

The "`?`" and `RELEARN` indicate that the displayed charge state is not reliable. A relearn cycle is recommended.

- Charge the battery completely. The LED "BATTERY" lights green when charging is finished.
- Remove the power supply unit from the transmitter. Discharge the battery completely. In order to deactivate the automatic power-off during discharging, start a measurement. Discharging takes min. 14 h. The LED "BATTERY" will flash red afterwards.

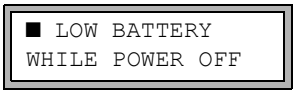
Automatic power-off

In battery mode, the transmitter has an automatic power-off. The transmitter will be switched off if

- no measurement is being made and no key is pressed within 10 min or
- the battery is empty.

This message will be displayed before the transmitter is switched off automatically. A countdown with an acoustic signal will be started.

The countdown can be stopped by pressing any key.



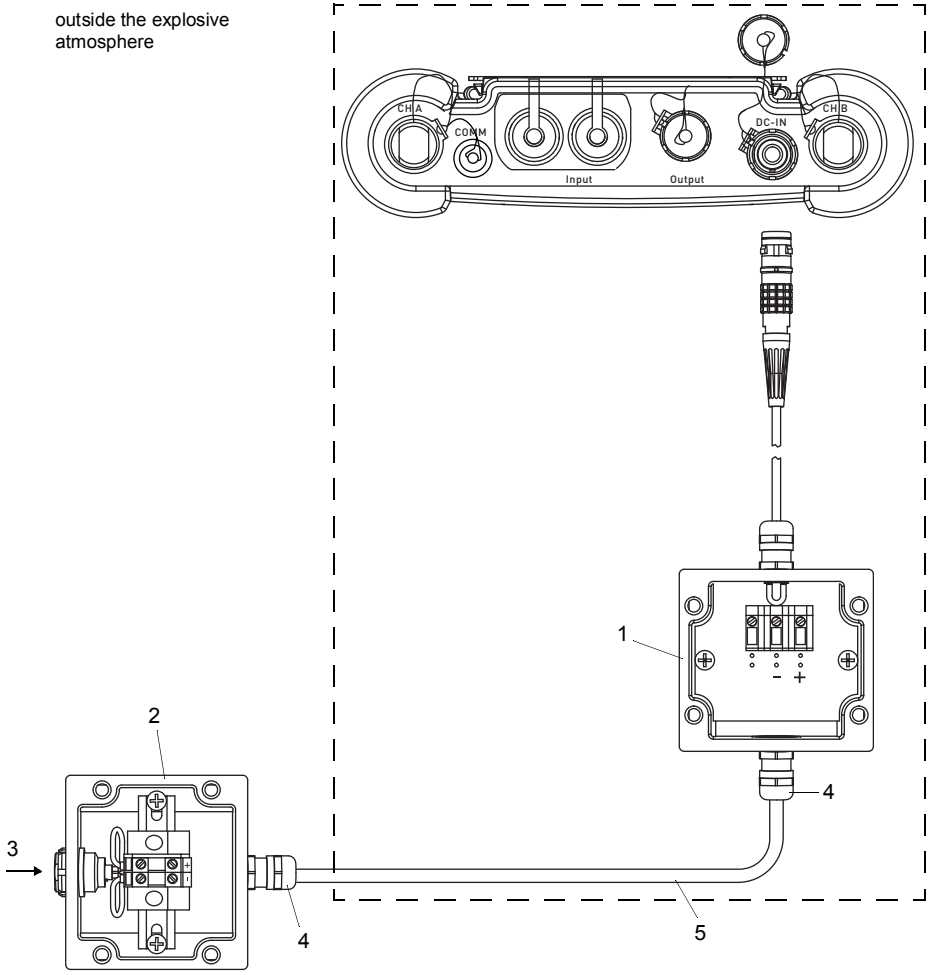
If this message is displayed when the transmitter is switched on, the transmitter has been switched off automatically due to a too low battery charge.

7.2.2.2 Power supply with adapter (option)

FLUXUS *608-A2**

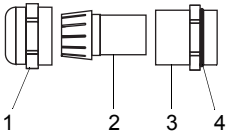
If the transmitter is operated within an explosive atmosphere, the power supply has to take place via the power adapter and the connection adapter, see Fig. 7.20.

Fig. 7.20: Connection of external adapters



1 – power adapter
2 – connection adapter
3 – connection for power supply unit
4 – cable gland M20 (provided by customer)
5 – cable (provided by customer)

Fig. 7.21: Cable gland



1 – cap nut
2 – compression part
3 – basic part
4 – gasket ring side of the basic part

- Remove the blind plug.
- Prepare the cable with a cable gland.
- Push the cable through the cap nut, the compression part and the basic part of the cable gland, see Fig. 7.21.
- The used cable has to have a wire cross-section of 1.5…2.5 mm².
- Push the cable through the cap nut, compression part and basic part of the cable gland.
- Insert the cable into the housing of the power adapter.
- Screw the sealing ring side of the basic part into the housing of the power adapter.
- Fix the cable gland by screwing the cap nut onto the basic part of the cable gland.
- Connect the cable to the terminals of the power adapter, see Fig. 7.20 and Tab. 7.5.
- Repeat the steps for the connection adapter..
- Connect the connector of the power adapter to the socket of the transmitter, see Fig. 7.20.

Tab. 7.5: Terminal assignment

terminal		**connection DC**
power adapter	**connection adapter**	
+	+	+DC
-	-	-DC

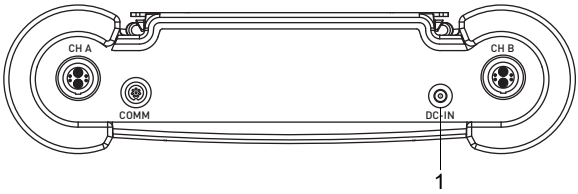
7.2.2.3 Power supply operation (FLUXUS *608**-F2)

Important!

→ Use only the supplied power supply unit.
→ The power supply unit must only be used outside explosive atmospheres.
→ The power supply is not protected against moisture. Use it only in dry rooms.
→ The voltage indicated on the power supply unit must not be exceeded.
→ Do not connect a defective power supply unit to the transmitter.

• Connect the power supply unit to the socket on the upper side of the transmitter, see Fig. 7.22.

Fig. 7.22: Connections on the transmitter



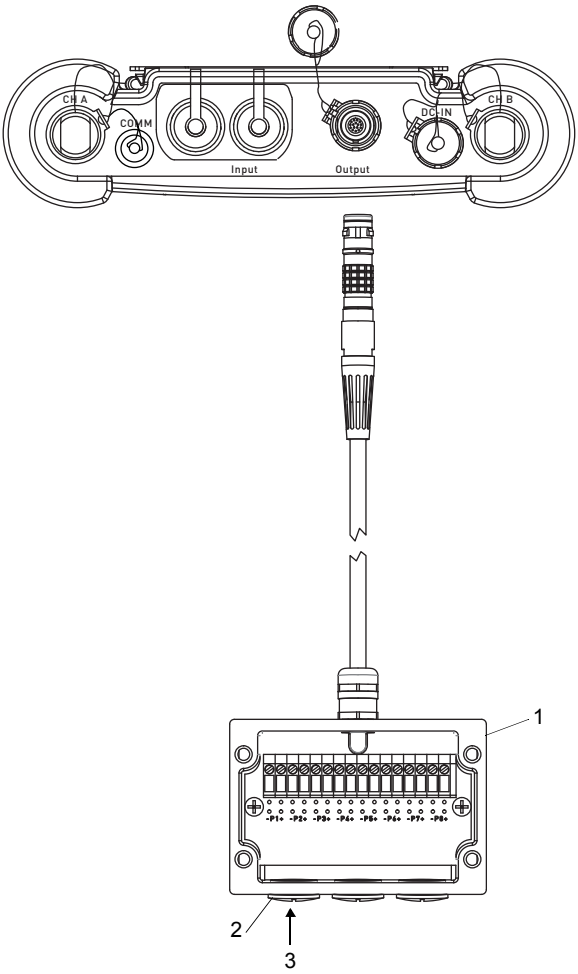
1 – power supply unit/battery charging unit

7.2.3 Outputs

The output adapter has to be used for the connection of the output adapters, see Fig. 7.23.

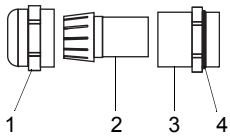
• Remove the blind plug.
• Prepare the output cable with an M20 cable gland.
• Push the output cable through the cap nut, the compression part and the basic part of the cable gland, see Fig. 7.24.
• Insert the output cable into the housing of the output adapter, see Fig. 7.23.
• Screw the sealing ring side of the basic part into the housing of the output adapter.
• Fix the cable gland by screwing the cap nut onto the basic part of the cable gland, see Fig. 7.24.
• Connect the leads of the output cable to the terminals of the output adapter, see Fig. 7.23 and Tab. 7.6.
• Remove the socket cover from the transmitter for the connection of the output adapter.
• Connect the connector of the output adapter to the socket.

Fig. 7.23: Connection of the output adapter to the transmitter



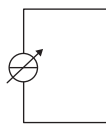
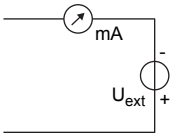
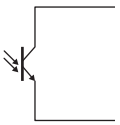
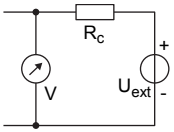
1 – output adapter
2 – blind plug
3 – connection of the outputs

Fig. 7.24: Cable gland



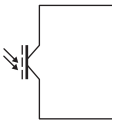
1 – cap nut
2 – compression part
3 – basic part
4 – gasket ring side of the basic part

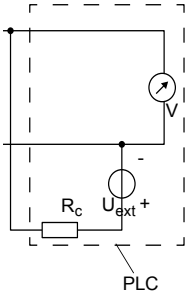
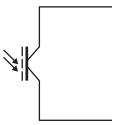
Tab. 7.6: Circuit of the outputs

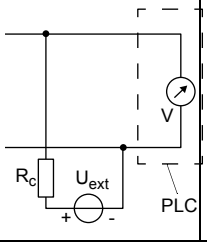
output	**transmitter**		**external circuit**	**remark**
	internal circuit	**connection**		
passive current output		Px+ Px-		U_{ext} = 4…9 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 6 V R_{ext} ≤ 90 Ω
frequency output (open collector)		Px+ Px-		U_{ext} = 5…24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1…4 mA

The number, type and the connections of the outputs depend on the order.
R_{ext} is the sum of all ohmic resistances in the circuit (e.g., resistance of the conductors, resistance of the ammeter/voltmeter).

Tab. 7.6: Circuit of the outputs

<table>
<tr><th>output</th><th colspan="2">transmitter</th><th>external circuit</th><th>remark</th></tr>
<tr><th></th><th>internal circuit</th><th>connection</th><th></th><th></th></tr>
<tr><td rowspan="4">binary output (optorelay)</td><td colspan="3">circuit 1</td><td rowspan="4">U_{ext} ≤ 26 V
I_c ≤ 100 mA
R_c [kΩ] = U_{ext}/I_c [mA]</td></tr>
<tr><td>  </td><td>Px+

Px-</td><td> 
</td></tr>
<tr><td colspan="3">circuit 2</td></tr>
<tr><td>  </td><td>Px+

Px-</td><td> 
</td></tr>
</table>

The number, type and the connections of the outputs depend on the order.
R_{ext} is the sum of all ohmic resistances in the circuit (e.g., resistance of the conductors, resistance of the ammeter/voltmeter).

7.2.4 Inputs (optional)

Notice!

For the connection, observe the specifications regarding the assignment of the inputs given on the nameplate on the backside of the transmitter.

Notice!

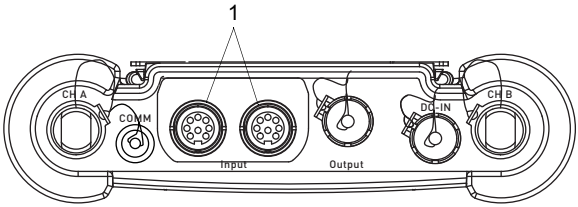
The max. voltage between the inputs and the internal power supply of the transmitter is 42 V DC (permanent).

7.2.4.1 Temperature input

It is possible to connect temperature probes Pt100/Pt1000 (4-wire) to the inputs of the transmitter (optional).

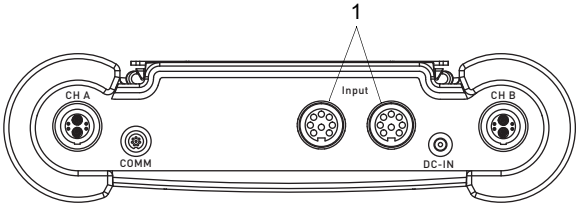
For the assignment and the activation of the temperature inputs, see chapter 14.

Fig. 7.25: Connections on the transmitter FLUXUS *608**-A2



1 – inputs

Fig. 7.26: Connections on the transmitter FLUXUS *608**-F2

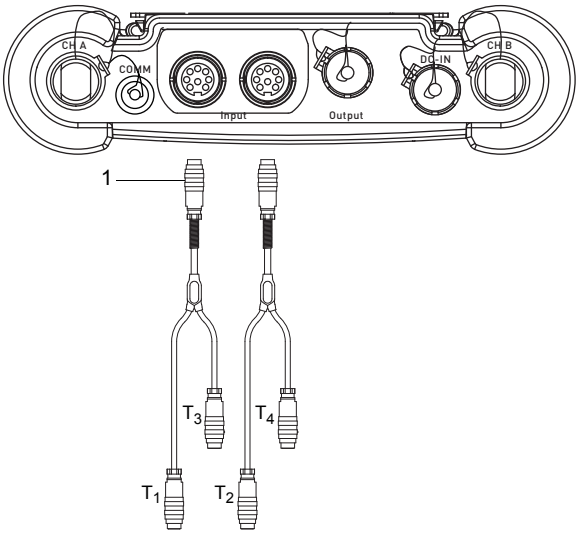


1 – inputs

7.2.4.2 Input adapter (optional)

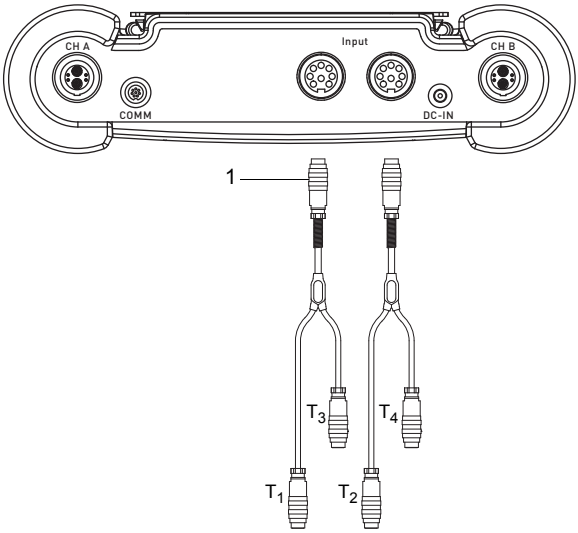
The number of temperature inputs can be increased to max. 4 by means of 2 input adapters.

Fig. 7.27: Connection of the input adapter to the transmitter FLUXUS *608**-A2



1 – input adapter

Fig. 7.28: Connection of the input adapter to the transmitter FLUXUS *608**-F2



1 – input adapter

7.2.5 Serial interface

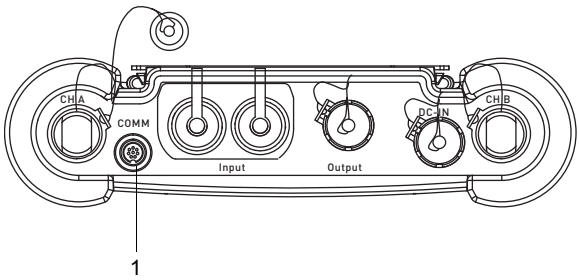
- Connect the RS232 cable to the transmitter and the serial interface of the PC.
- Use the RS232 adapter for the connection of the RS232 cable to the transmitter. If the RS232 cable cannot be connected to the PC, use the RS232/USB adapter.

The RS232 adapter, the RS232 cable and the RS232/USB adapter are part of the serial data kit (optional).

Notice!

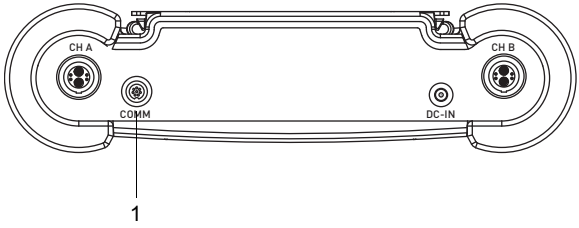
If a problem occurs when using the RS232/USB adapter for connection, contact your system administrator.

Fig. 7.29: Connection of the serial interface to the transmitter FLUXUS *608**-A2



1 – serial interface

Fig. 7.30: Connection of the serial interface to the transmitter FLUXUS *608**-F2



1 – serial interface

8 Start-up

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

8.1 Start-up settings

When starting up the transmitter for the first time, the following settings are required:

• language

• units of measurement

• date/time

These displays will only be indicated once when the transmitter is switched on for the first time.

```
Select language
```

The available transmitter languages are displayed.

• Select a language.

• Press ENTER.

The menus are displayed in the selected language.

```
Engineer. Units
```

• Select `metric` or `imperial`.

• Press ENTER.

```
CANADA-REGION
```

• Select `yes` if the transmitter is to be used in the region of Canada.
• Press ENTER.
This display will only be indicated if `imperial` is selected.

```
TIME
```

The current time is displayed.
• Press ENTER to confirm the time or to set the current time via the numeric field.
• Press ENTER.

```
DATE
```

The current date is displayed.
• Press ENTER to confirm the date or to set the current date via the numeric field.
• Press ENTER.

8.2 Switching on/off

Press key C to switch on the transmitter.

After switching on, it will be displayed which transducer has been detected at which measuring channel.

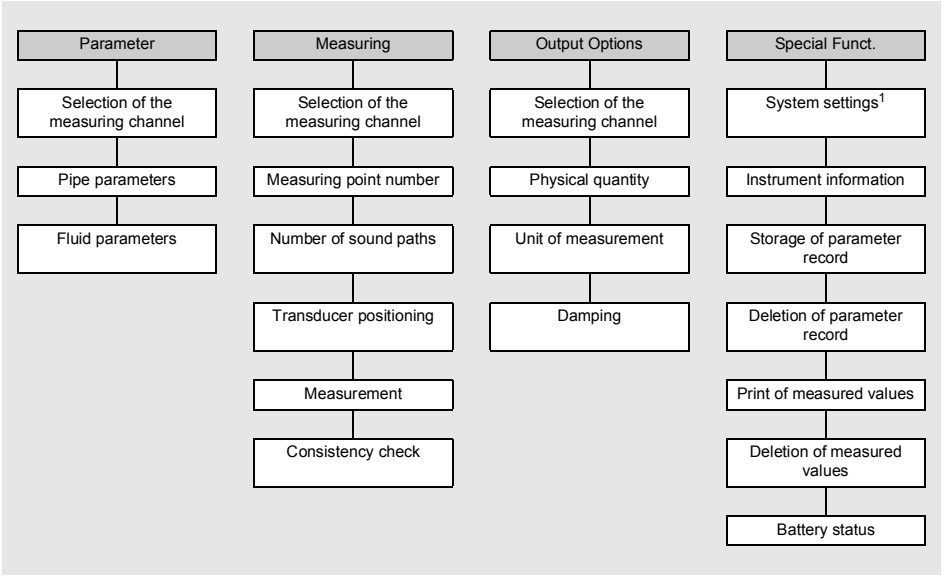
Afterwards, the serial number of the transmitter is displayed for a short time. It is not possible to enter any data while the serial number is displayed.

Afterwards, the main menu is displayed in the default language. The language of the display can be set, see section 8.4.

Press key BRK 3 times to switch off the transmitter.

8.3 Program branches

The following schema shows the program branches. For a detailed overview of the menu structure see annex A.



[1] `SYSTEM settings` contains the following menu items:

- dialogs and menus
- Inputs
- measurement
- outputs
- storing
- snap
- network
- serial transmission
- miscellaneous
- clock settings
- libraries

8.4 HotCodes

A HotCode is a digit sequence that activates certain functions or changes settings.

A HotCode can only be entered in the main menu immediately after switching on the transmitter. The HotCode is not displayed during the input.

function	HotCode	deactivation
reset of the display to medium contrast	555000	
language	9090xx	
enabling the FastFood mode	007022	HotCode 007022
settings of transducer temperature output and flow velocity storing	007043	
manual input of the lower limit for the inner pipe diameter	071001	
activation of the SuperUser mode	071049	switching off the transmitter
activation of the BTU mode	007025	HotCode 007025
transmission parameters change of the RS232 service interface	232-0-	

8.5 Language

The language can be selected with the following HotCodes:

language	HotCode
Dutch	909031
French	909033
Spanish	909034
English	909044
German	909049

When the last digit has been entered, the main menu is displayed in the selected language.

The selected language remains activated when the transmitter is switched off and on again. After an initialization of the transmitter, the language is reset to the default language.

8.6 Initialization

During an initialization (INIT) of the transmitter, the settings in the program branches `Parameter` and `Output Options` and some of the settings in the program branch `Special Funct.` are reset to the default settings of the manufacturer.

Proceed as follows to execute an initialization:

- When switching on the transmitter: keep keys BRK and C pressed.
- During the operation of the transmitter: press keys BRK, C and ENTER at the same time. A reset is executed. Release only key ENTER. Keep keys BRK and C pressed.

After the initialization has been executed, the message `INITIALISATION DONE` is displayed.

After the initialization, the remaining settings of the transmitter can be reset to the default settings and/or the stored measured values can be deleted.

```
FACTORY DEFAULT
```

- Select `yes` to reset the remaining settings of the transmitter to default settings or `no` to keep them at the current settings.
- Press ENTER.

If `yes` is selected, the message `FACTORY DEFAULT DONE` will be displayed.

```
Delete Meas.Val.
```

- Select `yes` to delete the stored measured values or `no` to keep them.
- Press ENTER.

This display will only be indicated if measured values are stored in the transmitter.

8.7 Time and date

The transmitter has a battery-powered clock. Measured values are automatically stored with date and time.

```
Special Funct.\SYSTEM settings\Set Clock\TIME
```

- Select `Set Clock`.
- Press ENTER.

The current time is displayed.

- Select `ok` to confirm the time or `new` to adjust it.
- Press ENTER.
- Select the character to be edited with key 〈4〉 and 〈6〉. Edit the selected character with key 〈8〉 and 〈2〉.
- Press ENTER.

The new time is displayed.

- Select `ok` to confirm the time or `new` to adjust it again.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Set Clock\DATE
```

After the time has been set, the date is displayed.

- Select `ok` to confirm the date or `new` to adjust it.
- Press ENTER.
- Select the character to be edited with key 〈4〉 and 〈6〉. Edit the selected character with key 〈8〉 and 〈2〉.
- Press ENTER.

The new date is displayed.

- Select `ok` to confirm the date or `new` to adjust it again.
- Press ENTER.

8.8 Instrument information

```
Special Funct.\Instrum. Inform.
```

• Select the menu item `Instrum. Inform.` to get information about the transmitter.
• Press ENTER.

```
x60x       -XXXXXXXX
```

The type and the serial number of the transmitter are displayed in the upper line.

```
Free:       18327
```

The max. available data logger will be displayed in the lower line (here: 18327 additional measured values can be stored).
• Press ENTER.

```
V x.xx     tt.mm.jj
```

The firmware version of the transmitter is displayed with the date in the lower line.
• Press ENTER.

9 Measurement

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

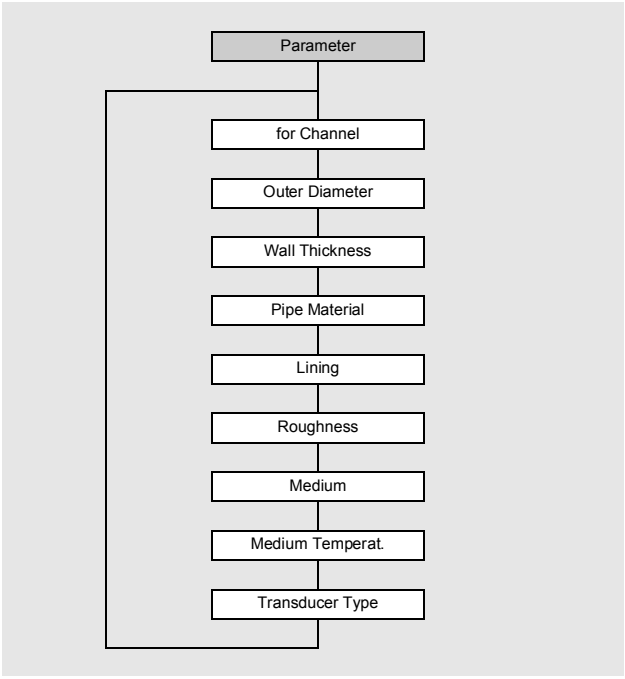
9.1 Parameter input

Notice!

The parameters will only be stored when the program branch `Parameter` has been edited in its entirety.

Notice!

During the parameter input, the transducers have to be connected to the transmitter.



see annex A, p. 228

The pipe and fluid parameters are entered for the selected measuring point. The parameter ranges are limited by the technical characteristics of the transducers and the transmitter.

• Select the program branch `Parameter`.

• Press ENTER.

```
Parameter\for Channel A
```

• Select the channel for which the parameters are to be entered (here: `Channel A`).

• Press ENTER.

If `Parameter from` is displayed, at least on parameter record can be stored and can be selected. Each parameter record comprises all data necessary for a measurement:

• pipe parameters

• fluid parameter

• transducer parameter

• output options

A parameter record can be defined for each measuring task, see section 19.3.

9.1.1 Input of pipe parameters

Outer pipe diameter/pipe circumference

```
Parameter\Outer Diameter
```

• Enter the outer pipe diameter.

• Press ENTER.

An error message will be displayed if the entered parameter is outside the range. The limit is displayed.

Example: upper limit 1100 mm for the connected transducers and for a pipe wall thickness of 50 mm.

```
Outer Diameter
1100.0   MAXIMAL
```

It is possible to enter the pipe circumference instead of the outer pipe diameter, see section 19.1.

If the input of the pipe circumference is activated and zero is entered in `Outer Diameter`, the menu item `Pipe Circumfer.` will be displayed. If the pipe circumference is not to be entered, press key BRK to return to the main menu and start the parameter input again.

Notice!

The inner pipe diameter (= outer pipe diameter - 2 × pipe wall thickness) will be calculated internally.

If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed.

It is possible to change the lower limit of the inner pipe diameter for a given transducer type, see section 17.11.

Pipe wall thickness

```
Parameter\Wall Thickness
```

• Enter the pipe wall thickness.

• Press ENTER.

Pipe material

```
Parameter\Pipe Material
```

The pipe material has to be selected to be able to determine the corresponding sound speed.

The sound speeds for the materials in the scroll list are stored in the transmitter.

- Select the pipe material.
- Press ENTER.
- If the material is not in the scroll list, select `Other Material`.
- Press ENTER.

Sound speed of the pipe material

```
Parameter\Pipe Material\Other Material\c-Material
```

- Enter the sound speed of the pipe material.
- Press ENTER.

Notice!
There are 2 sound speeds for pipe materials, the longitudinal and the transversal one. Enter the sound speed which is nearer to 2500 m/s.

These displays will only be indicated if `Other Material` is selected.

For the sound speed of some materials, see annex C.

Lining

```
Parameter\Lining
```

- Select `yes` if the pipe has a lining. Select `no` if the pipe has no lining.
- Press ENTER.

Lining material

```
Parameter\Lining
```

- Select the lining material.
- Press ENTER.
- If the lining material is not included in the scroll list, select `Other Material`.
- Press ENTER.

This display will only be indicated if `yes` is selected in the menu item `Lining`.

Sound speed of the lining material

```
Parameter\Lining\Other Material\c-Material
```

• Enter the sound speed of the lining material.
• Press ENTER.

Notice!

For pipe materials there are 2 sound speeds, the longitudinal and the transversal one. Enter the sound speed which is nearer to 2500 m/s.

These displays will only be indicated if `Other Material` is selected.

Lining thickness

```
Parameter\Liner Thickness
```

• Enter the thickness of the lining.
• Press ENTER.
This display will only be indicated if `yes` is selected in the menu item `Lining`.

Pipe roughness

```
Parameter\Roughness
```

The flow profile of the fluid is influenced by the roughness of the inner pipe wall.
The roughness is used for the calculation of the profile correction factor.
In most cases, the pipe roughness cannot be exactly determined and must therefore be estimated.
For the roughness of some materials, see annex C.
• Enter the roughness for the selected pipe or lining material.
• Change the value according to the condition of the inner pipe wall.
• Press ENTER.

Input of the disturbance distance

```
Parameter\Disturb.distance
```

• Enter the disturbance distance.
• Press ENTER.
This display will only be indicated if `With disturbance` is selected in the menu item `Special Funct.\SYSTEM settings\Measuring\ProfileCorr 2.0`.

9.1.2 Input of fluid parameters

Fluid

```
Parameter\Medium
```

• Select the fluid from the scroll list.
• Press ENTER.

If the fluid is not in the scroll list, select `Other Medium`.

If a fluid is selected from the scroll list, the menu item for the input of the fluid temperature will directly be displayed.

If `Other Medium` is selected, the following fluid parameters have to be entered first:

• average sound speed of the fluid
• range around the average sound speed of the fluid
• kinematic viscosity
• density

Sound speed of the fluid

```
Parameter\Medium\Other Medium\c-Medium
```

The sound speed of the fluid is used for the calculation of the transducer distance. The exact value of the sound speed is not always known. Therefore, a range of possible values for the sound speed has to be entered.

• Enter the average sound speed of the fluid.
• Press ENTER.

This display will only be indicated if `Other Medium` is selected.

Sound speed range of the fluid

```
Parameter\Medium\Other Medium\c-Medium range
```

• Select `auto` if the area around the average sound speed is to be calculated by the transmitter.
• Select `user` if the range around the average sound speed has to be entered.
• Press ENTER.

This display will only be indicated if `Other Medium` is selected.

```
Parameter\Medium\Other Medium\c-Medium range\c-Medium
```

• Enter the range around the average sound speed of the fluid.
• Press ENTER.

This display will only be indicated if `user` is selected.

Kinematic viscosity of the fluid

```
Parameter\Medium\Other Medium\Kinem.Viscosity
```

The kinematic viscosity influences the flow profile of the fluid. The value is considered in the profile correction.

• Enter the kinematic viscosity of the fluid.

• Press ENTER.

This display will only be indicated if `Other Medium` is selected.

Fluid density

```
Parameter\Medium\Other Medium\Density
```

The density is used to calculate the mass flow.

If the mass flow is not measured, an input is unnecessary. The default value can be used.

• Enter the operating density of the fluid.

• Press ENTER.

This display will only be indicated if `Other Medium` is selected.

Fluid temperature

```
Parameter\Medium Temperat.
```

At the beginning of the measurement, the fluid temperature is used for the interpolation of the sound speed and therefore for the calculation of the recommended transducer distance.

During the measurement, the fluid temperature is used for the interpolation of the density and viscosity of the fluid.

The value entered here is used for the calculation if the fluid temperature is not measured.

• Enter the fluid temperature. The value has to be within the operating temperature of the transducers.

• Press ENTER.

Fluid pressure

```
Parameter\Fluid pressure
```

The fluid pressure is used for the interpolation of the sound speed.

- Enter the fluid pressure.
- Press ENTER.

This display will only be indicated if the menu item `Special Funct.\SYSTEM settings\Dialogs/Menus\Fluid pressure` is activated.

9.1.3 Other parameters

Transducer parameter

If transducers are identified at a measuring channel, the input of parameters is finished. Press ENTER. The main menu will be displayed.

If no or special transducers are connected, the transducer parameters have to be entered.

```
Parameter\Transducer Type
```

- Select `Standard` to use the standard transducer parameters stored in the transmitter.
- Select `Special Version` to enter the transducer parameters. The transducer parameters have to be provided by FLEXIM.
- Press ENTER.

Notice!

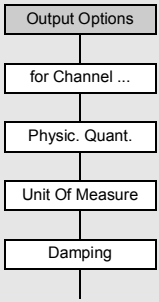
If a standard transducer is selected, no transducer-specific calibration values are considered. A higher uncertainty has to be expected.

```
Parameter\Transducer Type\Special Version
```

If `Special Version` is selected, enter the 6 transducer parameters specified by FLEXIM. Press ENTER after each input.

9.2 Measurement settings

9.2.1 Selection of the physical quantity and the unit of measurement



see annex A, p. 229

The following physical quantities can be measured:

- sound speed
- flow velocity: is calculated on the basis of the measured transit time difference
- volumetric flow rate: is calculated by multiplying the flow velocity by the cross-sectional pipe area
- mass flow rate: is calculated by multiplying the volumetric flow rate by the operating density of the fluid
- thermal energy rate (option): is calculated from the volumetric flow rate, the measured temperatures of the supply and return lines, and the thermal energy rate coefficients of the fluid

The physical quantity is selected as follows:

- Select the program branch `Output Options`.
- Press ENTER.

```
Output Options\for Channel A
```

- Select the channel for which a physical quantity has to be entered (here: `Channel A)`.
- Press ENTER.

```
Output Options\for Channel A\Physic. Quant.
```

- Select the physical quantity in the scroll list.
- Press ENTER.

```
Output Options\for Channel A\Physic. Quant.\Volume flow
```

For the selected physical quantity (except for the sound speed), a scroll list with the available units of measurement is displayed. The unit of measurement which was selected previously is displayed first.

- Select the unit of measurement of the selected physical quantity.
- Press ENTER.

Notice!

If the physical quantity or the unit of measurement is changed, the settings of the outputs have to be checked, see section 9.2.3.

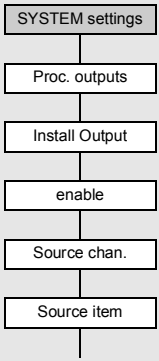
9.2.2 Input of the damping factor

Each displayed measured value is a floating average of all measured values of the last x seconds, with x being the damping factor. A damping factor of 1 s means that the measured values are not averaged because the measuring rate is approx 1/s. The default value of 10 s is appropriate for normal flow conditions. Values which fluctuate strongly due to a higher flow dynamic, require a higher damping factor.

```
Output Options\...\Damping
```

- Select the program branch `Output Options`.
- Press ENTER until the menu item `Damping` is displayed.
- Enter the damping factor.
- Press ENTER.
- Press key BRK to return to the main menu.

9.2.3 Installation of an output



see annex A, p. 232

If the transmitter is equipped with outputs, they have to be installed and activated before they can be used:

- assignment of a measuring channel (source channel) to the output (if the transmitter has more than one measuring channel)
- assignment of the physical quantity (source item) to be transmitted to the output by the source channel, and the properties of the signal
- definition of the output behavior in case no valid measured values are available
- activation of the installed output in the program branch `Output Options`

In the following, the configuration of an analog outputs is described.

Notice!

The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

```
Special Funct.\SYSTEM settings\Proc. outputs
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. outputs`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\Loop I1,I2
```

- Select `active` if all current outputs to be installed, are to be operated actively.
- Select `passive` if all current outputs to be installed, are to be operated passively.
- Press ENTER.

Selection of an output

```
Special Funct.\SYSTEM settings\Proc. outputs\Install Output
```

- Select the output to be installed.
- Press ENTER.

The scroll list contains all available outputs of the transmitter:

- Current Ix (--)
- Binary Bx (--)
- Frequency Fx (--)

A tick (✓) after a list item indicates that this output has already been installed.

```
Special Funct.\SYSTEM settings\Proc. outputs\enable I1
```

- Select yes to install or reconfigure the output.
- Press ENTER.
- Select no to uninstall the output and to return to the previous menu item in order to select another output.
- Press ENTER.

Assignment of a measuring channel

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source chan. I1
```

- Select the measuring channel to be assigned to the output as the source channel in the scroll list.
- Press ENTER.

Assignment of a source item

One source item has to be assigned to each selected output.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source item
```

- Select the physical quantity (source item) to be transmitted to the output by the source channel.
- Press ENTER.

If a binary output is configured, only the list items Limit and Impuls will be displayed.

The source items and their scroll lists are summarized in the Tab. 9.1.

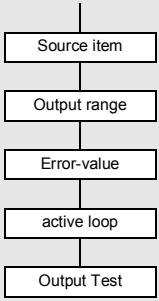
Tab. 9.1: Configuration of the outputs

source item	list item	output
Measuring value	actual measure	physical quantity selected in the program branch Output Options
	Flow	flow, independent of the physical quantity selected in the program branch Output Options
	Heatflow	thermal energy rate, independent of the physical quantity selected in the program branch Output Options
Quantity	Q+	totalizer for the positive flow direction
	* actual measure	totalizer for the physical quantity selected in the program branch Output Options
	* Flow	flow totalizer
	* Heatflow	thermal energy rate totalizer
	Q−	totalizer for the negative flow direction
	* actual measure	totalizer for the physical quantity selected in the program branch Output Options
	* Flow	flow totalizer
	* Heatflow	thermal energy rate totalizer
	ΣQ	sum of the totalizers (positive and negative flow direction)
	* actual measure	totalizer for the physical quantity selected in the program branch Output Options
	* Flow	flow totalizer
	* Heatflow	thermal energy rate totalizer
Limit	R1	limit message (Alarm Output R1)
	R2	limit message (Alarm Output R2)
	R3	limit message (Alarm Output R3)

Tab. 9.1: Configuration of the outputs

source item	list item	output
Temperature	is only available if a temperature input has been assigned to the channel	
	Tfluid ← (Ti)*	fluid temperature measured by the temperature probe at the point where the flow is measured
	Taux S/R ← (Ti)*	fluid temperature measured by the other temperature probe
	Tsupply ← (Ti)*	supply temperature
	Treturn ← (Ti)*	return temperature
	Ts-Tr ← (Ti-Tj)*	difference between supply and return temperature
	Tr-Ts ← (Ti-Tj)*	difference between return and supply temperature
	T(3) ← (Ti)*	third temperature input of the measuring channel
	T(4) ← (Ti)*	fourth temperature input of the measuring channel
	* i, j: number of the assigned temperature input	
Impuls	from abs(x)	pulse without sign consideration
	from x > 0	pulse for positive measured values of the volumetric flow rate
	from x < 0	pulse for negative measured values for the volumetric flow rate
Miscellaneous	c-Medium	sound speed of the fluid
	SCNR	ratio useful signal to correlated noise signal
	Signal	signal amplitude of a measuring channel
	VariAmp	standard deviation of the signal amplitude
	Density	density of the fluid
	Pressure	pressure of the fluid

9.2.3.1 Output of the measured value



see annex A, p. 232

Output range

When configuring an analog output, the output range has to be defined.

`Special Funct.\SYSTEM settings\Proc. outputs\...\Output range I1`

- Select the menu item `Special Funct.\SYSTEM settings\Proc. outputs\ ...\I1 Output range`.
- Press ENTER.
- Select a list item.
  - `4/20 mA`
  - `other range`
- Press ENTER.
- If `other range` is selected, enter the values `Output MIN` and `Output MAX`.
- Press ENTER after each input.

Error output

`Special Funct.\SYSTEM settings\Proc. outputs\...\Error-value I1`

In the following dialog, an error value can be defined which is to be transmitted if the source item cannot be measured, e.g., if there are solids in the fluid.

- Select a list item for the error output, see Tab. 9.2.
- Press ENTER.
- If `Other value...` is selected, enter an error value. The value has to be within the output range.
- Press ENTER.

Notice!

The settings will be stored at the end of the dialog.

Tab. 9.2: Error output

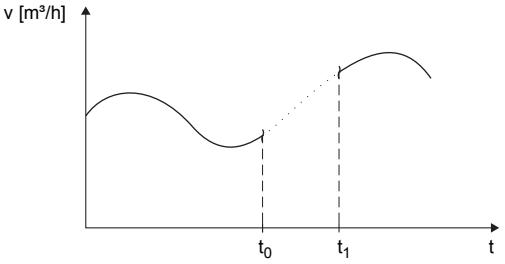
error value	result
`Minimum`	the lower limit of the output range is output
`Hold last value`	the last measured value is output
`Maximum`	the upper limit of the output range is output
`Other value...`	The value has to be entered manually. It has to be within the limits of the output.

Example

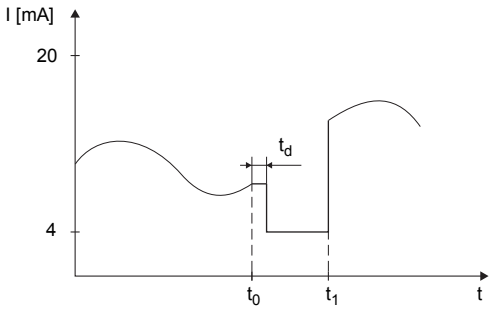
source item: volumetric flow rate
output: current output
output range: 4…20 mA

error delay: $t_d > 0$
(see section 9.2.5 and Tab. 9.3)

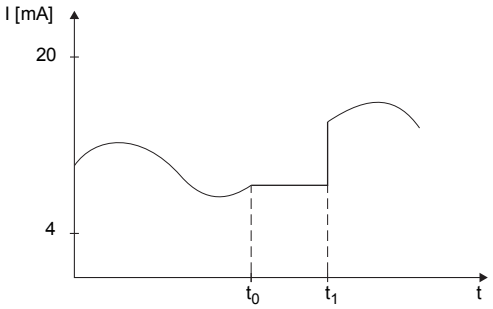
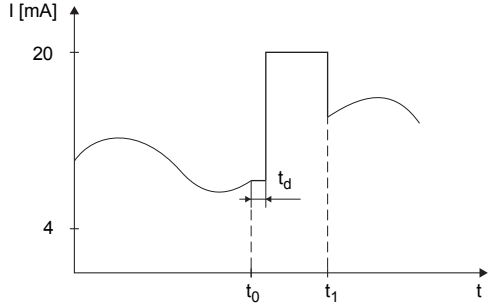
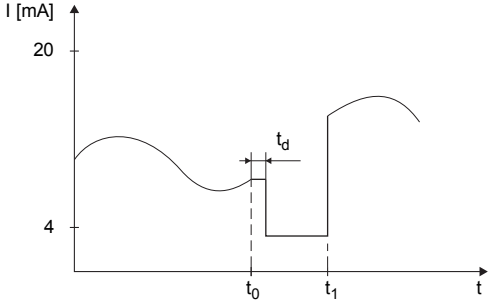
The volumetric flow rate cannot be measured during the time interval t_0...t_1. The error value will be output.



Tab. 9.3: Examples for the error output (output range: 4...20 mA)

list item	output signal
`Minimum (4.0 mA)`	

Tab. 9.3: Examples for the error output (output range: 4...20 mA)

list item	output signal
`Hold last value`	
`Maximum (20.0 mA)`	
`Other value...` error value = 3.5 mA	

Terminal assignment

```
Special Funct.\SYSTEM settings\Proc. outputs\...\I1 active loop
```

The terminals for the connection of the output are displayed.

• Press ENTER.

It will be displayed whether the current output is active or passive (here: active).

Output function test

The function of the output can now be tested.

• Connect an external measuring instrument to the terminals of the output.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\I1 Output Test
```

• Enter a test value. It has to be within the output range.

• Press ENTER.

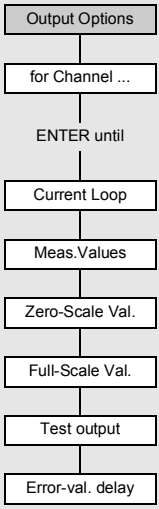
```
Special Funct.\SYSTEM settings\Proc. outputs\...\I1= 10 mA\Again?
```

If the external measuring instrument displays the entered value, the output functions correctly.

• Select `yes` to repeat the test, `no` to return to the menu item `SYSTEM settings`.

• Press ENTER.

9.2.4 Activation of an analog output



see annex A, p. 232

Notice!

An output can only be activated in the program branch `Output Options` if it has previously been installed.

`Output Options\for Channel A`

- Select the channel for which an output is to be activated in the program branch `Output Options`.
- Press ENTER.

`Output Options\...\Current Loop`

- Press ENTER until `Current Loop` is displayed.
- Select `yes` to activate the output.
- Press ENTER.

Measuring range

After an analog output has been activated in the program branch `Output Options`, the measuring range of the source item has to be entered.

`Output Options\...\Meas.Values`

- Select `sign` if the sign of the measured values is to be considered for the output.
- Select `absolut` if the sign of the measured values is not to be considered for the output.
- Press ENTER.

`Output Options\...\Zero-Scale Val.`

- Enter the lowest expected measured value. The unit of measurement of the source item will be displayed.

`Zero-Scale Val.` is the value assigned to the value `Output MIN` of the output range.

- Press ENTER.

`Output Options\...\Full-Scale Val.`

- Enter the highest expected measured value. The unit of measurement of the source item will be displayed.

`Full-Scale Val.` is the value assigned to the value `Output MAX` of the output range.

- Press ENTER.

Example

output: current output
output range: 4…20 mA
`Zero-Scale Val.`: 0 m³/h
`Full-Scale Val.`: 300 m³/h
volumetric flow rate = 0 m³/h, corresponds to 4 mA
volumetric flow rate = 300 m³/h, corresponds to 20 mA

Function test

The function of the output can now be tested.

• Connect an external measuring instrument to the terminals of the output.

```
Output Options\...\I1:Test output?
```

• Select `yes` to test the output.

• Press ENTER.

```
Output Options\...\I1:Test value
```

• Enter a test value for the selected physical quantity. If the external measuring instrument displays the entered value, the output functions correctly.

• Press ENTER.

```
Output Options\...\I1:Test output?
```

• Select `yes` to repeat the test.

• Press ENTER.

Example

output: current output

output range: 4…20 mA

`Zero-Scale Val.`: 0 m³/h

`Full-Scale Val.`: 300 m³/h

`Test value` = 150 m³/h (center of the measuring range, corresponds to 12 mA)

If the multimeter displays 12 mA, the current output functions correctly.

9.2.5 Input of the error delay

The error delay is the time after which an error value will be sent to an output if no valid measured values are available.

```
Output Options\...\I1:Error-val. delay
```

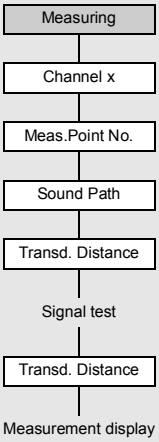
This display will only be indicated if the list item `edit` is selected in the menu item `Special Funct.\Dialogs/Menus\Error-val. delay`.

If the error delay is not entered, the damping factor will be used.

• Enter a value for the error delay.

• Press ENTER.

9.3 Start of the measurement



see annex A, p. 231

• Select the program branch `Measuring`.

• Press ENTER.

If the parameters in the program branch `Parameter` are not valid or incomplete, the error message `NO DATA!` will be displayed.

Activation of the channels

`Measuring\Channel ...`

The channels for the measurement can be activated and deactivated.

✓ the channel is activated

– the channel is deactivated

• the channel cannot be activated

Notice!

A channel cannot be activated if the parameters are not valid, e.g., if the parameters in the program branch `Parameter` of the channel are not complete.

• Select a channel with key 〈4〉 or 〈6〉.

• Press key 〈8〉 to activate or deactivate the channel.

• Press ENTER.

A deactivated channel will be ignored during the measurement. The parameters entered for this channel will remain unchanged.

- If the data logger or the serial interface is activated, the measuring point number has to be entered:

Input of the measuring point number

```
Measuring\Channel\Meas.Point No.
```

- Enter the number of the measuring point.
- Press ENTER.

For the activation of text input, see `Special Funct.\SYSTEM settings\Dialogs/Menus\Meas.Point No.`

Input of the sound path number

```
Measuring\Channel\...\Sound Path
```

A value for the number of sound paths corresponding to the connected transducers and the entered parameters is recommended.

- Change the value, if necessary.
- Press ENTER.

Profile correction

If `With disturbance` is selected in the menu item `Special Funct.\SYSTEM settings\Measuring\ProfileCorr 2.0`, it has to be checked whether the measurement arrangement is appropriate.

If the number of sound paths is odd and more than one measuring channel is activated, the following display appears:

```
A: Alone at measp
>NO<          yes
```

- Select `no` if there are 2 transducer pairs in X arrangement or displaced X arrangement at the measuring point (appropriate measurement arrangement). The profile correction 2.0 at non ideal inflow conditions will be used. Transverse flow effects will be compensated.
- Select `yes` if there is only one transducer pair at the measuring point (inappropriate measurement arrangement). The profile correction 2.0 at non ideal inflow conditions cannot be used. The profile correction 2.0 at ideal inflow conditions will be used. Transverse flow effects will not be compensated.
- Press ENTER.

If yes is selected, the following menu messages are displayed:

```
Disturb correct.
not applicable!
```

```
I assume ideal
inlet conditions
```

Adjustment of the transducer distance

```
Measuring\...\Transd. Distance
```

The recommended transducer distance will be displayed.

- Mount the transducers on the pipe adjusting the transducer distance.
- Press ENTER.

A – measuring channel

Reflec – reflection arrangement

Diagon – diagonal arrangement

The transducer distance is measured between the inner edges of the transducers.

In case of a measurement in diagonal mode on very small pipes, a negative transducer distance is possible.

Notice!

The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and fluid parameters.

The diagnostics window is displayed, see Fig. 9.1.

Fine adjustment of the transducer distance

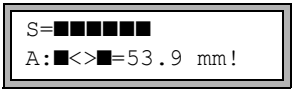
- If the displayed transducer distance is adjusted, press ENTER.

The measuring run for the positioning of the transducers is started.

The bar graph S= shows the amplitude of the received signal, see Fig. 9.1.

- Shift one of the transducers slightly within the range of the recommended transducer distance until the bar graph reaches the max. length (6 squares).

Fig. 9.1: Diagnostics window

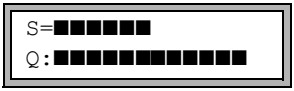


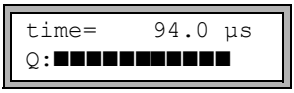
The following quantities can be displayed in the upper line by pressing key [9] and in the lower line by pressing key [3], see Fig. 9.2:

- ■<>■: transducer distance
- time: transit time of the measuring signal in µs
- S: signal amplitude
- Q: signal quality, bar graph has to have max. length

If the signal is not sufficient for a measurement, Q= UNDEF will be displayed.

Fig. 9.2: Diagnostics window





In case of large deviations, check if the entered parameters are correct or repeat the measurement at a different point on the pipe.

```
Measuring\...\Transd. Distance\54 mm
```

After the precise transducer positioning, the recommended transducer distance is displayed again.

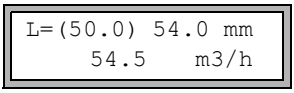
- Enter the current (exact) transducer distance.
- Press ENTER.

Repeat the steps for all channels on which a measurement is made. The measurement will be started automatically.

Consistency check

If a wide range for the sound speed has been entered in the program branch Parameter or the exact parameters of the fluid are unknown, a consistency check is recommended.

The transducer distance can be displayed during the measurement by scrolling the key [9].



The optimum transducer distance is displayed in brackets (here: 50.0 mm) in the upper line, followed by the entered transducer distance (here: 54.0 mm). The latter value has to correspond to the adjusted transducer distance.

• Press ENTER to optimize the transducer distance.

The optimum transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the sound speed range entered in the program branch `Parameter`.

If the difference between the optimum and entered transducer distance is less than specified in Tab. 9.4, the measurement is consistent and the measured values are valid. The measurement can be continued.

• If the difference is greater, adjust the transducer distance to the displayed optimum value.

• Afterwards, check the signal quality and the signal amplitude bar graph.

• Press ENTER.

Tab. 9.4: Standard values for signal optimization

transducer frequency (3rd character of the technical type)	**difference between the optimum and the entered transducer distance [mm]**	
	shear wave transducer	**Lamb wave transducer**
F	-	-60…+120
G	20	-45…+90
H	-	-30…+60
K	15	-20…+40
M	10	-10…+20
P	8	-5…+10
Q	6	-3…+5
S	3	-

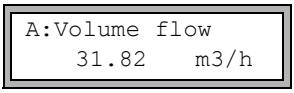
Notice!

If the transducer distance is changed during the measurement, the consistency check has to be repeated once again.

Repeat the steps for all channels on which a measurement is made.

9.4 Display of measured values

The measured values are displayed during the measurement as follows:



9.4.1 Value of the sound speed

The sound speed of the fluid can be displayed during the measurement by pressing key 3.

If an approximate range for the sound speed has been entered in the program branch `Parameter` and the transducer distance has been optimized afterwards, it is recommended to write down the sound speed for the next measurement. By doing this, it will not be necessary to repeat the fine adjustment.

Write down the fluid temperature as the sound speed depends on it. The value can be entered in the program branch `Parameter`.

9.4.2 Toggling between the channels

If more than one measuring channel is available/activated, the transmitter works with an integrated multiplexer providing simultaneous measurement on the different measuring channels.

The flow rate is measured on one measuring channel for approx. 1 s, then the multiplexer switches to the next activated channel.

The time necessary for the measurement depends on the measuring conditions. If the measuring signal e.g., cannot be detected immediately, the measurement duration might be > 1 s.

The outputs and the serial interface continuously receive the measured values of the corresponding channel. The results are displayed according to the currently selected output options. The predefined unit of measurement of the volume flow rate is m³/h.

The display of the measured values can be adjusted as follows:

- AutoMux mode
  - all channels
  - measuring channels only
  - calculation channels only
- HumanMux mode

Press key 1 to toggle between the modes.

AutoMux mode

- All channels
  The measured values of all activated channels (measuring and calculation channels) are displayed consecutively. The display and the measuring process are synchronized. The channel on which a measurement is being made is displayed in the upper line on the left.

- Measuring channels only
  The measured values of all measuring channels are displayed. The next active measuring channel is selected after min. 1.5 s.
- Calculation channels only
  The measured values of all calculation channels are displayed. The next active calculation channel is displayed after min. 1.5 s.

  This mode can only be activated if at least 2 calculation channels are active.

HumanMux mode

The measured values of one channel are displayed in the HumanMux mode. The measurement on the other channels is continued, but not displayed.

Press key [7] to display the next activated channel. The measured values for the selected channel are displayed.

9.4.3 Adjustment of the display

During the measurement, the display can be adapted in order to display 2 measured values at the same time (one in each line of the display). This does not affect totalizing, storing of measured values, transmission of measured values, etc.

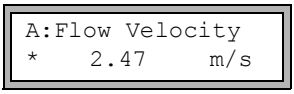
The following information can be displayed in the upper line:

display	explanation
BATT	charge state of the battery
Mass Flow	designation of the physical quantity
A: +8.879 m³	values of the totalizers, if activated
Tx	temperatures assigned to the channel and their difference if the temperature is measured
full	date and time at which the data logger will be full, if activated
Mode	measuring mode
L	transducer distance
Transd.	transducer temperature
Rx	alarm state indication if activated and if alarm outputs are activated
δc	difference between the measured sound speed and the sound speed of a selected reference fluid, if activated

The measured values of the physical quantity selected in the program branch `Output Options` can be displayed in the lower line:

display	explanation
`12.3 m/s`	flow velocity
`1423 m/s`	sound speed
`124 kg/h`	mass flow rate
`15 m3/h`	volumetric flow rate
`12 kW`	thermal energy rate

Press key [9] during the measurement to change the display in the upper line, press key [3] to change the display in the lower line.



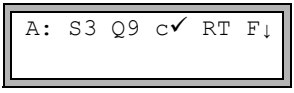
The character * indicates that the displayed value (here: flow velocity) is not the selected physical quantity.

Status line

Important information of the running measurement is summarized in the status line. Quality and precision of the running measurement can be evaluated accordingly.

Press key [9] during the measurement to scroll through the upper line to the status line.

Fig. 9.3: Display of the status line



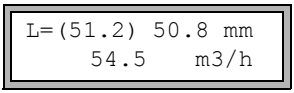
Tab. 9.5: Description of the status line

	value	explanation
S		**signal amplitude**
	0 … 9	< 5 % … ≥ 90 %
Q		**signal quality**
	0 … 9	< 5 % … ≥ 90 %
c		**sound speed** comparison of the measured and the expected sound speed of the fluid The expected sound speed is calculated from the fluid parameters.
	√	OK, is equal to the expected value
	↑	> 20 % of the expected value
	↓	< 20 % of the expected value
	?	unknown, cannot be measured
R		**flow profile** information about the flow profile based on the Reynolds number
	T	fully turbulent flow profile
	L	fully laminar flow profile
	↕	transition range between laminar and turbulent flow
	?	unknown, cannot be calculated
F		**flow velocity** comparison of the measured flow velocity with the flow limits of the system
	√	OK, the flow velocity is not within the critical range
	↑	the flow velocity is higher than the current limit
	↓	the flow velocity is lower than the current cut-off flow
	0	the flow velocity is within the limit range of the measuring method
	?	unknown, cannot be measured

9.4.4 Transducer distance

The transducer distance can be displayed during the measurement by scrolling the key [9].

Fig. 9.4: Display of the transducer distance



The optimum transducer distance (here: 51.2 mm) will be displayed in parentheses in the upper line, followed by the entered transducer distance (here: 50.8 mm).

The optimum transducer distance might change during the measurement (e.g., due to temperature fluctuations).

A deviation from the optimum transducer distance (here: 0.4 mm) will be compensated internally.

Notice!

Never change the transducer distance during the measurement.

9.5 Execution of special functions

Some key have multiple functions. They can be used to enter data, to navigate through scroll lists and to execute special functions, see Tab. 9.6.

Tab. 9.6: Key functions

key	function
[1]	toggling between the AutoMux and HumanMux mode
[8]	totalizer display
[5]	triggering snaps
[7]	toggling between the displays of the activated channels
[0]	toggling between the TransitTime and the FastFood mode
[–]	toggling between the TransitTime and the NoiseTrek mode
BRK	measurement stop
ENTER	display of diagnostic window

9.6 Determination of the flow direction

The flow direction in the pipe can be detected with the help of the displayed volumetric flow rate sign in conjunction with the arrow on the transducers:

- The fluid flows in the direction of the arrow if the displayed volumetric flow rate is positive (e.g., 54.5 m³/h).
- The fluid flows against the arrow direction if the displayed volumetric flow rate is' negative (e.g., -54.5 m³/h).

9.7 Stop of the measurement

A measurement is stopped by pressing key BRK.

Notice!
Be careful not to stop a current measurement by inadvertently pressing key BRK.

10 Troubleshooting

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

Caution!

Touching hot or cold surfaces

This may result in injuries (e.g., thermal damages).

→ Observe the ambient conditions at the measuring point during installation.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

If any problem appears which cannot be solved with the help of this operating instruction, contact our sales office and give a precise description of the problem. Specify the type, the serial number and the firmware version of the transmitter.

The display does not work at all or fails regularly

Check the contrast setting of the transmitter or enter the HotCode **555000** to set the display to medium contrast.

Check that the battery is inserted and charged. Connect the power supply unit. If the power supply is OK, the transducers or an internal component of the transmitter are defective. The transducers and the transmitter have to be sent to FLEXIM for repair.

The message "SYSTEM ERROR" is displayed

Press key BRK to return to the main menu.

If this message is displayed repeatedly, write down the number displayed in the lower line. Track down the situations when the error is displayed. Contact FLEXIM.

The backlight of the display does not work, but all other functions are available

The backlight is defective. This problem has no influence on other functions of the display. Send the transmitter to FLEXIM for repair.

The display in the lower line constantly toggles between different physical quantities

Automatic toggling of the display in the BTU mode is activated. For the deactivation of the automatic toggling, see section 21.3.

Date and time are wrong, the measured values are deleted when the transmitter is switched off

The data backup battery has to be replaced if the date and the time are reset or wrong or the measured values are deleted after the transmitter has been switched off and on. Send the transmitter to FLEXIM.

An output does not work

Make sure that the outputs are configured correctly. Check the function of the output. If the output is defective, contact FLEXIM.

10.1 Problems with the measurement

A measurement is not possible because no signal is received. A question mark is displayed after the physical quantity.

- Check whether the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the fluid. Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.
- Check the number of sound paths.
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point is selected and the number of sound paths was entered correctly.
- Try to establish a better acoustic contact between the pipe and the transducers.
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high fluid viscosity or deposits on the inner pipe wall.

The measuring signal is received but no measured values can be obtained

- A exclamation point (!) in the lower line on the right indicates that the defined upper limit of the flow velocity is exceeded and, therefore, the measured values are marked as invalid. The limit has to be adapted to the measuring conditions or the check has to be deactivated.
- If no exclamation point is displayed, a measurement at the selected measuring point is impossible.

Signal loss during the measurement

- If there is no measuring signal after the pipe had been run empty and refilled, contact FLEXIM.
- Wait a moment until the acoustic contact is reestablished. The measurement can be interrupted due to a temporarily higher proportion of gas bubbles and solids in the fluid.

The measured values substantially differ from the expected values

- Wrong measured values are often caused by wrong parameters. Make sure that the entered parameters are correct for the measuring point.

10.2 Measuring point selection

- Make sure that the recommended min. distance to any disturbance source is observed.
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points in the vicinity of deformations and defects on the pipe as well as welds.
- Make sure the pipe surface at the selected measuring point is even.
- Measure the temperature at the measuring point and make sure that the transducers are suitable for this temperature.
- Make sure that the outer pipe diameter is within the measuring range of the transducers.
- When measuring on a horizontal pipe, the transducers have to be mounted laterally on the pipe.
- The measuring point on a vertically mounted pipe has always to be filled. The fluid should flow upward.
- No gas bubbles should form (even bubble-free fluids can form gas bubbles when the fluid expands, e.g., upstream of pumps and downstream of great cross-section enlargements).

10.3 Maximum acoustic contact

see section 6.2

10.4 Application-specific problems

A fluid with a wrong sound speed was selected

If the selected sound speed in the fluid does not match the actual one, the transducer distance can probably not be determined correctly.

The fluid sound speed is used to calculate the transducer distance and is therefore very important for the transducer positioning. The sound speeds stored in the transmitter only serve as an orientation.

The entered pipe roughness is not appropriate

Check the entered value. The pipe state should be considered.

Measurements on pipes made of porous materials (e.g., concrete or cast iron) are only conditionally possible

Contact FLEXIM.

The pipe lining may cause problems during the measurement if it is not firmly attached to the inner pipe wall or consists of acoustically absorbing material

Try to measure on a section of the pipe free from lining.

Highly viscous fluids strongly attenuate the ultrasonic signal

The measurement of fluids with a viscosity of > 1000 mm²/s is only conditionally possible.

A high concentration of gases or solids in the fluid scatter and absorb the ultrasonic signal and thus attenuate the measuring signal

A measurement is impossible if the value is ≥ 10 %. If the proportion is high, but < 10 %, a measurement is only conditionally possible.

10.5 Significant deviations of the measured values

A fluid with a wrong sound speed was selected

If a fluid was selected whose sound speed does not match the actual one, the measuring signal may be confused with the pipe wall signal.

The flow calculated on the basis of the wrong signal by the transmitter is very small or fluctuates around zero.

There is gas in the pipe

If there is gas in the pipe, the measured flow will be too high because both, the liquid and gas volume, are measured.

The defined upper limit of the flow velocity is too low

All measured flow velocities that are greater than the upper limit will be ignored and marked as invalid. All quantities deviated from the flow velocity will also be indicated as invalid. If several correct measured values are ignored, the totalizer values will be too low.

The entered cut-off flow is too high

All flow velocities below the cut-off flow are set to zero. All derived quantities are also set to zero. The cut-off flow has to be set to a low value to be able to measure at low flow velocities (default: 2.5 cm/s).

The entered pipe roughness is not appropriate

The flow velocity of the fluid is outside the measuring range of the transmitter

The measuring point is not appropriate

Check whether a different measuring point provides better results. Because pipes are never rotationally symmetric, the flow profile is affected.

10.6 Problems with the totalizers

The values of the totalizers are too high

See `Special Funct.\SYSTEM settings\Measuring\Quantity recall`. If this menu item is activated, the values of the totalizer will be stored. The totalizer will continue with this value at the start of the next measurement.

The values of the totalizers are too small

One of the totalizers has reached the upper limit and has to be reset to zero manually.

The sum of the totalizers is not correct

See `Special Funct.\SYSTEM settings\Measuring\Quant. wrapping`. The sum of both totalizers (throughput) transmitted via the output is no longer valid after the first overflow (wrapping) of one of the totalizers.

10.7 Problems during the heat flow measurement

The measured values for the fluid temperature differ from the actual values.

The temperature probes are not sufficiently insulated.

On a pipe with a small pipe diameter, the temperature probe is lifted from the pipe surface by the insulation foam.

The measured absolute value of the heat flow is correct but has the opposite sign.

Check the assignment of the supply and return temperature to the temperature inputs.

The calculated heat flow differs from the actual heat flow although the measured flow and temperature values are correct

Check the heat flow coefficient of the fluid.

11 Maintenance and cleaning

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

Caution!

Touching hot or cold surfaces

This may result in injuries (e.g., thermal damages).

→ Observe the ambient conditions at the measuring point during installation.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

11.1 Maintenance

The transmitter and the transducers are practically maintenance-free. In order to ensure security, the following maintenance intervals are recommended:

item	maintenance step	interval	measure
housing • transmitter	visual inspection for corrosion and damages	annually	cleaning, see section 11.2
	visual inspection for contamination	annually, depending on the ambient conditions more frequently	
transducers	check of the transducer coupling on the tube	annually	replacement of coupling foil, if necessary
transmitter	firmware check for updates	annually	update, if necessary
transmitter	functional test	annually	reading of measured and diagnostic values
transmitter and transducers	calibration	-	see section 11.3
transmitter	charge state of the battery	-	see section 7.1.2.1 (FLUXUS *601) or 7.2.2.1 (FLUXUS *608)

11.2 Cleaning

Housing

• Clean the housing with a soft cloth. Do not use detergents.

Transducers

• Remove traces of coupling compound from the transducers with a soft paper towel.

11.3 Calibration

If installed as recommended in an appropriate location, used cautiously and serviced conscientiously, no troubles should appear.

The transmitter has been calibrated at factory and, usually, a re-calibration of the transmitter is not necessary.

A re-calibration is recommended if:

- the contact surface of the transducers show visible wear or
- the transducers were used for a prolonged period at high temperatures (several months > 130 °C for normal transducers or > 200 °C for high temperature transducers)

In order to realize a recalibration under reference conditions either the transmitter, the transducers or the transmitter with transducers have to be sent to FLEXIM depending on which part needs to be calibrated.

12 Dismounting and disposal

Danger!

Risk of explosion when using the measuring instrument in explosive atmospheres (ATEX, IECEx)

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608.

Danger!

Risk of explosion when using the measuring instrument FLUXUS *608-F2 in explosive atmospheres**

This may result in personal or material damage or other dangerous situations.

→ Observe the "Safety instructions for the use in explosive atmospheres", see document SIFLUXUS_608F2.

12.1 Dismounting

The dismounting is carried out in reverse order to its installation, see chapter 6.

12.2 Disposal

The measuring equipment has to be disposed in accordance to the applicable regulations.

Depending on the material, the corresponding parts have to be disposed in residual or special waste or recycled. For further information, contact FLEXIM.

Notice!

Used batteries do not belong to the domestic waste. Consult national regulations and guidelines for returning used batteries. Used batteries can be returned free of charge to FLEXIM.

13 Outputs

13.1 Installation of an output when using the adapter for the active current input

If the transmitter has an active current output (FLUXUS *601 only), it can be used by means of an adapter as a power supply for a passive current sink (e.g., pressure transmitter) which is connected to a passive current input, see section 7.1.4 for the connection.

Installation of the output

```
Special Funct.\SYSTEM settings\Proc. outputs
```

• Select the menu item `Special Funct.\SYSTEM settings\Proc. outputs`.
• Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\Loop I1,I2
```

• Select `active`.
• Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\Install Output
```

• Select a current output.
• Press ENTER.
A tick (✓) after a list item indicates that this output has already been installed.

```
Special Funct.\Proc. outputs\...\As energy helper
```

• Select `yes`.
• Press ENTER.
After starting the measurement, the current output is set to 24 mA.

Terminal assignment

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Active loop I1
```

The terminals for the connection of the output are displayed.
• Press ENTER.

Output function test

The function of the output can now be tested.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Energy helper I1
```

- Connect a voltmeter to the terminals of the installed output.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Check volt. now?
```

If the voltmeter is within the range 25.5 V ± 2.5 V, the output works correctly.

13.2 Installation of a binary output

If the transmitter is equipped with binary outputs, they have to be installed and activated before they can be used:

- assignment of a measuring channel (source channel) to the binary output (if the transmitter has more than one measuring channel)
- assignment of the physical quantity (source item) to be transmitted to the output by the source channel, and the properties of the signal
- activation of the installed binary output in the program branch `Output Options`

Notice!

The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

```
Special Funct.\SYSTEM settings\Proc. outputs
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. outputs`.
- Press ENTER.

Selection of a binary output

```
Special Funct.\SYSTEM settings\Proc. outputs\Install Output
```

- Select the binary output to be installed.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\Enable B1
```

- Select `yes` to install or reconfigure the output.
- Press ENTER.
- Select `no` to uninstall the output and to return to the previous menu item in order to select another output.
- Press ENTER.

Assignment of a measuring channel

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source chan. B1
```

- Select the measuring channel to be assigned to the output as the source channel in the scroll list.
- Press ENTER.

Assignment of a source item

One source item has to be assigned to each selected output.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source item
```

- Select the physical quantity (source item) to be transmitted to the binary output by the source channel.
- Press ENTER.

The source items and their scroll lists are summarized in the following table.

Tab. 13.1: Configuration of the binary outputs

source item	list item	output
`Limit`	`R1`	limit message (`Alarm Output R1`)
	`R2`	limit message (`Alarm Output R2`)
	`R3`	limit message (`Alarm Output R3`)
`Impuls`	`from abs(x)`	pulse without sign consideration
	`from x > 0`	pulse for positive measured values of the volumetric flow rate
	`from x < 0`	pulse for negative measured values for the volumetric flow rate

Function test of the binary output

The function of the output can now be tested.

- Connect an external measuring instrument to the terminals of the output.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Output Test B1\
Opto-Relay OFF
```

- Select `Opto-Relay OFF` in the scroll list `Output Test` to test the de-energized state of the output.
- Press ENTER. Measure the resistance at the output. The value has to be high ohmic.

```
Special Funct.\...\Output Test B1\B1=ON\Again?
```

- Select `yes` to repeat the test, `no` to return to the menu item `SYSTEM settings`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Output Test B1\
Opto-Relay ON
```

- Select `Opto-Relay ON` in the scroll list `Output Test` to test the energized state of the output.
- Press ENTER. Measure the resistance at the output. The value has to be low ohmic.

```
Special Funct.\...\Output Test B1\B1=ON\Again?
```

- Select `yes` to repeat the test, `no` to return to the menu item `SYSTEM settings`.
- Press ENTER.

13.3 Configuration of a frequency output as pulse output

A frequency output sends a signal with a frequency that depends on the volumetric flow rate. The frequency output can be configured in such way that the source item can be totalized by using each period of the output signal as the increment.

Installation of a frequency output (optional)

```
Special Funct.\SYSTEM settings\Proc. outputs\Install Output
```

- Select the frequency output to be installed.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\Enable F1
```

- Select `yes` to install or reconfigure the output.
- Press ENTER.
- Select `no` to uninstall the output and to return to the previous menu item in order to select another output.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source chan. F1
```

- Select the measuring channel to be assigned to the frequency output as the source channel in the scroll list.
- Press ENTER.

This display will not be indicated if the transmitter has only one measuring channel.This display will not be indicated if the transmitter has only one measuring channel.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Source item\
Measuring value
```

- Select as source item `Measuring value` in the scroll list (but not `Impuls`).
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Setup as pulse ?
```

If `Measuring value` is selected and the source item can be totalized, a request will be indicated whether the frequency output is to be configured as a pulse output.

- Select `yes`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. outputs\...\Output MAX F1
```

• Enter the upper limit of the frequency.
• Press ENTER.

The lower limit of the frequency and the error value will be set automatically to 0.5 Hz.

Activation of a frequency output

```
Output Options\for Channel A
```

• Select the channel for which the output is to be activated in the program branch `Output Options`.
• Press ENTER.

This display will not be indicated if the transmitter has only one measuring channel.This display will not be indicated if the transmitter has only one measuring channel.

```
Output Options\...\Frequency Output
```

• Press ENTER until `Frequency Output` is displayed.
• Select `yes` to activate the output.
• Press ENTER.

```
Output Options\...\Frequency Output\Pulses per unit
```

• Enter the number of pulses that is to be assigned to the unit of measurement of the totalizer.
• Press ENTER.

Example: 1000 pulses correspond to 1 m³ of the totalized fluid.

```
Output Options\...\Frequency Output\INFO: max flow= 3600.0 m3/h
```

The max. flow depending on the upper limit of the frequency and pulse value is indicated.
• Press ENTER.

13.4 Activation of a binary output as pulse output

A pulse output is an integrating output which emits a pulse when the volume or the mass of the fluid which has passed the measuring point reaches a given value (`Pulse Value`). The integrated quantity is the selected physical quantity. Integration is restarted as soon as a pulse is emitted.

Notice!

The menu item `Pulse Output` will only be indicated in the program branch `Output Options` if a pulse output has been installed.

```
Output Options\for Channel A
```

- Select the channel for which the output is to be activated in the program branch `Output Options`.
- Press ENTER.

```
Output Options\...\Pulse Output
```

- Press ENTER until `Pulse Output` is displayed. Select `yes` to activate the output.
- Press ENTER.

```
Output Options\...\Pulse Output\NO COUNTING
```

This error message will be displayed if the flow velocity is selected as the physical quantity.

The use of the pulse output is not possible in this case because the integration of the flow velocity does not result in a reasonable value.

```
Output Options\...\Pulse Output\Pulse Value
```

- Enter the pulse value. The unit of measurement will be displayed according to the actual physical quantity.

When the counted physical quantity reaches the entered pulse value, a pulse will be transmitted.

- Press ENTER.

```
Output Options\...\Pulse Output\Pulse Width
```

• Enter the pulse width.

The range of possible pulse widths depends on the specification of the instrument (e.g., counter, PLC) that is to be connected to the output.

• Press ENTER.

The max. flow the pulse output can work with will be displayed now. This value is calculated on the basis of the entered pulse value and pulse width.

If the flow exceeds this value, the pulse output does not work correctly. In this case, the pulse value has to be increased.

• Press ENTER.

14 Inputs

Transducers of other manufacturers can also be connected to the inputs (option) in order to measure the following physical quantities:

• temperature
• density
• pressure
• kinematic viscosity
• dynamic viscosity

The values of the current, voltage, and temperature inputs can be used by all measuring channels.

An input has to be assigned to a measuring channel and activated before it can be used for the measurement and for the storing of measured values.

```
Special Funct.\SYSTEM settings\Proc. inputs
```

• Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs`.
• Press ENTER.

Depending on the configuration of the transmitter, one or several of the following list items will be displayed:

Tab. 14.1: List items for `Proc. inputs`

list item	function
`Link temperature`	assignment of temperature inputs to measuring channels
`Link other inp.`	assignment of other inputs to measuring channels
`Pt100 / Pt1000`	selection of a temperature probe
`...go back`	return to the previous menu item

14.1 Assignment of the temperature inputs to the measuring channels

For the assignment of the temperature inputs during the thermal energy rate measurement see chapter 21.

```
Special Funct.\SYSTEM settings\Proc. inputs
```

• Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs`.
• Press ENTER.
• Select the list item `Link temperature`.
• Press ENTER.

```
Special Funct.\SYSTEM settings\...\A:T-Inlet
```

- Select the temperature input to be assigned to measuring channel A as supply temperature.
- Select the list item `Fixed input val.` if the supply temperature is to be entered manually before the measurement.
- Select the list item `No measuring` if no supply temperature is to be assigned to measuring channel A.
- Press ENTER.

```
Special Funct.\SYSTEM settings\...\T-Fluid/Outle\Input T1
```

- Select the temperature input to be assigned to measuring channel A as fluid temperature. The temperature value will be used for the calculation of the selected physical quantity.
- Select the list item `Fixed input val.` if the temperature is to be entered manually before the measurement.
- Select the list item `No measuring` if no temperature is to be assigned to measuring channel A.
- Press ENTER.
- Select the list items `T(3)` and `T(4)` if additional temperature values besides the fluid temperature are to be measured and stored. These additional temperature values will not be used for the calculation of the selected physical quantity.
- Repeat the steps for the available measuring channel.
- Press ENTER after each input.

Notice!

The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog for a channel has to be completed in order to store the changes.

Selection of the temperature probe

```
Special Funct.\SYSTEM settings\Proc. inputs
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. inputs\PT100/PT1000
```

- Select the list item `PT100/PT1000`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\...\Input T1
```

- Select the temperature probe.
- Press ENTER.
- If necessary, select the temperature probe for `Input T2...T4` accordingly.

14.2 Assignment of other inputs to the measuring channels

```
Special Funct.\SYSTEM settings\Proc. inputs
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Proc. inputs\Link other inp.
```

- Select the list item `Link other inp.`
- Press ENTER.

```
Special Funct.\SYSTEM settings\...\A:ext.Input(1)\Input I1
```

- Select the first input to be assigned to measuring channel A. Only the installed inputs are displayed in the scroll list.
- Select the list item `No measuring` if no input is to be assigned to measuring channel A.
- Press ENTER.

Select the list items for `ext.Input(2)...(4)` of the measuring channel A and all available channels accordingly.

Notice!

The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog for a channel has to be completed in order to store the changes.

14.3 Activation of the channels

The display for the activation of the inputs in the program branch `Output Options` will only be displayed if the transmitter has inputs of the corresponding type and they have been assigned to a measuring channel.

14.3.1 Activation of the temperature inputs

Notice!

If `Heatflow` is selected as the physical quantity, the corresponding temperature inputs will be activated automatically. The steps described below are only necessary if the measured temperatures are to be displayed or transmitted.

The temperature inputs have to be activated in case the measured temperature is to be displayed, stored and/or transmitted or if the measured temperature is to be used for the interpolation of the viscosity and the density of the fluid.

```
Output Options\for Channel A
```

- Select the channel for which an input is to be activated in the program branch `Output Options`.
- Press ENTER.

```
Output Options\...\T1:Temperature
```

- In the program branch `Output Options`, select the channel for which an temperature input is to be activated. The temperature inputs assigned to the channel will be displayed one after another.
- Select `yes` for the temperature inputs that are to be activated.
- Press ENTER.

Notice!

The total number of measured values that can be stored will be reduced if a temperature input is activated.

14.3.2 Activation of other inputs

Important!

Observe the correct polarity in order to avoid damaging the connected external transducer. A permanent short circuit can lead to the destruction of the current input.

Inputs have to be activated if the measured values are to be displayed, stored and/or transmitted together with the other measured values.

```
Output Options\for Channel A
```

- Select the channel for which an input is to be activated in the program branch `Output Options`.
- Press ENTER.

```
Output Options\...\I1:Input
```

- In the program branch `Output Options`, select the channel for which an input is to be activated. The inputs assigned to the channel will be displayed one after another.
- Select `yes` for the inputs to be activated.
- Press ENTER.

Notice!

The total number of measured values that can be stored will be reduced if a input is activated.

14.4 Temperature correction

A temperature correction (offset) can be set for each temperature input. If a correction value has been defined, it will be added automatically to the measured temperature. This function is useful if e.g.,:

- the characteristic curves of both temperature probes differ considerably from each other
- a known and constant temperature gradient exists between the measured temperature and the actual temperature

14.4.1 Activation/deactivation of the temperature correction

```
Special Funct.\SYSTEM settings\Dialogs/Menus
```

The temperature correction can be activated/deactivated in the program branch `Special Funct.\SYSTEM settings\Dialogs/Menus`.

```
Special Funct.\SYSTEM settings\Dialogs/Menus\Tx Corr.Offset
```

- Select `on` to activate the temperature correction, `off` to deactivate it.
- Press ENTER.

Notice!

If `off` is selected, the temperature correction will be deactivated for all inputs. However, the entered correction values for each temperature input will be stored and displayed again when the temperature correction is activated again.

14.4.2 Input of the temperature correction

During the flow transducer positioning, the correction values will be requested for each input which has been activated and where the temperature can be measured.

```
T1 Corr.Offset\0.3 C
```

- Enter the offset for the temperature input.
- Press ENTER.

Notice!

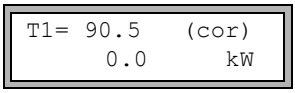
Only measured temperatures can be corrected.

In order to adjust the zero point, the same reference temperature is measured with both temperature probes. The difference of both measured temperatures is entered as the offset for one of the temperature inputs. The difference can also be distributed between the offsets of both channels.

The display of the temperature difference T1-T2 does not indicate if one or both temperatures are constant or if the values have been corrected.

During the measurement, a corrected temperature value is marked by `cor`.

Fig. 14.1: Display of the corrected temperature



15 Data logger

The transmitter has a data logger which stores the following data during the measurement.

- date
- time
- measuring point number
- pipe parameters
- fluid parameter
- transducer data
- sound path (reflection or diagonal arrangement)
- transducer distance
- damping factor
- storage rate
- physical quantity
- unit of measurement
- values of the totalizers
- diagnostic values

In order to store the data, the data logger has to be activated.

The available data logger can be displayed.

The storing of each measured value will be signalized acoustically. The acoustic signal can be deactivated.

15.1 Activation/Deactivation of the data logger

```
Output Options\for Channel A
```

- Select the channel for which the output is to be activated in the program branch `Output Options`.
- Press ENTER.

```
Output Options\...\Store Meas.Data
```

- Press ENTER until `Store Meas.Data` is displayed.
- Select `yes` to activate the data logger, `no` to deactivate it.
- Press ENTER.

15.2 Setting the storage rate

The storage rate is the frequency to transmit or store measured values. The storage rate is set separately. If the storage rate is not set, the storage rate previously selected will be used.

The storage interval should be at least equal to the number of activated measuring channels, 4 s are recommended

```
Output Options\...\Storage Rate
```

- Select a storage rate or `EXTRA`.
- Press ENTER.

This display will only be indicated if `Store Meas.Data` and/or `Serial Output` are activated.

```
Output Options\...\Storage Rate\EXTRA
```

- Enter the storage rate if `EXTRA` was selected.
- Press ENTER.

15.3 Configuration of the data logger

```
Special Funct.\SYSTEM settings\Storing
```

- Select the menu item `Special Funct.\SYSTEM settings\Storing`.
- Press ENTER.

Ringbuffer

The setting of the ringbuffer influences the storing of measured values as soon as the data logger is full:

- If the ringbuffer is activated, the available data logger will be halved. The oldest measured values will be overwritten. Only the data logger memory that was free during the activation will be used by the ringbuffer. If more data logger memory is necessary, measured values in the data logger should be previously deleted.
- If the ringbuffer is deactivated, the storing of measured values will be stopped.

```
Special Funct.\SYSTEM settings\Storing\Ringbuffer
```

- Select `ON` to activate the ringbuffer.
- Press ENTER.

Storage mode

```
Special Funct.\SYSTEM settings\Storing\Storage mode
```

• Select the storage mode.

• Press ENTER.

If `sample` is selected, the current measured value will be used for the storing and online transmission of data.

If `average` is selected, the average of all values measured during a storage interval will be used for the storing and online transmission of data.

Notice!

The storage mode does not affect the outputs.

Notice!

`Storage mode` = `average`

The average of the physical quantity and other measurands assigned to the measuring channel, will be calculated.

If the storage rate < 5 s is selected, `sample` will be used.

If no average could be calculated over the complete storage interval, the value will be marked as invalid. The ASCII file will contain `???` for invalid average values of the data and `?UNDEF` instead of invalid temperatures.

Totalizer storing

It is possible to store the currently displayed totalizer only or to store one value for each flow direction.

```
Special Funct.\SYSTEM settings\Storing\Quantity Storage
```

• Select `one` to store the currently displayed totalizer value only. This can apply for the positive and negative totalizer.

• Select `both` to store the totalizer values for both flow directions.

• Press ENTER.

Signal amplitude storing

```
Special Funct.\SYSTEM settings\Storing\Store Amplitude
```

- Select `on` to store the amplitude of the measured signal together with the measured values.
- Press ENTER.

Fluid sound speed storing

```
Special Funct.\SYSTEM settings\Storing\Store c-Medium
```

- Select `on` to store the fluid sound speed together with the measured values.
- Press ENTER.

Diagnostic values storing

```
Special Funct.\SYSTEM settings\Storing\Store diagnostic
```

- Select `on` to store the diagnostic values together with the measured values.
- Press ENTER.

Acoustic signal during the storing

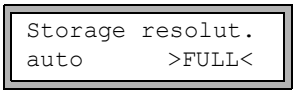
Per default, an acoustic signal will be emitted every time a measured value is stored or transmitted to a PC or printer.

```
Special Funct.\SYSTEM settings\Storing\Beep on storage
```

- Select `off` to deactivate the acoustic signal, `on` to activate it.
- Press ENTER.

Option of flow velocity storing

- Enter the HotCode **007043** immediately after the transmitter has been switched on.



- Select `auto` to store the flow velocity as an integer. Select `full` to store the flow velocity as a floating-point number.
- Press ENTER.

15.4 Measurement with activated data logger

```
Measuring\Channel\Meas.Point No.
```

• Start the measurement.
• Enter the number of the measuring point.
• Press ENTER.

If `Output Options\Store Meas.Data` is activated and `Special Funct.\SYSTEM settings\Ringbuffer` is deactivated, a message indicating an error will be displayed as soon as the data logger is full.

```
DATA LOGGER IS FULL!
```

• Press ENTER.

The error message will be displayed periodically.

15.5 Deletion of measured values

```
Special Funct.\Delete Meas.Val.
```

• Select the menu item `Special Funct.\Delete Meas.Val.`
• Press ENTER.

```
Special Funct.\Delete Meas.Val.\Really Delete?
```

• Select `yes` or `no`.
• Press ENTER.

15.6 Information relating the data logger

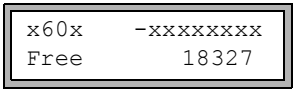
According to the configuration of the data logger and the stored series of measured values, the available data logger will be displayed in the menu item `Special Funct.\ Instrum. Inform.`

```
Special Funct.\Instrum. Inform.
```

• Select the menu item `Special Funct.\Instrum. Inform.`
• Press ENTER.

It is recommended to delete the old series of measured values before starting a measurement, see section 15.5.

Fig. 15.1: Information relating the data logger



The type and the serial number of the transmitter are displayed in the upper line.

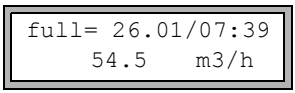
The available data logger will be displayed in the lower line (here: 18 327 additional measured values can be stored).

• Press key BRK twice to return to the main menu.

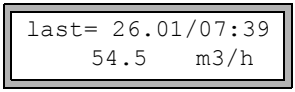
It is possible to store max. 100 series of measured values. The number of series of measured values depends on the total number of measured values stored in the previous series of measured values.

It is possible to display the time at which the data logger will be full during the measurement. All activated channels, totalizers and other values will be considered.

Press key [9] to scroll through the display of the upper line.



If the ringbuffer is activated and has overflown at least once, the following display will be indicated:



16 Data transmission

The data can be transmitted to the transmitter via the service interface RS232.

Tab. 16.1: Data transmission overview

program	data transmission	see
FluxDiagReader	offline	section 16.1
FluxDiag (optional)	online or offline	section 16.1
terminal program	online or offline	section 16.2

16.1 FluxDiagReader/FluxDiag

With the help of FluxDiagReader and FluxDiag it is possible to display measurement data, snaps and parameter settings on the PC and to export them as csv file. In order to use FluxDiagReader, the measurement has to be stopped.

In addition to this, FluxDiag allows to analyze, to compare and to visualize measurement data as well as to create reports during the measurement. A permanent data transmission via FluxDiag is not recommended.

For the operation of the programs see FluxDiagReader support or FluxDiag support.

For the connection of the service interface see section 7.1.5.

16.2 Terminal program

If FluxDiag is not available, the measurement data can be transmitted to a terminal program in ASCII format.

16.2.1 Online transmission

The measured values are transmitted during the measurement.

The data logger works independently of the online transmission but with the same transmission rate.

- Start the terminal program.
- Enter the transmission parameters into the terminal program. The transmission parameters of the terminal program and the transmitter have to be identical, see section 16.3.

```
Output Options\for Channel A
```

- Select the program branch `Output Options`.
- Press ENTER.
- Select the channel for which the online transmission is to be activated.

```
Output Options\...\Serial Output
```

- Press ENTER until the menu item `Serial Output` is displayed.
- Select `yes` to activate the online transmission.
- Press ENTER.

```
Output Options\...\Serial Output\SEND ONLINE-HEAD
```

- Enter the storage rate.
- Start the measurement.

16.2.2 Offline transmission

Notice!

During the offline transmission only those data is transmitted that is stored in the transmitter.

- Start the terminal program.
- Enter the transmission parameters into the terminal program. The transmission parameters of the terminal program and the transmitter have to be identical, see section 16.3.

Transmitter settings

```
Special Funct.\Print Meas.Val.
```

- Select the menu item `Special Funct.\Print Meas.Val.`
- Press ENTER.

The following message will be displayed if no measured values are stored.

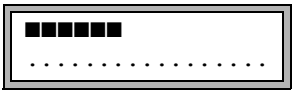
```
NO VALUES
Print Meas.Val.
```

- Press ENTER.

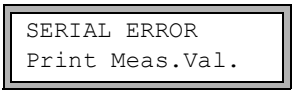
The following message will be displayed if the measurement values are transmitted.

```
Send Header
..................
```

The progress of the transmission of data is displayed by a bar graph.



The following error message will be displayed if an error has occurred during the serial transmission.



• Press ENTER.

• Check the connections and make sure the PC is ready to receive data.

16.3 Transmission parameters

• the transmitter sends CRLF-terminated ASCII

• max. line length: 255 digits

RS232

default: 9600 bits/s, 8 data bits, even parity, 2 stop bits, protocol RTS/CTS (hardware, handshake)

The transmission parameters of the RS232 service interface can be changed.

• Enter HotCode **232-0-** immediately after the transmitter has been switched on.

• Set the transmission parameters in the 4 scroll lists.

• Press ENTER.

  – `baud`: baud rate
  – `data`: number of data bits
  – `par`: parity
  – `st`: number of stop bits

16.4 Data format

`Special Funct.\SYSTEM settings\Serial transmis.\SER:kill spaces`

• Select the menu item `Special Funct.\SYSTEM settings\Serial transmis.`
• Press ENTER until `SER:kill spaces` is displayed.
• Select `on` if the space characters are not to be transmitted.
• Press ENTER.
The file size will be considerably smaller (shorter transmission time).

`Special Funct.\SYSTEM settings\Serial transmis.\SER:decimalpoint`

• Select the decimal marker to be used for floating-point numbers (point or comma).
• Press ENTER.
This setting depends on the setting of the operating system of the PC.

`Special Funct.\SYSTEM settings\Serial transmis.\SER:col-separat.`

• Select the character to be used to separate columns (semicolon or tabulator).
• Press ENTER.

16.5 Data structure

First, the header is transmitted. The first 4 lines contain general information about the transmitter and the measurement. The following lines contain the parameters for each channel.

Example

```
\DEVICE                    : F60x -XXXXXXXX
\MODE                      : ONLINE
DATE                       : 2018-01-09
TIME                       : 19:56:52
Par.Record
Meas.Point No.:            : A:F5050
Pipe
 Outer Diameter            : 60.3 mm
 Wall Thickness            : 5.5 mm
 Roughness                 : 0.1 mm
 Pipe Material             : Carbon Steel
 Lining                    : WITHOUT LINING
Medium                     : Water
 Medium Temperat.          : 38 C
 Fluid pressure            : 1.00 bar
Transducer Type            : xxx
Sound Path                 : 3 NUM
Transd. Distance           : -15.6 mm
Damping                    : 20 s
Full-Scale Val.            : 4.50 m3/h
Physic. Quant.             : Volume flow
Unit Of Measure            : [m3/h]/[m3]
Numb.Of Meas.Val           : 100
```

Next, the line `\DATA` is transmitted. Followed by the column titles, see Tab. 16.2, for the corresponding channel. The measured values are transmitted afterwards.

Example

```
\DATA
A: \*MEASURE; Q_POS; Q_NEG;
B: \*MEASURE; Q_POS; Q_NEG;
```

Depending on the storage interval, one data line per activated measuring channel is transmitted. The line "???" will be transmitted if there are no measured values available for the storage interval.

Example

With a storage interval of 1 s, 10 lines with "???" will be transmitted if the measurement has been restarted after a 10 s interruption for the positioning of the transducers.

The following data columns can be transmitted:

Tab. 16.2: Data columns

column title	column format	content
*MEASURE	###000000.00	physical quantity selected in the program branch Output Options
Q_POS	+00000000.00	totalizer value for the positive flow direction
Q_NEG	-00000000.00	totalizer value for the negative flow direction
FQ_POS		value of the totalizer for the positive flow direction (if the thermal energy rate is selected as physical quantity)
FQ_NEG		value of the totalizer for the negative flow direction (if the thermal energy rate is selected as physical quantity)
T1	###000.0	temperature T1 (= supply temperature if the thermal energy rate has been selected as physical quantity)
T2	###000.0	temperature T2 (= return temperature if the thermal energy rate has been selected as physical quantity)
...		designation for other inputs
SSPEED		sound speed of the fluid
AMP		signal amplitude

Online transmission

Columns will be created for all quantities appearing during the measurement. The columns Q_POS and Q_NEG remain empty if the totalizers are deactivated.

As the totalizers cannot be activated for the physical quantity "flow velocity", these columns will not be generated.

Offline transmission

During the offline transmission of data, columns will only be created if at least one measured value is stored in the data set. The columns Q_POS and Q_NEG will not be generated if the totalizers are deactivated.

17 Advanced functions

17.1 Totalizers

The thermal energy, total volume or total mass of the fluid at the measuring point can be determined.

There are 2 totalizers, one for the positive and the other for the negative flow direction. The unit of measurement used for totalizing corresponds to the heat, volume or mass unit selected for the physical quantity.

The totalizer values can be displayed with up to 11 places, e.g., `74890046.03`. For the adjustment of the decimal places (max. 4), see section 18.7.

Tab. 17.1: Functions to display the totalizers

activation	press key 8 during the measurement
deactivation	press key 2 3 times during the measurement
display of the flow totalizer for the positive flow direction	press key 6 during the measurement
display of the flow totalizer for the negative flow direction	press key 4 during the measurement
toggling of totalizer display between positive and negative flow direction	Select the menu item `Special Funct.\SYSTEM settings\Measuring\Toggle totalizer`. Enter a time interval between 0 (off) and 5 s.
reset of the totalizers to zero	press key 8 3 times during the measurement

Notice!

The totalizers can only be activated for the measuring channel whose measured values are currently displayed.

Notice!

The pressing of a key will only influence the flow totalizers of the measuring channel whose measured values are currently displayed.

Automatic display toggling

The automatic toggling of the totalizer display between positive and negative flow direction can be set.

```
Special Funct.\SYSTEM settings\Measuring\Toggle totalizer
```

- Enter a time interval between 0 (off) and 5 s.
- Press ENTER.

Totalizer storing

It is possible to store the currently displayed totalizer only or to store one value for each flow direction.

```
Special Funct.\SYSTEM settings\Storing\Quantity Storage
```

- Select the menu item `Special Funct.\SYSTEM settings\Storing\Quantity Storage`.
- Press ENTER.
- If `one` is selected, only the value of the totalizer currently displayed will be stored. This can apply for the positive and negative totalizer.
- If `both` is selected, the values of the totalizers for both flow directions will be stored.
- Press ENTER.

Totalizer behavior during the thermal energy rate measurement

It is possible to output and store the values of the thermal energy totalizer and the volume totalizer during thermal energy rate measurement. Select the menu item `Special Funct.\SYSTEM settings\Measuring\heat+flow quant.`

```
Special Funct.\SYSTEM settings\Measuring\heat+flow quant.
```

- Select `on` to store and output the values of the thermal energy and volume totalizer during the thermal energy rate measurement.
- Press ENTER.

Totalizer behavior after the measurement is stopped

The totalizer behavior when the measurement is stopped or after a reset of the transmitter is set in the menu item `Special Funct.\SYSTEM settings\Measuring\Quantity recall`.

```
Special Funct.\SYSTEM settings\Measuring\Quantity recall
```

- If `on` is selected, the values of the flow totalizers will be stored and used for the next measurement.
- If `off` is selected, the flow totalizers will be reset to zero.
- Press ENTER.

Totalizer overflow

The overflow behavior of the totalizers can be set:

```
Special Funct.\SYSTEM settings\Measuring\Quant. wrapping
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\Quant. wrapping`.
- Select `on` to work with overflow.

The flow totalizer will be reset to zero automatically when ±9999999999 is reached.

- Select `off` to work without overflow.

The value of the totalizer increases to the internal limit of 10^{38}. The values will be displayed as exponential numbers (±1.00000E10), if necessary. The flow totalizer can only be reset to zero manually.

- Press ENTER.

Independent of the setting, the flow totalizers can be reset to zero manually.

Notice!

The overflow of a totalizer influences all output channels, e.g., data logger, online transmission of data.

The output sum of both totalizers (throughput ΣQ) transmitted via an output is not valid after the first overflow (wrapping) of one of the totalizers.

In order to signalize the overflow of a totalizer, an alarm output with the switching condition `QUANT.` and the type `HOLD` has to be activated.

17.2 NoiseTrek parallel beam mode

The NoiseTrek parallel beam mode works with parallel mounted transducers. It improves the signal quality when measuring on small pipes or with strongly attenuating fluids.

```
Special Funct.\SYSTEM settings\Measuring\Enable NoiseTrek
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring`.
- Press ENTER until the menu item `Enable NoiseTrek` is displayed.
- Select `on` to enable the NoiseTrek mode, `off` to disable it.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Measuring\Enable NoiseTrek\
NT parallel beam
```

- Select `on` to enable the NoiseTrek parallel beam mode, `off` to disable it.
- Press ENTER.

This display will only be indicated if the NoiseTrek mode is enabled.

17.3 HybridTrek mode

The HybridTrek mode combines the TransitTime and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime and the NoiseTrek mode depending on the gaseous or solid content in the fluid in order to receive valid measuring values.

Notice!

Due to its higher measuring accuracy, the TransitTime mode should be used preferentially over the NoiseTrek mode.

```
Special Funct.\SYSTEM settings\Measuring\Enable NoiseTrek
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring`.
- Press ENTER until the menu item `Enable NoiseTrek` is displayed.
- Select `on` to enable the NoiseTrek mode, `off` to disable it.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Measuring\Enable NoiseTrek\
Auto NoiseTrek
```

- Select `no` to deactivate the automatic toggling between the TransitTime and the NoiseTrek mode. If `no` is selected, the NoiseTrek mode can only be activated and deactivated manually during the measurement.
- Select `yes` to activate the automatic toggling between the TransitTime and the NoiseTrek mode. If `yes` is selected, the NoiseTrek mode can also be activated and deactivated manually during the measurement.
- Press ENTER.

This display will only be indicated if the NoiseTrek mode is enabled and the NoiseTrek parallel beam mode has not been activated yet.

If the automatic toggling between the TransitTime and NoiseTrek mode is activated, the toggling parameters have to be configured.

```
Special Funct.\...\Auto NoiseTrek\TT-Failed |After →NoiseTrek
```

- Enter the time after which the transmitter has to toggle to the NoiseTrek mode if there are no valid measured values in the TransitTime mode. If zero is entered, the transmitter does not toggle to the NoiseTrek mode.
- Press ENTER.

```
Special Funct.\...\Auto NoiseTrek\NT-Failed |After →TransTime
```

- Enter the time after which the transmitter has to toggle from the NoiseTrek to the TransitTime mode if there are no valid measured values. If zero is entered, the transmitter does not toggle to the TransitTime mode.

If there are valid measured values in the NoiseTrek mode, the transmitter can periodically toggle to the TransitTime mode in order to check whether a measurement in the TransitTime mode is possible again. The time interval and the duration of the checking are set as follows:

```
Special Funct.\...\Auto NoiseTrek\NT-Ok,but |Each check TT
```

- Enter the time after which the transmitter has to toggle to the TransitTime mode. If zero is entered, the transmitter does not toggle to the TransitTime mode.
- Press ENTER.

```
Special Funct.\...\Auto NoiseTrek\Keep TT |For checking
```

- Enter the time after which the transmitter has to toggle from the TransitTime mode back to the NoiseTrek mode if there are no valid measured values.
- Press ENTER.

Example

```
TT-Failed →NoiseTrek: After 40s
NT-Failed →TransTime: After 60s
NT-Ok,but check TT: Each 300s
Keep TT checking: For 5s
```

If no measurement is possible in the TransitTime mode within 40 s, the transmitter toggles to the NoiseTrek mode. If no measurement is possible in the NoiseTrek mode within 60 s, the transmitter toggles back to the TransitTime mode.

If valid measured values are obtained during the measurement in the NoiseTrek mode, the transmitter toggles to the TransitTime mode every 300 s. If no measurement is possible in the TransitTime mode for the duration of 5 s, the transmitter toggles back to the NoiseTrek mode. If a valid measured value is obtained in the TransitTime mode within 5 s, the transmitter continues the measurement in the TransitTime mode.

In order to manually toggle between the TransitTime and the NoiseTrek mode during the measurement, press key [–] when the measuring mode is displayed.

17.4 Upper limit of the flow velocity

Single outliers caused by heavily disturbed surroundings can appear among the measured values of the flow velocity. If these outliers are not ignored, they will affect all derived physical quantities, which will be unsuitable for the integration (e.g., pulse outputs).

It is possible to ignore all measured flow velocities exceeding the preset upper limit. These measured values will be marked as outliers.

The upper limit of the flow velocity is set in `Special Funct.\SYSTEM settings\Measuring\Velocity limit`.

```
Special Funct.\SYSTEM settings\Measuring\Velocity limit
```

- Enter zero to switch off the outliers check.
- Enter a limit > 0 to switch on the outliers check. The measured flow velocity will then be compared to the entered upper limit.
- Press ENTER.

If the flow velocity is higher than the upper limit,

- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- the LED of the measuring channel will light red
- a (`!`) will be displayed after the unit of measurement (in case of a normal error (`?`) is displayed).

Notice!

If the upper limit is too low, a measurement might be impossible because most of the measured values will be marked as invalid.

17.5 Cut-off flow

The cut-off flow is a lower limit for the flow velocity. All measured flow velocities that are lower than the limit and their derived quantities are set to zero.

The cut-off flow can depend on the flow direction. The cut-off flow is set in `Special Funct.\SYSTEM settings\Measuring\Cut-off Flow`.

```
Special Funct.\SYSTEM settings\Measuring\Cut-off Flow
```

- Select `sign` to define a cut-off flow depending on the flow direction. One limit is set for the positive and negative flow velocity.
- Select `absolut` to define a cut-off flow independent of the flow direction. A limit is set for the absolute value of the flow velocity.
- Press ENTER.
- Select `factory` to use the default limit of 2.5 cm/s (0.025 m/s) for the cut-off flow.
- Select `user` to enter the cut-off flow.
- Press ENTER.

If `Cut-off Flow\sign` and `user` are selected, 2 values have to be entered:

```
Special Funct.\...\+Cut-off Flow
```

- Enter the cut-off flow.
- Press ENTER.

All positive values of the flow velocity smaller than this limit are set to zero.

```
Special Funct.\...\-Cut-off Flow
```

• Enter the cut-off flow.
• Press ENTER.

All negative values of the flow velocity greater than this limit will be set to zero.

If `Cut-off Flow\absolut` and `user` are selected, only one value have to be entered:

```
Special Funct.\...\Cut-off Flow
```

• Enter the cut-off flow.
• Press ENTER.

All absolute values of the flow velocity smaller than this limit are set to zero.

17.6 Profile correction

The following settings can be made for the calculation of the fluid mechanics calibration factor k_{Re}:

• `off`: profile correction 1.0
• `on`: profile correction 2.0 at ideal inflow conditions (default)
• `With disturbance`: profile correction 2.0 at non ideal inflow conditions

The following steps are necessary to set the profile correction:

• Selection of the profile correction setting for all measuring channels in the program branch `Special Funct.`
• Input of the disturbance distance in the program branch `Parameter` if `With disturbance` has been selected

If `With disturbance` has been selected, the transducers have to be mounted in reflection arrangement, X arrangement or displaced X arrangement to compensate transverse flow effects. When mounting in X arrangement, it is essential to set the same parameters for both measuring channels and to activate for them a calculation channel with average generation.

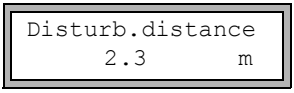
Selection of the setting

```
Special Funct.\...\Measuring\ProfileCorr 2.0
```

• Select the menu item `Special Funct.` in the program branch `Measuring`.
• Press ENTER until the menu item `ProfileCorr 2.0` is displayed.
• Select a list item (default: `on`).
• Press ENTER.

Input of the disturbance distance

If `With disturbance` is selected in the menu item `Special Funct.\SYSTEM settings\Measuring\ProfileCorr 2.0`, the disturbance distance has to be entered in the program branch `Parameter`.



• Enter the disturbance distance.

• Press ENTER.

Measurement

When starting the measurement, it is checked whether the measurement arrangement is appropriate.

17.7 Uncorrected flow velocity

For special applications, the uncorrected flow velocity might be of interest.

The profile correction for the flow velocity is activated in `Special Funct.\SYSTEM settings\Measuring\Flow Velocity`.

```
Special Funct.\SYSTEM settings\Measuring\Flow Velocity
```

• Select `normal` to display and output the flow velocity with profile correction.

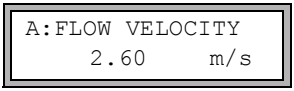
• Select `uncorr.` to display and output the flow velocity without profile correction.

• Press ENTER.

If `uncorr.` is selected, each time the program branch `Measuring` is selected it will be requested whether the profile correction is to be used or not.

If `no` is selected, the profile correction will be switched off. All physical quantities will be calculated with the uncorrected flow velocity.

During the measurement, the designation of the physical quantity is displayed in capital letters to indicate that the value is uncorrected.



• Press ENTER.

If `yes` is selected, the uncorrected flow velocity will only be used if the flow velocity is selected as physical quantity in the program branch `Output Options`.

All other physical quantities (volumetric flow rate, mass flow rate, etc.) will be determined with the corrected flow velocity.

During the measurement, the designation of the physical quantity "flow velocity" is displayed in capital letters to indicate that the value is uncorrected.

• Press ENTER.

In both cases, the corrected flow velocity can also be displayed.

Press key [3] to scroll until the flow velocity is displayed. The uncorrected flow velocity is marked with an "`U`".

Uncorrected flow velocities transmitted to a PC are marked with `uncorr.`

17.8 FastFood mode

The FastFood mode allows to measure high dynamic flows. A continuous adaptation to changing measuring conditions is only partially realized in the FastFood mode.

The sound speed of the fluid is not updated. The last measured value of the sound speed before toggling to the FastFood mode is used.

It is not possible to change the measuring channel. The measurement takes place on one channel only. As long as the FastFood mode is activated, no measurement is carried out on the other channels.

The outputs of the FastFood mode activated channel can still be used. They are actualized every 100 ms independently from the storage rate.

Outputs for further channels (multi-channel measurement) transmit an error value.

The measured values are stored with the storage rate of the FastFood mode, see section 17.8.2.

The FastFood mode has to be enabled and activated.

17.8.1 Enabling/disabling the FastFood mode

• Enter the HotCode **007022** immediately after the transmitter has been switched on.

```
Enable FastFood
```

• Select `yes` to enable the FastFood mode, `no` to disable it.

• Press ENTER.

```
Enable FastFood\FF-check (0=OFF)
```

If the FastFood mode is enabled, a time t has to be entered. When the FastFood mode is started, the signal amplification settings will always be checked after the expiration of time t.

Enter zero if no check is to be carried out.

17.8.2 Storage rate of the FastFood mode

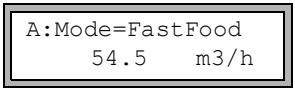
```
Output Options\...\Storing\Storage Rate
```

If the FastFood mode is enabled and when activating the data logger it is necessary to enter a storage rate in ms in the program branch `Output Options`.

17.8.3 Activation/deactivation of the FastFood mode

If the FastFood mode is enabled and a measurement is started, the normal measuring mode will still be running (i.e. multi-channel measurement with permanent adaptation to the measuring conditions). If the data logger is activated, the measured values will not be stored.

- Press key [0] to activate/deactivate the FastFood mode for the measuring channel currently displayed.
- Press key [9] to scroll through the upper line until the activated measuring mode `A:Mode=FastFood` or `A:Mode=TransTime` is displayed.



If the data logger is activated, a new data set will be created and the storing of measured values will be started. If the FastFood mode is deactivated or the measurement is interrupted, the storing will be stopped.

Notice!

The values of the current series of measured values will be deleted if the FastFood mode is deactivated and activated again without interrupting the measurement.

The values of the current series of measured values will be kept if the measurement is interrupted before the FastFood mode is activated again. A new series of measured values is created when the next measurement is started.

17.9 Calculation channels

Notice!

Calculation channels are only available if the transmitter has more than one measuring channel.

In addition to the ultrasonic measuring channels, the transmitter has 2 virtual calculation channels Y and Z. The measured values of the measuring channels A and B can be calculated via the calculation channels.

The result of the calculation is the measured value of the selected calculation channel. This measured value is equivalent to the measured values of a measuring channel. All functions which are possible with the measured values of a measuring channel (totalizing, online transmission of data, storing, output, etc.) can also be done with the values of a calculation channel.

17.9.1 Characteristics of the calculation channels

The measuring channels to be used for calculation and the calculation function have to be entered in the program branch `Parameter`.

It is possible to define 2 cut-off flows for each calculation channel. The cut-off flow is not based on the flow velocity as is the case with the measuring channels. Instead, it is defined in the unit of measurement of the physical quantity selected for the calculation channel. During the measurement, the calculation values are compared with the cut-off values and set to zero, if necessary.

A calculation channel provides valid measured values if at least one measuring channel provides valid measured values.

17.9.2 Parameterization of a calculation channel

```
Parameter\for Channel Y
```

- Select a calculation channel (Y or Z) in the program branch `Parameter`.
- Press ENTER.

```
Parameter\for Channel Y\Calculation: Y= A - B
```

The current calculation function is displayed.

- Press ENTER to edit the function.

```
>CH1< funct  ch2↕
 A      -       B
```

Three scroll lists are displayed in the upper line:

  – selection of the first measuring channel (`ch1`)
  – selection of the calculation function (`funct`)
  – selection of the second measuring channel (`ch2`)

- Select a scroll list with key 4 or 6.

The list items are displayed in the lower line.

- Press key 8 and 2 to scroll through the scroll list. All measuring channels and their absolute values can be assigned to an input channel.

The following calculation functions are available:

-	Y = ch1 - ch2
+	Y = ch1 + ch2
(+)/2	Y = (ch1 + ch2)/2
(+)/n	Y = (ch1 + ch2)/n
|-|	Y = |ch1 - ch2|

• Press ENTER.

After the parameterization of the calculation channel, the message `Y: is valid if A: and B: valid` will be displayed if the calculation function `(+)/2` is selected. The measured values of the calculation channel (here: `Y`) will be valid if the measured values of both measuring channels (here: `A` and `B`) are valid. If only one measuring channel provides valid measured values, the measured values of the calculation channel will be invalid.

After the parameterization of the calculation channel, the message `Y: is valid if A: or B: valid` will be displayed if the calculation function `(+)/n` is selected. The measured values of the calculation channel (here: `Y`) will be valid if the measured values of at least one measuring channel (here `A` or `B`) are valid. If only one measuring channel provides valid measured values, these measured values will be used for the calculation channel.

17.9.3 Output options for a calculation channel

```
Output Options\for Channel Y
```

• Select a calculation channel in the program branch `Output Options`.

• Press ENTER.

```
Output Options\for Channel Y\Physic. Quant.
```

• Select the physical quantity to be calculated.

• Press ENTER.

Make sure that the physical quantity selected for the calculation channel can be calculated from the physical quantities of the selected measuring channels, Tab. 17.2.

Tab. 17.2: Physical quantity of the calculation channel

physical quantity of the calculation channel	possible physical quantity of the first measuring channel				possible physical quantity of the second measuring channel			
	flow velocity	volume flow rate	mass flow rate	thermal energy rate	flow velocity	volume flow rate	mass flow rate	thermal energy rate
flow velocity	x	x	x	x	x	x	x	x
volumetric flow rate		x	x	x		x	x	x
mass flow rate		x	x	x		x	x	x
heat flow				x				x

Example

The difference of the volume flow rates of the channels A and B is to be calculated.

The physical quantity of the measuring channel A and B can be the volumetric flow rate or the mass flow, but not the flow velocity. The physical quantities of the 2 measuring channels do not need to be identical (channel A = mass flow, channel B = volumetric flow rate).

```
Output Options\for Channel Y:\...\Mass in
```

• Select the unit of measurement.

• Press ENTER.

It is possible to define 2 cut-off flows for each calculation channel. They are defined in the unit of measurement of the physical quantity selected for the calculation channel.

```
Output Options\for Channel Y\...\+Cut-off Flow
```

All positive calculated values less than the limit are set to zero.

```
Output Options\for Channel Y\...\-Cut-off Flow
```

All negative calculated values that are greater than the limit are set to zero.

```
Output Options\for Channel Y\...\Damping
```

- Enter the damping factor. If the damping factor for the measuring channels A or B has already been entered in the program branch, see section 9.2.2, enter zero.
- Press ENTER.

```
Output Options\for Channel Y\...\Store Meas.Data
```

- Select `yes` to activate the data logger and `no` to deactivate it.
- Press ENTER.

17.9.4 Measurement with calculation channels

```
Measuring\CHANN: A B Y Z
```

- Select the program branch `Measuring`.
- Press ENTER.
- Activate the necessary channels. The calculation channels are activated or deactivated the same way as measuring channels.
- Press ENTER.

If a measuring channel that is needed for an activated calculation channel has not been activated, a warning will be displayed.

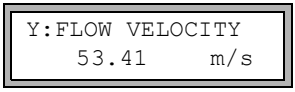
```
Measuring\...\WARNING! CHANNEL B:INACTIV!
```

- Press ENTER.

Position the transducers for all activated measuring channels. The measurement will be started automatically.

If a calculation channel is activated, the HumanMux mode will be selected at the beginning of the measurement and the values of the calculation channel will be displayed.

If the AutoMux mode is selected, the measured values of the measuring channels will be displayed alternately (but not the measured values of the calculation channels).



- Press key 9 to display the calculation function.
- Press key 7 to display the measured values of the different channels.

17.10 Diagnosis with the help of the snap function

By means of the snap function it is possible to store measuring parameters which are useful for the evaluation of measuring results or diagnosis purposes.

```
Special Funct.\SYSTEM settings\Signal snap
```

• Select the menu item `Special Funct.\SYSTEM settings\Signal snap`.
• Press ENTER.

Snap memory settings

```
Special Funct.\SYSTEM settings\Signal snap\DSP-SignalSnap
```

• Select `on` to activate the snap function and `off` to deactivate it.
• Press ENTER.

```
Special Funct.\...\DSP-SignalSnap\Install Snap
```

• Select `Install Snap`.
• Press ENTER.

```
Special Funct.\...\DSP-SignalSnap\Install Snap\Snap-Memory
```

• Enter the number of the snap memory storage space.
• Press ENTER.

```
Special Funct.\...\DSP-SignalSnap\AutoSnap
```

• Activate or deactivate the auto-snap function.
• Press ENTER.

```
Special Funct.\...\DSP-SignalSnap\Snap ringbuffer
```

• Activate or deactivate the snap ringbuffer.
• Press ENTER.

Delete snaps

```
Special Funct.\SYSTEM settings\Signal snap\DSP-SignalSnap\
Clear Snaps
```

• Select `Clear Snaps`.
• Press ENTER.

Read snaps

```
Special Funct.\SYSTEM settings\Signal snap\DSP-SignalSnap\
Snaps ->Rs232
```

• Select `Snaps ->Rs232`.
• Press ENTER.

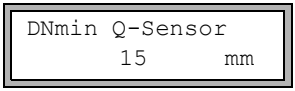
Activation of the snap function

In order to activate the snap function, press key 5 during the measurement.

17.11 Modification of the limit for the inner pipe diameter

It is possible to modify the lower limit of the inner pipe diameter for a given transducer type.

• Enter the HotCode **071001** immediately after the transmitter has been switched on.



• Enter the lower limit of the inner pipe diameter of the displayed transducer type.
• Press ENTER to select the next transducer type.

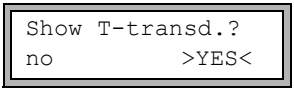
Notice!

If a transducer is used below its recommended inner pipe diameter, a measurement might be impossible.

17.12 Transducer temperature

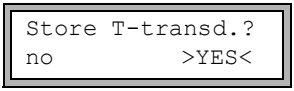
It is possible to output the transducer temperature.

• Enter the HotCode **007043** immediately after the transmitter has been switched on.



• Select `yes` to display the transducer temperature during the measurement.

• Press ENTER.



• Select `yes` to store the transducer temperature.

• Press ENTER.

17.13 Activation of a binary output as alarm output

Notice!

The menu item `Alarm Output` will only be displayed in the program branch `Output Options` if a binary output has been installed, see section 13.2.

`Output Options\for Channel A`

• Select the channel for which the output is to be activated in the program branch `Output Options`.

• Press ENTER.

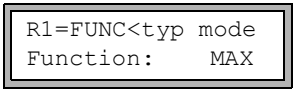
• Press ENTER until `Alarm Output` is displayed. Select `yes` to activate the alarm output.

• Press ENTER.

A max. of 3 independently operating alarm outputs R1, R2, R3 can be configured per channel. The alarm outputs can be used to output information on the current measurement or to start and stop pumps, motors, etc.

17.13.1 Alarm properties

The switching condition, the holding behavior and the switching function of an alarm output can be defined.



The following 3 scroll lists are displayed:

- `func`: switching condition
- `typ`: holding behavior
- `mode`: switching function

Press key 〈4〉 and 〈6〉 to select a scroll list in the upper line. Press key 〔8〕 and 〔2〕 to select a list item in the lower line.

- Press ENTER to store the settings.

Tab. 17.3: Alarm properties

alarm property	setting	description
`func` (switching condition)	`MAX`	The alarm will switch if the measured value exceeds the upper limit.
	`MIN`	The alarm will switch if the measured value falls below the lower limit.
	`+→- -→+`	The alarm will switch if the flow direction changes (sign change of measured value).
	`QUANT.`	The alarm will switch if totalizing is activated and the totalizer reaches the limit.
	`ERROR`	The alarm will switch if a measurement is not possible.
	`OFF`	The alarm is switched off.
`typ` (holding behavior)	`NON-HOLD`	If the switching condition is no longer true, the alarm will return to the idle state after approx. 1 s.
	`HOLD`	The alarm remains activated even if the switching condition is no longer true.
`mode` (switching function)	`NO Cont.`	The alarm is energized if the switching condition is true and de-energized if idle.
	`NC Cont.`	The alarm is de-energized if the switching condition is true and energized if idle.

Notice!

If no measurement is made, all alarms will be de-energized, independently of the programmed switching function.

17.13.2 Setting the limits

If the switching condition `MIN` or `MAX` is selected in the scroll list `func`, the limit of the output has to be defined:

```
R1 Input\Mass Flow
```

- Select the physical quantity to be used for the comparison in the scroll list `Input`. The following list items are available for the alarm output R1:
  - selected physical quantity
  - signal amplitude
  - sound speed of the fluid
- Press ENTER.

For the alarm outputs R2 and R3 the current physical quantity is set automatically.

If the switching condition `MAX` is selected in the scroll list `func`:

```
R1 Input\Function: MAX\High Limit
```

- Enter the upper limit.
- Press ENTER.

The alarm will switch if the measured value exceeds the limit.

If the switching condition `MIN` is selected in the scroll list `func`:

```
R1 Input\Function: MIN\Low Limit
```

- Enter the lower limit.
- Press ENTER.

The alarm will switch if the measured value falls below the limit.

Example

`High Limit`: -10 kg/h

mass flow rate = -9.9 kg/h
the limit is exceeded, the alarm switches

mass flow rate = -11 kg/h
the limit is not exceeded, the alarm does not switch

Example

`Low Limit`: -10 kg/h

mass flow rate = -11 kg/h
the measured value is below the limit, the alarm switches

mass flow rate = -9.9 kg/h
the measured value is not below the limit, the alarm does not switch

If the switching condition `QUANT.` is selected in the scroll list `func`, the limit of the output has to be defined:

```
R1 Input\Function: QUANT.\Quantity Limit
```

• Enter the limit of the totalizer.
• Press ENTER.

The alarm will switch when the measured value reaches the limit.

A positive limit will be compared to the totalizer value for the positive flow direction.

A negative limit will be compared to the totalizer value for the negative flow direction.

The comparison will also take place if the totalizer of the other flow direction is displayed.

Notice!

The unit of measurement of the limit is set according to the unit of measurement of the selected physical quantity.

If the unit of measurement of the physical quantity is changed, the limit has to be converted and entered again.

Example

physical quantity: mass flow rate in kg/h
`Quantity Limit`: 1 kg

Example

physical quantity: mass flow rate in kg/h
`Low Limit`: 60 kg/h

The unit of measurement of the physical quantity is changed to kg/min. The new limit to be entered is 1 kg/min.

17.13.3 Defining the hysteresis

A hysteresis can be defined for the alarm output R1. This prevents a constant triggering of the alarm when measured values fluctuate marginally around the limit.

The hysteresis is a symmetrical range around the limit. The alarm will be activated if the measured values exceed the upper limit and deactivated if the measured values fall below the lower limit.

Example

`High Limit`: 30 kg/h
`Hysterese`: 1 kg/h

The alarm is activated for measured values > 30.5 kg/h and deactivated for measured values < 29.5 kg/h.

If the switching condition `MAX` or `MIN` is selected in the scroll list `func`:

```
R1 Input\...\Hysterese
```

- Enter a value for the hysteresis or enter zero to work without hysteresis.
- Press ENTER.

17.14 Behavior of the alarm outputs

17.14.1 Apparent switching delay

The measured values and totalizer values will be displayed rounded to 2 decimal places. The limits, however, will be compared to the non-rounded measured values. This might cause an apparent switching delay when the measured value changes marginally (less than 2 decimal places). In this case the switching accuracy of the output is higher than the accuracy of the display.

17.14.2 Reset and initialization of the alarms

After an initialization of the transmitter, all alarm outputs will be configured as follows:

Tab. 17.4: Alarm state after an initialization

func	OFF
typ	NON-HOLD
mode	NO Cont.
Limit	0.00

Press 3 times key C during the measurement to set all alarm outputs to idle state. Alarm outputs whose switching condition is still met will be activated again after 1 s. This function is used to reset alarm outputs of the type HOLD if the switching condition is no longer met.

By pressing key BRK, the measurement is stopped and the main menu is selected. All alarm outputs will be de-energized, independently of the programmed idle state.

17.14.3 Alarm outputs during transducer positioning

At the beginning of the transducer positioning (bar graph display), all alarm outputs switch back to the programmed idle state.

If the bar graph is selected during the measurement, all alarm outputs will switch back to the programmed idle state.

An alarm output of the type HOLD that has been activated during the previous measurement will remains in idle state after the transducer positioning if its switching condition is no longer met.

The switching of the alarms into idle state will not be displayed.

17.14.4 Alarm outputs during measurement

An alarm output with switching condition MAX or MIN will be updated max. once per second to avoid humming (i.e. fluctuation of the measured values around the value of the switching condition).

An alarm output of the type NON-HOLD will be activated if the switching condition is met. It will be deactivated if the switching condition is no longer met. The alarm remains activated for at least 1 s even if the switching condition is met for a shorter period of time.

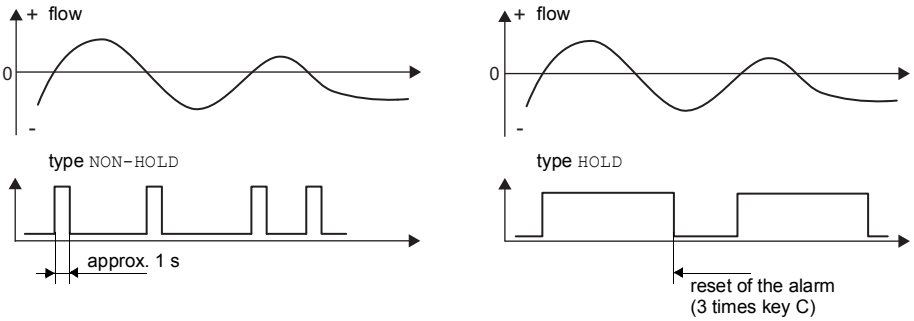
Alarm outputs with the switching condition QUANT. will be activated if the limit is reached.

Alarm outputs with the switching condition ERROR will only be activated after several unsuccessful measuring attempts. Therefore, typical short-term disturbances of the measurement (e.g., switching on of a pump) will not activate the alarm.

Alarm outputs with the switching condition +→− −→+ and the type NON-HOLD will be activated with each change of the flow direction for approx. 1 s, see Fig. 17.1.

Alarm outputs with the switching condition +→− −→+ and of the type HOLD will be activated after the first change of the flow direction. They can be switched back by pressing key C 3 times, see Fig. 17.1.

Fig. 17.1: Behavior of a relay when the flow direction changes



When adjusting to changed measurement conditions e.g, a substantial increase of the fluid temperature, the alarm will not be switched. Alarm outputs with the switching condition `OFF` will be set automatically to the switching function `NO Cont`.

Notice!

There is neither a visual nor an acoustic indication of the alarm output switching.

The alarm state can be displayed after the configuration of the alarm outputs and during the measurement. This function is activated in `Special Funct.\SYSTEM settings\Dialogs/Menus`. The activation of this function is recommended when alarm outputs have to be reconfigured frequently.

`Special Funct.\SYSTEM settings\Dialogs/Menus\SHOW RELAIS STAT`

- Select `SHOW RELAIS STAT`.
- Select `on` to activate the alarm state indication.
- Press ENTER.

If the alarm state indication is activated, the alarm output state is displayed after configuring the alarm outputs.

The alarm state indication is structured as follows:

`Rx =` [ ] [ ] [ ], with `X` being the number of the alarm output and [ ] a pictogram according to Tab. 17.5.

The configuration of the alarm outputs can be repeated by pressing key C. When the configuration of the alarm outputs is finished, press ENTER. The main menu will be displayed.

If the alarm output indication is activated, the alarm state can be displayed during the measurement. Press key 9 to scroll through the upper line or key 3 in the lower line until the alarm state is displayed.

Tab. 17.5: Pictograms for the alarm state indication

	no.		func (switching condition)	typ (holding behavior)	mode (switching function)	current state
R		=				
			OFF	NON-HOLD	NO Cont.	closed
	1		MAX	HOLD	NC Cont.	open
	2		MIN			
	3		+→- -→+			
			QUANT.			
			ERROR			

Example

R1 =

17.14.5 Deactivation of an alarm output

If the programmed outputs are no longer required, they can be deactivated. The configuration of a deactivated output is stored and will be available if the output is activated again.

`Output Options\...\Alarm Output`

- Select `no` in the menu item `Output Options\Alarm Output` to deactivate an output.
- Press ENTER.

18 SuperUser mode

The SuperUser mode offers the possibility of an advanced diagnostic of signals and measured values as well as the definition of additional parameters adapted to the measuring point, in order to achieve better measured values or for experimental work. Special features of the SuperUser mode are:

- Default settings will not be used.
- There are no plausibility tests during the parameter entry.
- It is not checked whether the entered parameters are within the limits given by physical laws and technical data.
- The cut-off flow is not activated.
- A number of sound paths has to be entered.

Some menu items that are not visible in the normal mode are displayed.

Notice!

The SuperUser mode is intended for experienced users with advanced application knowledge. The parameters can affect the normal measuring mode and lead to wrong measured values or to a measurement failure when a new measuring point is set up.

18.1 Activation/deactivation

- Enter the HotCode **071049** immediately after the transmitter has been switched on.

```
SUPERUSER MODE\IS ACTIVE NOW
```

It is displayed that the SuperUser mode is activated.

- Press ENTER. The main menu will be displayed.

The SuperUser mode is deactivated by switching off the transmitter.

Notice!

Some of the defined parameters are still activated after the deactivation of the SuperUser mode.

18.2 Transducer parameters

In the SuperUser mode, the menu item `Transducer Type` will be displayed in the program branch `Parameter` at the end of the input even if the transducers are detected by the transmitter.

```
Parameter\...\Transducer Type\Q2E-314
```

• Press ENTER.

or:

```
Parameter\...\Transducer Type\Special Version
```

• Select `Special Version` to enter the transducer parameters.

• Press ENTER.

```
Parameter\...\Transducer Type\Special Version\Transd. Data 1
```

• If `Special Version` is selected, the transducer parameters have to be entered.

The transducer parameters have to be provided by FLEXIM.

• Press ENTER after each input.

18.3 Defining flow parameters

In the SuperUser mode, it is possible to define some flow parameters (profile bounds, correction of the flow velocity) for the specific application or measuring point.

```
Special Funct.\SYSTEM settings\Measuring\Calibration
```

• Select the menu item `Special Funct.\SYSTEM settings\Measuring\Calibration`.

• Press ENTER.

```
Special Funct.\SYSTEM settings\Measuring\Calibration\for Channel A
```

• Select the measuring channel for which the flow parameters are to be defined (here: `Channel A`).

• Press ENTER.

18.3.1 Profile bounds

```
Special Funct.\...\Calibration\...\Profile bounds
```

- Select `user` to define the profile bounds. If `factory` is selected, the default profile bounds will be used and the menu item `Calibration` will be displayed.
- Press ENTER.

```
Special Funct.\...\Calibration\...\Laminar flow
```

- Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to hundreds. Enter zero to use the default value of 1000.
- Press ENTER.

```
Special Funct.\...\Calibration\...\Turbulent flow
```

- Enter the min. Reynolds number at which the flow is turbulent. The entered number will be rounded to hundreds. Enter zero to use the default value of 3000.
- Press ENTER.

```
Special Funct.\...\Calibration\...\Calibration
```

A request is displayed if an additional correction of the flow velocity is to be defined.

- Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.

Example

profile bound for laminar flow: 1500

profile bound for turbulent flow: 2500

At Reynolds numbers < 1500, the flow is regarded as laminar for the calculation of the physical quantity. At Reynolds numbers > 2500, the flow is regarded as turbulent. The range 1500...2500 is the transition range between laminar and turbulent flow.

Notice!

The defined profile bounds are still activated after the deactivation of the SuperUser mode.

18.3.2 Correction of the flow velocity

After the profile bounds have been defined, it is possible to define a correction of the flow velocity:

$v_{cor} = m \cdot v + n$

where

v – measured flow velocity

m – slope, range: -2.0...+2.0

n – offset, range: -12.7…+12.7 cm/s

v_{cor} – corrected flow velocity

All quantities derived from the flow velocity will be calculated with the corrected flow velocity. The correction data will be transmitted to the PC or printer during the online or offline transmission.

Notice!

It will not be displayed that the correction of the flow velocity is active during the measurement.

```
Special Funct.\...\Calibration\...\Calibration
```

- Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.

```
Special Funct.\...\Calibration\...\Calibration\Slope
```

- If `on` is selected, enter the slope. The input of zero deactivates the correction.
- Press ENTER.

```
Special Funct.\...\Calibration\...\Calibration\Offset
```

- Enter the offset. Enter zero to work without offset.
- Press ENTER.

Example

`Slope`: 1.1
`Offset`: -10.0 cm/s = -0.1 m/s

If a flow velocity v = 5 m/s is measured, before the calculation of the derived quantities, it will be corrected as follows:

v_{cor} = 1.1 · 5 m/s - 0.1 m/s = 5.4 m/s

Example

`Slope`: -1.0
`Offset`: 0.0

Only the sign of the measured values changes.

Notice!

The correction data will only be stored when a measurement is started. If the transmitter is switched off without starting a measurement, the entered correction data will be lost.

Notice!

The correction of the flow velocity is still activated after the deactivation of the SuperUser mode.

18.4 Limit of the signal amplification

In order to prevent disturbing and/or pipe wall signals (e.g., if the pipe has run empty) from being interpreted as useful signals, it is possible to define a max. signal amplification. If the signal amplification is greater than the max. signal amplification,

- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- a hash symbol (`#`) will be displayed after the unit of measurement (in case of a normal error, (`?`) is displayed).

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\
Gain threshold
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`.
- Press ENTER until the menu item `Gain threshold` is displayed.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\
Gain threshold\Fail if > 90 dB
```

- Enter for each measuring channel the max. signal amplification.
- Enter zero to measure without a limit of the signal amplification.
- Press ENTER.

The current value of the amplification (`GAIN`) can be displayed in the upper line in the program branch `Measuring`. If the current value of the amplification is higher than the max. amplification, the current value is displayed with `→FAIL!`.

Notice!

The limit of the signal amplification is still activated after the deactivation of the SuperUser mode.

18.5 Upper limit of the sound speed

When the plausibility of the signal is evaluated, it will be checked whether the sound speed is within a defined range. The used upper limit of the fluid sound speed is the greatest of the following values:

- fixed upper value, default: 1848 m/s
- value of the sound speed curve of the fluid at the operating point plus offset, default offset: 300 m/s

In the SuperUser mode, the values can be defined for fluids that are not contained in the data set of the transmitter.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Bad
soundspeed
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Bad soundspeed` is displayed.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Bad
soundspeed\thresh.
```

- Enter for each measuring channel the fixed upper limit of the sound speed.
- Enter zero to use the default value of 1848 m/s.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Bad
soundspeed\offset
```

- Enter for each measuring channel the offset.
- Enter zero to use the default value of 300 m/s.
- Press ENTER.

Example

fixed upper value of the sound speed (`thresh.`): 2007 m/s
`offset`: 600 m/s
value of the sound speed curve at the operating point: 1546 m/s

As 1546 m/s + 600 m/s = 2146 m/s is greater than the fixed upper value 2007, this value will be used as the upper limit of the sound speed when the plausibility of the signal is evaluated.

It is possible to display the valid range for the sound speed (`SS`) in the lower line within the program branch `Measuring` during the measurement. The second value (here: 2146 m/s) corresponds to the upper limit at the operating point.

Fig. 18.1: Display of the valid sound speed range

```
GAIN=91dB
SS=1038/2146 m/s
```

Notice!

The defined upper limit of the sound speed remains activated after the deactivation of the SuperUser mode.

18.6 Detection of long measurement failures

If there are no valid measured values during a long time interval, new increments of the totalizers will be ignored. The values of the totalizers remain unchanged.

In the SuperUser mode, it is possible to set the time interval.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Do not
total. if no meas.
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Do not total. if no meas.` is displayed.
- Enter the time. If zero is entered, the default value of 30 s will be used.
- Press ENTER.

18.7 Number of decimal places of the totalizers

The totalizer values can be displayed with up to 11 places, e.g., `74890046.03`. In the SuperUser mode, it is possible to define the number of decimal places.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Total
digits
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Total digits` is displayed.
- Select one of the following list items:
  - `Automatic`: dynamic adaptation
  - `Fixed to x digit`: x decimal places (range: 0...4)
- Press ENTER.

`Total digits = Automatic`

The number of decimal places will be adjusted dynamically. Low totalizer values will initially be displayed with 3 decimal places. If the values of the totalizers are higher, the number of decimal places will be reduced.

max. value	display		
< 10^6	±0.000	…	±999999.999
< 10^7	±1000000.00	…	±9999999.99
< 10^8	±10000000.0	…	±99999999.9
< 10^{10}	±1000000000	…	±9999999999

`Total digits = Fixed to x digit`

The number of decimal points is constant. The max value of the totalizer is reduced with the number of decimal places.

decimal places	max. value	max. display
0	$< 10^{10}$	±9999999999
1	$< 10^{8}$	±99999999.9
2	$< 10^{7}$	±9999999.99
3	$< 10^{6}$	±999999.999
4	$< 10^{5}$	±99999.9999

Notice!

The number of decimal places and the max. value defined here only affect the display of the totalizers.

18.8 Temperature-based thermal energy rate cut-off

With the temperature-based thermal energy rate cut-off, all measured temperature differences between the supply and return line that are lower than a defined value are set to zero. The thermal energy rate is also set to zero. The value of the thermal energy totalizer remains unchanged.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Thermal
low cut
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Thermal low cut` is displayed.
- Select `on` to activate the temperature-based thermal energy rate cut-off, `off` to deactivate it.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Thermal
low cut\Thermal flow ->0
```

- If `on` is selected, enter the limit of the temperature difference. All temperature differences between the supply and return line that are lower than this value will be set to zero. Enter zero to work without the temperature-based thermal energy rate cut-off.
- Press ENTER.

18.9 Manual reset of the totalizers

If the manual reset of the totalizers is activated, the totalizers can be reset to zero during the measurement by pressing key C 3 times.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\3xC
clear totals
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `3xC clear totals` is displayed.
- Select `on` to activate the manual reset of the totalizers, `off` to deactivate it.
- Press ENTER.

Notice!

The manual reset of the totalizers is still activated after the deactivation of the SuperUser mode.

18.10 Display of the totalizer sum

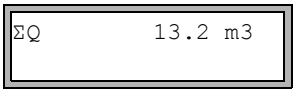
The totalizer sum of both flow directions can be displayed in the upper line during the measurement.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Show ΣQ
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Show ΣQ` is displayed.
- Select `on` to activate the display of the totalizer sum, `off` to deactivate it.
- Press ENTER.

If the display of the totalizer sum is activated, the sum ΣQ of the totalizers can be displayed in the upper line during the measurement.

Fig. 18.2: Display of the totalizer sum



18.11 Display of the last valid measured value

If the signal is not sufficient for a measurement, `UNDEF` is normally displayed. Instead of UNDEF, it is also possible to display the last valid measured value.

```
Special Funct.\SYSTEM settings\Measuring\Miscellaneous\Keep
display val
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring\ Miscellaneous`.
- Press ENTER until the menu item `Keep display val` is displayed.
- Select `on` to activate the display of the last valid measured value, `off` to deactivate it.
- Press ENTER.

18.12 Displays during the measurement

Besides the normal information, see section 9.4, the following parameters can be displayed during the measurement in the SuperUser mode:

display	explanation
`t`	transit time of the measuring signal in the fluid
`c`	sound speed
`REYNOLD`	Reynolds number
`VARI A`	standard deviation of the signal amplitude
`VARI T`	standard deviation of the transit time of the measuring signal
`dt-norm`	transit time difference standardized to the transducer frequency
	fluid density

19 Settings

19.1 Dialogs and menus

```
Special Funct.\SYSTEM settings\Dialogs/Menus
```

- Select the menu item `Special Funct.\SYSTEM settings\Dialogs/Menus`.
- Press ENTER.

Notice!

The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

19.1.1 Pipe circumference

```
Special Funct.\...\Dialogs/Menus\Pipe Circumfer.
```

- Select `on` if the pipe circumference is to be entered instead of the pipe diameter in the program branch `Parameter`.
- Press ENTER.

```
Special Funct.\...\Dialogs/Menus\Pipe Circumfer.\Outer Diameter
```

If `on` is selected for `Pipe Circumfer.`, the outer pipe diameter will still be requested in the program branch `Parameter`.

- In order to select the menu item `Pipe Circumfer.`, enter zero.
- Press ENTER.

The value displayed in `Pipe Circumfer.` is calculated on the basis of the last displayed value of the outer pipe diameter.
Example: 100 mm · π = 314.2 mm

- Enter the pipe circumference. The limits for the pipe circumference are calculated on the basis of the limits for the outer pipe diameter.
- Press ENTER.

During the next scroll through the program branch `Parameter`, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.
Example: 180 mm : π = 57.3 mm

Notice!

The edition of the pipe circumference is only temporarily. When the transmitter switches back to the display of the pipe circumference (internal recalculation), slight rounding errors may occur.

Example

entered pipe circumference: 100 mm
displayed outer pipe diameter: 31.8 mm

When the transmitter switches back to the display of the pipe circumference, 99.9 mm will be displayed.

19.1.2 Fluid pressure

The dependence of the parameters of a fluid on the pressure can be taken into account.

```
Special Funct.\...\Dialogs/Menus\Fluid pressure
```

- Select `on` to enter the fluid pressure in the program branch `Parameter`. Select `off` if 1 bar is to be used for all calculations.
- Press ENTER.

Notice!

For documentation purposes, it is useful to enter the fluid pressure, even if the transmitter contains no pressure-dependent characteristic curves.

19.1.3 Measuring point number

```
Special Funct.\...\Dialogs/Menus\Meas.Point No.
```

- Select (`1234`) if the measuring point is to be identified only by numbers, point and hyphen.
- Select (↑ ↓ ← →) if the measuring point is to be designated with ASCII characters.
- Press ENTER.

19.1.4 Transducer distance

```
Special Funct.\...\Dialogs/Menus\Transd. Distance
```

recommended setting: `user`

- `user` will be selected if the measuring point is always the same
- `auto` can be selected if the measuring point often changes

In the program branch `Measuring`, the recommended transducer distance will be displayed in parentheses, followed by the entered transducer distance if the recommended and the entered transducer distance are not identical.

```
Transd. Distance
(50.8) 50.0   mm
```

During the transducer positioning, in the program branch `Measuring`:

- only the entered transducer distance will be displayed if `Transd. Distance` = `user` is selected and the recommended and the entered transducer distances are identical
- only the recommended transducer distance will be displayed if `Transd. Distance` = `auto` is selected

19.1.5 Steam in inlet

```
Special Funct.\...\Dialogs/Menus\Steam in inlet
```

- Select `on` in case the fluid in the supply line is vaporous during the thermal energy rate measurement, see section 21.6. In this case, the supply pressure will have to be entered in the program branch `Parameter`.
- Press ENTER.

19.1.6 Temperature correction

```
Special Funct.\...\Dialogs/Menus\Tx Corr.Offset
```

- Select `on` to enable the input of a temperature correction for each temperature input.
- Press ENTER.

19.1.7 Error delay

The error delay is the time interval after which the entered value for the error value is transmitted to the output in case no valid measured values are available.

```
Special Funct.\...\Dialogs/Menus\Error-val. delay
```

- Select `damping` if the damping factor is to be used as the error delay. Select `edit` to activate the menu item `Error-val. delay` in the program branch `Output Options`. From now on, the error delay can be entered in the program branch `Output Options`.
- Press ENTER.

19.1.8 Alarm state indication

```
Special Funct.\...\Dialogs/Menus\SHOW RELAIS STAT
```

- Select `on` to display the alarm state during the measurement.
- Press ENTER.

19.1.9 Units of measurement

It is possible to set the units of measurement for the length, temperature, pressure, density and kinematic viscosity and sound speed.

- Select a unit of measurement for all quantities.
- Press ENTER after each selection.

19.1.10 Settings relating the fluid pressure

It is possible to set whether the absolute or the relative pressure is to be used:

```
Special Funct.\...\Dialogs/Menus\Pressure absolut
```

- Select `on` or `off`.
- Press ENTER.

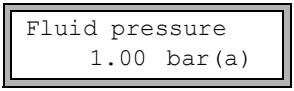
If `on` is selected, the absolute pressure p_a will be displayed/input/transmitted.

If `off` is selected, the relative pressure p_g will be displayed/input/transmitted.

$p_g = p_a - 1.01$ bar

The pressure and its unit of measurement will, e.g., be displayed in the program branch `Parameter`. It is followed by the selected pressure, indicated in parentheses:

a – absolute pressure
g – relative pressure



19.2 Measurement settings

```
Special Funct.\SYSTEM settings\Measuring
```

- Select the menu item `Special Funct.\SYSTEM settings\Measuring`.
- Press ENTER.

Notice!

The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

```
Special Funct.\...\Measuring\Enable NoiseTrek
```

- Select `on` to enable the NoiseTrek mode, `off` to disable it.
- Press ENTER.

```
Special Funct.\...\Measuring\Compare c-fluid
```

- Select `yes` if the measured sound speed is to be compared to the theoretical or expected value.
- Press ENTER.

The difference $\delta c = c_{mea} - c_{stored}$ between the two sound speeds will be displayed in the lower line during the measurement. c_{stored} is the sound speed of the reference fluid stored in the database.

- Press key 9 during the measurement to scroll to the display of δc.

```
Special Funct.\...\Measuring\ProfileCorr 2.0
```

- Select a list item:
  - `off`: profile correction 1.0
  - `on`: profile correction 2.0 at ideal inflow conditions (default)
  - `With disturbance`: profile correction 2.0 at non ideal inflow conditions
- Press ENTER.

```
Special Funct.\...\Measuring\Flow Velocity
```

- Select `normal` to display and transmit the profile corrected flow values, `uncorr.` to display and output the flow values without flow profile correction.
- Press ENTER.

For further information, see section 17.7.

```
Special Funct.\...\Measuring\Velocity limit
```

An upper limit for the flow velocity can be entered, see section 17.4.

- Enter zero to deactivate the flow velocity check.
- Press ENTER.

```
Special Funct.\...\Measuring\Cut-off Flow
```

A lower limit for the flow velocity can be entered.

- Select `sign` to define a cut-off flow depending on the flow direction. One limit is set for the positive and negative flow velocity.
- Select `absolut` to define a cut-off flow independent of the flow direction. A limit is set for the absolute value of the flow velocity.
- Press ENTER.
- Select `factory` to use the default limit of 2.5 cm/s (0.025 m/s) for the cut-off flow.
- Select `user` to enter the cut-off flow.
- Press ENTER.

If `Cut-off Flow\sign` and `user` are selected, 2 values have to be entered:

```
Special Funct.\...\Measuring\Cut-off Flow\+Cut-off Flow
```

- Enter the cut-off flow.
- Press ENTER.

All positive values of the flow velocity smaller than this limit are set to zero.

```
Special Funct.\...\Measuring\Cut-off Flow\-Cut-off Flow
```

- Enter the cut-off flow.
- Press ENTER.

All negative values of the flow velocity greater than this limit will be set to zero.

If `Cut-off Flow\absolut` and `user` are selected, only one value have to be entered:

```
Special Funct.\...\Measuring\Cut-off Flow
```

• Enter the cut-off flow.
• Press ENTER.

The absolute value of all flow velocity values lower than this limit will be set to zero.

```
Special Funct.\...\Measuring\Heat Quantity
```

The thermal energy is the totalizer of the thermal energy rate.

• Select the unit of measurement for the thermal energy (`J` or `Wh`).
• Press ENTER.

```
Special Funct.\...\Measuring\heat+flow quant.
```

• Select `on` to store and to output the values of the thermal energy totalizer and the volume totalizer during thermal energy rate measurement.
• Press ENTER.

```
Special Funct.\...\Measuring\Quant. wrapping
```

• Select the overflow behavior of the totalizers, see section 17.1.
• Press ENTER.

```
Special Funct.\...\Measuring\Quantity recall
```

• Select `on` to keep the previous totalizer values after a restart of the measurement.
• Select `off` to reset the totalizers to zero after a restart of the measurement.
• Press ENTER.

```
Special Funct.\...\Measuring\Toggle totalizer
```

It is possible to set a time period after which the display toggles between the positive and the negative totalizer during the measurement.

• Enter a time interval between 0 (off) and 5 s.
• Press ENTER.

```
Special Funct.\...\Measuring\Turbulence mode
```

The activation of the turbulence mode can enhance the signal quality if the flow is highly turbulent (e.g., in the vicinity of an elbow or valve). An SNR value of min. 6 dB is required during the measurement.

• Select `on` to activate the turbulence mode.

• Press ENTER.

19.3 Working with parameter records

19.3.1 Introduction

Parameter records are data sets that contain all information necessary to perform a certain measurement task:

• pipe parameters

• transducer parameters

• fluid parameter

• output options

Working with parameter records will make repeated measurement tasks easier and faster. The transmitter can store max. 14 parameter records.

Notice!

No parameter records are stored in the delivery state. Parameter records are entered manually.

The parameters have first to be entered in the program branch `Parameter`. Afterwards, they can be stored as parameter record.

```
Special Funct.\Store Curr.Rec.
```

• Select the menu item `Special Funct.\Store Curr.Rec.`

• Press ENTER.

The error message NO DATA! will be displayed if no complete parameter record is available. Storing is impossible.

• Enter the missing parameters in the program branch Parameter.

```
Special Funct.\Store Curr.Rec.\Store Par. To:
```

14 parameter records (Par.Record 01...Par.Record 14) can be stored.

• Select a parameter record.

• Press ENTER.

If parameters are already stored in the selected parameter record, they can be overwritten.

```
Special Funct.\Store Curr.Rec.\Store Par. To:\Overwrite
```

• Select yes to overwrite the parameters, or no to select another parameter record.

• Press ENTER.

19.3.2 Load of a parameter record

Stored parameter records can be loaded and used for measurement.

```
Parameter\for Channel A
```

• Select the program branch Parameter.

• Press ENTER.

• Select the channel for which a parameter record is to be loaded.

• Press ENTER.

```
Parameter\for Channel A\Parameter from\Par.Record 01
```

• Select the parameter record to be loaded.

• Press ENTER.

19.3.3 Deletion of parameter records

```
Special Funct.\Delete Para.Rec.
```

• Select the menu item Special Funct.\Delete Para.Rec.

• Press ENTER.

If no parameter record is stored, the message NO PAR. STORED! will be displayed.

```
Special Funct.\Delete Para.Rec.\Delete
```

- Select the parameter record to be deleted.
- Press ENTER.

```
Special Funct.\Delete Para.Rec.\Delete\Really Delete?
```

- Confirm the deletion of the parameter record.
- Press ENTER.

19.4 Libraries

The internal material database of the transmitter contains parameters for pipe and lining materials as well as for fluids.

The material and fluid scroll list displayed in the program branch `Parameter` can be arranged. Shorter scroll lists make work more effective.

```
Special Funct.\SYSTEM settings\Libraries
```

- Select the menu item `Special Funct.\SYSTEM settings\Libraries`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Libraries\Material list
```

- Select `Material list` to edit the material scroll list or `Medium list` to edit the fluid scroll list.
- Select `go back` to return to the menu item `SYSTEM settings`.
- Press ENTER.
- Select `factory` if all materials/fluids of the internal database are to be displayed in the scroll list. An already existing scroll list will not be deleted but only deactivated.
- Select `user` to activate the user defined scroll list.
- Press ENTER.

```
Special Funct.\...\Material list\user\Show list
```

If `user` is selected, the material or fluid scroll list can be edited, see section 19.4.1...19.4.3.

```
Special Funct.\...\Material list\user\End of Edit
```

• Select `End of Edit` to stop editing.
• Press ENTER.

```
Special Funct.\...\Material list\user\Save List?
```

• Select `yes` to store all changes of the scroll list or `no` to quit the menu item without storing.
• Press ENTER.

Notice!

If the material/fluid scroll list is quit by pressing key BRK before storing, all changes will be lost.

19.4.1 Displaying a scroll list

```
Special Funct.\...\Material list\user\Show list
```

• Select `Show list`.
• Press ENTER to display the scroll list as in the program branch `Parameter`.

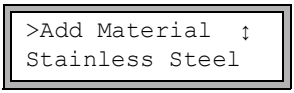
```
Special Funct.\...\Material list\user\Show list\Current list ↕
```

The current scroll list is displayed in the lower line.
• Press ENTER to return to the scroll list `Material list` or `Medium list`.

19.4.2 Adding a material/fluid to the scroll list

```
Special Funct.\...\Material list\user\Add Material
```

• Select `Add Material` or `Add Medium` to add a material/fluid to the scroll list.
• Press ENTER.
All materials/fluids that are not contained in the current scroll list will be displayed in the lower line.



- Select the material/fluid.
- Press ENTER. The material/fluid is added to the scroll list.

Notice!

The materials/fluids are displayed in the order in which they have been added.

19.4.3 Adding all materials/fluids to the scroll list

`Special Funct.\...\Material list\user\Add all`

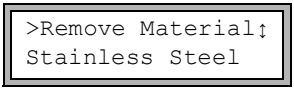
- Select `Add all` to add all materials/fluids of the database to the current scroll list.
- Press ENTER.

19.4.4 Removing a material/fluid from the scroll list

`Special Funct.\...\Material list\user\Remove Material`

- Select `Remove Material` or `Remove Medium` to remove a material/fluid from the scroll list.
- Press ENTER.

All materials/fluids of the current scroll list will be displayed in the lower line.



- Select the material/fluid.
- Press ENTER. The material/fluid will be removed from the scroll list.

Notice!

User defined materials/fluids will always be displayed in the scroll lists of the program branch `Parameter`. They cannot be removed.

19.4.5 Removing all materials/fluids from the scroll list

```
Special Funct.\...\Material list\user\Remove all
```

- Select `Remove all` to remove all materials/fluids from the scroll list.
- Press ENTER. User defined materials/fluids will not be removed.

19.5 Contrast settings

```
Special Funct.\SYSTEM settings\Miscellaneous
```

- Select the menu item `Special Funct.\SYSTEM settings\Miscellaneous`.
- Press ENTER.

```
Special Funct.\SYSTEM settings\Miscellaneous\SETUP DISPLAY
```

- Select the menu item `Special Funct.\SYSTEM settings\Miscellaneous` to set the display contrast of the transmitter.

The display contrast is adjusted with the following keys:

6 increases the contrast
4 reduces the contrast
2 sets to min. contrast
5 sets to medium contrast
8 sets to max. contrast

- Press ENTER.

It is possible to reset the display to medium contrast by means of a HotCode.

- Enter the HotCode **555000** immediately after the transmitter has been switched on.

Notice!
After an initialization of the transmitter, the display is reset to medium contrast.

20 Wall thickness measurement (optional)

Caution!

Touching hot or cold surfaces

This may result in injuries (e.g., thermal damages).

→ Observe the ambient conditions at the measuring point during installation.

→ Wear the required personal protective equipment.

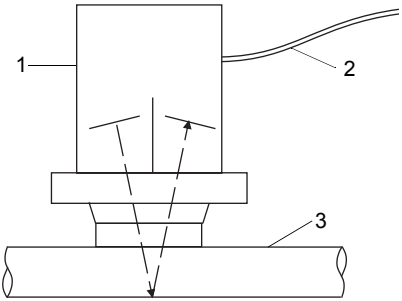
→ Observe the applicable rules.

If the transmitter has the optional wall thickness measurement, the wall thickness and the longitudinal sound speed of the pipe can be measured. In this case, a wall thickness probe that can be connected directly to the socket of a measuring channel will be included in shipment. The wall thickness probe will be detected automatically when connected to the transmitter. The measured wall thickness can be transmitted directly into the current parameter record.

A modified transit time method is used to determine the wall thickness or the sound speed of the pipe.

- The wall thickness probe emits an ultrasonic pulse which propagates in the pipe.
- The pulse is reflected by the boundary layer of the pipe and received by the wall thickness probe.
- The time difference between emitting and receiving the signal is a measure of the pipe wall thickness (if the sound speed of the material is known) or of the longitudinal sound speed of the pipe (if the wall thickness is known).

Fig. 20.1: Measurement principle



1 – wall thickness probe
2 – cable
3 – pipe

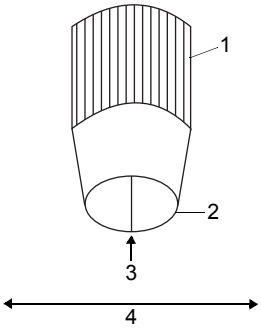
Notice!

With some few exceptions, the transversal sound speed of a material is approx. 30...60 % of the longitudinal sound speed.

20.1 Orientation of the wall thickness probe

When measuring on pipes or cylindrical vessels, the probe has to be pressed centrally against object. The applied pressure has to be constant. The acoustic partition boundary of the wall thickness probe has to be perpendicular to the longitudinal axis of the pipe, see Fig. 20.2.

Fig. 20.2: Orientation of the wall thickness probe



1 – wall thickness probe
2 – contact surface
3 – acoustic partition boundary
4 – pipe axis

20.2 Activation of the wall thickness measurement

• Connect the wall thickness probe to the measuring channel A or B.

The wall thickness measuring mode is activated automatically. A message is displayed that the wall thickness probe has been detected.

```
*WALL THICKNESS*
*DETECTED ON A:*
```

The main menu of the wall thickness measurement is displayed. The menu structure is similar to the structure of the flow measurement. The program branches are adapted to the wall thickness measurement.

Notice!

The wall thickness measurement mode will remain activated as long as the wall thickness probe is connected to the measuring channel.

20.3 Parameter input

20.3.1 Parameter input for the wall thickness measurement

The sound speed of the pipe material has to be entered to measure the wall thickness.

```
Output Options\Physic. Quant.\Wall Thickness
```

- Select in the menu item `Output Options\Physic. Quant.` the physical quantity `Wall Thickness` for the measuring channel to which the wall thickness probe is connected.

Pipe material

```
Parameter\Pipe Material
```

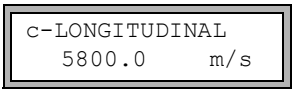
- Select the pipe material in the menu item `Parameter\Pipe Material`.
- If the material is not in the list, select `Other Material`.
- Press ENTER.

Fluid temperature

```
Parameter\Medium Temperat.
```

- Enter the fluid temperature.
- Press ENTER.

This display will not be indicated if `Other Material` is selected.



A value for the longitudinal sound speed of the selected material is recommended. If `Other Material` has been selected, 0.0 m/s will be displayed.

- Enter the sound speed, if necessary.
- Press ENTER.

Notice!

The measurement can only be started if the entered sound speed is > 0.

Compared to the flow measurement, the sound speed has a great, approximately linear influence on the measuring result. The input of a 10 % higher sound speed will result in a wall thickness which is approx. 10 % too high.

The actual sound speed of a material often differs substantially from the values published in the literature as it depends on the composition, the manufacturing process and the temperature. The sound speed values given in the annex, section C.1.

Notice!

The longitudinal sound speed of a material can be precisely measured using a reference object of known thickness, see section 20.4.2.

20.3.2 Parameter input for the sound speed measurement

The thickness of the pipe has to be entered to determine the longitudinal sound speed of a material.

```
Output Options\Physic. Quant.\c-LONGITUDINAL
```

- Select in the menu item `Output Options\Physic. Quant.` the physical quantity `c-LONGITUDINAL` for the measuring channel to which the wall thickness probe is connected.

```
Parameter\Wall Thickness
```

- Select the menu item `Parameter\Wall Thickness`.
- Enter the pipe wall thickness.

20.4 Measurement

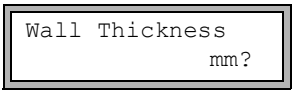
```
Measuring
```

- Select the program branch `Measuring` in the main menu.
- Press ENTER.

```
Measuring\NO DATA!
```

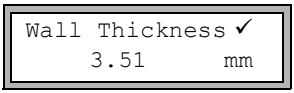
This error message will be displayed if the entered parameters are not complete.

20.4.1 Measurement of the wall thickness



This display is indicated if the wall thickness is selected as the physical quantity for the measuring channel connected to the probe.

As long as there is no valid measured value, the unit of measurement and a question mark will be displayed in the lower line.



- Apply a thin film of the coupling compound to the pipe wall.
- Press the wall thickness probe against the pipe wall in this position.

As soon as a valid measured value is obtained, it will be displayed in the lower line. A tick will be displayed in the upper line on the right.

The measured value remains on the display when the wall thickness probe is removed from the pipe.

To minimize errors when measuring the wall thickness, measure the longitudinal sound speed on a reference object of the same material with known dimensions.

- The reference object should be even and smooth.
- The thickness of the reference object should be comparable to the max. thickness of the pipe.

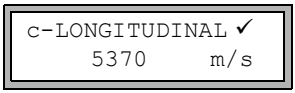
Notice!

The sound speed of the material depends on the temperature. Therefore, the sound speed of a reference object should be measured at the place where the flow will be measured later to obtain the sound speed at the correct temperature.

20.4.2 Measurement of the sound speed

This display will be indicated if the sound speed is selected as measurand for the measuring channel connected to the wall thickness probe.

As long as there is no valid measured value, the unit of measurement and a question mark will be displayed in the lower line.



• Apply a thin film of the coupling compound to the pipe wall.

• Press the wall thickness probe against the pipe wall in this position.

As soon as a valid measured value is obtained, it will be displayed in the lower line. A tick will be displayed in the upper line on the right.

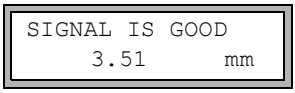
The measured value remains on the display when the wall thickness probe is removed from the pipe.

Notice!

For pipe materials whose longitudinal sound speed can be used for the measurement of the volumetric flow rate see annex, section C.1.

20.4.3 Further information concerning the measurement

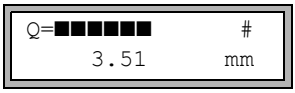
• Press key [9] to obtain information on the measuring signal.



This message will be displayed if the measuring signal is sufficient. The LED of the measuring channel lights green.

This message will be displayed if the measuring signal is not sufficient (# = number). The LED of the measuring channel lights red.

• Press key [9] again. The bar graph of the signal quality (Q=) will be displayed.



If the signal is not sufficient for measurement, UNDEF will be displayed. The LED of the measuring channel lights red.

• Shift the wall thickness probe slightly on the pipe until the LED of the measuring channel lights green.

• Press key [3] to display the transit time of the signal.

```
Wall Thickness
LZ=  186     ns
```

20.4.4 Errors during the measurement

If no valid wall thickness can be measured:

- remove the wall thickness probe from the pipe wall
- clean the wall thickness probe and the place where the measurement takes place
- apply a thin film of the coupling compound to the pipe wall
- press the wall thickness probe against the pipe wall in this position
- try to measure again

Notice!

Use a small amount of coupling compound. Press the wall thickness probe evenly against the pipe wall.

20.4.5 Possible reasons for incorrect measuring results

- **temperature fluctuations:**
  The sound speed is temperature dependent.
- **doubling effect:**
  When measuring the wall thickness using ultrasonic signals, a phenomenon called doubling effect can occur if the wall thickness is smaller than the min. value of the measuring range of the probe. The measured value is then twice (or sometimes 3 times) as high as the actual wall thickness because of repeated reflections of the ultrasonic signal.
- **the measured value is too low:**
  The ultrasonic signal was reflected by a defect and not by the boundary layer, resulting in a shorter transit time and therefore a lower wall thickness.
- **curved surfaces:**
  The probe has to be pressed centrally against the pipe or cylindrical vessel. The applied pressure has to be constant. The acoustic partition boundary of the wall thickness probe has to be perpendicular to the longitudinal axis of the pipe, see Fig. 20.2.
- **surface conditions:**
  Regular unevenness (e.g., small grooves) on the surface of the pipe can result in wrong measured values. Normally, this problem can be avoided by turning the wall thickness probe in such way that its acoustic partition boundary is perpendicular to the orientation of the grooves, see Fig. 20.2.

When measuring on a rough surface, applying too much of the coupling compound can result in wrong measured values. A measurement on a very rough surface might be impossible (the message `NO COUPLING` will be displayed). In this case, the surface has to be smoothed.

20.4.6 Storing/transmission of the wall thickness

• Press ENTER to stop the measurement and to store or output the measured value.

The following display appears if a valid wall thickness has been measured and the transmission of measured value is activated:

• Select `yes` to store and/or output the measured value.

The wall thickness can be transmitted into the current parameter record.

The pipe material will be replaced by the material used for the wall thickness measurement.

If the serial transmission is activated, the measured value will be transmitted.

20.4.7 Stop of the wall thickness measurement

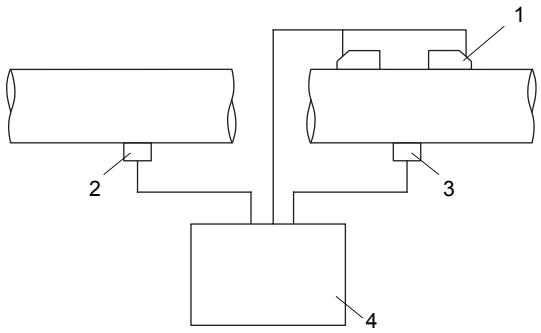
• In order to quit the wall thickness measurement mode, disconnect the wall thickness measurement from the transmitter.

21 Heat flow measurement

If the transmitter has the optional heat quantity measurement and 2 temperature inputs, the heat flow can be measured. A temperature probe is fixed on the supply and the return line.

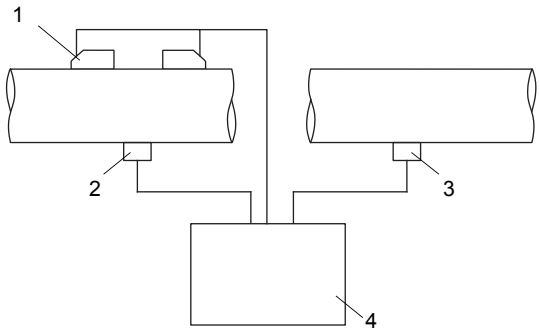
The transducers are fixed on the return line, see Fig. 21.1. If this is not possible, they can also be mounted on the supply line, see Fig. 21.2.

Fig. 21.1: Heat flow measurement on return line



1 – transducers on return line
2 – temperature probe on supply line (temperature input T1)
3 – temperature probe on return line (temperature input T2)
4 – transmitter

Fig. 21.2: Heat flow measurement on supply line



1 – transducers on supply line
2 – temperature probe on supply line (temperature input T1)
3 – temperature probe on return line (temperature input T2)
4 – transmitter

For the thermal energy rate measurement, 2 different measuring modes can be used:

- The normal measuring mode can be used if in a heating application the transducers are mounted on the return line.
- The BTU mode facilitates the measurement with other configurations (e.g., if the transducers are mounted on the supply line or in a cooling application) and offers additional units of measurement for the thermal energy rate.

A temperature correction value (offset) can be set for each temperature input.

If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered as a constant value. In this case, the corresponding temperature probe does not need to be connected.

If the supply pressure is constant or can be measured with an additional input, the thermal energy rate can be determined for a fluid that is vaporous in the supply line, see section 21.6.

In the SuperUser mode, it is possible to define a temperature-based cut-off flow of the thermal energy rate, see section 18.8.

The thermal energy is the totalizer of the thermal energy rate.

21.1 Calculation of the heat flow

The heat flow is calculated with the following formula:

$\Phi = k_i \cdot \dot{V} \cdot (T_V - T_R)$

where

Φ – heat flow

k_i – heat coefficient

$\dot{V}$ – volumetric flow rate

T_V – supply temperature

T_R – return temperature

The heat coefficient k_i is calculated from several heat flow coefficients for the specific enthalpy and the density of the fluid. The heat coefficients of some fluids are stored in the internal database of the transmitter.

21.2 Normal measuring mode

The supply and return temperature have to be assigned to the measuring channels as `T-Inlet` and `T-Fluid/Outle`. The temperatures can be measured or entered as constant values.

21.2.1 Flow measurement on the return line

The temperature inputs are configured as follows:

```
Special Funct.\SYSTEM settings\Proc. inputs\Link temperature
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Inlet\Input T1
```

- Select the list item `Input T1` to assign the temperature probe on the supply line to the temperature input T1.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Fluid/Outle\Input T2
```

- Select the list item `Input T2` to assign the temperature probe on the return line to the temperature input T2.
- Press ENTER.

21.2.2 Flow measurement on the supply line

The temperature inputs, see Fig. 21.1, are configured as follows:

```
Special Funct.\SYSTEM settings\Proc. inputs\Link temperature
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Inlet\Input T2
```

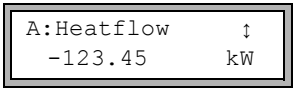
- Select the list item `Input T2` to assign the temperature probe on the supply line to the temperature input T2 (even though it is connected to the temperature input T1).
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Fluid/Outle\Input T1
```

- Select the list item `Input T1` to assign the temperature probe on the return line to the temperature input T1 (even though it is connected to the temperature input T2).
- Press ENTER.

The measuring values of the thermal energy rate will be displayed with the opposite sign during the measurement.

Fig. 21.3: Display of the thermal energy rate



21.2.3 Input of a constant temperature

If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered as a constant value.

The temperature inputs are configured as follows:

```
Special Funct.\SYSTEM settings\Proc. inputs\Link temperature
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Inlet\Fixed input val.
```

- Select the list item `Fixed input val.` if the supply temperature is known and constant.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Fluid/Outle\Fixed input val.
```

- Select the list item `Fixed input val.` if the return temperature is known and constant.
- Press ENTER.
- Repeat the steps for all measuring channels on which a measurement is being made.

The constant value of the temperature is entered in the program branch `Measuring` before the start of the measurement.

21.2.4 Definition of the physical quantity and the unit of measurement

`Output Options\for Channel A`

- Select the channel in the program branch `Output Options` on which the thermal energy rate is to be measured (the channel to which the temperature inputs have been assigned).
- Press ENTER.

`Output Options\...\Physic. Quant.\Heatflow`

- Select `Heatflow` as physical quantity.
- Press ENTER.
- Select the unit of measurement to be used for the thermal energy rate.
- Press ENTER.

Notice!

The physical quantity `Heatflow` will only be displayed in the program branch `Output Options` of a measuring channel if the supply and return temperature have been assigned to this channel.

`Special Funct.\SYSTEM settings\Measuring\Heat Quantity`

- If the thermal energy is also to be measured, select the menu item `Special Funct.\ SYSTEM settings\Measuring`.
- Press ENTER until `Heat Quantity` is displayed.
- Select the unit of measurement (`J` or `Wh`).

Press ENTER.

21.3 BTU mode

The BTU mode (BTU = British Thermal Unit) is a measuring mode that is designed specifically for the thermal energy rate measurement. In the BTU mode, the position of the transducers and the application can be assigned to avoid receiving the opposite sign of the measured values.

21.3.1 Activation/deactivation of the BTU mode

• Enter the HotCode **007025** immediately after the transmitter has been switched on.

```
Act as BTU-meter
```

• Select `on` to activate the BTU mode, `off` to deactivate it.
• Press ENTER.

Notice!
The BTU mode remains activated after a restart of the transmitter.

21.3.2 Assignment of the transducers and the temperature inputs

The position of the transducers and the temperature inputs can be assigned in accordance with the application.

Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.

```
Special Funct.\SYSTEM settings\Proc. inputs\Link temperature
```

• Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.
• Press ENTER.

```
Special Funct.\...\A:Thermal energy
```

• In case of a heating application, select `heat`, in case of a cooling application `chill`.
• Press ENTER.

```
Special Funct.\...\Transd. Location
```

• Select `return`, if the transducers are mounted on the return line or `supply`, if the transducers are mounted on the supply line.
• Press ENTER.

```
Special Funct.\...\Thermal energy
```

- Select `sign` if the sign of the thermal energy rate is to be considered, `absolute`, if the absolute value of the thermal energy rate is to be displayed.
- Press ENTER.

```
Special Funct.\...\With PhaseChange
```

- Select `yes` if the aggregate state of the fluid changes between the retun and supply line. Select `no` if it does not change.
- Press ENTER.

```
Special Funct.\...\A:T-Supply\Input T1
```

- Select the temperature input to be assigned to the supply temperature.
- Press ENTER.

```
Special Funct.\...\A:T-Return\Input T2
```

- Select the temperature input to be assigned to the return temperature.
- Press ENTER.

21.3.3 Input of a constant temperature

If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered as a constant value.

The temperature inputs are configured as follows:

```
Special Funct.\SYSTEM settings\Proc. inputs\Link temperature
```

- Select the menu item `Special Funct.\SYSTEM settings\Proc. inputs\Link temperature`.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Inlet\Fixed input val.
```

- Select the list item `Fixed input val.` if the supply temperature is known and constant.
- Press ENTER.

```
Special Funct.\...\Link temperature\T-Fluid/Outle\
Fixed input val.
```

• Select the list item `Fixed input val.` if the return temperature is known and constant.
• Press ENTER.
• Repeat the steps for all measuring channels on which a measurement is being made.

The constant value of the temperature is entered in the program branch `Measuring` before the start of the measurement.

21.3.4 Definition of the physical quantity and the unit of measurement

```
Output Options\for Channel A
```

• Select the channel in the program branch `Output Options` on which the thermal energy rate is to be measured (the channel to which the temperature inputs have been assigned).
• Press ENTER.

```
Output Options\...\Physic. Quant.\Thermal energy
```

• Select `Thermal energy` as physical quantity.
• Press ENTER.
• Select the unit of measurement to be used for the thermal energy rate.
• Press ENTER.

In the BTU mode, additional units of measurement are available for the thermal energy rate and the thermal energy. The unit of measurement displayed during the measurement will be adjusted automatically:

unit of measurement of the thermal energy rate	unit of measurement of the thermal energy
kBTU/min	kBTU
kBTU/h	kBTU
MBTU/h	MBTU
kBTU/day	MBTU
TON (TH)	TH
TON (TD)	TD
kTON (kTH)	kTH
kTON (kTD)	kTD

21.3.5 Automatic display toggling in the lower line

In the BTU mode, it is possible to activate automatic toggling of the display in the lower line.

Activation

• Press key [▪] 3 times during the measurement.

The following physical quantities will be displayed at an interval of 3 s:

– physical quantity selected in the program branch `Output Options`
– fluid temperature in the supply line
– fluid temperature in the return line
– difference between the fluid temperatures in the supply line and return line

Deactivation

• Press key [▪] 3 times during the measurement.

21.4 Measurement

• Start the measurement as usual.

If no thermal energy rate coefficients are available for the selected fluid, an error message will be displayed.

```
Heatflow
*INVALID MEDIUM*
```

The two temperature inputs are checked and the measured temperatures are displayed. Press ENTER.

```
T1=  90.2       C
T2=  70.4       C
```

If a temperature cannot be measured (the temperature probe is not connected or is defective), the error message `?UNDEF` will be displayed.

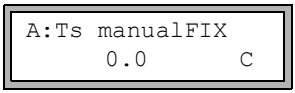
```
T1=?UNDEF       C
T2=  70.4       C
```

If `Fixed input val.` is selected during the configuration of the temperature input, the temperature input (`Ts`) or the return temperature (`Tr`) have to be entered now.

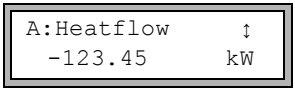
For simulations, it is possible to enter both the supply and return temperatures as constants. In this case, do not connect the temperature probes to the transmitter.

• Enter the fluid temperature.

• Press ENTER.



The measured thermal energy rate (in BTU mode `Thermal energy`) is displayed.



21.5 Two independent heat flow measurements

If the transmitter has 2 measuring channels and 4 temperature inputs for each measuring channel, it is possible to conduct 2 independent heat flow measurements at the same time. Tab. 21.1 shows a typical configuration of the temperature inputs.

Tab. 21.1: Configuration of the temperature inputs in case of 2 independent heat flow measurements

		temperature input
measuring channel A	supply temperature	T1 or constant value
	return temperature	T2 or constant value
	heat quantity measurement	possible
measuring channel B	supply temperature	T3 or constant value
	return temperature	T4 or constant value
	heat quantity measurement	possible

21.6 Steam in inlet

If the supply pressure is constant or can be measured with an additional input, the thermal energy rate can be determined for a fluid that is vaporous in the supply line.

The state of aggregation of the fluid is determined by means of the supply pressure and the supply temperature.

Notice!

The measurement of the volumetric flow rate and the thermal energy rate is only possible when the fluid is liquid in the return line.

The steam coefficient of water and ammonia are stored in the internal database of the transmitter. The steam coefficient of other fluids have to be entered with the program FluxSubstanceLoader.

21.6.1 Activation/deactivation

`Special Funct.\SYSTEM settings\Dialogs/Menus\Steam in inlet`

- Select the menu item `Special Funct.\SYSTEM settings\Dialogs/Menus\Steam in inlet`.
- Press ENTER.
- Select `on` to deactivate `Steam in inlet`. The state of aggregation of the fluid is determined by means of the supply pressure and the supply temperature of the fluid.
- Select `off` to deactivate `Steam in inlet`. The fluid is then always considered to be liquid in the supply line.
- Press ENTER.

`Special Funct.\...\Steam in inlet\Inlet pressure`

- If `Steam in inlet` is activated, the supply pressure has to be entered in the program branch `Parameter`.
- Enter the supply pressure.
- Press ENTER.

Notice!

The menu item `Steam in inlet` will always be displayed independently of the selected physical quantity. However, the supply pressure will only be used for the thermal energy rate measurement.

21.6.2 Display of the aggregation state

During the thermal energy rate measurement, the state of aggregation of the fluid can be displayed in the upper line by pressing the key 9.

display	explanation
S	aggregation state in the supply line
R	aggregation state in the return line
GAS	The fluid is completely gaseous.
LIQU	The fluid is completely liquid.
BOIL	The fluid is in phase transition. In this case, an exact measurement of the thermal energy rate is not possible because the proportion of the fluid in liquid phase in the supply line has to be known in order to calculate the enthalpy of the supply. The critical range of water is defined as the range ±3 °C around the boiling temperature. In the critical range, the steam saturation enthalpy is used to calculate the thermal energy rate.

Example

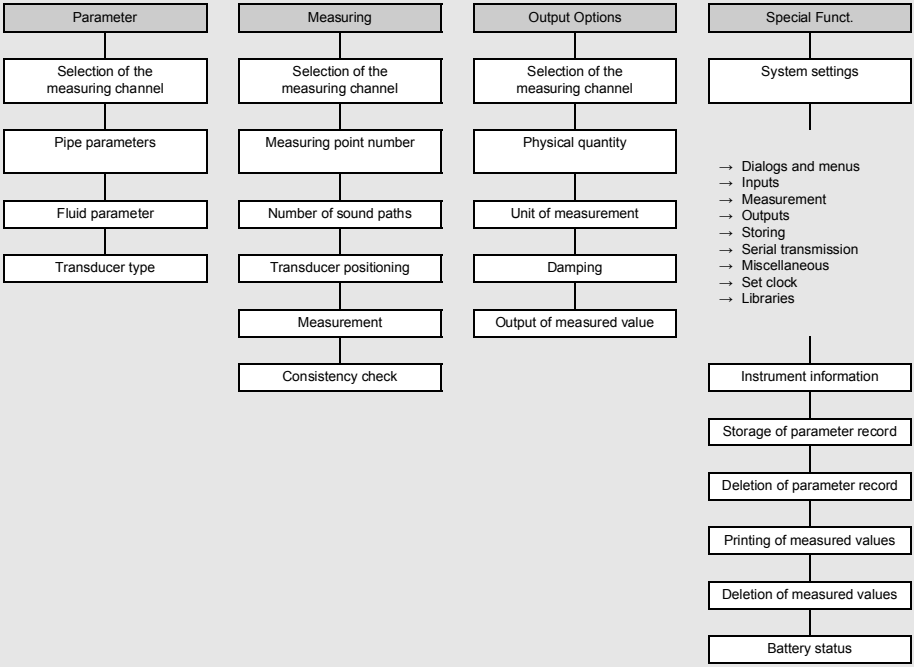
A:S= GAS R= LIQU

The fluid in the supply line is completely gaseous. The fluid in the return line is completely liquid. A thermal energy rate measurement is possible.

Annex

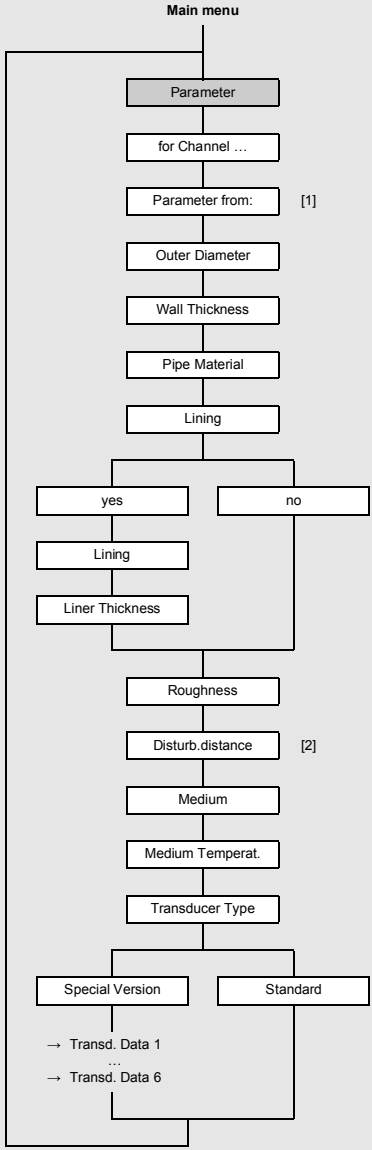
A Menu structure

Program branches



Parameter input

(see chapter 9)



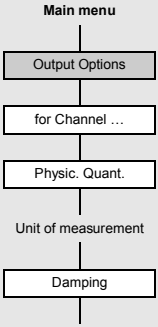
Legend

[1] only if a parameter record is stored

[2] only if `With disturbance` is selected in the menu item `Special Funct.\SYSTEM settings\ Measuring\ProfileCorr 2.0`

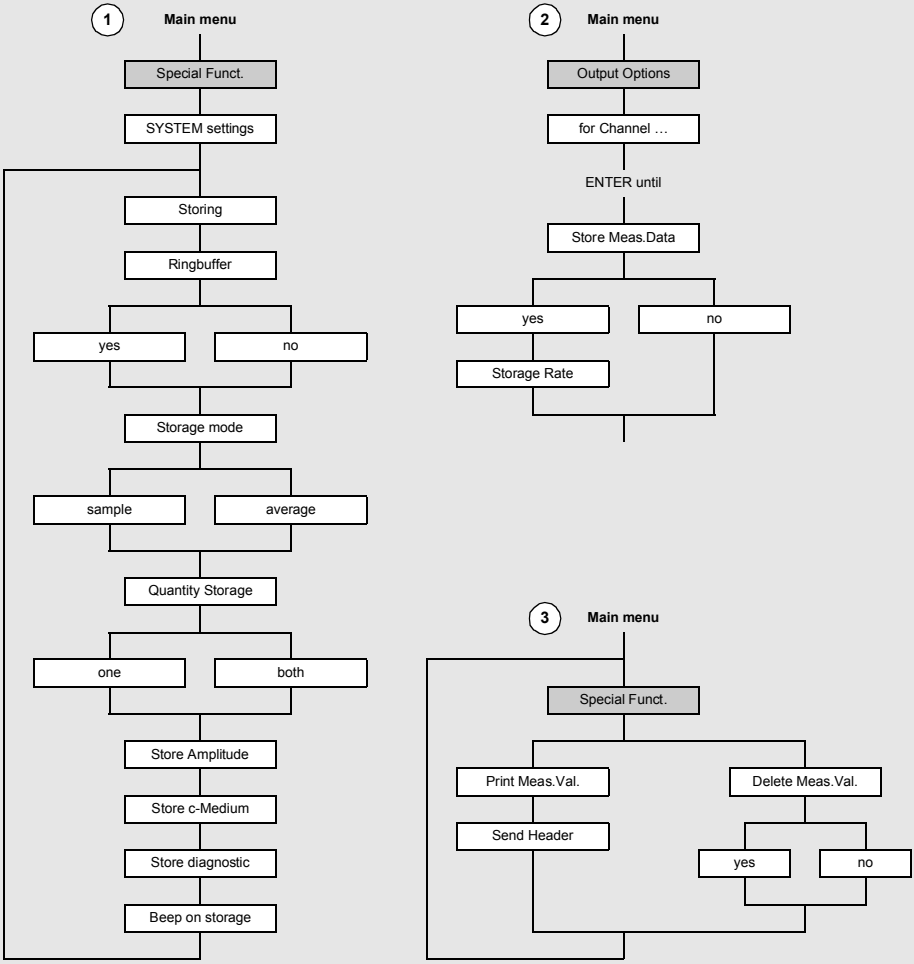
Measurement settings

(see chapter 9)



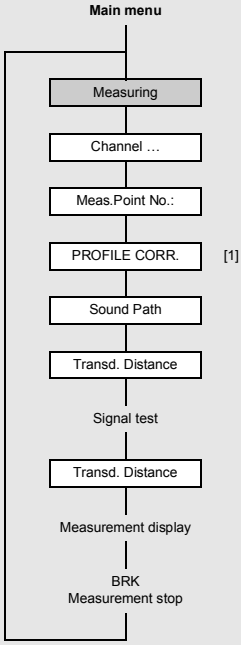
Data logger

(see chapter 15)



Measurement start

(see chapter 9)

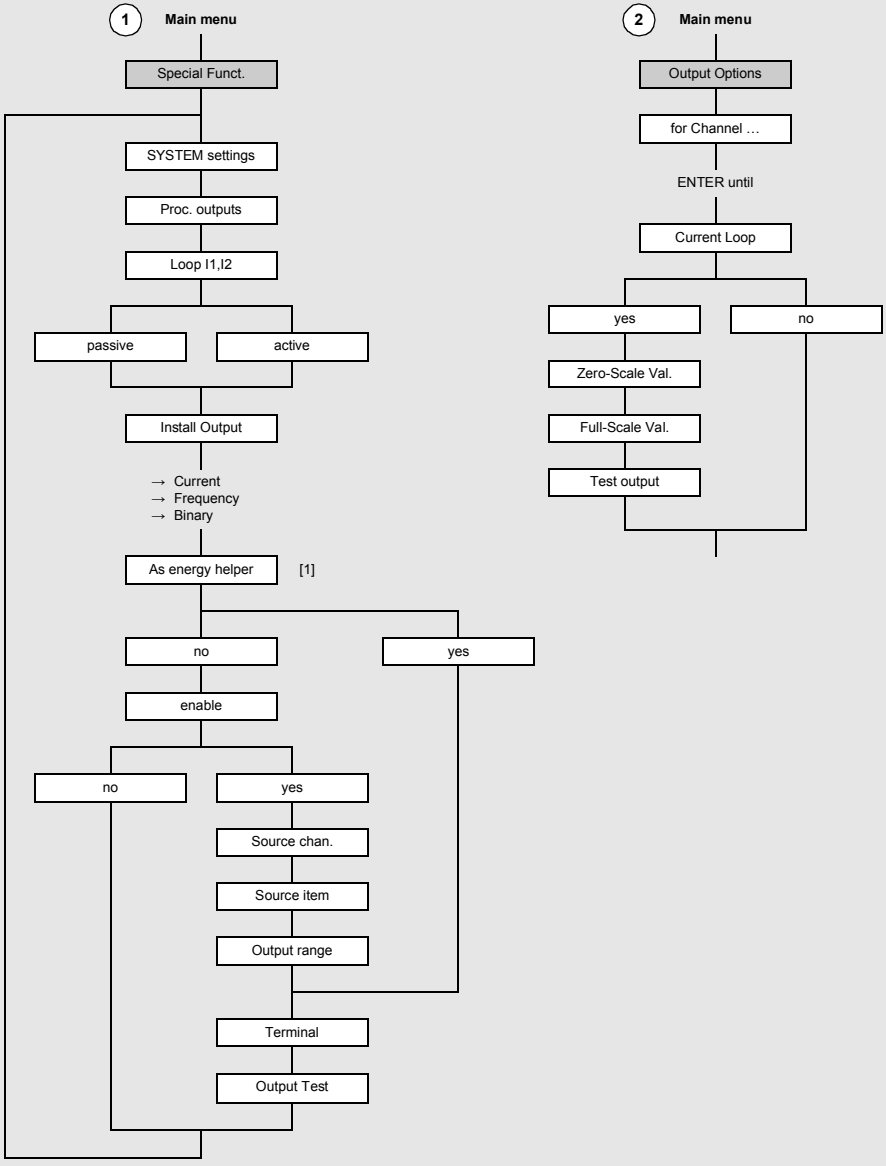


legend

[1] this will only be displayed if `Special Funct.\SYSTEM settings\Measuring\Flow Velocity uncorr.` is selected in the menu item

Configuration of the outputs

(see chapter 9)

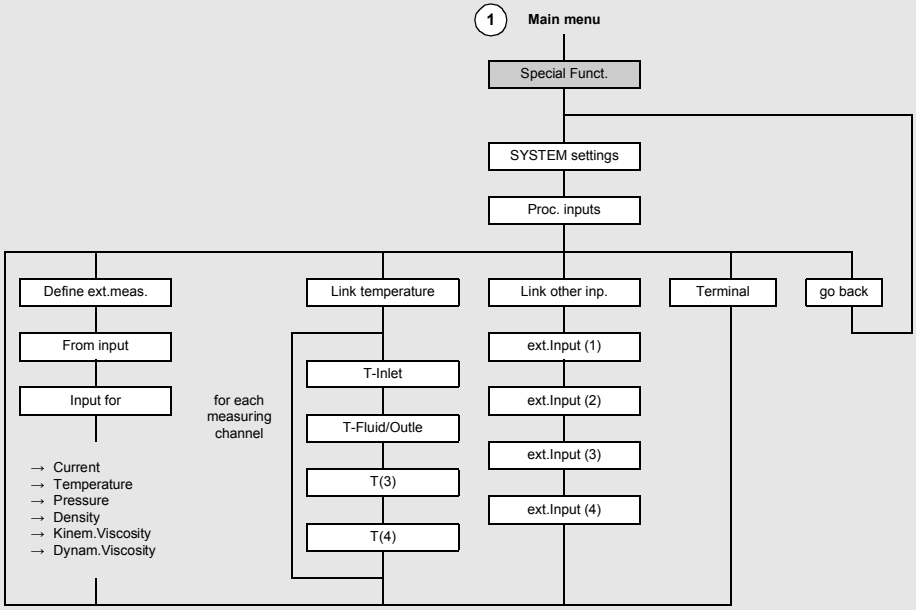


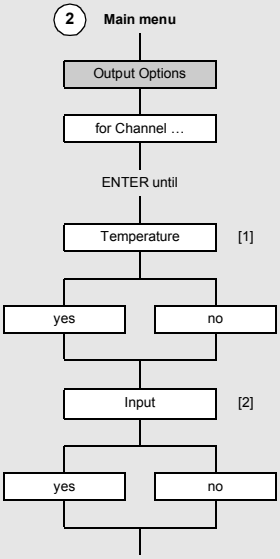
Legend

[1] this will only be displayed if `Current` and `active` are selected

Configuration of the inputs

(see chapter 14)





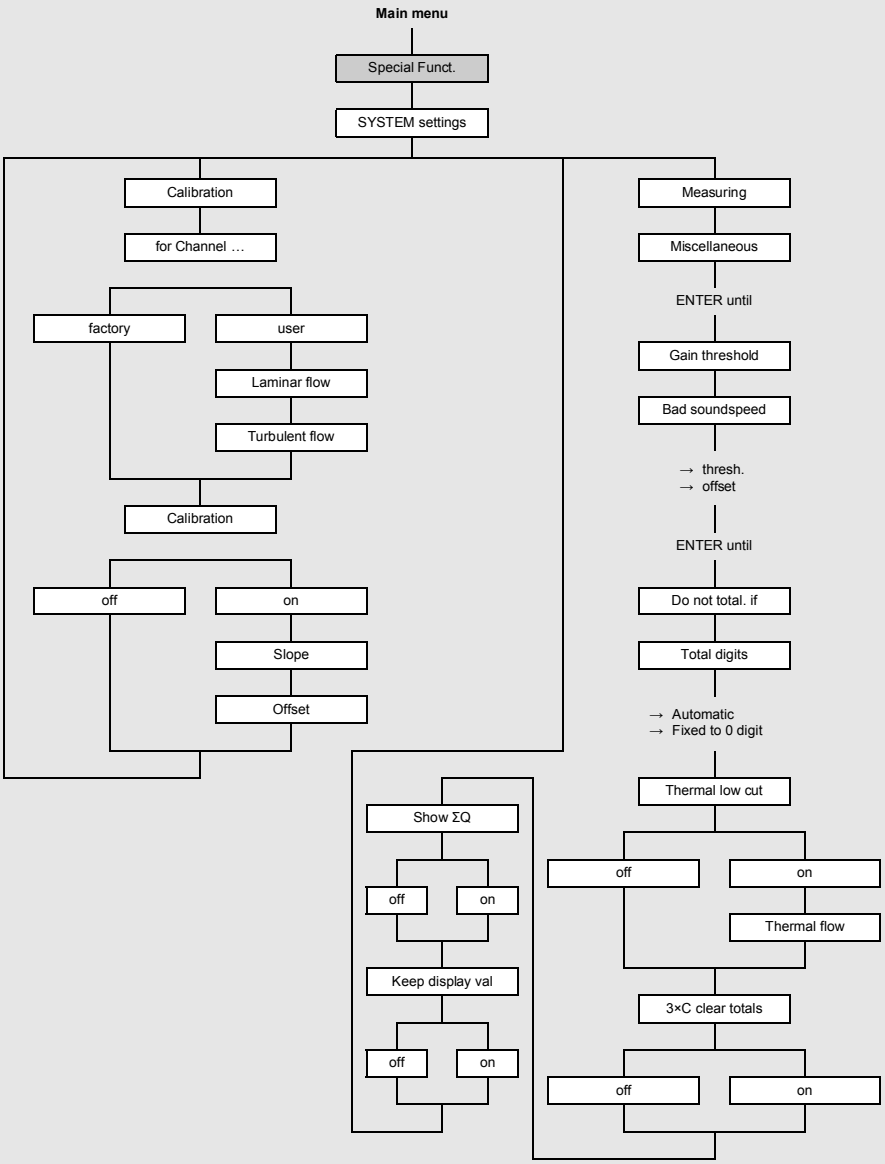
legend

[1] all temperature inputs assigned to the channel will be displayed consecutively

[2] all inputs assigned to the channel will be displayed consecutively

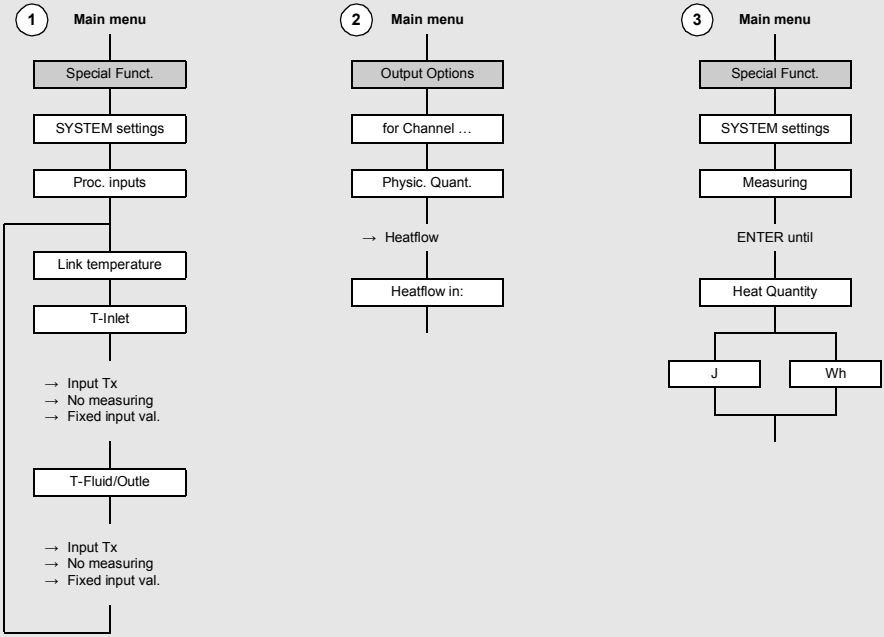
SuperUser mode

(see chapter 18)



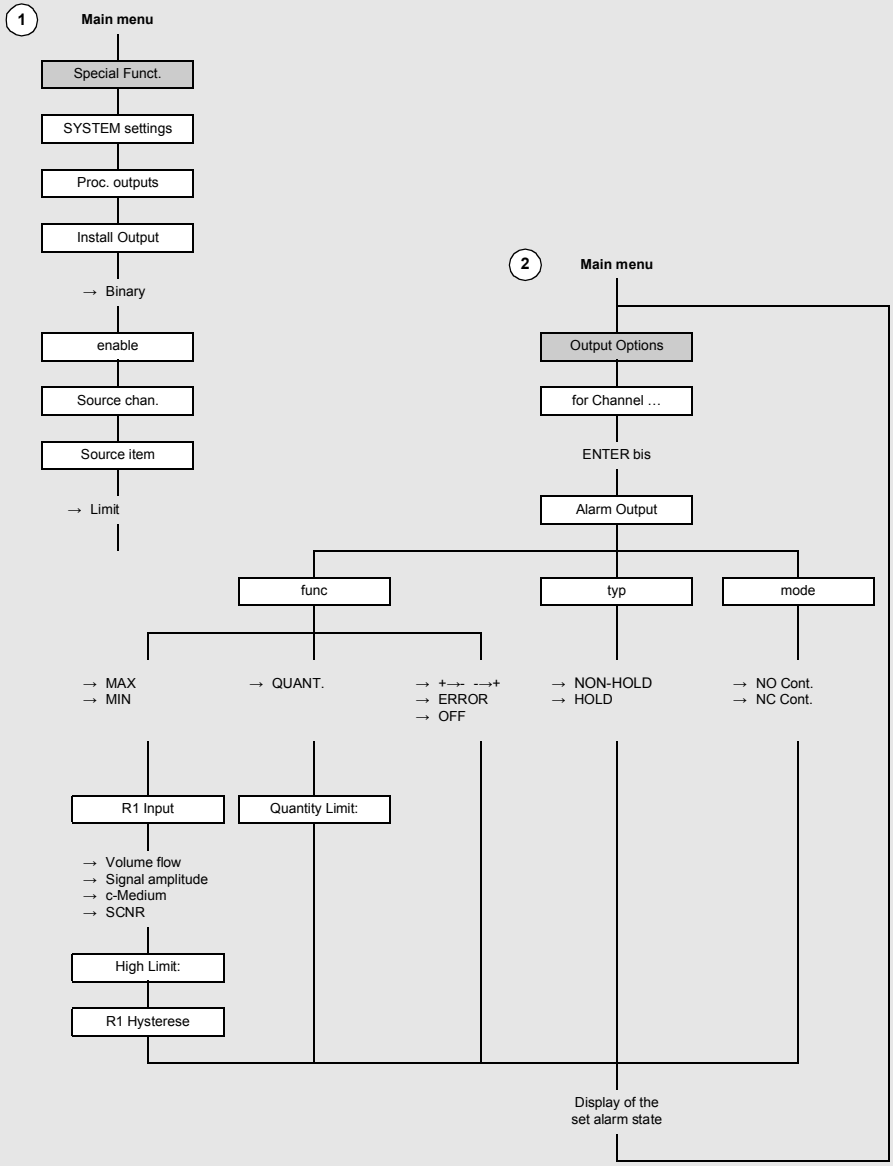
Thermal energy rate measurement

(see chapter 21)



Alarm output

(see chapter 17)



B Units of measurement

Length/roughness

unit of measurement	description
mm	millimeter
inch	inch

Temperature

unit of measurement	description
°C	degree Celsius
°F	degree Fahrenheit

Pressure

unit of measurement	description
bar(a)	bar (absolute)
bar(g)	bar (relative)
psi(a)	pound per square inch (absolute)
psi(g)	pound per square inch (relative)

Density

unit of measurement	description
g/cm³	gram per cubic centimeter
kg/cm³	kilogram per cubic centimeter

Sound speed

unit of measurement	description
m/s	meter per second

Kinematic viscosity

unit of measurement	description
mm²/s	square millimeter per second

1 mm²/s = 1 cSt

Flow velocity

unit of measurement	description
m/s	meter per second
cm/s	centimeter per second
inch/s	inch per second
fps (ft/s)	foot per second

Volumetric flow rate

unit of measurement	description	volume (totalized)
m³/d	cubic meter per day	m³
m³/h	cubic meter per hour	m³
m³/min	cubic meter per minute	m³
m³/s	cubic meter per second	m³
km³/h	cubic kilometer per hour	km³
ml/min	milliliter per minute	l
l/h	liter per hour	l
l/min	liter per minute	l
l/s	liter per second	l
hl/h	hectoliter per hour	hl

(1) cft: cubic foot
(2) aft: acre foot
1 US-gal = 3.78541 l
1 UK-gal = 4.54609 l
1 bbl = US Oil ≈ 159 l
1 bbl = US Wine ≈ 119 l
1 bbl = US Beer ≈ 117 l
1 bbl = UK ≈ 164 l

unit of measurement	description	volume (totalized)
hl/min	hectoliter per minute	hl
hl/s	hectoliter per second	hl
Ml/d (megaliter/d)	megaliter per day	Ml
bbl/d	barrel per day	bbl
bbl/h	barrel per hour	bbl
bbl/m	barrel per minute	bbl
bbl/s	barrel per second	bbl
USgpd (US-gal/d)	gallon per day	gal
USgph (US-gal/h)	gallon per hour	gal
USgpm (US-gal/m)	gallon per minute	gal
USgps (US-gal/s)	gallon per second	gal
KGPM (US-Kgal/m)	kilogallon per minute	kgal
MGD (US-Mgal/d)	million gallons per day	Mgal
IGPD (UK-gal/d)	gallon per day	lgal
CFD	cubic foot per day	cft [1]
CFH	cubic foot per hour	cft
CFM	cubic foot per minute	cft
CFS	cubic foot per second	aft [2]
MMCFD	million cubic feet per day	MMCF
MMCFH	million cubic feet per hour	MMCF

[1] cft: cubic foot
[2] aft: acre foot
1 US-gal = 3.78541 l
1 UK-gal = 4.54609 l
1 bbl = US Oil ≈ 159 l
1 bbl = US Wine ≈ 119 l
1 bbl = US Beer ≈ 117 l
1 bbl = UK ≈ 164 l

Thermal energy rate

unit of measurement	description	thermal energy (totalized)
W	watt	Wh or J (1)
kW	kilowatt	kWh or kJ (1)
MW	megawatt	MWh or MJ (1)
GW	gigawatt	GWh or GJ (1)
kBTU/minute	kBTU per minute	kBT
kBTU/hour	kBTU per hour	kBT
MBTU/hour	MBTU per hour	MBT
MBTU/day	MBTU per day	MBT
TON (TH)	TON, totals in TONhours	TH
TON (TD)	TON, totals in TONdays	TD
kTON (kTH)	kTON, totals in kTONhours	kTH
kTON (kTD)	kTON, totals in kTONdays	kTD

BTU: British Thermal Unit
1 W = 1 J/s
= (1/1055.05585262) BTU/s

TON: ton of refrigeration
1 W = 1 J/s = (1/3516.852842) TON
1 TON = 200 BTU/min

(1) selection in `Special Funct.\SYSTEM settings\ Measuring`

Mass flow rate

unit of measurement	description	mass (totalized)
t/h	ton per hour	t
t/d	ton per day	t
kg/h	kilogram per hour	kg
kg/min	kilogram per minute	kg
kg/s	kilogram per second	kg
g/s	gram per second	g
lb/d	pound per day	lb
lb/h	pound per hour	lb
lb/m	pound per minute	lb
lb/s	pound per second	lb
klb/h	kilopound per hour	klb
klb/m	kilopound per minute	klb

1 lb = 453.59237 g
1 t = 1000 kg

C Reference

The following tables provide assistance for the user. The accuracy of the data depends on the composition, temperature and processing of the material. FLEXIM does not assume liability for any inaccuracies.

C.1 Sound speed of selected pipe and lining materials at 20 °C

The values of some of these materials are stored in the internal database of the transmitter. Column c_{flow} shows the sound speed (longitudinal or transversal) used for the flow measurement.

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
Carbon Steel	steel, normal	3230	5930	trans
Stainless Steel	steel, stainless	3100	5790	trans
DUPLEX	duplex stainless steel	3272	5720	trans
Ductile Iron	ductile iron	2650	-	trans
Asbestos Cement	asbestos cement	2200	-	trans
Titanium	titanium	3067	5955	trans
Copper	copper	2260	4700	trans
Aluminium	aluminum	3100	6300	trans
Brass	brass	2100	4300	trans
Plastic	plastic	1120	2000	long
GRP	glass reinforced plastic (GRP)	-	2650	long
PVC	polyvinyl chloride	-	2395	long
PE	polyethylene	540	1950	long
PP	polypropylene	2600	2550	trans
Bitumen	bitumen	2500	-	trans
Acrylic	acrylic glass	1250	2730	long
Lead	lead	700	2200	long
Cu-Ni-Fe	copper-nickel-iron alloy	2510	4900	trans
Grey Cast Iron	gray cast iron	2200	4600	trans
Rubber	rubber	1900	2400	trans

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
Glass	glass	3400	5600	trans
PFA	perfluoralcoxy	500	1185	long
PVDF	polyvinylidene fluorid	760	2050	long
Sintimid	Sintimid	-	2472	long
Teka PEEK	Teka PEEK	-	2534	long
Tekason	Tekason	-	2230	long

The sound speed depends on the composition and the manufacturing process of the material. The sound speed of alloys and cast materials fluctuates strongly. The values only serve as an orientation.

C.2 Typical roughness values of pipes

The values are based on experience and measurements.

material	absolute roughness [mm]
drawn pipes of non-ferrous metal, glass, plastics and light metal	0…0.0015
drawn steel pipes	0.01…0.05
fine-planed, polished surface	max. 0.01
planed surface	0.01…0.04
rough-planed surface	0.05…0.1
welded steel pipes, new	0.05…0.1
after long use, cleaned	0.15…0.2
moderately rusted, slightly encrusted	max. 0.4
heavily encrusted	max. 3
cast iron pipes:	
bitumen lining	> 0.12
new, without lining	0.25…1
rusted	1…1.5
encrusted	1.5…3

C.3 Typical properties of selected fluids at 20 °C and 1 bar

fluid (display)	explanation	sound speed [m/s]	kinematic viscosity [mm^2/s]	density [g/cm^3]
Aceton	acetone	1190	0.4	0.7300
Ammonia(NH3)	ammonia (NH_3)	1386	0.2	0.6130
Gasoline	gasoline	1295	0.7	0.8800
Beer	beer	1482	1.0	0.9980
BP Transcal LT	BP Transcal LT	1365	20.1	0.8760
BP Transcal N	BP Transcal N	1365	94.3	0.8760
Diesel	diesel	1210	7.1	0.8260
Std. natural gas	natural gas, standard composition	433	12.42	0.0010
Ethanol	ethanol	1402	1.5	0.7950
HF acid 50%	hydrofluoric acid 50 %	1221	1.0	0.9980
HF acid 80%	hydrofluoric acid 80 %	777	1.0	0.9980
Glycol	glycol	1665	18.6	1.1100
20% Glycol / H2O	glycol/H_2O, 20 %	1655	1.7	1.0280
30% Glycol / H2O	glycol/H_2O, 30 %	1672	2.2	1.0440
40% Glycol / H2O	glycol/H_2O, 40 %	1688	3.3	1.0600
50% Glycol / H2O	glycol/H_2O, 50 %	1705	4.1	1.0750
ISO VG 100	ISO VG 100	1487	314.2	0.8690
ISO VG 150	ISO VG 150	1487	539.0	0.8690
ISO VG 22	ISO VG 22	1487	50.2	0.8690
ISO VG 220	ISO VG 220	1487	811.1	0.8690
ISO VG 32	ISO VG 32	1487	78.0	0.8690
ISO VG 46	ISO VG 46	1487	126.7	0.8730
ISO VG 68	ISO VG 68	1487	201.8	0.8750
Methanol	methanol	1119	0.7	0.7930

fluid (display)	explanation	sound speed [m/s]	kinematic viscosity [mm^2/s]	density [g/cm^3]
Milk	milk	1482	5.0	1.0000
Mobiltherm 594	Mobiltherm 594	1365	7.5	0.8730
Mobiltherm 603	Mobiltherm 603	1365	55.2	0.8590
caustic soda 10%	soda lye, 10 %	1762	2.5	1.1140
caustic soda 20%	soda lye, 20 %	2061	4.5	1.2230
Paraffin 248	Paraffin 248	1468	195.1	0.8450
R134 Freon	R134 Freon	522	0.2	1.2400
R22 Freon	R22 Freon	558	0.1	1.2130
Crudeoil hi-API	crude oil, light	1163	14.0	0.8130
Crudeoil low API	crude oil, heavy	1370	639.5	0.9220
30% H2SO4	sulfuric acid, 30 %	1526	1.4	1.1770
80% H2SO4	sulfuric acid, 80 %	1538	13.0	1.7950
96% H2SO4	sulfuric acid, 96 %	1366	11.5	1.8350
Juice	juice	1482	1.0	0.9980
HCl 25%	hydrochloric acid, 25 %	1504	1.0	1.1180
HCl 37%	hydrochloric acid, 37 %	1511	1.0	1.1880
Seawater	seawater	1522	1.0	1.0240
Shell Thermia B	Shell Thermia B	1365	89.3	0.8630
Silicon oil	silicone oil	1019	14 746.6	0.9660
SKYDROL 500-B4	SKYDROL 500-B4	1387	21.9	1.0570
SKYDROL 500-LD4	SKYDROL 500-LD4	1387	21.9	1.0570
Water	water	1482	1.0	0.9990

C.4 Properties of water at 1 bar and at saturation pressure

fluid temperature [°C]	fluid pressure [bar]	sound speed [m/s]	density [kg/m³]	specific heat capacity[1] [kJ/kg/K^{-1}]
0.1	1,013	1402.9	999.8	4,219
10	1,013	1447.3	999.7	4,195
20	1,013	1482.3	998.2	4,184
30	1,013	1509.2	995.6	4,180
40	1,013	1528.9	992.2	4,179
50	1,013	1542.6	988.0	4,181
60	1,013	1551.0	983.2	4,185
70	1,013	1554.7	977.8	4,190
80	1,013	1554.4	971.8	4,197
90	1,013	1550.5	965.3	4,205
100	1,013	1543.2	958.3	4,216
120	1,985	1519.9	943.1	4,244
140	3,615	1486.2	926.1	4,283
160	6,182	1443.2	907.4	4,335
180	10.03	1391.7	887.0	4,405
200	15.55	1332.1	864.7	4,496
220	23.20	1264.5	840.2	4,615
240	33.47	1189.0	813.4	4,772
260	46.92	1105.3	783.6	4,986
280	64.17	1012.6	750.3	5,289
300	85.88	909.40	712.1	5,750
320	112.8	793.16	667.1	6,537
340	146.0	658.27	610.7	8,208
360	186.7	479.74	527.6	15.00
373,946	220,640	72,356	322.0	∞

[1] at constant pressure

D Conformity declarations

FLEXIM

EU declaration of conformity

CE

KEFLUXUS_x601V3-0EN, 2020-01-25

EU declaration of conformity according to low voltage directive

FLEXIM Flexible Industriemesstechnik GmbH
Boxberger Straße 4
12681 Berlin
Germany

declares as manufacturer under its sole responsibility that the ultrasonic flowmeter(s)

FLUXUS *a*601

***a* = F, G**

complies/comply with the relevant EU regulations and directives, including any amendments valid at the time this declaration was signed. This declaration of conformity is based on the following harmonized EU standards:

EU directive 2014/35/EU (low voltage directive) relating to the making available on the market of electrical equipment designed for use within certain voltage limits

EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
EN 61010-2-030:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits

EU directive 2014/30/EU (EMC directive) relating to electromagnetic compatibility

EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements – Part 1: General requirements
	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-3: Particular requirements – Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning
EN 61326-2-5:2013	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-5: Particular requirements – Test configurations, operational conditions and performance criteria for field devices with field bus interfaces according to IEC 61784-1
EN 55011:2009/A1:2010	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement

EU directive 2011/65/EU (RoHS directive) on the restriction of the use of certain hazardous substances in electrical and electronic equipment

EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

FLEXIM GmbH	Berlin, 2020-01-25	Jens Hilpert Managing Director
Signed for and on behalf of	Place and date	

Supplement to operating instruction
SU_disturbances_x0xV1-0LX
AN 27033
2024-07-01

Flexim FLUXUS **0*

Disturbances **0*

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EMERSON

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1 About this supplement

This supplement has to be used together with the operating instruction FLUXUS and PIOX S. It contains new firmware functions of V6.60:

• profile correction enhancements

For better orientation, each section begins with an overview containing the following information:

reference	section of the operating instruction
transmitter	transmitters to which this description applies
description	description of the section

Make sure you have read and understood this supplement, the operating instruction and the safety instructions before using the measuring equipment.

Observe the safety instructions!

2 General principles

reference	operating instruction chapter "General principles", section "Undisturbed flow profile"
transmitter	FLUXUS **0*
description	new disturbances added: 45° elbow, 45° double elbow, reducer with upstream disturbance

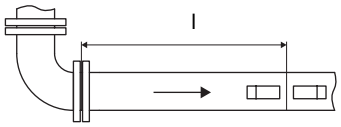
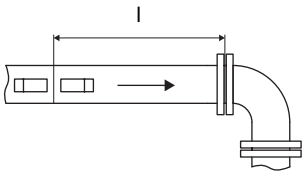
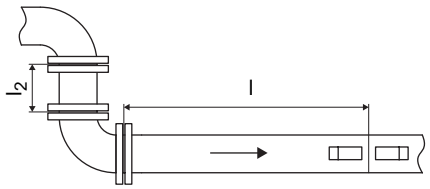
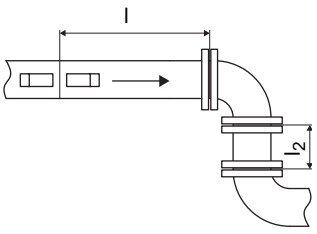
Undisturbed flow profile

Some flow elements (e.g., elbows, valves, pumps, reducers) distort the flow profile in their vicinity. The axisymmetrical flow profile in the pipe needed for correct measurement is no longer given. A careful selection of the measuring point helps to reduce the impact of disturbances.

It is most important that the measuring point is chosen at a sufficient distance from any disturbances. Only then it can be assumed that the flow profile in the pipe is fully developed. The use of the disturbance correction allows a measurement even at smaller distances of min. 2 d.

The recommended straight inlet and outlet pipe lengths for different types of flow disturbances are shown in the following table. These are to be measured from the end of the disturbances, which is not always at the position of the nearest flange (see Tab. 3.1).

Tab. 2.1: Recommended distance from disturbances
d – inner pipe diameter at the measuring point
l – recommended distance between disturbance and transducer position

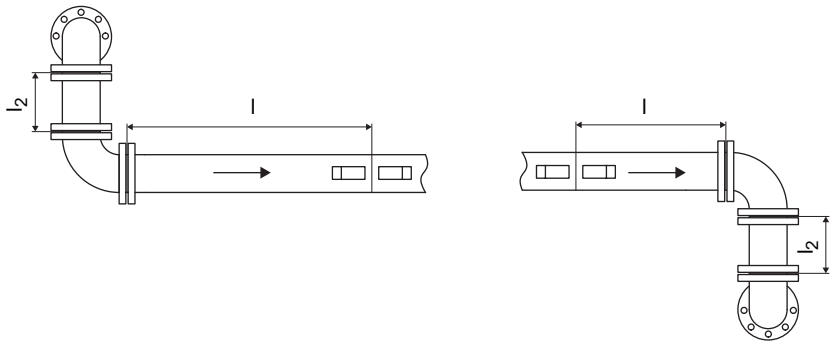
disturbance: 90° elbow inlet: l ≥ 10 D (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	
disturbance: 90° double elbow (with elbow distance l_2 ≥ 3 d) inlet: l ≥ 10 D (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

Tab. 2.1: Recommended distance from disturbances
d – inner pipe diameter at the measuring point
l – recommended distance between disturbance and transducer position

disturbance: double elbow out of plane (with elbow distance $l_2 \geq 3$ d)

inlet: l ≥ 10 D
(l ≥ 2 d with disturbance correction)

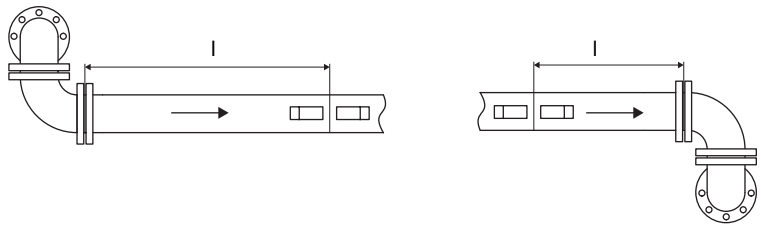
outlet: l ≥ 3 d



disturbance: double elbow out of plane (directly coupled)

inlet: l ≥ 40 D
(l ≥ 2 d with disturbance correction)

outlet: l ≥ 3 d



disturbance: 45° elbow

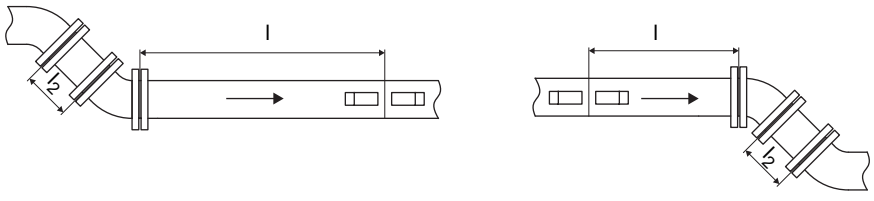
inlet: l ≥ 15 D
(l ≥ 2 d with disturbance correction)

outlet: l ≥ 3 d

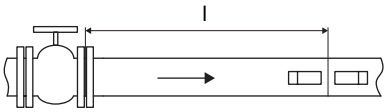
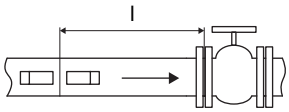
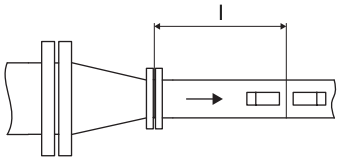
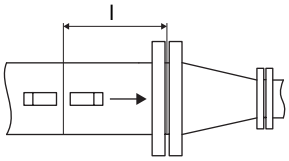
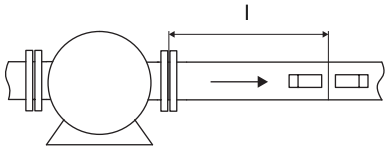
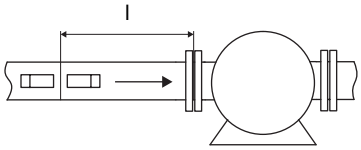
disturbance: 45° double elbow (with elbow distance $l_2 \geq 3$ d)

inlet: l ≥ 15 D
(l ≥ 2 d with disturbance correction)

outlet: l ≥ 3 d



Tab. 2.1: Recommended distance from disturbances
d – inner pipe diameter at the measuring point
l – recommended distance between disturbance and transducer position

disturbance: valve	
inlet: l ≥ 40 d	outlet: l ≥ 3 d
	
disturbance: reducer	
inlet: l ≥ 10 D (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	
disturbance: pump/valve	
inlet: l ≥ 20 d	outlet: l ≥ 3 d
	

3 Measurement

reference	operating instruction chapter "Measurement", section "Parameter input"
transmitter	FLUXUS **0*
description	description of disturbances

Profile correction

For the calculation of the fluid mechanic calibration factor k_{Re} the following settings can be selected:

- `ProfileCorr 2.0\OFF`: measurement without profile correction
- `ProfileCorr 2.0\ON`: improved profile correction (current version)
- `ProfileCorr 2.0`: improved profile correction at non ideal inflow conditions for the positive flow direction (negative flow direction without disturbance correction, default)

The following steps are necessary to set the profile correction:

- selection of the profile correction version in the menu `Special Funct.`

If `ProfileCorr 2.0` or `With disturbance` is selected:

- selection of the disturbance in the menu `Parameter`
- input of the disturbance distance in the menu `Parameter`

Selection of the version

```
Special Funct.\SYSTEM settings\Measuring\ProfileCorr 2.0
```

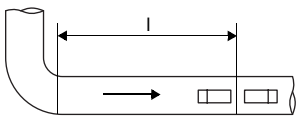
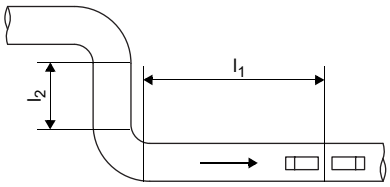
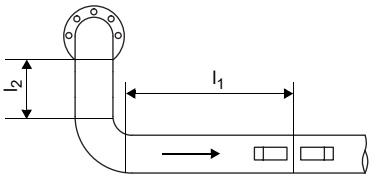
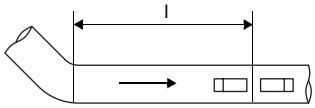
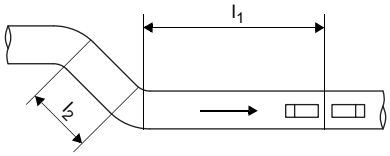
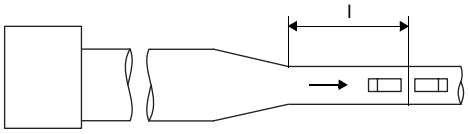
- Select the list item `Measuring` in the menu `Special Funct.`
- Press ENTER until the menu item `ProfileCorr 2.0` is displayed.
- Select a list item.
- Press ENTER.

Selection of the disturbance

```
Parameter\Disturb. source
```

- Select a list item.
- Press ENTER.
- Enter the parameters for the disturbance distances.
- Press ENTER.

Tab. 3.1: Disturbance parameters

disturbance type	parameter	description
90° elbow	Disturb.distance (l)	
2x90° in plane	Disturb.distance (l_1) elbow <--> elbow (l_2)	
2x90° OutOfPlane	Disturb.distance (l_1) elbow <--> elbow (l_2)	
45° elbow	Disturb.distance (l)	
2x45° in plane	Disturb.distance (l_1) elbow <--> elbow (l_2)	
Pipe reducing	Disturb.distance (l)	

E-mail: info@flexim.com **Emerson.com**

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FLEXIM

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Calibration Certificate

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Device under Test (DUT)

Calibration Certificate No.: 20250414_007

Transducer Type: CLK1NZ7 **Serial No.:** 172785
Fluid: Water
Temperature: 70.1 °F

Customer Information:
City of Coos Bay
680 Ivy Ave
Coos Bay, OR 97420

Measurement results

Acoustic calibration factor	4088.80 m/s	+- 0.15 %
Repeatability	0.006 %	**Passed**
at T=68°F	4095.57 m/s	

The uncertainty of the calibration is 0.15 % of the measurement value. The mentioned uncertainty is resulting from the standard deviation multiplied by a coverage factor of k = 2 (95 % confidence interval).

Zero point test: **Passed**

The indicated measuring system meets the specified accuracy (Passed / Failed): **Passed**

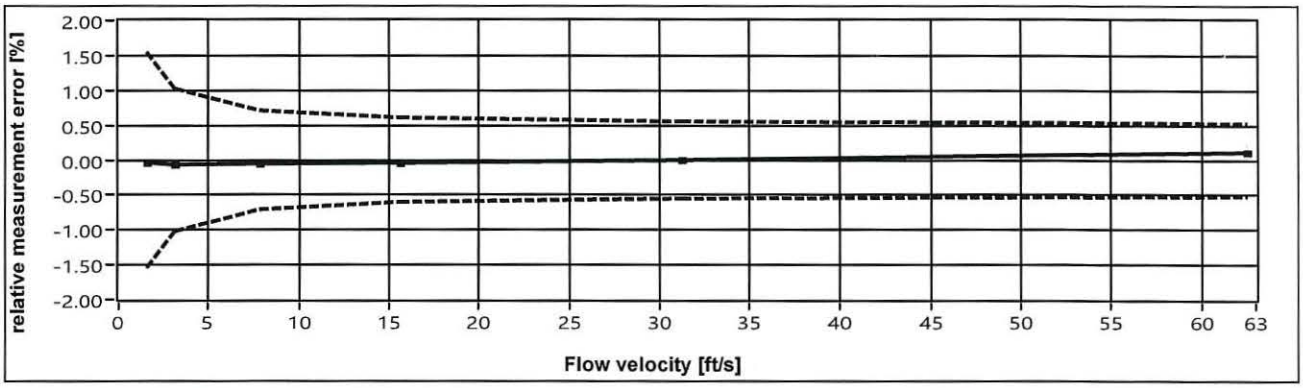
Calibration result as left

Measuring point	Flow velocity [ft/s] Standard	Flow [gpm] Standard	Flow [gpm] DUT	Relative measurement error [%] Error	Limit [1]	
1	1.57	2084.16	2083.33	-0.04	1.55	Passed
2	3.13	4166.33	4163.40	-0.07	1.02	Passed
3	7.82	10409.83	10403.96	-0.06	0.71	Passed
4	15.63	20816.10	20806.40	-0.05	0.60	Passed
5	31.26	41629.30	41628.46	-0.00	0.55	Passed
6	62.52	83257.28	83349.27	0.11	0.53	Passed

Pipe diameter used for flow velocity calculation: 23.32 inches

[1] **Adjustment limit:** 0.50 % +- 0.0164 ft/s

Adjustment of the acoustic calibration factor shall be performed at the latest when reaching this limit.



The measuring system specified above was calibrated against measurement standards which are traceable to national measurement standards (PTB or NIST). The calibration was carried out according to the guidelines monitored by our certified quality management system in compliance with DIN EN ISO 9001.

Calibration Facility Type | Serial No.: VXX1NHO | 10351

Calibration valid until: 11/21/2025 **Calibration Certificate No.:** VXX1NHO10351 20241121

Date: 04/14/2025 **Calibration Laboratory Supervisor:** Tobias Jochum **Person in charge:** Alessandro Garcia

This calibration certificate consists of one page and may not be reproduced other than in full.

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EMERSON

Calibration Certificate
Kalibrierschein

Certificate No.: *Kalibrierschein Nr.:*	FT_20250312-005
Customer information / *Kundeninformation*	

Device under test (DUT) / *Kalibriergegenstand*

Transmitter: FLUXUS F 601 **Ser. No.:** 60116728
Messumformer: *Ser. Nr.:*

Simulation parameter / *Simulationsparameter*

Transducer: *Sensor:*	cal_02	**Frequency [MHz]:** *Frequenz:*	4.00
Inner pipe diameter [inch]: *Rohrinnendurchmesser [mm]:*	2.36 *60.00*	**Flow range [m³/h]:** *Flussbereich:*	50
Fluid: *Fluid:*	Water *Wasser*	**Sound velocity [m/s]:** *Schallgeschwindigkeit:*	1500

Environmental conditions / *Umgebungsbedingungen*
Temperature [°C]: 25±5
Temperatur:

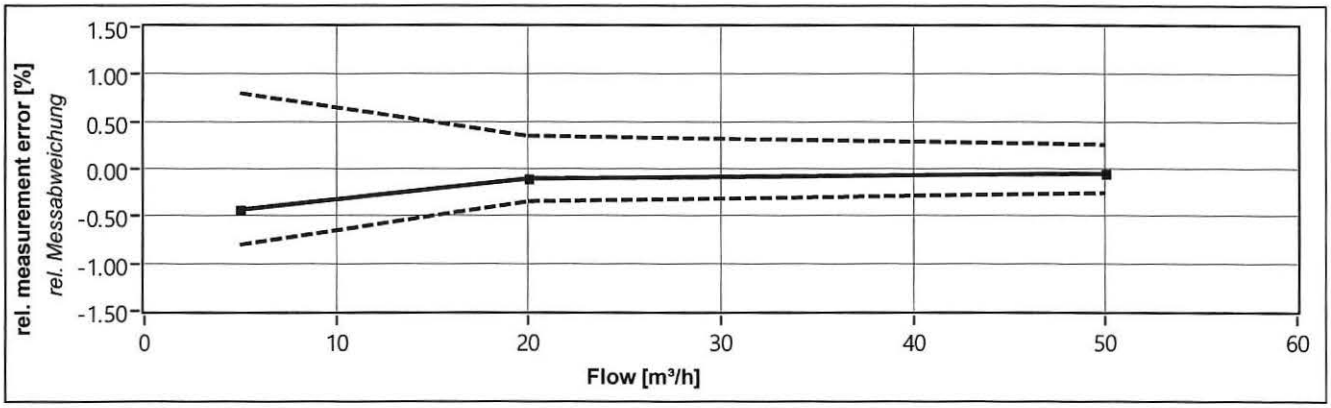
Measurement results Flow / *Messergebnisse Durchfluss*

Meas. Uncertainty	**u(Q):**	0.004	% ±	0.202	cm/s
Error limit	**Q:**	0.200	% ±	0.500	cm/s

The mentioned uncertainty is resulting from the standard deviation multiplied by a coverage factor of k = 2. The value of the measured quantity is usually within the related interval with a probability of 95%.

Angegeben ist die erweiterte Messunsicherheit, die sich durch Multiplikation mit dem Erweiterungsfaktor k = 2 ergibt. Der Wert der Messgröße liegt im Regelfall mit einer Wahrscheinlichkeit von annähernd 95 % im zugeordneten Werteintervall.

	Flow velocity [m/s] *Strömungsgeschwindigkeit*	**Flow [m³/h]** *Durchfluss*					
Meas. point *Messpunkt*	**Standard** *Normal*	**Standard** *Normal*	**DUT** *Prüfling*	**Measurement error** *Messabweichung*		**Limit incl. uncertainty** *Grenze inkl. Messunsicherheit*	**Result** *Ergebnis*
	V	Q_n	Q_{DUT}	$Q_{DUT} - Q_n$	$(Q_{DUT} - Q_n)/Q_n$		
1	0.00	0.00	-0.01	-0.014	-	0.030	passed
2	0.49	5.00	4.98	-0.022	-0.435%	0.040	passed
3	1.96	20.00	19.98	-0.021	-0.107%	0.070	passed
4	4.91	50.00	49.97	-0.026	-0.052%	0.128	passed



The indicated measuring system meets the specified accuracy (passed / failed).
Das angegebene Messsystem erfüllt die spezifizierte Genauigkeit (passed / failed).

passed

The measuring system specified above was calibrated against measurement standards which are traceable to national measurement standards. The calibration was carried out according to the guidelines monitored by our certified QM system in compliance with DIN EN ISO 9001.

Die Kalibrierung des oben angegebenen Messsystems wurde gegen Normale ausgeführt, die sich auf nationale Normale rückführen lassen. Die Kalibrierung erfolgte nach Vorgaben, die im Rahmen unseres zertifizierten QM-Systems nach DIN EN ISO 9001 überwacht werden.

Measuring Standard: *Normal:*	**Type:** *Typ:*	**Ser. No.:** *Ser. Nr.:*	**Calibration due:** *Kalibriert bis:*	**Calibration certificate:** *Kalibrierschein:*
Transit Time Calibrator	FS100	144	24.04.2025	F250124PM2622_FS144

Calibration certificates with the full names of the approval responsible persons are valid without signature.
Kalibrierscheine sind bei Nennung der für die Freigabe Verantwortlichen in Klarschrift auch ohne Unterschrift gültig.

Date: 12.03.2025 *Datum:*
Calibration laboratory supervisor: Jochum, Tobias *Laborleiter Kalibrierung:*
Person in charge: Schmidt, JoernPhilipp *Bearbeiter:*

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35(LE/LIT)3203	Entech Controller, 24VDC, 4 Relays	Ati	00-1979	Section 40 91 00	09-I-003, 4091-386
002	1	"	Entech Standard Sensor, 20-ft Cable	Ati	00-1799	Section 40 91 00	09-I-003, 4091-386
003	1	"	Sensor Multi-Flex Assembly	Ati	00-1809	Section 40 91 00	09-I-003, 4091-386
004	1	"	Sensor Fixed Brackets, Stainless Steel	Ati	00-1831	Section 40 91 00	09-I-003, 4091-386
005	1	"	Controller Floor Mount w/ Weather Shield	Ati	00-1830	Section 40 91 00	09-I-003, 4091-386
006							
007							
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Bainbridge Associates, LLC

Entech Design Products

QUOTATION:

Project: Coos Bay WWTP Clarifier

Here is our quotation on the goods named, subject to the following conditions: The prices and terms on this quotation are not subject to verbal changes or other agreements unless approved in writing by ATI - Entech Design. Prices are based on costs and conditions existing on date of quotation and are subject to change by the Seller before final acceptance. Shipping costs are not included in our price quotation.
FOB will be Shipping Point Prepaid and Added (SP-PPA) unless otherwise specified in writing.
Payment terms: Net 30 Days.
This quote is made subject to the terms and conditions found at https://www.badgermeter.com/terms-and-conditions.

Qty.	Part No.	Description	Amount
1	00-1979	Entech Controller, 24VDC, 4 Relays	
1	00-1799	Entech Standard Sensor, 20ft cable*	
1	00-1809	Sensor Multi-flex Assembly	
1	00-1831	Sensor Fixed Brackets, Stainless Steel	
1	00-1830	Floor Mount Bracket, Stainless Steel	
1	MISC	Stainless Steel Tag – "C35LE3203"	

ALTERNATES AND NOTES:
Note that Standard Sensor with Multi-Flex assembly means no wiper sensor required.

PLEASE REMIT TO:

Badger Meter Inc.
Sales@analyticaltechnology.com

Controls for the Process Industry * Manufacturers Representatives

Seattle Office
P.O. Box 501, Fall City, WA 98024
(425) 331-1453– Fax: (503) 697-9970
Email: asmith@bainbridgeassoc.com

Portland Office
P.O. Box 909 Camas, WA 98607
(503)697-9711 - Fax: (503) 697-9970
Email: knavidi@bainbridgeassoc.com

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EchoSmart™

Interface Level Analyzers

www.EntechDesign.com

ATI ANALYTICAL TECHNOLOGY, INC.

Entech Design

Smart

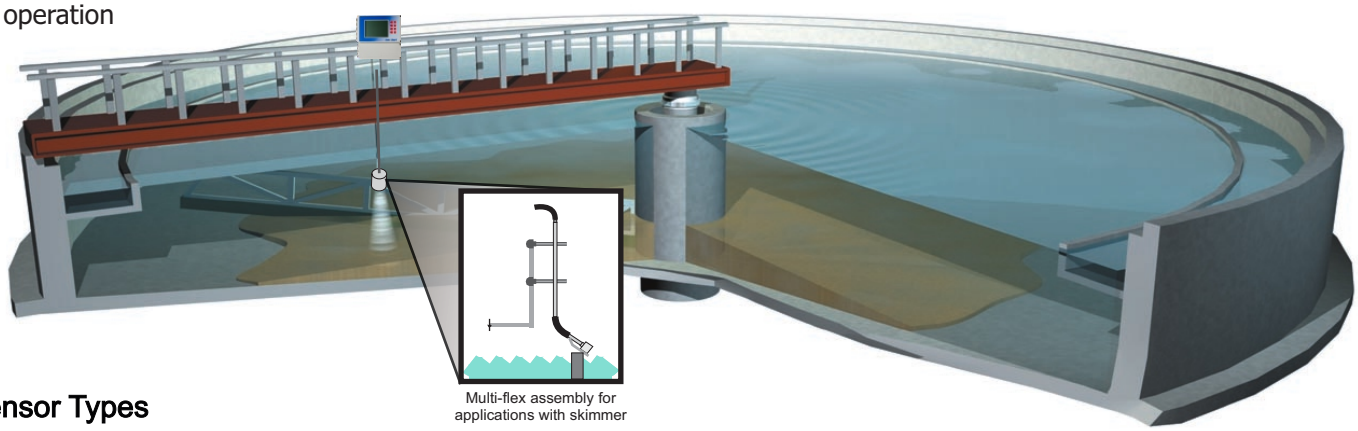
EchoSmart Sensors generate and process the ultrasonic signal for continuous, real-time measurement and maximum flexibility.

EchoSmart Sensors employ interface-detection algorithms developed exclusively by Entech with proven performance across the US and around the world.

Friendly

Easy to set-up, easy to operate, and easy to secure consistent, reliable, trouble-free measurements - that's user-friendly, that's EchoSmart!

- Large display with intuitive screens for quick entry of parameters
- Soft Key operation with Help Prompts for all settings
- Automatic initialization for easy start-up
- Adaptive algorithms in each sensor for uninterrupted operation
- Track well-settled blankets
- Can also be configured to track dispersed solids (fluff or rag layer)
- Monitor blanket levels 24/7/365
- Suitable for round or rectangular clarifiers



Multi-flex assembly for applications with skimmer

Sensor Types

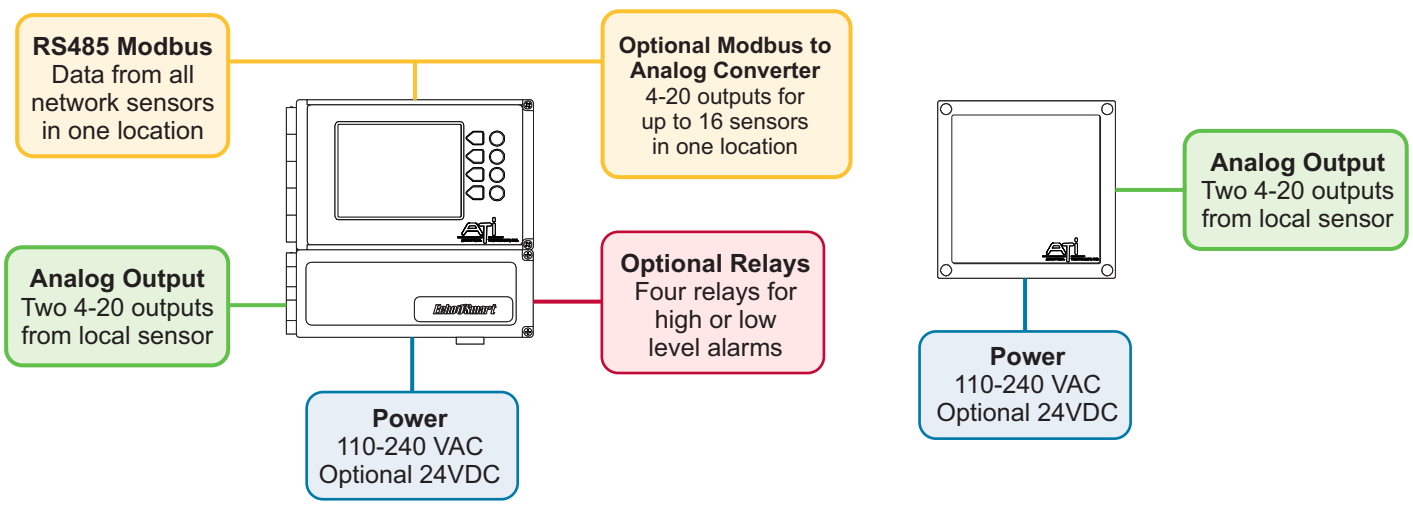
Standard Sensor
Typical for applications with surface skimmers. Multi-flex assembly recommended.

Wiper Sensor
Self-cleaning face for applications without surface skimmers.

Level & Turbidity
Self-cleaning face with sludge level and turbidity in one sensor.

Sensors come standard with 20 feet of cable with custom lengths of up to 400 feet possible

Available Outputs

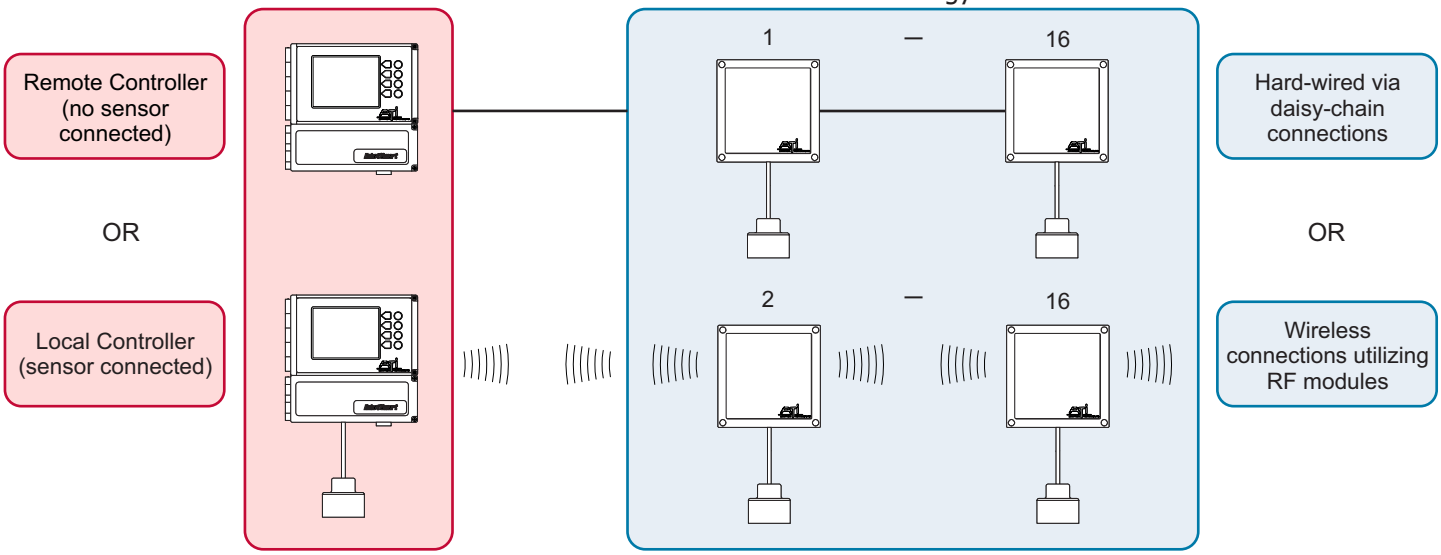


EchoSmart™ Interface Level Analyzer

Flexible

Adaptable configuration options for a variety of installation requirements and straightforward plant retrofit solutions

- Available as stand-alone system
- Networks of up to sixteen sensors possible with only one Controller needed
- Easily add more sensors to an existing network
- Communication between devices can be achieved through:
  - + Hard-wired connections
  - + Powerful sub-1GHz RF with self-healing mesh technology*



** Radio available as internally mounted plug-and-play module with external antenna or in a separate enclosure for maximum range and flexibility. Self-healing mesh technology eliminates most line of sight interference.*

Free Demo
Ask about a 30-day free trial consisting of a stand-alone system with a cell modem for insights into the benefits of continuous monitoring.

Worldwide Installation
ATI-Entech enjoys a HUGE install base across the country and around the world. References available.

Remote Service via Cell Modem*
Our Factory Remote Service puts every EchoSmart system in the reach of our expert engineers and service technicians for optional instrument commissioning and follow-on service at a fraction of the cost of field services.

* Connection is independent of local LAN and requires no customer activation

EchoSmart™ Specifications

EchoSmart Sensor

Measuring Principle
Underwater acoustic

Range
1.0 to 32 ft. (0.305 to 10.0 m)

Sensor Measurement Resolution
0.1 Unit of measure

Accuracy
0.2 in at 10.0 ft. (5 mm at 3.05 m)

Operating Temperature
34 to 125°F (1 to 52°C)

Power Requirement
15VDC Standard: 2.4W; Wiper: 3W

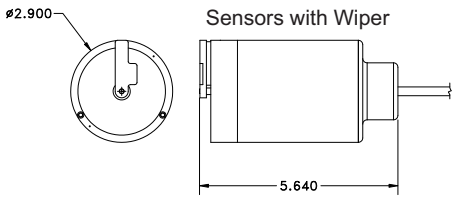
Configuration Backup
Settings stored in FLASH memory

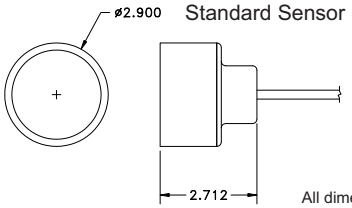
Sensor Construction
IP68, ABS and epoxy
Stainless steel and rubber (wiper only)

Turbidity (Optional)
Measurement Principle
90 degrees scattered light, pulsed LED
Range
0-50 NTU

Weight
Standard Sensor: 2.25 lb (1.02 kg)
Wiper Sensor: 2.75 lb (1.25 kg)
Wiper Sensor w/ Turbidity: 2.75 lb (1.25 kg)

Certifications
CE





All dimensions in inches

Controller

Operational Conditions
-40° to +140°F (-40° to +60° C)

Power Requirements
100 to 240 VAC, 50/60 Hz - 1.4A
Power 65 W (fused)
Optional: 24VDC

Display
Graphical backlit monochrome screen
Resolution: 320 x 240 pixels
Viewing Area: 2.6 x 3.45 in (92 x 122 mm)

Reported Measurement Resolution
1.0 (in & cm), 0.1 (ft), 0.01 (m)

Communications
RS-485 MODBUS RTU
(2) 4-20mA Output
(1) Level Measurement
(1) Turbidity (Optional)

Optional 900MHz RF Module
Self-healing mesh network
Approvals: FCC Part 15C, Industry Canada

Relays (Optional)
(4) Relays: 10A @ 250 VAC; 10A @ 30VDC
Configurable for high/low measurement alert or sensor fault

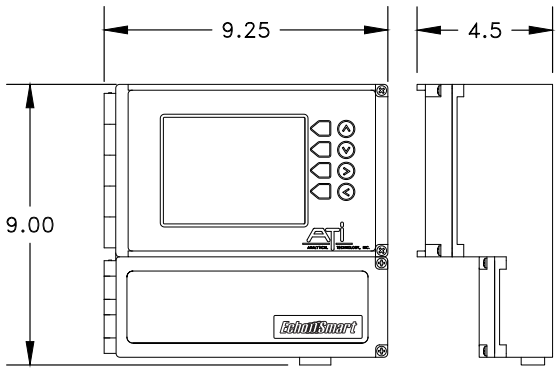
Configuration Backup
Battery backup retains settings in event of power loss

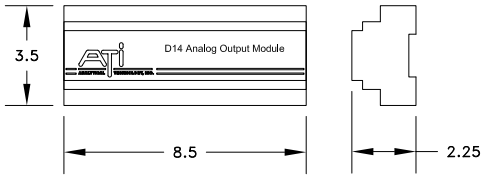
Enclosure
NEMA 4X, IP65; Polycarbonate

Weight
Approximately 3.0 lb (1.36 kg) depending on configuration

Certifications
CE

Modbus to Analog Output Converter (optional)
18-30VDC
DIN Rail Mount
Up to 16 isolated analog outputs





Power Supply Unit (Required only in multi-sensor network applications)

Operational Conditions
-40° to +140°F (-40° to +60° C)

Power Requirements
100 to 240 VAC, 50/60 Hz - 0.5A
Power 20 W (fused)
Optional: 24VDC

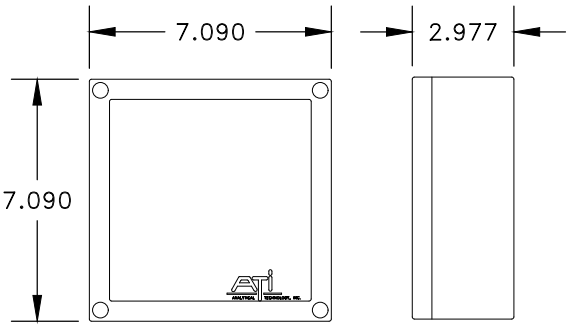
Communications
RS-485 MODBUS RTU
(2) 4-20mA Output
(1) Level Measurement
(1) Turbidity (Optional)

Optional 900MHz RF Module
Self-healing mesh network
Approvals: FCC Part 15C, Industry Canada

Enclosure
NEMA 4X, IP65; Polycarbonate

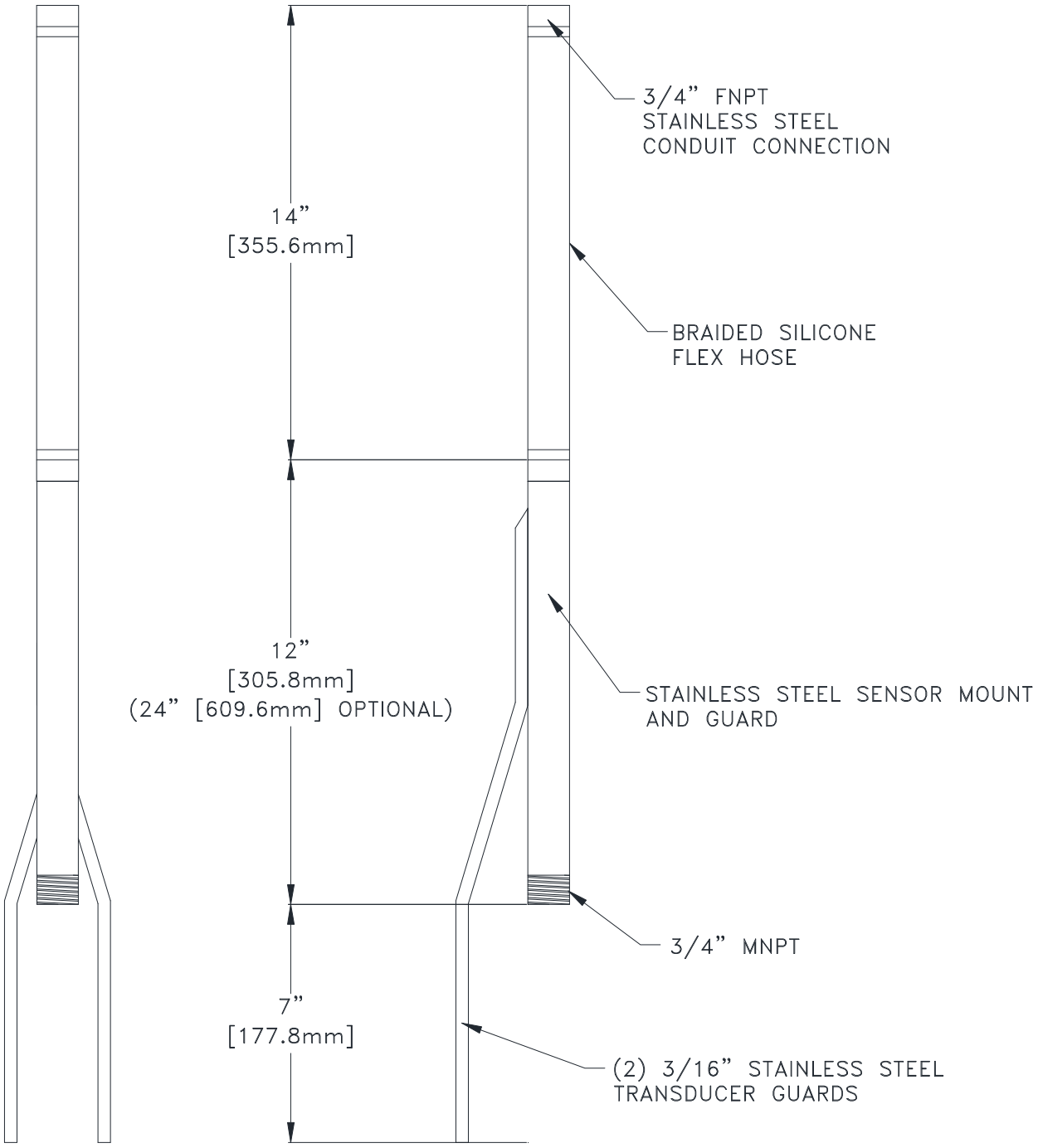
Weight
Approximately 1.5 lb (0.68 kg)

Certifications
CE



ANALYTICAL TECHNOLOGY, INC.
6 Iron Bridge Drive
Collegeville, PA 19426
(610) 917-0991
sales@analyticaltechnology.com

Entech Design
315 S. Locust Street, Suite 104
Denton, TX 76201
(940) 898-1173
entech@entechdesign.com



Material:
1. Stainless Steel
2. Braided Silicone Hose

1. See EchoSmart Sensor Installation drawing for installation recommendations and guidelines.

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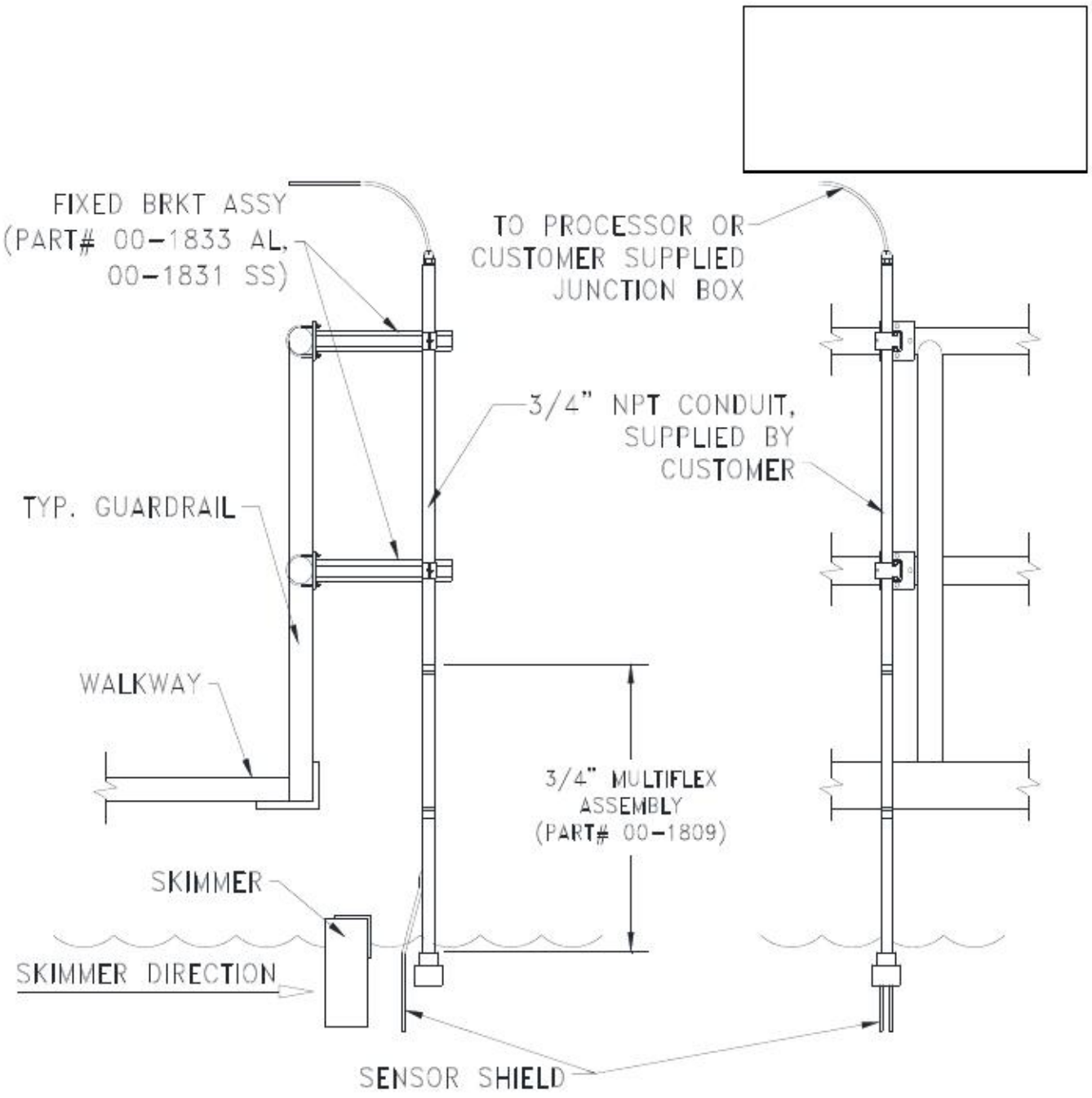
FIXED BRKT ASSY
(PART# 00-1833 AL,
00-1831 SS)
TO PROCESSOR OR
CUSTOMER SUPPLIED
JUNCTION BOX
3/4" NPT CONDUIT,
SUPPLIED BY
CUSTOMER
TYP. GUARDRAIL
WALKWAY
3/4" MULTIFLEX
ASSEMBLY
(PART# 00-1809)
SKIMMER
SKIMMER DIRECTION
SENSOR SHIELD

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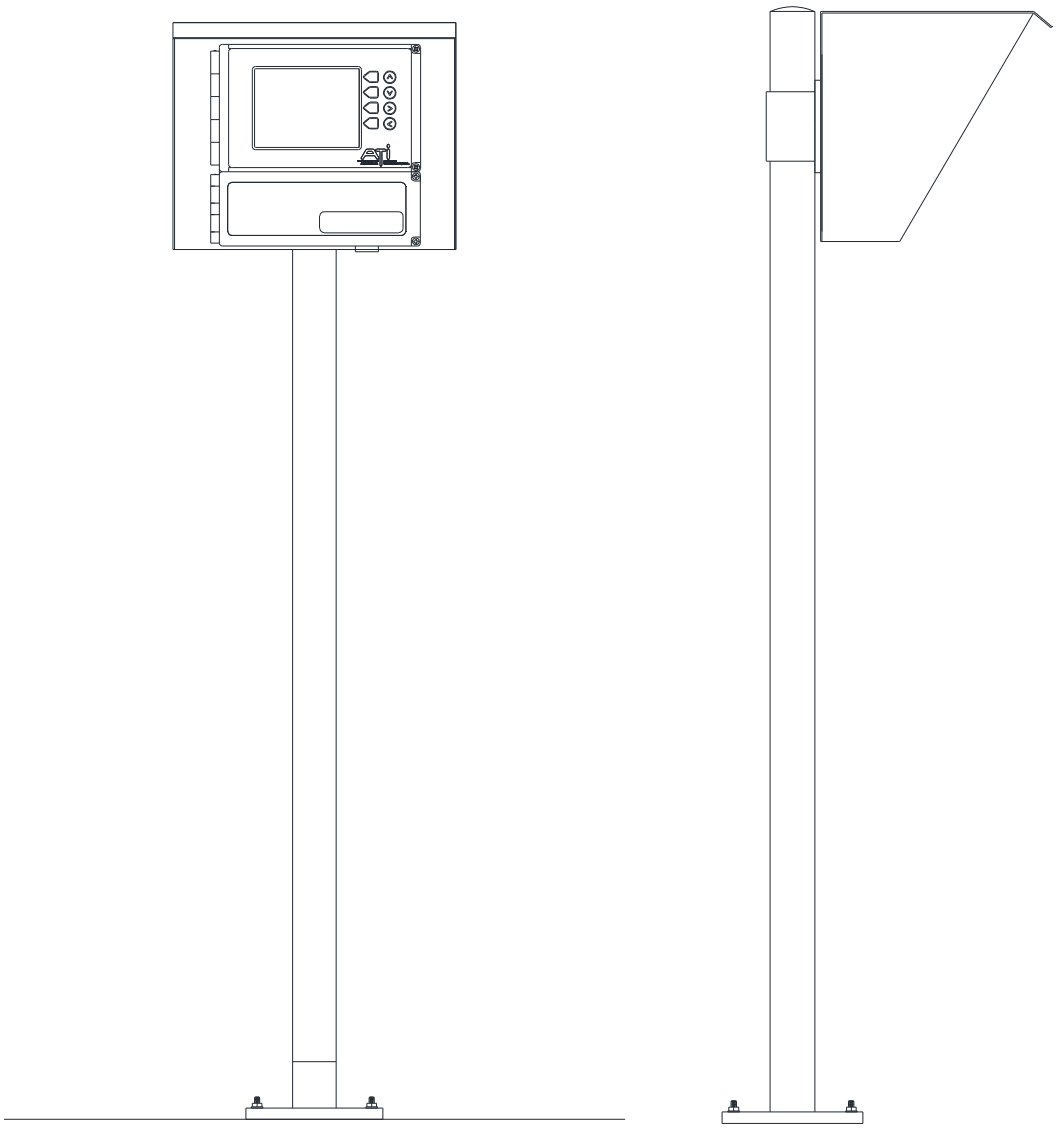
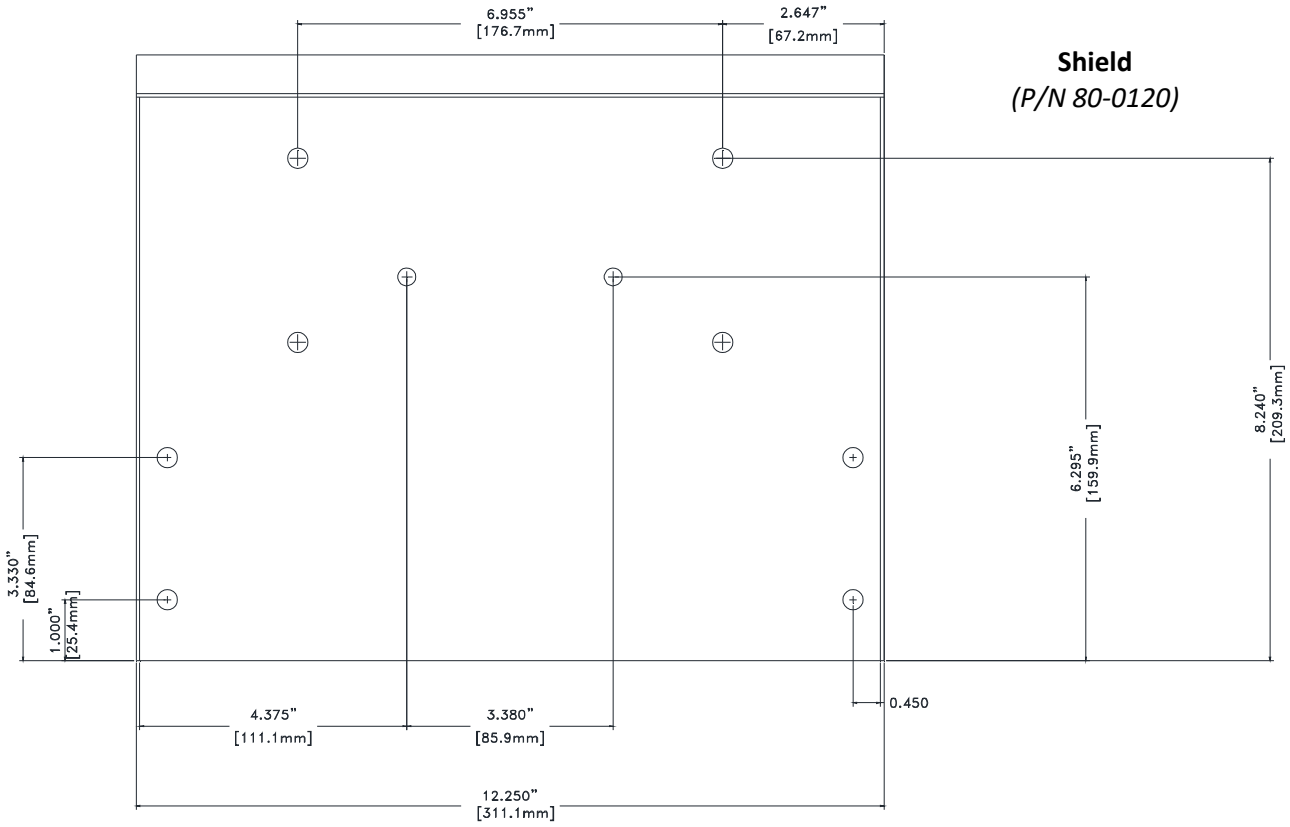
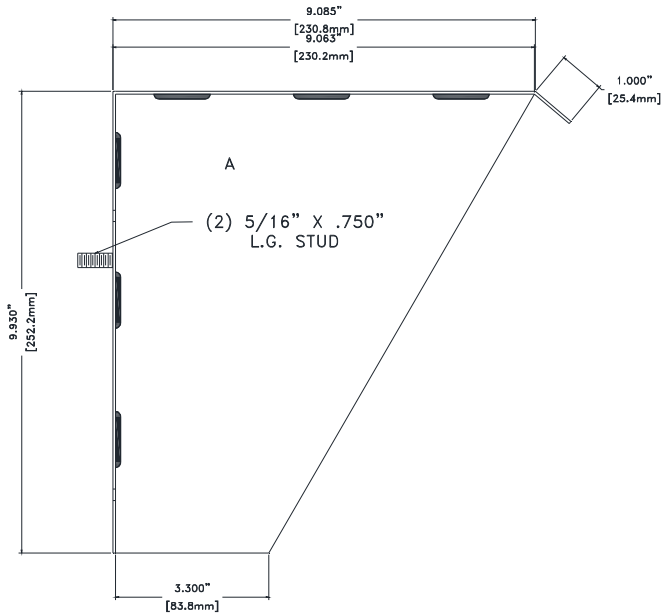
WEATHERSHIELD INSTALLATION FOR FLOOR MOUNT



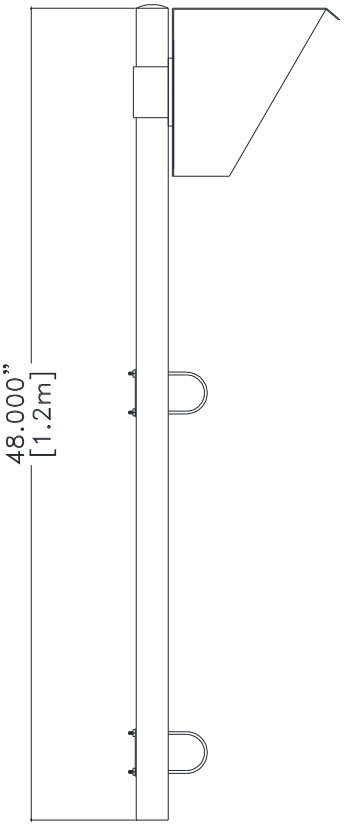
COMPONENT DIMENSIONAL DRAWINGS

Shield
(P/N 80-0120)

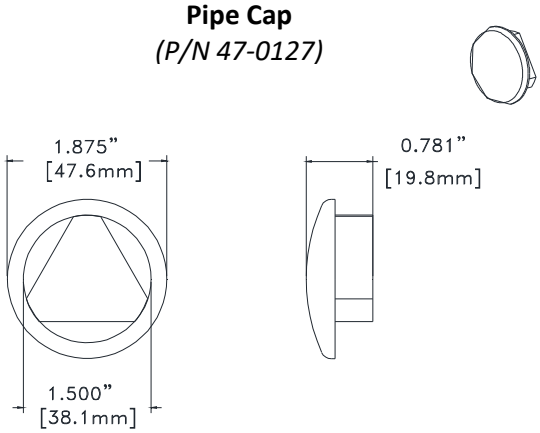


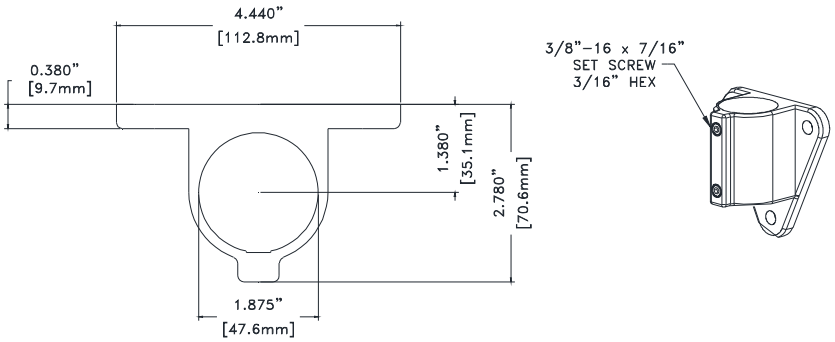


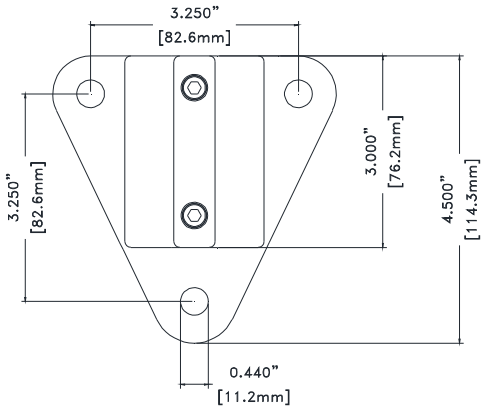
Pipe
(P/N 48-0211)



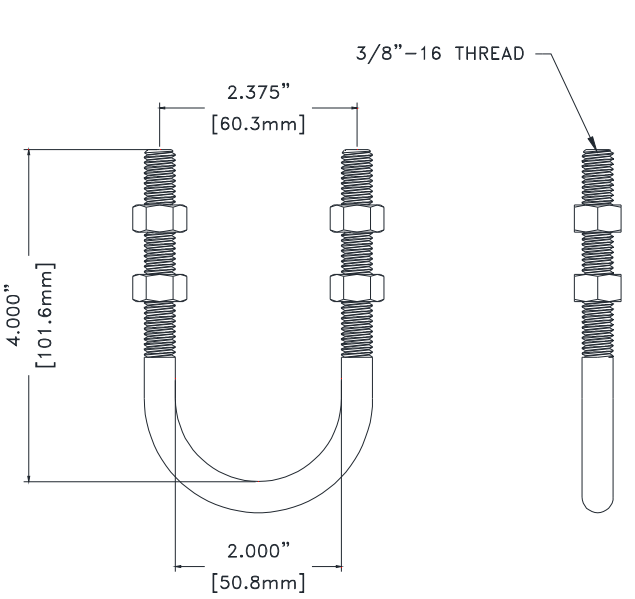
Pipe Cap
(P/N 47-0127)

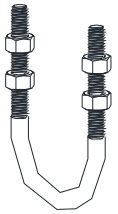




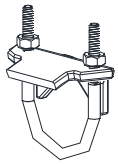


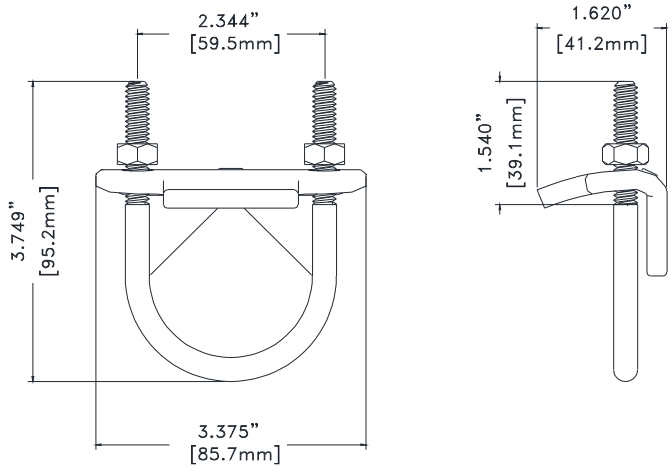
Slip-on Rail Fitting
(P/N 47-0125)



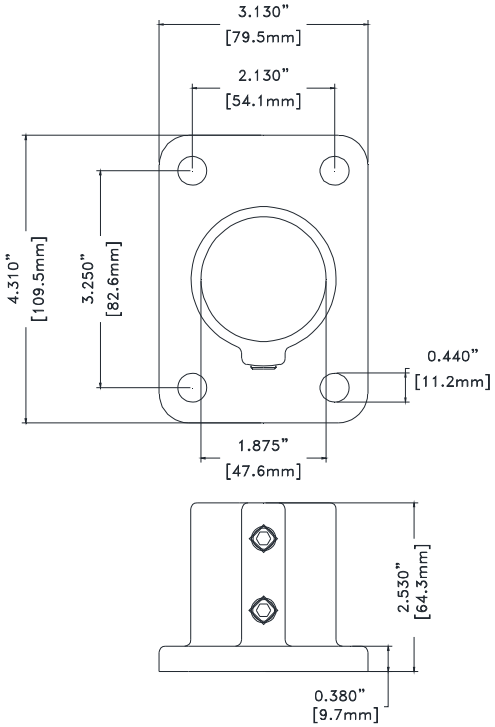


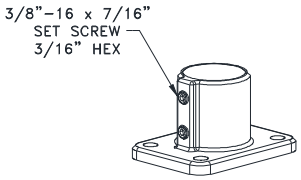
Pipe U-bolts
(P/N 47-0126)





Beam Pipe Clamp
(P/N 47-0129)





Slip-on Rail
Floor Mount
(P/N 47-0130)

Weathershield Configurations

Component	Round	Square	Floor
Shield	●	●	●
Pipe	●	●	●
Pipe Cap	●	●	●
Slip-on Rail Fitting	●	●	●
Pipe U-bolts	●		
Beam Pipe Clamp		●	
Slip-on Rail Floor Mount			●

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EchoSmart

Operation & Installation

Manual

Version A2.3

EchoSmart Sensor **EchoSmart Controller**

EchoSmart Power Supply Unit

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Safety Precautions

About this Manual: PLEASE READ THE ENTIRE MANUAL PRIOR TO INSTALLING OR USING THIS PRODUCT.

The following safety precautions should be observed in the implementation and use of this product.

The EchoSmart Controller (ESC), EchoSmart Power Supply Unit (ESP), and EchoSmart Sensor (ESS) are intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

User's Responsibility for Safety:

Responsible body: this is the individual or group responsible for the use and maintenance of equipment, and for ensuring that operators are adequately trained. Operators are to use the product for its intended function. They should not be allowed access to the electrical connections within the control box and would normally only operate the external keypad and monitor the display.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, checking the line voltage or checking electrical connections, replacing main fuses, etc. Only service personnel should perform other tasks.

There are no user serviceable parts on the main PCB section of the EchoSmart ESC or ESP. Service personnel are trained to work on live circuits and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Wiring and Electrical: Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. Product users must be trained to protect themselves from the risk of electric shock.

Before operating an instrument, make sure the line cable is connected to a properly grounded power receptacle. Inspect the connection cables for possible wear, cracks, or breaks before each use. When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

For **CE and safety compliance**, adequate grounding and shielding is required. All EchoSmart system cables are to be installed in metal conduit that is properly grounded and shielded utilizing EMC compliant methods. Each conduit should be individually shielded and grounded. Where metal

enclosures are supplied, each enclosure should be grounded and shielded to each individual conduit.
External chassis components cannot be used as safety earth ground connections.

Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. If you are unsure about the applicability of a replacement component, call Analytical Technology, Inc. for information. Only use the EchoSmart ESC or ESP with the sensor supplied. Replace Fuse with: 1.25A 5x20mm T-Lag UL approved.

This equipment is suitable for use with 110-240 Volts AC power at 50-60 Hz. No internal changes are required within this range. Equipment is optionally available and can be ordered for use with 24VDC power. Caution must be taken to supply main power in the form for which the equipment is designed.

A protective earth should be provided for all installations.

WARNING ⚠

If this equipment is used in a manner not specified by Analytical Technology, Inc., the protection provided may be impaired. The EchoSmart ESC, ESP, and ESS are regarded as permanently installed equipment and as such a switch or circuit breaker must be included in the installation. This should be in close proximity to the equipment, it should be marked as the disconnecting device, and it should disconnect both current carrying conductors.

WARNING ⚠

CHECK THAT THE POWER SUPPLY IS SUITABLE BEFORE SWITCHING POWER ON.

Proper Installation and Handling: The normal application for the EchoSmart ESC or ESP requires it to be installed at industrial installations including water and wastewater treatment plants. While the ESC and ESP enclosures are liquid-resistant (IP65), they are not designed to be immersed. These items should be mounted in such a way that the enclosure does not come into contact with the application media under normal operational conditions. The ESS (sensor) and its cabling are designed to be submerged without hazard to the equipment or to operators when correctly connected as described in this manual.

To clean the instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner to the inside of the instrument or allow liquids to enter or spill on the instrument.

Material Compatibility: The ESC and ESP enclosures are made of flame-retardant Polycarbonate (PC/ABS FR). The ESS enclosure is made of epoxy-filled ABS. Some sensor models include additional wetted parts. Make sure that the model which you have selected is chemically compatible with the application media, temperatures, and pressures to which it will be exposed.

WARNING WHEN APPLICABLE ⚠

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

1. Product Description

EchoSmart™ is an exciting new development in liquid/solid interface level analyzers. Instruments employ digital sensors in an architecture that locates microprocessor signal control, enhancement, and interpretation in the ultrasonic sensor rather than in a remote analyzer. The sensor is a Smart device. When connected to a power source and instrument programmer (typically EchoSmart Controller or EchoSmart Power Supply Unit), it produces the Level or Range measurement and an indication of the dispersed solids Level above the primary interface. Optional sensors are available that additionally provide surface back scatter turbidity measurements.

This equipment design opens the door for a wide range of flexible installation configuration options. The Controller is the operator graphical user interface device and power source to a sensor. It is also a communication hub for analog and digital communication outputs to the customer data acquisition system. EchoSmart can be implemented as a stand-alone instrument (Controller + Smart Sensor) or with numerous sensors networked together and operated by a single Controller as discussed below.

1.1. Stand-Alone Instrument Option

When connected to an EchoSmart Controller, the instrument has all the functionality of a complete measurement system. The Controller provides power to the sensor and is the user interface for instrument programming and communication with the sensor. Customer terminations for digital and analog communications to the customer's data acquisition and control system are provided inside the Controller.

A large graphical LCD with control keypad provides a simple and intuitive platform to implement Sensor Parameters, configure communications, view current and historical measurements, and perform system diagnostics. HELP PROMPTS are automatically displayed for each parameter and system function.

1.2. Field Network Option

Up to 16 EchoSmart Sensors can be operated by a single Controller in a wired or wireless Field Network. In either arrangement, the network is fully integrated and requires no software integration by the customer.

The Controller handles all programming and monitoring functions for all sensors in the network. Power Supply Units provide power to associated sensors and are fitted with integrated two-way transmitter modules when used in an RF network. Terminations for analog communication (4-20mA signal) are also at the Power Supply Unit.

1.3. Network Integrated to Customer Data Acquisition and Controls

EchoSmart Field Networks can be integrated to the customer's data acquisition and control system via two-wire RS-485, Modbus RTU protocol. See Section 8.2.1 for additional information.

2. Applications

EchoSmart is suitable for most municipal and industrial liquid/solid separation processes in which a reliable measurement of the level of a solids or suspended-solids blanket is desired. Typical applications include municipal and industrial wastewater and water treatment clarifiers and gravity thickeners. Sensors with optional turbidity measurement are available for applications in which a 0-50 NTU turbidity indication at the location of the sensor is desired. A broad range of industrial process applications are also appropriate. Self-cleaning sensors and special design sensors to accommodate high temperature and exposure to chemical environments are available.

2.1. Wastewater and Water Treatment Clarifiers and Thickeners

EchoSmart instruments are most frequently implemented to provide reliable sludge blanket level measurements in municipal wastewater and water treatment operations. Instruments are suitable for circular and rectangular basins, uncovered and covered tanks, and those with both fixed and traveling bridge arrangements. Mounting arrangements easily accommodate surface skimmers and rakes. Automatic signal control functions adapt to differences in sludge density that typically occur in primary, secondary and final clarifiers, and gravity thickeners.

Instruments are also effective in granular media gravity and pressure filters for conditional backwash control. Measurements include media level and expansion, and above filter turbidity (backwash turbidity).

2.2. Industrial Wastewater and Raw Water Treatment

EchoSmart is effective in providing sludge level measurements in a wide range of industrial water treatment applications. Raw water from a surface water source is often sent to a clarifier for particulate removal prior to introduction to plant processes. Water spent in plant processes often requires primary, and even secondary treatment prior to being directed to a municipal plant for further processing or being discharged in the environment. EchoSmart sludge level measurements can be used to effectively control clarifier solids blow-down, optimize chemical application, and limit solids discharge in the effluent stream.

2.3. Industrial Process Applications

Suitable process applications are found in the Power Generation, Mining and Mineral Processing, Chemical, Pulp and Paper and other process industries. Contact Analytical Technology, Inc. or an authorized representative for further information on the characteristics and requirements for successful implementation of EchoSmart equipment in these environments.

3. EchoSmart Sensor (ESS)

The EchoSmart Sensor is a microprocessor controlled piezoelectric transducer designed specifically for operation under water (submerged in the process liquid).

3.1. General Overview

The EchoSmart Sensor generates an ultrasonic sound wave that propagates through a liquid medium and is reflected back from material that is present in the vessel (typically settled solids, suspended solids, and/or the tank bottom). The sound wave travels at known velocities providing the ability to convert elapsed time into Range and Level measurements.

The EchoSmart Sensor does more than just produce a raw signal. It is equipped with an advanced programmable microprocessor and dynamic memory. Through these facilities, the sensor provides all signal control, enhancement and interpretation, and determines the final process measurement. The Smart Sensor communicates with an EchoSmart Controller via digital communication. The sensor also generates a 4-20 mA proportional current loop signal. Customer connections are provided at the Controller. If a Smart Sensor is part of a field network, connections are made at the Controller or Power Supply Unit that is supplying power to the sensor.

Sensors with a 90° surface back-scatter turbidity meter integrated into the ESS are available. This option can be beneficial and cost effective in applications where a turbidity measurement at the location of the sensor is desired. It is often used in secondary clarifiers and similar applications to alert process upset conditions. It is also employed in water and wastewater treatment media filters as part of an effective conditional backwash control system.

3.2. Specifications

POWER REQUIREMENT	15VDC Standard Sensor: 2.4W Wiper Sensor: 3W
RANGE	1.0 to 32 ft. (0.305 to 10.0 m)
SENSOR MEAS. RESOLUTION	0.1 Unit of measure
ACCURACY	0.2 in at 10.0 ft (5mm at 3.05m)
OPERATING TEMPERATURE	34 to 125 °F (1 to 52 °C)
CONFIGURATION BACKUP	Settings stored in FLASH memory

SENSOR CONSTRUCTION	IP68, ABS and epoxy Stainless steel and rubber (wiper only)
TURBIDITY (OPTIONAL)	Measurement Principle: 90-degree scattered light, pulsed LED Range: 0 to 50 NTU
WEIGHT	Standard Sensor: 2.25 lb (1.02 kg) Wiper Sensor: 2.75 lb (1.25 kg) Wiper Sensor with Turbidity: 2.75 lb (1.25 kg)
CERTIFICATIONS	CE

4. EchoSmart Controller (ESC)

The EchoSmart Controller allows for programming and local monitoring of one to sixteen EchoSmart Sensors.

4.1. General Overview

The Controller display consists of a graphical backlit LCD (2.6 x 3.45 inch viewing area) that is divided into five functional sections. Soft Keys and Navigation Keys located to the right of the screen are used for data entry and other operations. Figure 1 points out the functional sections of the screen and the location of the Soft Keys and Navigation Keys.

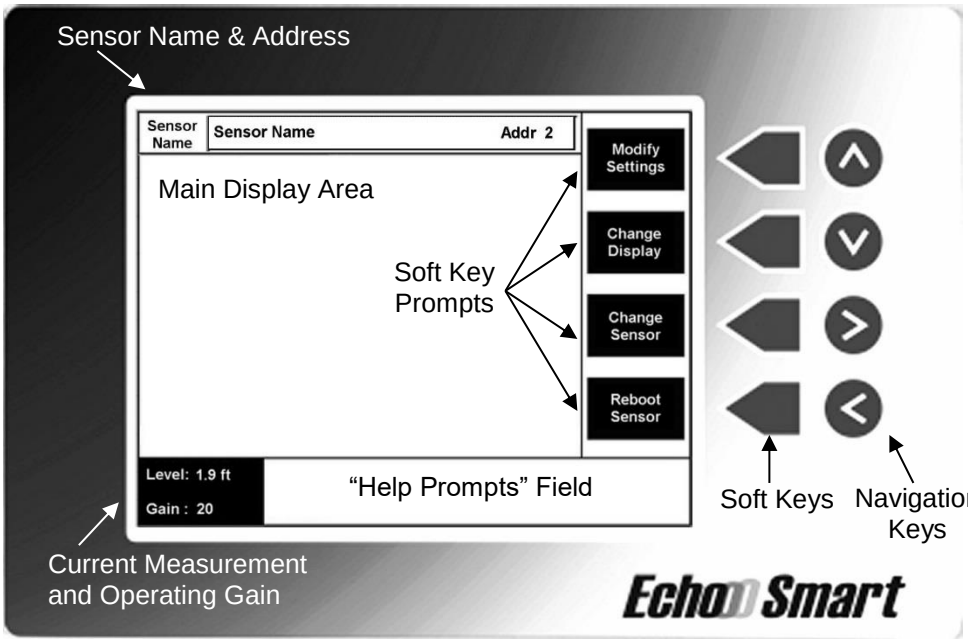

Figure 1: LCD Display

4.1.1. Operator Interface Overview

The display has five informative sections:

Smart Sensor Name & Address

The bar at the top of the display shows the name and network address that has been assigned to the sensor. This is the sensor that is currently being interrogated. Information on this and all other displays relates to this sensor.

If the Controller is operating a multi-sensor field network, other sensors are available by pressing the *Change Sensor* soft key. A listing of network sensors will appear (See Figure 20). Use the Navigation Keys to select the desired sensor and press *Select Sensor*.

Current Measurement and Operating Gain

The current measurement, operating gain (signal amplification), and turbidity value (when applicable) are conveniently available in the lower left corner of all displays. Additionally, messages regarding external communication (see Section 8.2) taking place and error messages (see Section 10.2) associated with the active sensor are displayed in this section.

Help Prompts Field

The Help Prompts Field across the lower section of each display provides an explanation of the screen, or the highlighted parameter. Help Prompts reduce the need for reference to the print operating manual.

Main Display Area

The area has both digital and graphical capabilities. The content changes with the functionality of the selected display.

Soft Key Prompts

The vertical bar on the right side of the display consists of four boxes. Each box contains text that describes the function of the Soft Key that is located next to that box. The text changes when the user selects a different function or navigates to a different instrument parameter.

4.1.2. Keypad

The Echo Smart Controller has four Soft Keys and four Navigation Keys.

Soft Keys

The function of a Soft Key is described by the Soft Key Prompt located immediately to the left of the key. Soft Keys are used to change instrument settings, switch to a different display, or trigger other actions.

When using a soft key to increase or decrease a value, the key can be held down in order to quickly modify the value.

Navigation Keys

Navigation Keys advance the instrument cursor to the desired location on the display for operation by Soft Key commands.

4.1.3. Screen Navigation Overview

An overview of the organizational structure of the available screens is shown in Figure 2 below.

Note: Functionality for the Relay Setup and Digital to Analog Converter Setup requires purchase of the associated hardware.

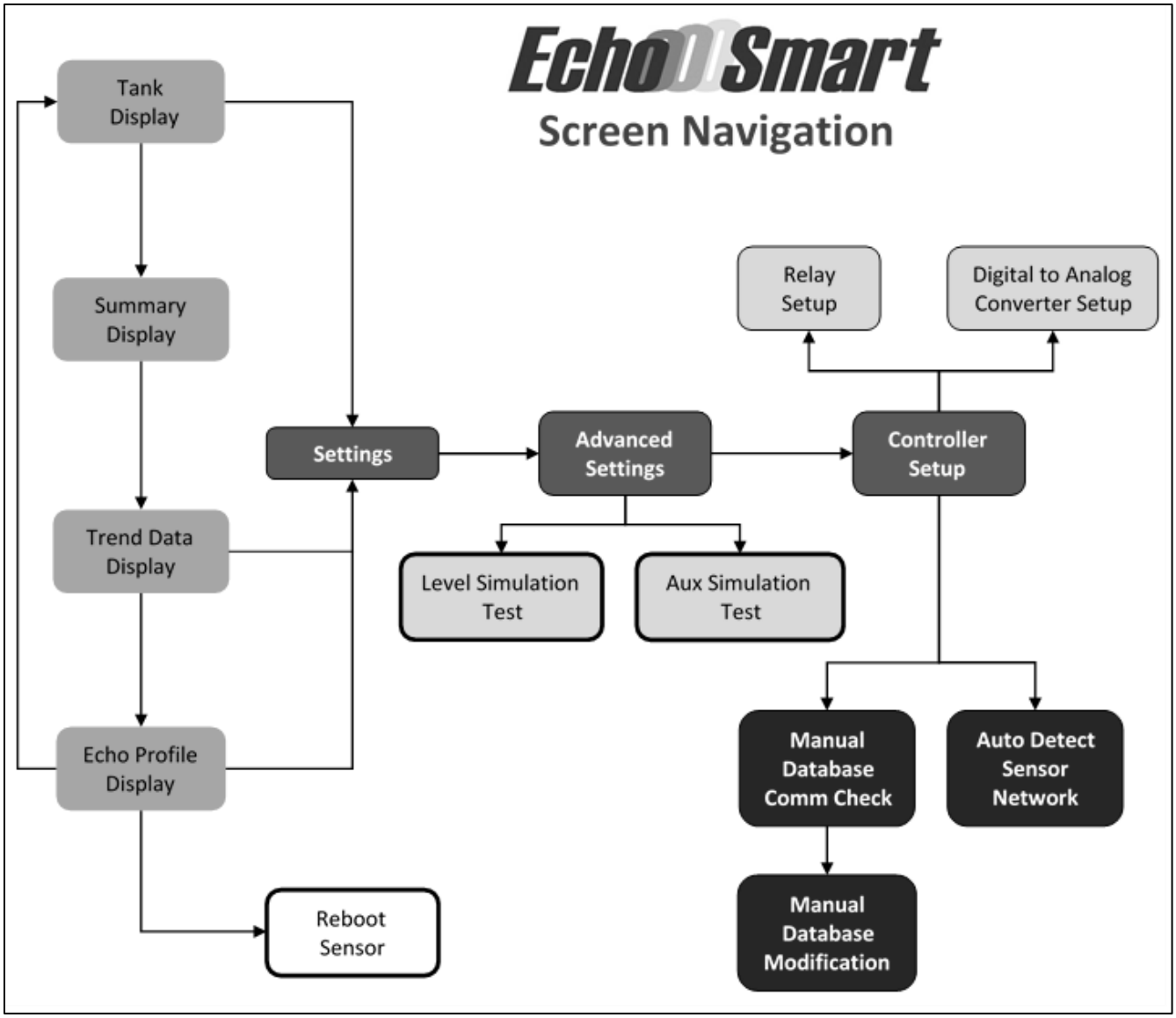

Figure 2: Screen Navigation Overview

4.2. Specifications and Connections

This section pertains to the physical layout of the Controller terminal connectors and how they are connected as a stand-alone system. If you are wishing to network the Controller with other devices (Ex: ESP, SCADA Systems, etc.), see Section 8 for sample connection diagrams.

4.2.1. Specifications

INPUT POWER	100-240 VAC, 50/60 Hz – 1.5A, 65W Optional 24 VDC: 19 – 42 VDC
SUPPLY CABLE	10-18 AWG, -40 to +140 F

FUSE	1.25A 250V 5x20mm T-lag UL approved fuse
ANALOG LOOPS	(2) 4-20mA Outputs 15 – 24 VDC (provided by ESC for local sensor)
AMBIENT TEMPERATURE	-40 to +140 °F (-40 to +60 °C)
DISPLAY	Graphical backlit monochrome screen Resolution: 320 x 240 pixels Viewing Area: 2.6 x 3.45 in (92 x 122 mm)
REPORTED MEAS. RESOLUTION	1.0 (in & cm), 0.1 (ft), 0.01 (m)
RF MODULE (OPTIONAL)	900MHz frequency band Self-healing mesh network Approvals: FCC Part 15C, Industry Canada
RELAYS (OPTIONAL)	(4) Relays: 10A @ 250 VAC; 10A @ 30VDC
ENCLOSURE	NEMA 4X, IP65; Polycarbonate
WEIGHT	Approx. 3.0 lb (1.36 kg) depending on configuration
CERTIFICATIONS	CE

Caution must be taken to supply main power in the form for which the equipment is designed.

4.2.2. Connections Overview

The ESC circuit board contains four screw-terminal connectors as well as additional plug-in connectors as shown in Figure 3. Use caution in tightening the screw terminals to prevent damage from over-tightening.

Ensure the power cable (10-18 AWG) is connected to the power connector properly. A breaker should be installed to fully remove power from the unit in the event that repairs to the unit are required. Sensors (ESS) should be connected to the controller by color code as shown in Figure 3 below. The table in Figure 4 contains a functional description of the screw terminal connectors.

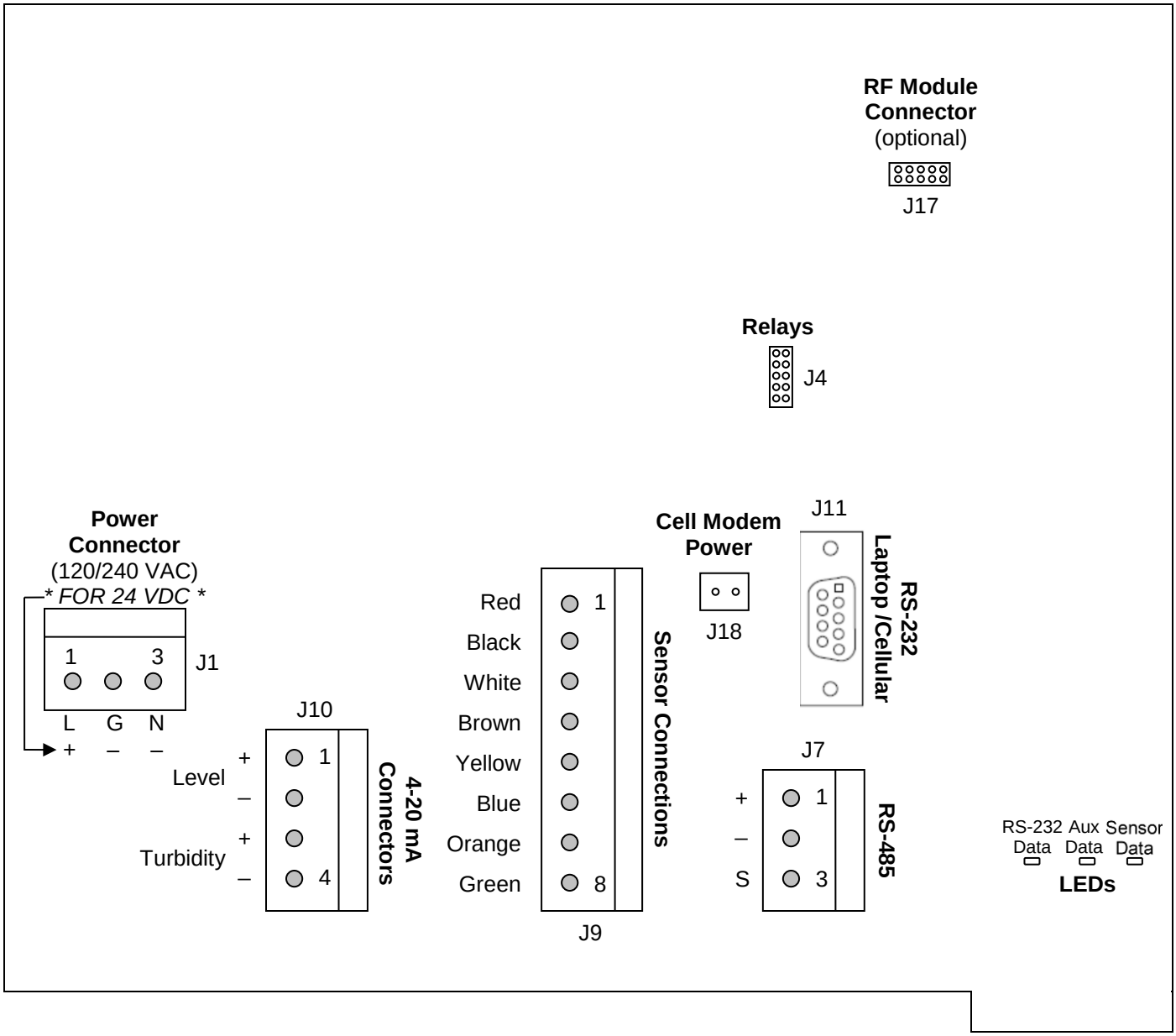

Figure 3: Connections for Controller

Power Connector (J1)		4-20 Analog Connectors (J10)		Sensor Connections (J9)		RS-485 Connector (J7)	
Pin #	*Description*	*Pin #*	*Description*	*Pin #*	*Description*	*Pin #*	*Description*
1	Live	1	Level +	1	15 V	1	Sensor Comm
2	Ground	2	Level –	2	Ground	2	Sensor Comm
3	Neutral	3	Turbidity +	3	Sensor Comm (+)	3	Ground
		4	Turbidity –	4	Sensor Comm (–)		
*** FOR 24 VDC * (J1)**				5	4-20mA Level		
1	+			6	4-20mA Level		
2	–			7	4-20mA Turbidity		
3	–			8	4-20mA Turbidity		

Figure 4: Table of Connections for Controller

Notes:

Sensor Connector (J9): Use Pin 3 and Pin 4 to link the Sensor Communication cable from the Controller to the next Power Supply Unit in a Wired RS-485 Field Network. Conductors are ganged with those from the sensor. Connection at the associated Power Supply Unit is at the RS-485 Connector (J8).

RS-485 Connector (J7): Use this connector when integrating a Field Network to the customer data acquisition and control system. This is the communication link between the Controller and an outside device. It is not used to interconnect Controllers and Power Supply Units.

4-20mA current loops are internally powered, grounded, and galvanically isolated.

4.3. Initializing and Configuring EchoSmart System

IMPORTANT: Disconnect any outside RS-485 device prior to initiating Controller Setup to avoid communication errors.

4.3.1. Initial Controller Setup Display

The Initial Controller Setup Screen will appear when power is applied to a Controller with an empty sensor register.

EchoSmart instruments employ Smart Sensor technology and are often implemented with multiple sensors operating in union with one Controller. To establish communication, each Smart Sensor must be assigned a unique address during initialization (see also Section 4.3.2). This address is held in the memory of both the Controller and the Smart Sensor(s).

IMPORTANT: All Smart Sensors are shipped from the factory with the pre-assigned address of 01. In multiple sensor Network installations it is imperative that sensors be added to the Network one at a time as further described in Section 4.3.2 below. The address of each sensor must be changed to a unique number from 2 – 240. The sensor that is directly connected to the Controller must be initialized first. Power and initialize additional sensors one at a time, carefully noting the location of the tank and the corresponding sensor name and address.

Enter the Current Date and Time at this screen using the Navigation and Soft Keys.

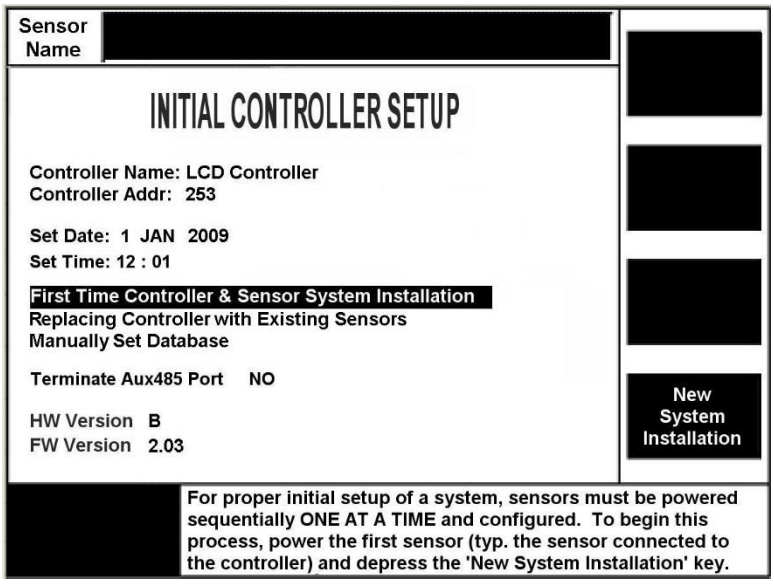

Figure 5: Initial Controller Setup

4.3.2. First Time Controller & Sensor System Installation

If this is a new installation, select First Time Controller & Sensor System Installation and press the Soft Key next to New System Installation (Figure 5). The Controller will automatically locate the Smart Sensor that has been powered (this will take a few seconds) and will open the Initial Sensor Setup Display (Figure 6).

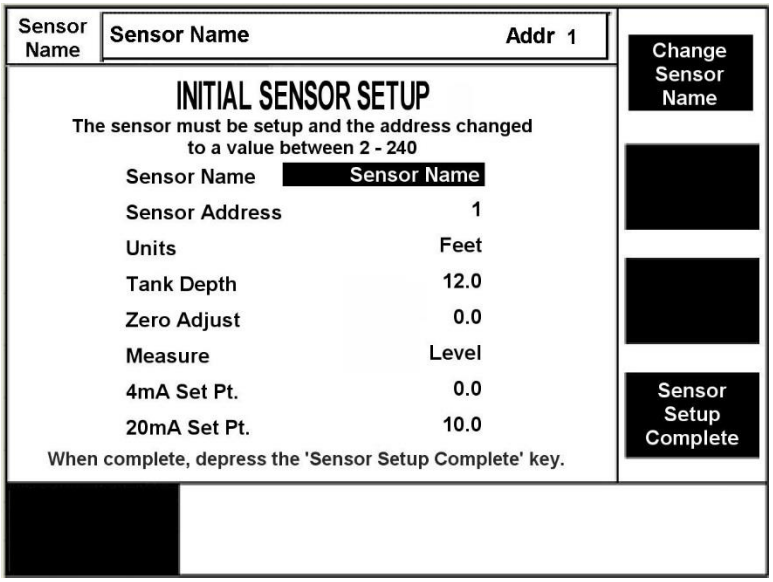

Figure 6: Initial Sensor Setup

Follow the Soft Key Prompts and use the Navigation Keys to enter the Sensor Name and Sensor Address. It is imperative that the Sensor Address be changed from 01 to any unrepeated number from 2 – 240 before initializing the next sensor in a network.

CAUTION: All sensors are supplied from the factory with the Sensor Address set at 01. A unique address must be assigned to each sensor as it is added to the network (powered ON). This procedure allows the Controller to establish communication and provide a unique address for each sensor as it is added to the network. Failure to follow this procedure will result in multiple sensors having the same address and will prevent communication.

Press the Soft Key next to Sensor Setup Complete to finalize setup of the sensor. The Power Next Sensor Screen (Figure 7) will appear. Apply power to the EchoSmart Power Supply Unit connected to the next sensor and repeat the steps above.

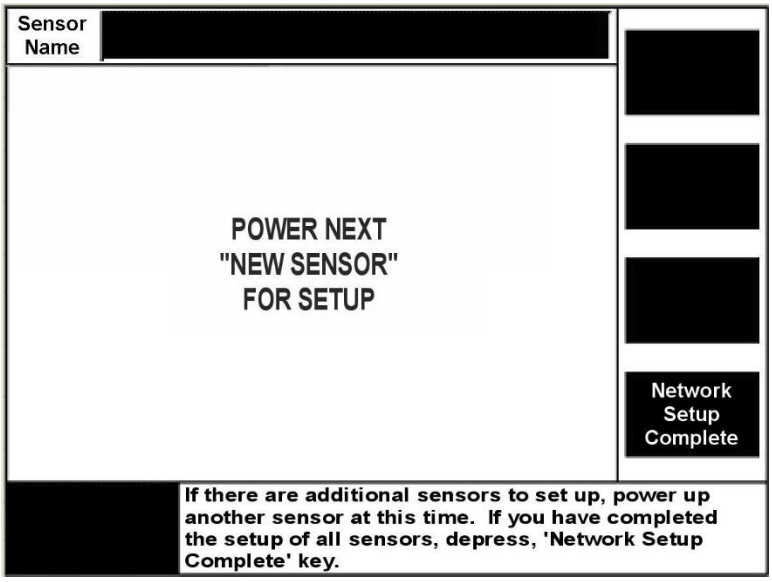

Figure 7: Power Next Sensor

After all sensors have been initialized, Press the Soft Key next to the Network Setup Complete prompt (Figure 7). The Controller will then begin to poll all the EchoSmart Sensors and display current measurements.

See also the Quick Start Guide in Section 12 of this manual for step-by-step instruction on configuring a single sensor or a network of sensors.

4.3.3. Replacing a Controller with Existing Sensor(s)

If Smart Sensors have previously been initialized and the Controller is being replaced, select *Replacing Controller with Existing Sensors* and press the Soft Key next to Replace Controller Only. The Controller will automatically detect the existing sensors and return to full operation after the initialization routine is completed.

4.4. Utilization of Informational Displays

The Controller has four informational displays: Echo Profile Display, Sensor Register Display, Tank View Display, and Historical Trend Display. Selections are made by pressing the *Change Display* Soft Key. At power up, the system defaults to the Echo Profile Display.

There are also three displays that are used to enter instrument settings: Modify Settings Display, Advanced Settings Display and Controller Setup Display.

4.4.1. Echo Profile Display

The Echo Profile Display (Figure 8) shows the echo waveform generated by the selected sensor. To view the waveform of another sensor, press the *Change*

Sensor soft key, select the desired sensor from the dropdown list, and press *Select Sensor*.

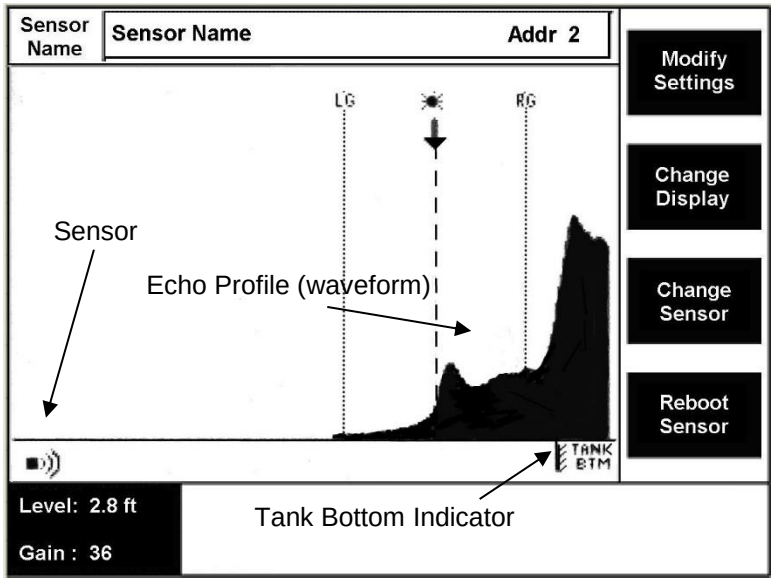

Figure 8: Echo Profile Display

This display presents the actively updated signal waveform generated by the sensor and used to determine the Level or Range measurement.

The horizontal x-axis is a distance axis based on the span between the sensor (lower, left side of the screen) and the bottom of the tank (lower, right side of the screen). The vertical y-axis corresponds to the strength of signal at locations between the sensor and the tank bottom. EchoSmart proprietary interpretive algorithms are applied to the signal waveform to determine the position of an interface – typically between a supernatant liquid and settled solids or suspended solids.

4.4.2. Sensor Register Displays

This display consists of a table that shows the name of each sensor and its Current Measurement and Operating Gain value. If the Controller is communicating with four or fewer sensors, information is presented as shown in Figure 9.

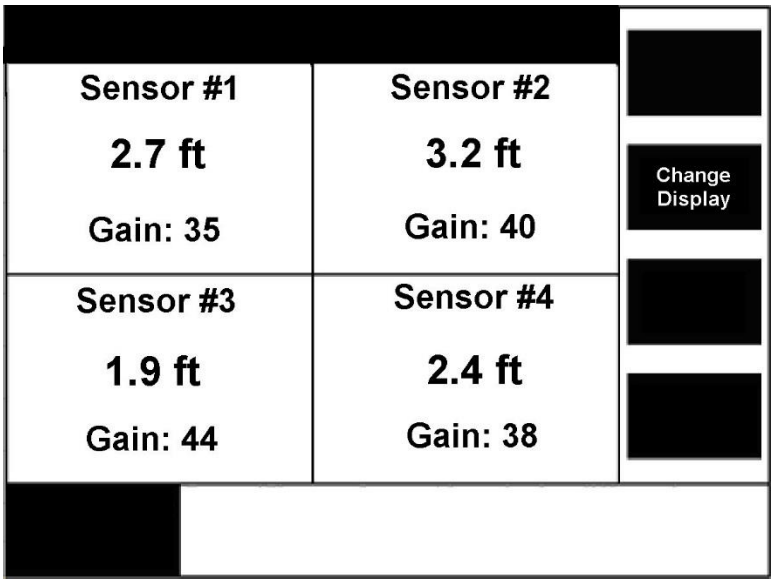

Figure 9: Four Sensor Field Network Display

With five or more sensors, information is presented as shown in Figure 10.

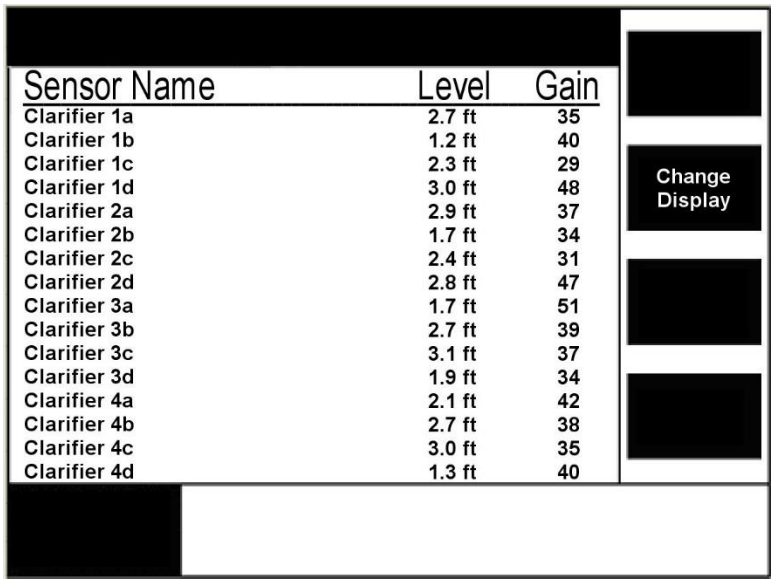

Figure 10: Multiple Sensor Field Network Display

These displays are not available when only one sensor is in use.

4.4.3. Tank View Display

The Tank View Display (Figure 11) shows a scaled cross-sectional view of the tank. The arrow on the left side of the tank provides a visual indication of the current fill Level. Dispersed solids that may be indicated in the echo waveform are represented by pixilated gradients above the primary interface.

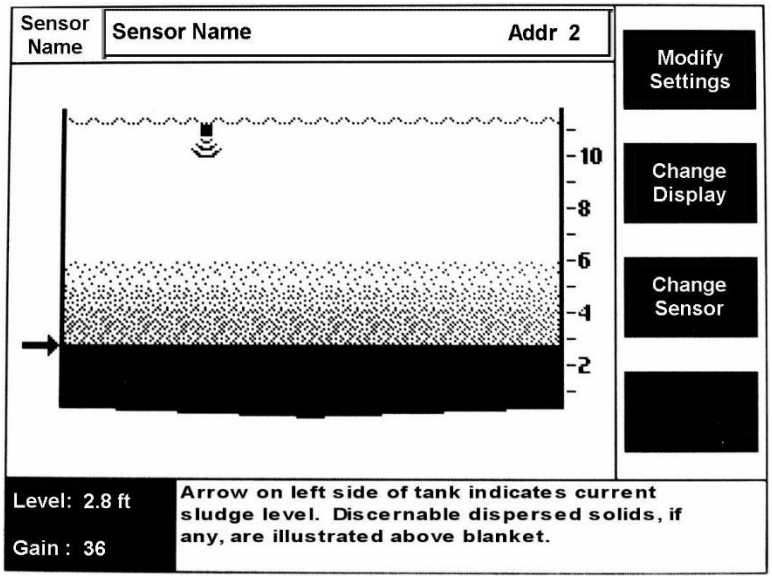

Figure 11: Tank View Display

The Tank View Display is enabled at the Modify Settings Display. Optional diagrams are available to correspond with the specific application (Figure 12).

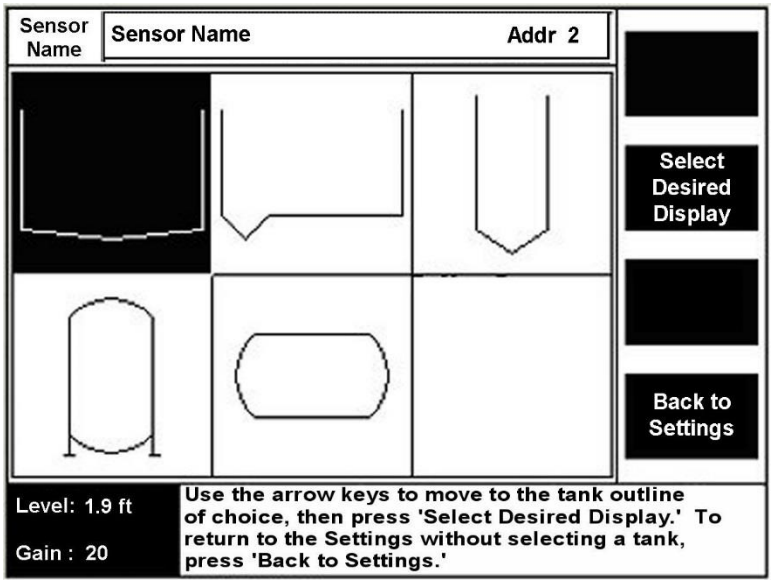

Figure 12: Tank Options

4.4.4. Historical Trend Display

The EchoSmart Controller captures and stores the current measurement value every six minutes. The database is updated on a “first in/first out” basis to maintain a continuous register of the most recent seven days of data for all sensors. Newest data is reported on the right side of the screen.

The Historical Trend Display (Figure 13) provides a graphical illustration of stored measurements for the selected sensor. The user may choose to view from one to seven days of data.

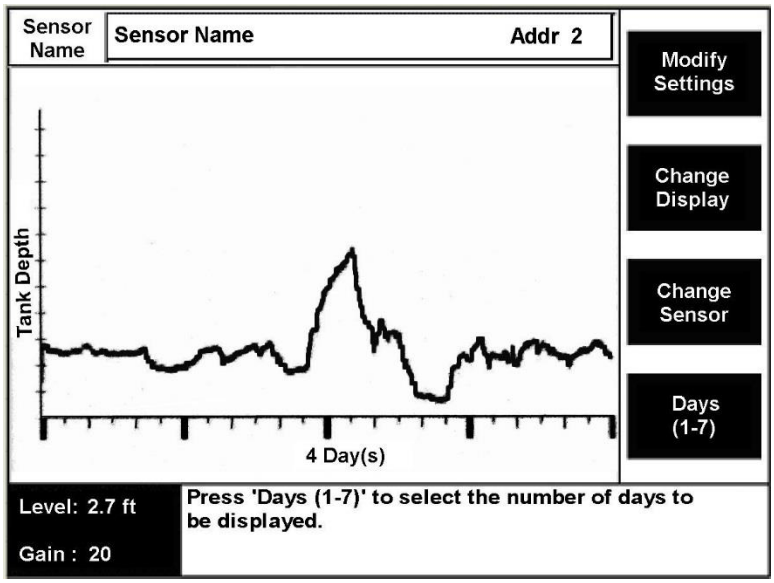

Figure 13: Historical Trend Display

The Historical Trend Display is enabled at the Modify Settings Display.

4.4.5. Modify Settings Display

This display (Figure 14) is used to enter the primary parameter settings for each sensor and to enable the Historical Trend Display and the Tank View Display. A Display Contrast adjustment function is also found here.

Changes are implemented once entered and the user exits the display. No confirming command is required.

Descriptions of parameter functions are found in Section 9.1.

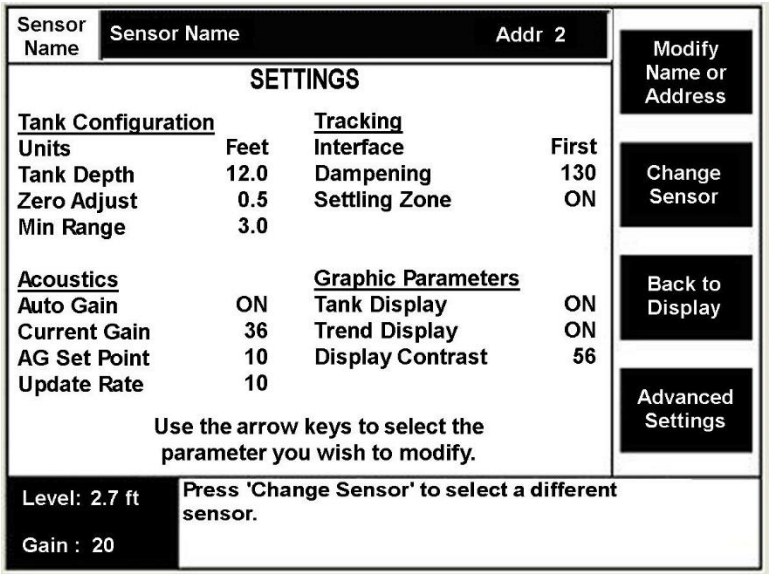

Figure 14: Modify Settings Display

A unique Alpha-Numeric name may be assigned to the sensor and its identifier address can be changed by pressing the Soft Key next to the *Modify Name or Address* prompt (Figure 15).

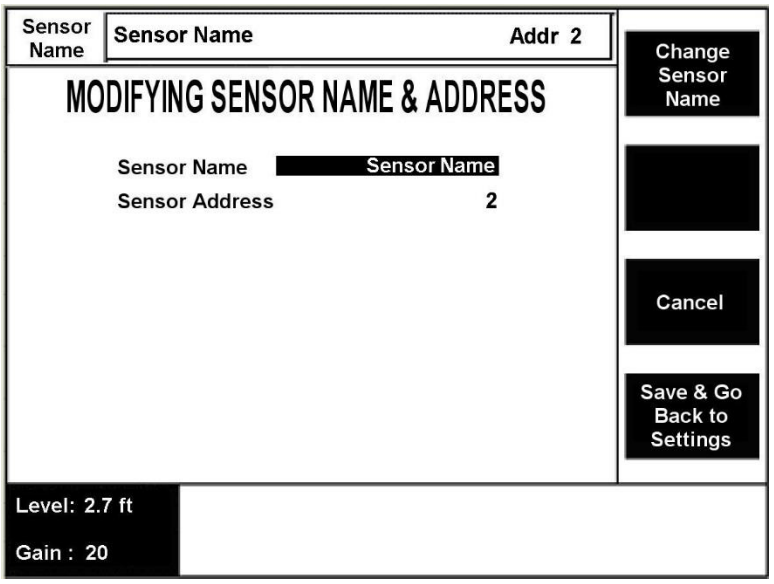

Figure 15: Modifying Sensor Name and Address Display

When modifying the sensor name, the Navigation Keys are used to scroll to selected letters, numbers and symbols to enter the desired sensor name. The Soft Keys assist with other functions, as indicated by the Soft Key Prompts.

4.4.6. Advanced Settings Display

This display (Figure 16) is used to enter additional parameter settings for each sensor. It is also used to establish the Analog Output parameters for the sensor.

The Advanced Settings Display is accessed by Soft Key function from the Modify Settings Display.

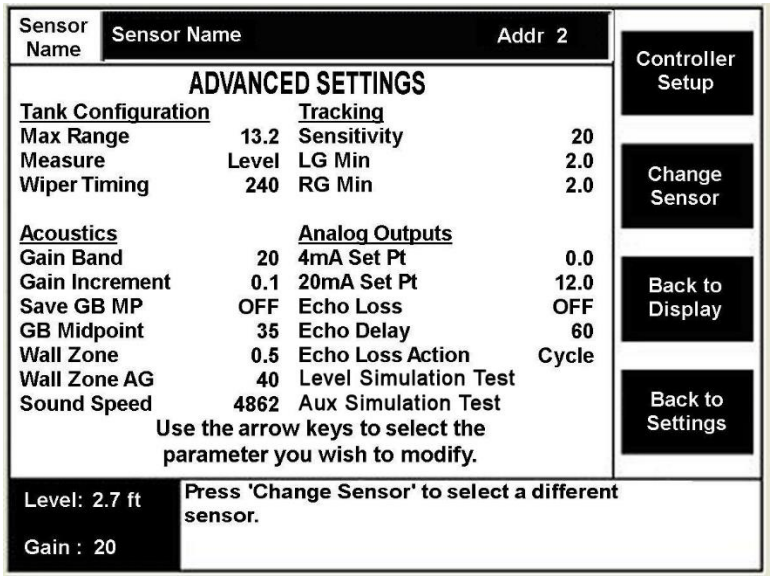

Figure 16: Advanced Settings Display

Descriptions of parameter functions are found in Section 9.2.

4.4.7. Controller Setup Display

The purpose of this display (Figure 17) is to change the Current Date and Time, and to initiate either a manual or automatic establishment of the sensor network. Actual Hardware and Firmware version will be displayed on the setup screen.

Setup screens for the optional relays and optional Digital to Analog Converter are available from this screen. The functionality of these options requires the purchase of the associated hardware.

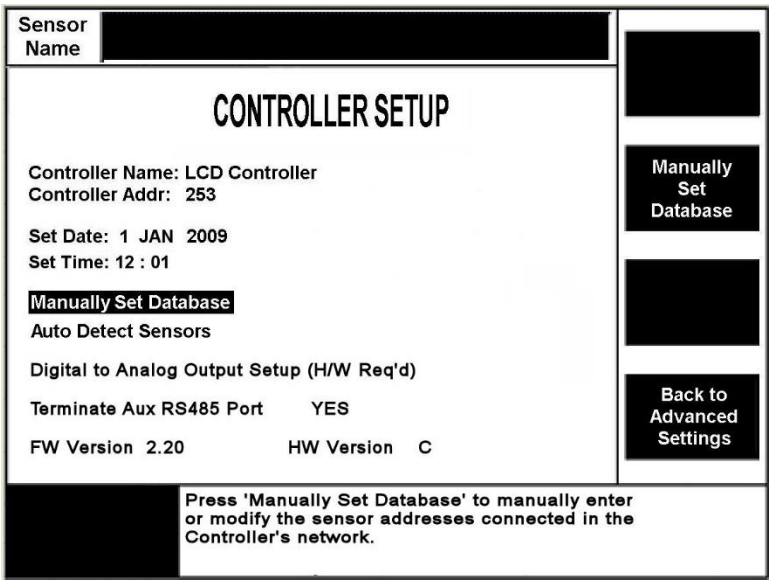

Figure 17: Controller Setup Display

Auto Detect Sensors begins a search for sensors that are directly connected to the Controller and are part of a Field Network of sensors. This option is used to initialize a new instrument and to add sensors from an existing network.

Manually Set Database (Figure 18) allows the user to specify sensor addresses and establishes the order in which the addresses will appear in the Sensor Register Display. Manually setting the database causes the Controller to persist in attempts to detect listed sensors in cases where Auto Detect has failed to locate all sensors.

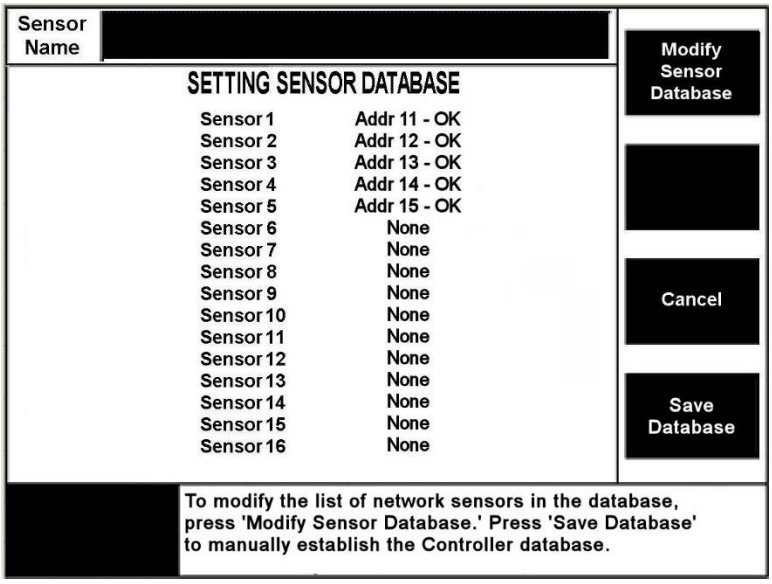

Figure 18: Sensor Database Display

When *Manually Set Database* is selected, a quick check of the network sensors is performed. When communication is verified, "OK" is placed next to the sensor address. If communication cannot be verified, "??" is displayed next to the address.

Any needed modifications to the database can be performed once *Modify Sensor Database* is selected. From the Modifying Sensor Database Display (
Figure 19), network addresses to be polled by the Controller can be changed, the sensor display order can be modified, and a sensor can be deleted.

IMPORTANT**:** Changes made from this menu are ONLY used to modify the existing network of sensor addresses to be polled by the Controller and DOES NOT change the sensor's address. Any changes to the sensor address parameter contained in the sensor must be performed from the Modifying Sensor Name and Address screen (Section 4.4.5).

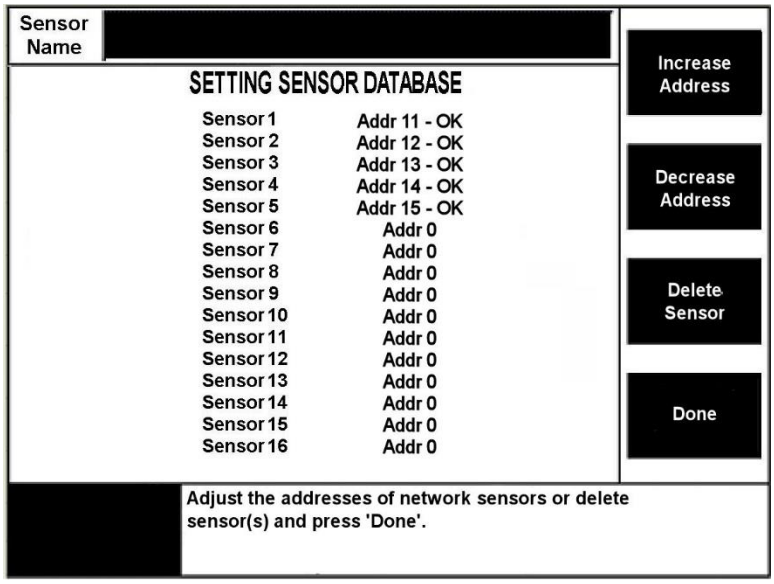

Figure 19: Modifying Sensor Database Display

Once desired changes are complete, press *Done* to return to the Sensor Database Display. If any changes were made, the *Save Database* key (Figure 18) must be pressed for the modifications to take effect.

After initiating either the *Auto Detect Sensors* or the *Manually Set Database* command, the Help Prompt field (lower right portion of display area) will report the number of sensors found, followed by the number of sensors validated. The display will then redirect to the Echo Profile screen and begin polling all the sensors in the database.

The Controller Setup Display is accessed from the Advanced Settings Display by pressing the *Controller Setup* soft key.

4.4.8. Sensor Selection Menu

To change the sensor that the Controller is currently displaying, press the *Change Sensor* Soft Key (available at any informational display and the settings displays). Use the Navigation Keys to move to the desired sensor and press the *Select Sensor* key (Figure 20).

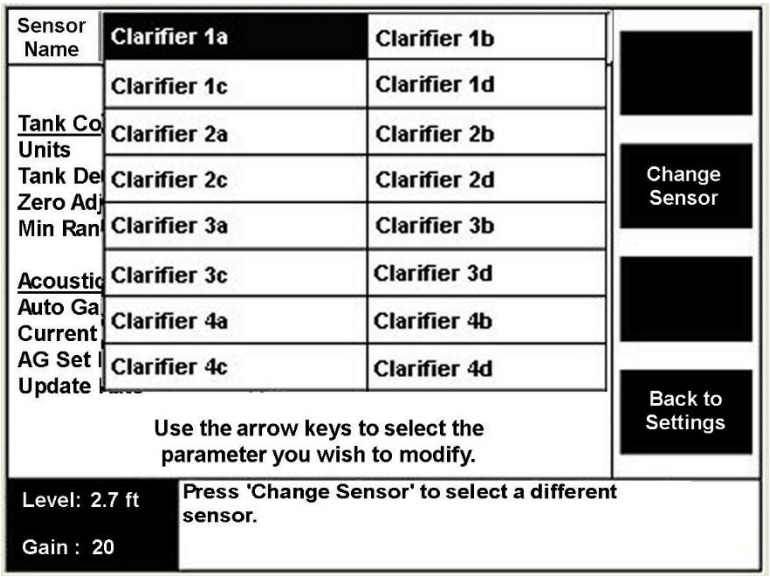

Figure 20: Sensor Selection Drop-down Window

4.5. Automatic Initialization and Reboot

EchoSmart performs automatic initialization whenever power is applied to the sensor or the Reboot Sensor command is selected at the Echo Profile Display. Instrument settings are not lost as a result of power interruption.

Automatic Initialization establishes operating gain (signal amplification) and determines current measurement values and signal outputs. It is advisable to re-initialize a sensor that has been out of service or has been operating while not submerged in the process water. Re-initializing the sensor after a process upset has stabilized will quickly return the sensor to normal operation.

5. EchoSmart Power Supply (ESP)

The Echo Smart Power Supply Unit provides power to an EchoSmart Sensor and acts as a communication hub to facilitate analog, digital and Wireless RF communications from an EchoSmart Sensor.

EchoSmart Power Supply Units do not have display monitors or data entry keypads. They are typically used in a Field Network arrangement in which an EchoSmart Controller provides the user interface function for setup and monitoring of EchoSmart Sensors. See Section 8: Communications, Outputs, and Networking.

5.1. Specifications and Connections

This section pertains to the physical layout of the ESP terminal connectors and how they are implemented. If you are wishing to network the ESP with other devices (Ex: ESC, other ESPs, SCADA Systems, etc.), see Section 8 for sample connection diagrams.

5.1.1. Specifications

INPUT POWER	100-240 VAC, 50/60 Hz – 1A, 20W Optional 24 VDC: 18 – 36 VDC
SUPPLY CABLE	10-18 AWG, -40 to +140 F
FUSE	0.250A, 250V 5x20mm T-lag UL approved fuse
ANALOG LOOPS	15 – 24 VDC (provided by ESP for local sensor) (2) 4-20mA Outputs
AMBIENT TEMPERATURE	-40 to +140 °F (-40 to +60 °C)
RF MODULE (OPTIONAL)	900MHz frequency band Self-healing mesh network Approvals: FCC Part 15C, Industry Canada
ENCLOSURE	NEMA 4X, IP65; Polycarbonate
WEIGHT	Approx. 1.5 lb (0.68 kg)
CERTIFICATIONS	CE

Caution must be taken to supply main power in the form for which the equipment is designed.

5.1.2. Connections Overview

The ESP circuit board contains four screw-terminal connectors as well as additional plug-in connectors as shown in Figure 21. Use caution in tightening the screw terminals to prevent damage from over-tightening.

Ensure the power cable (10-18 AWG) is connected to the power connector properly. Sensors (ESS) should be connected to the power supply by color code as shown in Figure 21 below. The table in Figure 22 contains a functional description of the screw terminal connectors.

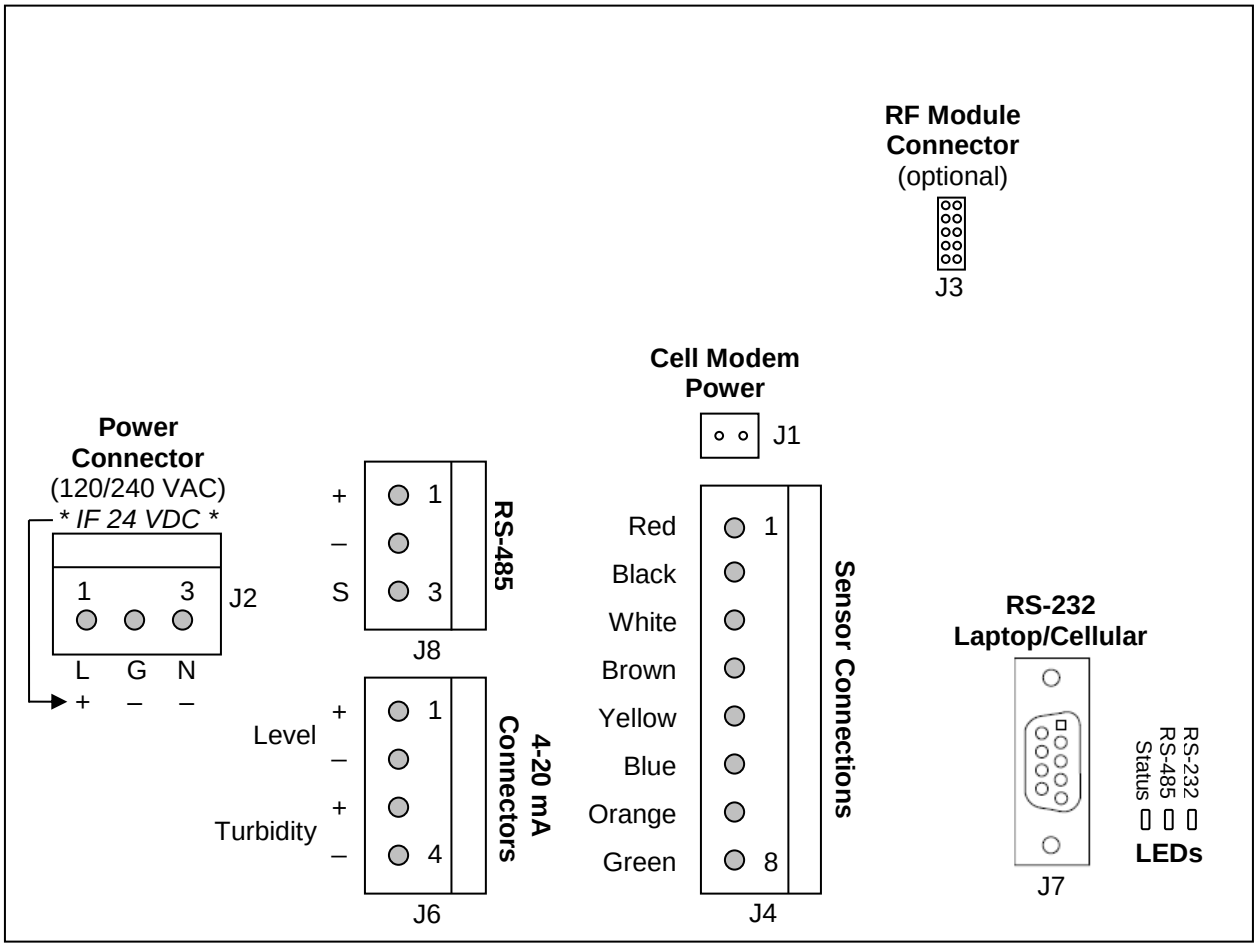

Figure 21: Connections for Power Supply

Power Connector (J2) FOR 100-240 VAC		4-20 Analog Connectors (J6)		Sensor Connections (J4)		RS-485 Connector (J8)	
Pin #	*Description*	*Pin #*	*Description*	*Pin #*	*Description*	*Pin #*	*Description*
1	Live	1	Level +	1	15 V	1	Sensor Comm
2	Ground	2	Level –	2	Ground	2	Sensor Comm
3	Neutral	3	Turbidity +	3	Sensor Comm (+)	3	Ground
		4	Turbidity –	4	Sensor Comm (–)		
*** FOR 24 VDC * (J2)**				5	4-20mA Level		
1	+			6	4-20mA Level		
2	–			7	4-20mA Turbidity		
3	–			8	4-20mA Turbidity		

Figure 22: Table of Power Supply Connections

Notes:

RS-485 Connector (J8): Attach the Network Communication cable from the Controller or Power Supply Unit in a Wired RS-485 Field Network to this connector. Connection at the Controller is made at Pin 3 and Pin 4 of the Sensor Connector (J9).

4-20mA current loops are internally powered, grounded, and galvanically isolated.

6. Installation of Equipment

6.1. Installation of EchoSmart Sensor

The EchoSmart Sensor must be fully submerged in the supernatant process liquid during operation. It is not capable of transmitting a signal through gas (air) or solid materials.

Mount the sensor using a rigid pipe or conduit to minimize excessive side-to-side sway or other avoidable movement. If a surface skimmer is present, install using a sensor mounting fixture that rotates the sensor out of the path of the skimmer (Multi-flex Assembly, Part No. 00-1809).

Orient the sensor such that the path of the transmit pulse is at 90˚ with respect to the surface of the sludge blanket or other material that is to be measured, as illustrated in Figure 23.

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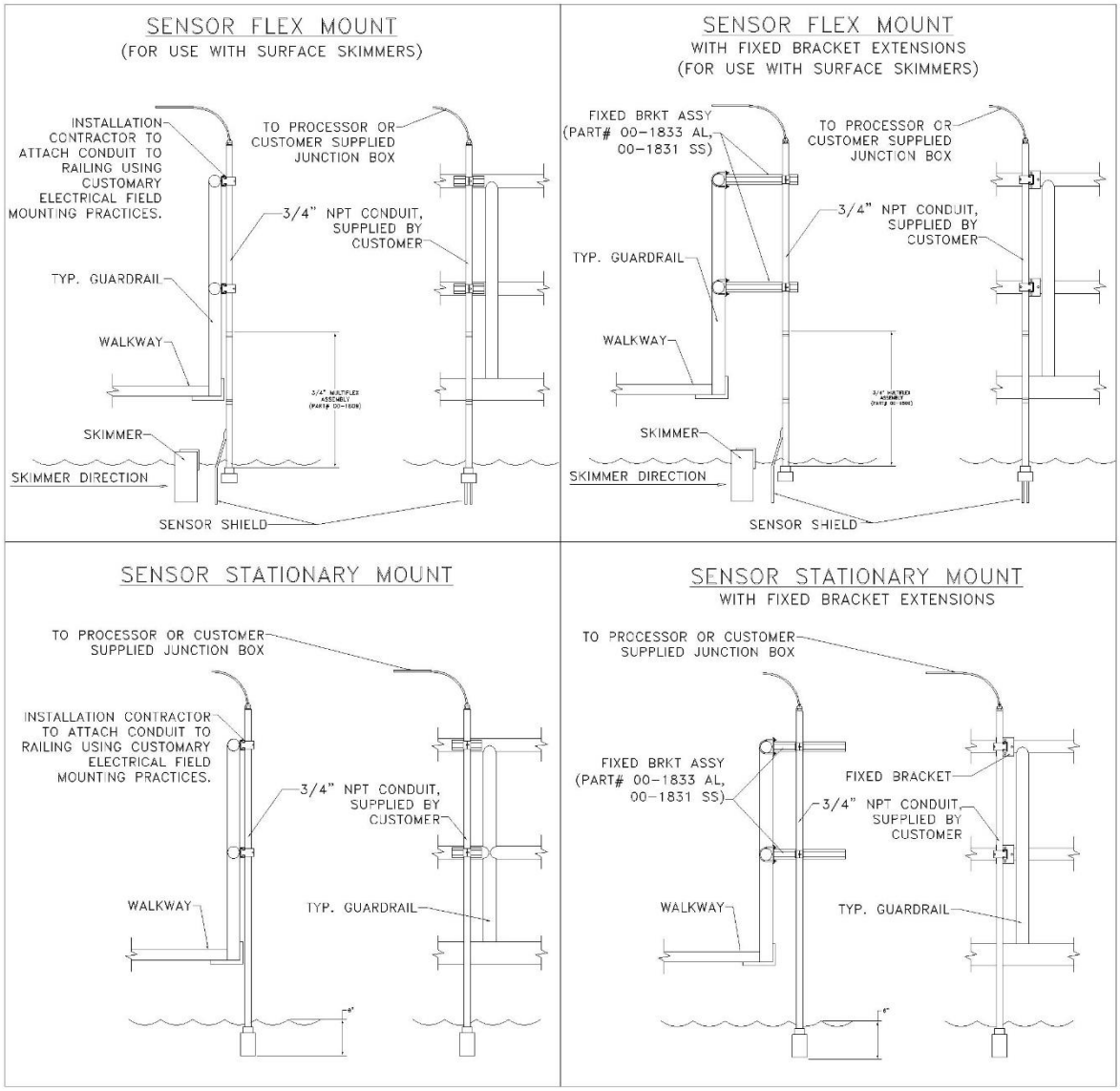


Sensor Installation Notes:
1. Position sensor shield such that it makes first contact with surface skimmer. Ensure the skimmer structure does not contact the sensor or the Multiflex assembly above the sensor shield.
2. Position sensor so that it is fully submerged under water (typically 6" below surface).
3. See Multiflex Assembly drawing for detail
4. See Fixed Bracket Assembly drawing for detail

ANALYTICAL TECHNOLOGY INC. 1-800-959-0298	
SCALE: N/A	DRAWN BY: TODD McCLENDON
DATE: 10-26-20	
SENSOR INSTALLATION	
ECHO SMART	DRAWING NO.

Figure 23: EchoSmart Sensor Installation Arrangements

6.2. Sensor Location Selection Criteria

Optimal performance depends on: (1) acceptable process liquid (supernatant) in which the ultrasonic pulse is to be transmitted, (2) responsive interface material (suspended solids blanket, other settled solids), (3) freedom from objects encroaching into the path of the transmit pulse, and (4) avoiding areas of excessive turbulence.

6.2.1. Acceptable Process Liquid

Most relatively uniform and homogeneous liquids found in water and wastewater treatment applications and many industrial process applications are suitable for transmitting the ultrasonic pulse. Excessive amounts of suspended solids, gas or air bubbles or other concentrations of solids in the supernatant may inhibit or obstruct the signal. The sensor should be positioned to avoid these conditions if possible.

6.2.2. Responsive Interface Material

The EchoSmart Sensor relies on minimal qualifying characteristics of the material that is it measuring. Relatively dense, well-settled suspended solids form a well-defined interface and are effective in reflecting signal to the sensor. Light density material (< 0.5% solids) that is not well-settled does not form a well-defined interface and is less effective in reflecting signal to the sensor. If possible, locate the sensor in an area that minimizes exposure to these conditions. Attempt to position the sensor in an area where the material (sludge) is relatively deep in the tank under normal process operating conditions.

6.2.3. Stationary Objects in Path of Transmit Pulse

Do not locate the sensor near piping, tank structural elements, or other objects that encroach on the signal trajectory. Continuously moving rakes and skimmers found in water and wastewater treatment applications typically do not interfere with measurements.

6.2.4. Areas of Excessive Air/Gas Bubbles and Turbulence

Avoid locating the sensor in areas where there are high concentrations of air/gas bubbles or suspended solids in the supernatant. When possible, select sensor locations to avoid these conditions.

6.2.5. Typical Circular Clarifier

The recommended sensor location for most circular clarifiers is outlined in Figure 24 below.

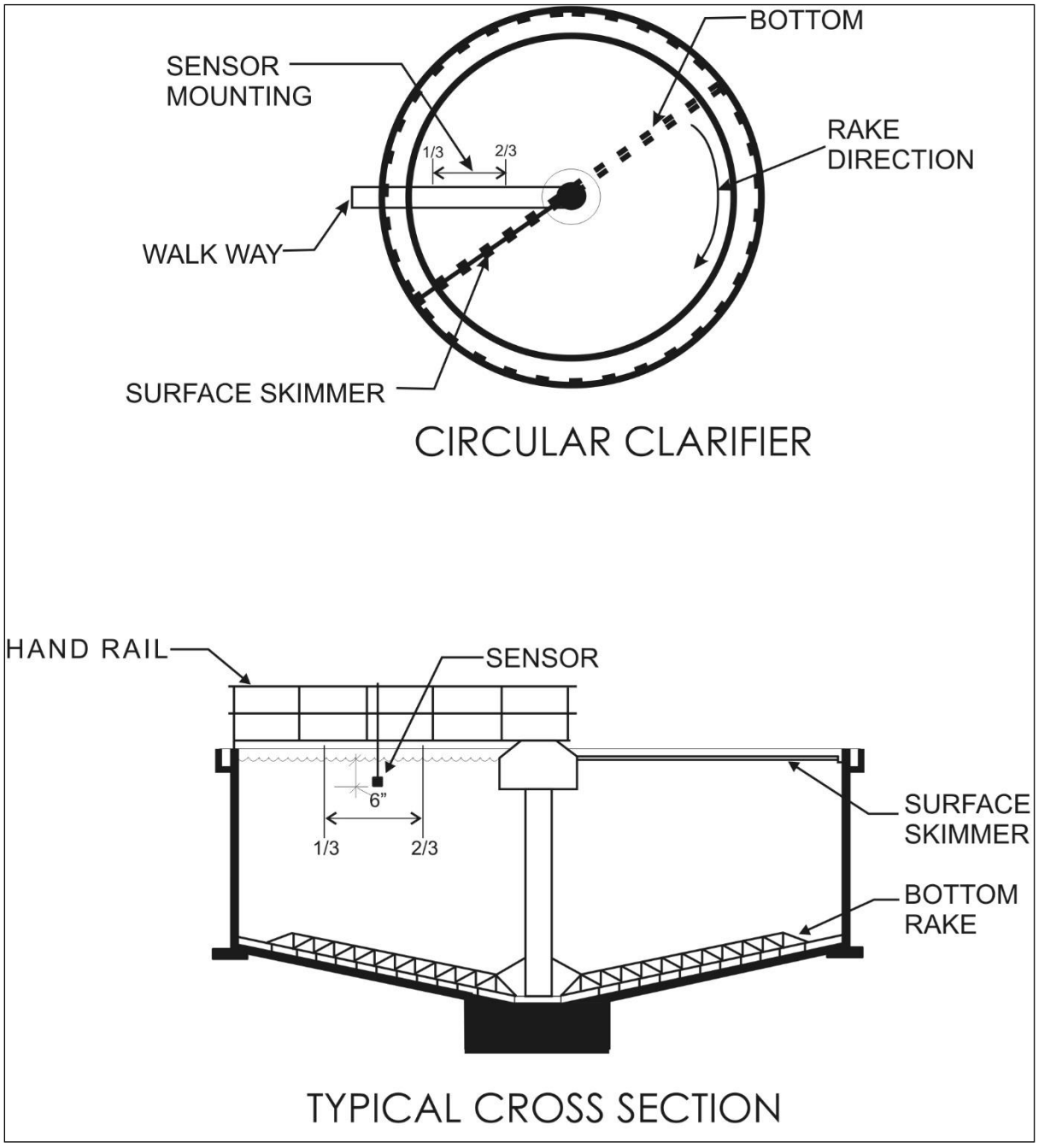


Figure 24: Typical 1/3 – 2/3 Location in Circular Clarifier

6.2.6. Typical Rectangular Clarifier

Sensors may be located along the length of the clarifier or in the area of the sludge sump. Care should be taken to consider inlet flow and the design of the sludge collection system. Contact Analytical Technology factory service for specific recommendations regarding sensor location to assure optimal performance.

6.2.7. Sensors in Applications with Surface Skimmers

Surface skimmers are common in many municipal and industrial clarifiers and thickeners. Skimmer sweep arms typically pass in the area of installed sensors and special mounting equipment is required. The Sensor Multi-flex Assembly provides a safe, durable and maintenance-free solution in most installations. The standard Multi-flex Assembly must be installed in accordance with manufacturer recommendations and cannot be used if the skimmer sweep rises more than six inches above the operating water line in the application or in cases where multiple structural members or supports prevent sensors from returning to the water without striking one of these objects. Special mounting arrangements and assemblies are available for virtually all applications with surface skimmers. Contact Analytical Technology for additional information.

6.3. Installation of EchoSmart Controller and EchoSmart Power Supply Unit

The EchoSmart Controller and EchoSmart Power Supply Unit are designed for outdoor installation and are typically attached to safety railing or other structure.

Typically, locate the Controller or Power Supply Unit within 20.0 ft. of the sensor, as illustrated in Figure 25 and Figure 26 below. Sensor cables may be extended at water-tight junction boxes using manufacturer specified cables or by special order of sensors with continuous cable of longer lengths.

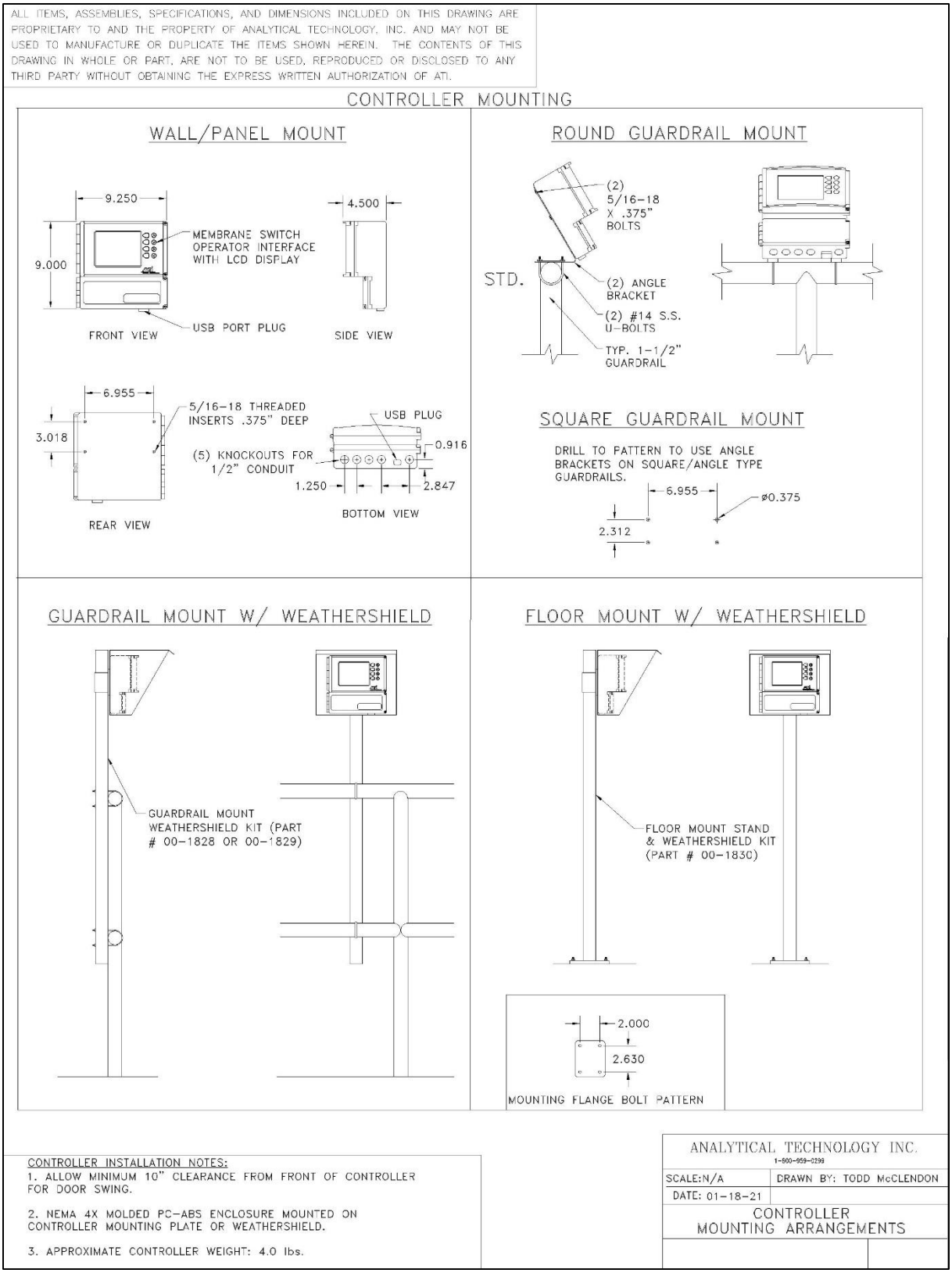


Figure 25: Controller Installation Drawing

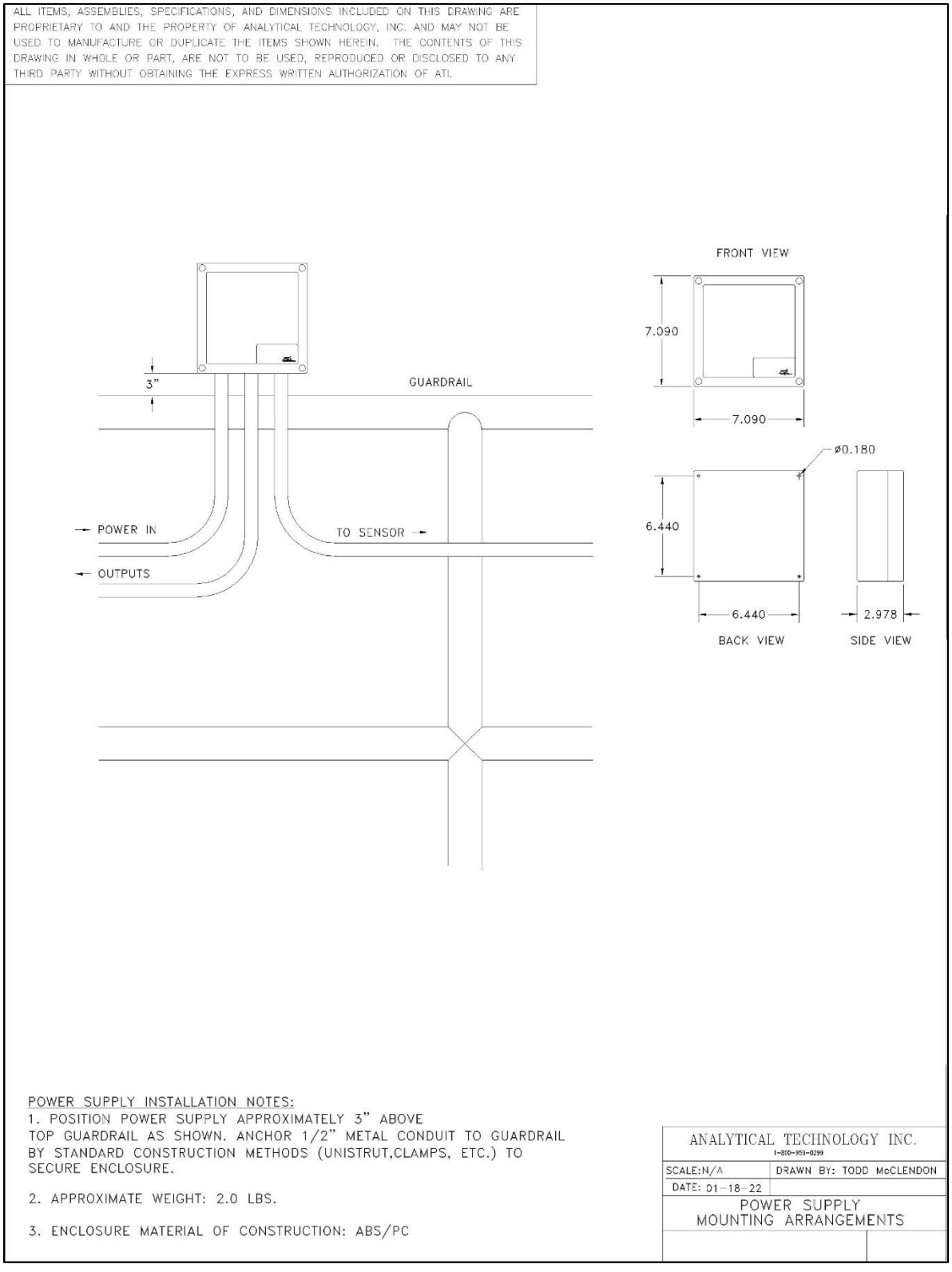


Figure 26: Power Supply Unit Installation Drawing

7. Tank Configuration, Waveform Analysis, and Tracking

EchoSmart applies advanced proprietary echo waveform analysis and filtering routines to provide reliable and repeatable measurements. For proper operation, instrument settings must conform to the dimensions of the tank in which the sensor is installed.

7.1. Tank Configuration

Tank Depth and Zero Adjust parameters (see also Sections 9.1.2 and 9.1.3) orient the instrument to the dimensions of the tank and assure that the echo waveform corresponds with tank dimensions at the location of the sensor (see Figure 27).

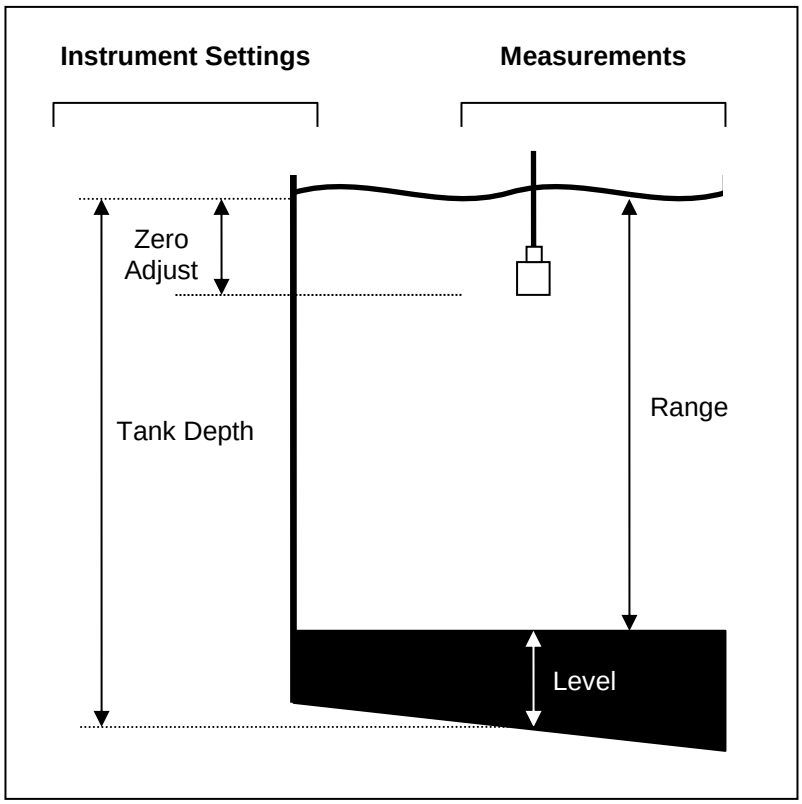


Figure 27: Tank Configuration

7.2. Waveform Analysis

The EchoSmart Sensor produces a signal waveform (Figure 28) that is used to produce LEVEL and RANGE measurements. The waveform is available to the user as a diagnostic tool in the Echo Profile Display, as illustrated here.

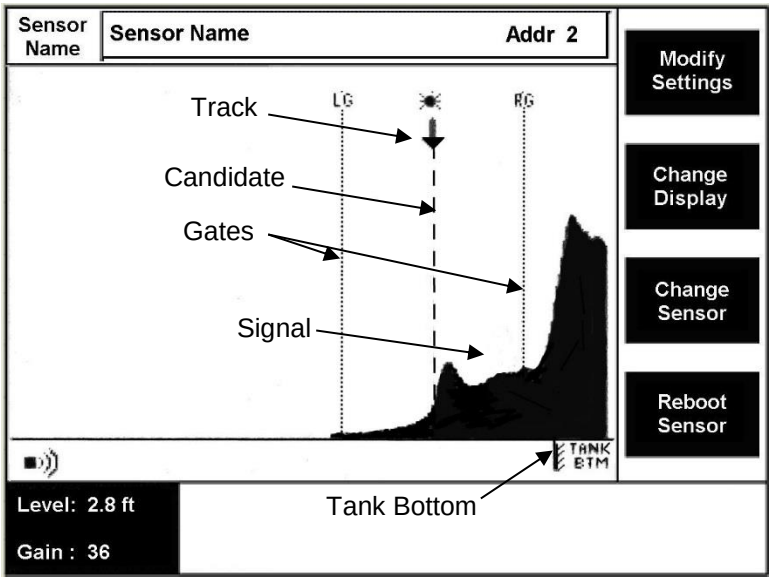


Figure 28: Echo Profile Display

The signal waveform is presented graphically with the horizontal x-axis representing the Tank Depth and the vertical y-axis as the strength of signal at positions along the dimensional axis. The Sensor is identified by symbol in the lower left corner of the graph, and the Tank Bottom is indicated in the lower right corner.

An interface is generally identified as a rising slope (left side) of the curve of a signal. This reflects a significant increase in the amplitude of signal at a particular location (distance from the sensor). Stable and repeated signals are given preference over more transient ones.

The selected signal is identified on the waveform by a dashed vertical line that is called a Candidate.

7.3. Tracking

Tracking is the term EchoSmart uses to specify the process of producing the primary measurement and following (tracking) its progress over time. The "Track" is the position of the Current Measurement on the Waveform graphic and is identified by a downward pointing arrow at the top of the screen.

7.3.1. Gates

EchoSmart employs enhanced algorithms that operate to stabilize measurements and prevent inadvertent tracking to transient or spurious signals. One of these is referred to as the Gate mechanism. The Gate is a stable yet dynamic area around the Current Measurement. Signal that is inside the Gate is given preferential consideration. Signal outside the Gate must persist in order to be considered valid. It is seen on the waveform graphic as dotted lines on either side of the Track.

See 9.2.12 LG Min and 9.2.13 RG Min for parameters that establish the dimensions of the Gate.

7.3.2. Signal Waveform Symbols

↓ The Down Arrow points to the current Track (See Section 7.2). This position corresponds with the Current Measurement.

→ The Right Arrow indicates that a signal meeting the tracking criteria is located outside the Gate, to the right. The measurement will only be affected by this signal if it persists for repeated updates.

← The Left Arrow indicates that a signal meeting the tracking criteria is located outside the Gate, to the left. The measurement will only be affected by this signal if it persists for repeated updates.

! ! The Double Exclamation Mark indicates that the current signal is insufficient for tracking purposes. The Current Measurement will be held until sufficient signal returns. An Echo Loss message will accompany the output measurement on the Controller if it persists longer than the Echo Delay setting. Loss of Echo will be reported on the 4-20mA circuit if the Loss of Echo parameter has been activated (See 9.2.16 – 9.2.18).

8. Communications, Outputs, and Networking

EchoSmart may be implemented as a stand-alone instrument, or it may be configured in a Wired or Wireless RF Field Network arrangement. In a stand-alone environment Communication refers to analog signal outputs and digital communication with external devices. (See Section 1.1)

When implemented in a Field Network arrangement, Communication additionally refers to information exchange and control functions between EchoSmart devices, as well as communication and output signals that are connected to the customer data and control systems. (See Section 1.2)

8.1. Configuration of Individual Units and Networks

Multiple configurations are possible for the EchoSmart equipment.

8.1.1. Stand-Alone Instrument

A stand-alone instrument consists of an EchoSmart Controller with a Smart Sensor connected to the Controller.

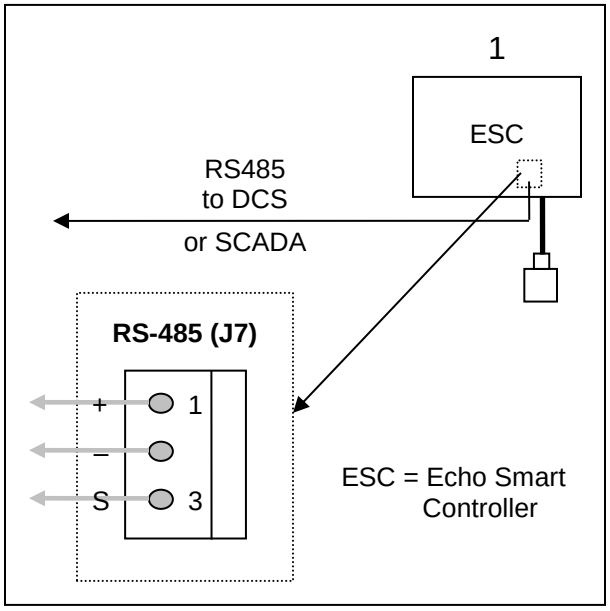


Figure 29: Controller with Single Sensor

8.1.2. Wired RS-485 Field Network

Up to sixteen Smart Sensors can be operated with one EchoSmart Controller via two-wire RS-485 from a Controller to each Power Supply Unit. No user programming or other integration is required.

To create the wired network, a shielded two-wire twisted pair (recommended Belden 9463) should be used between each ESP and to the ESC. Connections for the RS-485 communication line are made at the 3-pin terminal strip (J8) on each ESP and at the 8-pin sensor connector (J9) on the ESC as shown in Figure 30 below.

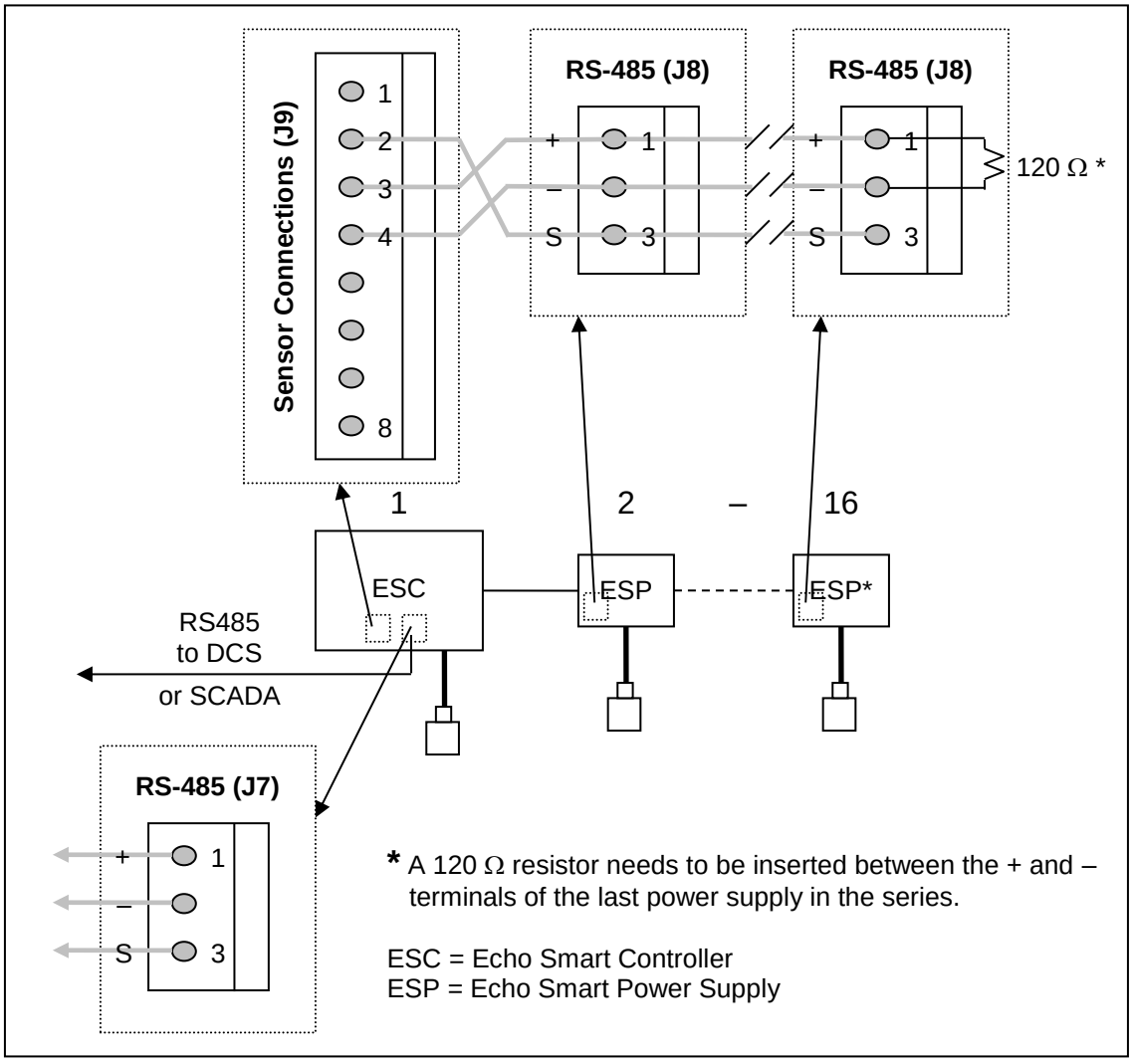


Figure 30: Single Wired Field Network

8.1.3. Wireless (RF) Field Network

Field Networks as described and configured in Section 8.1.2 can be implemented using optional fully integrated Radio Frequency (RF) Modules without the installation of field interconnection cabling and conduit. The Controller and each Power Supply Unit in the Field Network must be equipped with an RF Module. No user programming or other integration is required.

Figure 31 illustrates a single wireless RF Field Network configuration. Multiple RF Field Networks may be integrated to a SCADA system by connecting Controllers as shown in the "Customer Integration" section of Figure 31.

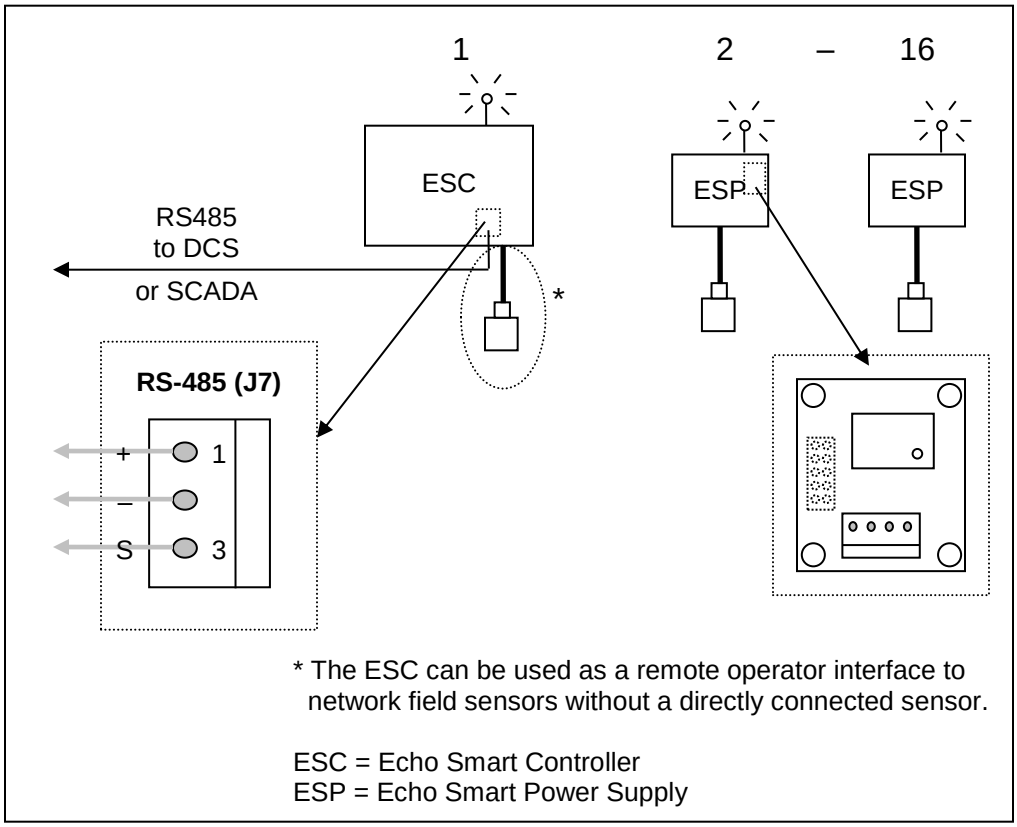


Figure 31: Single RF Field Network

8.1.4. Integrated Field Networks

EchoSmart Controllers operating Field Networks may be interconnected in an integrated two-wire RS-485 Network of up to 240 Smart Sensors. Each Controller can maintain a network of up to sixteen sensors utilizing either wired connections or the wireless radio modules. The Controllers can then be connected using a two-wire twisted pair so that only one cable run has to be made to the control system. Customer Modbus RTU integration is required.

IMPORTANT: The two-wire cable to the control system should not be connected to the ESC until all sensors are installed and communicating with the local ESC.

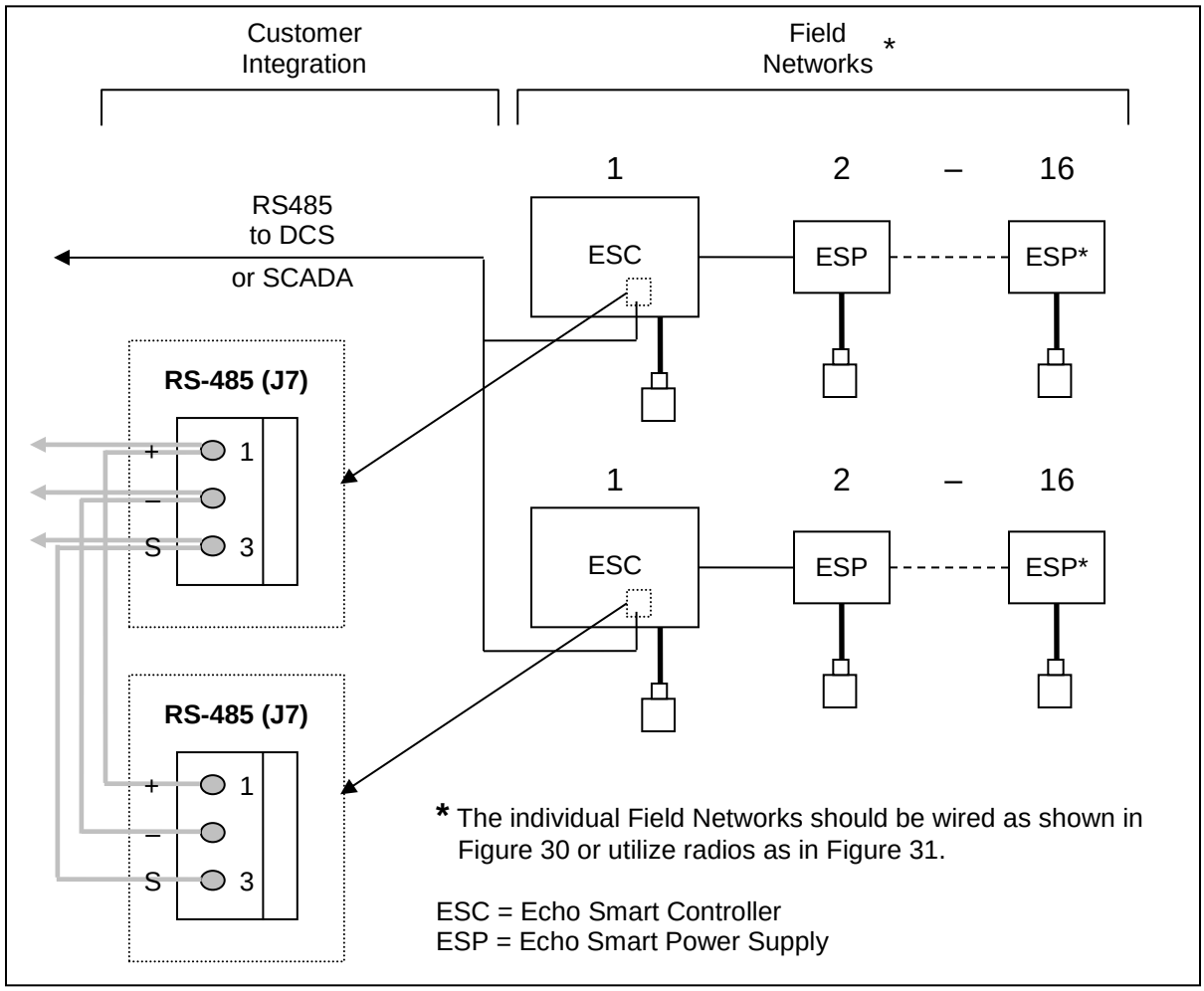


Figure 32: Integrated Wired Field Network

8.2. Outputs & Communication Options

Current measurements from each sensor can be accessed through a Modbus RTU command request or an analog 4-20 mA current loop in addition to the measurement displayed on the installed ESC.

Factory Remote Service is additionally available (see Section 8.2.3).

8.2.1. RS-485 Modbus RTU

EchoSmart sensors respond to Modbus RTU command requests via the local ESC that is monitoring the sensor(s).

Connection

A shielded two-wire twisted pair (recommended Belden 9463) should be used between the RS-485 3-pin connector (J7) of the ESC and the local control system.

IMPORTANT: This two-wire cable should not be connected to the ESC until all sensors are installed and communicating with the local ESC.

When communication is occurring through the RS-485 connection, an "RS-485" message will appear in the lower left portion of most display screens.

Polling Basics

The supported baud rate is 9600 and the RTU format is 8 bits, no parity, 1 start, and 1 stop bit.

The slave address used for polling will be each sensor's unique address that was entered when the EchoSmart equipment was commissioned. When multiple sensors are communicating with the ESC, each sensor's address must be polled separately for the desired Modbus value(s).

Recommended Polling

The current measurement can be obtained by utilizing Function Code 03 and polling for Register 40001. The returned value will be in the sensor's selected Units and will be reported as the base measurement times ten (i.e. 42 = 4.2 units).

If the EchoSmart sensor is equipped with the Turbidity add-on, additionally poll Register 40036 for the current turbidity value. The returned value will be the current NTU value times 100 (i.e. 135 = 1.35 NTU).

For the most up-to-date information, it is recommended that only the desired data be retrieved from each sensor.

Additional Information

The information provided in this manual only serves as a brief overview of the capabilities and data available via Modbus. See the OEM Smart Sensor Probe

(SSP) Communications Protocol for further detailed information on available commands, settings, and programming.

8.2.2. Analog 4-20 mA Current Loop

Two 4-20 mA proportional current loop signals are generated by each sensor. These signals are accessed through the 4-pin 4-20 Loop connector on the ESC (J10) or ESP (J6) that is supplying power to the sensor. One current loop is assigned to the Level or Range measurement and the other to either the turbidity measurement (when applicable) or the secondary interface.

The sensor's 4 mA Set Point and 20 mA Set Point (see Section 9.2.14 and 9.2.15) should be scaled to represent the installation environment with consistent scaling at the control device. Set Points for the primary Level measurement are automatically assigned to the output for the secondary interface measurement and no additional assignment is required or available.

The turbidity 4-20 mA current loop output is factory scaled from 0.0 to 50 NTU and is not user-adjustable.

8.2.3. Factory Remote Service

EchoSmart Controllers are designed for optional installation of a cellular service modem. With the user's authorization, this facility enables startup and service by expert factory technicians. Cellular connectivity is included with the service and is limited to areas where cell service is available.

This service utilizes the onboard RS-232 serial connection. When communication is occurring through this port, a "Maint Port" message will appear in the lower left portion of most display screens.

See Figure 33 below for instructions on how to properly install and remove the modem from an ESC.

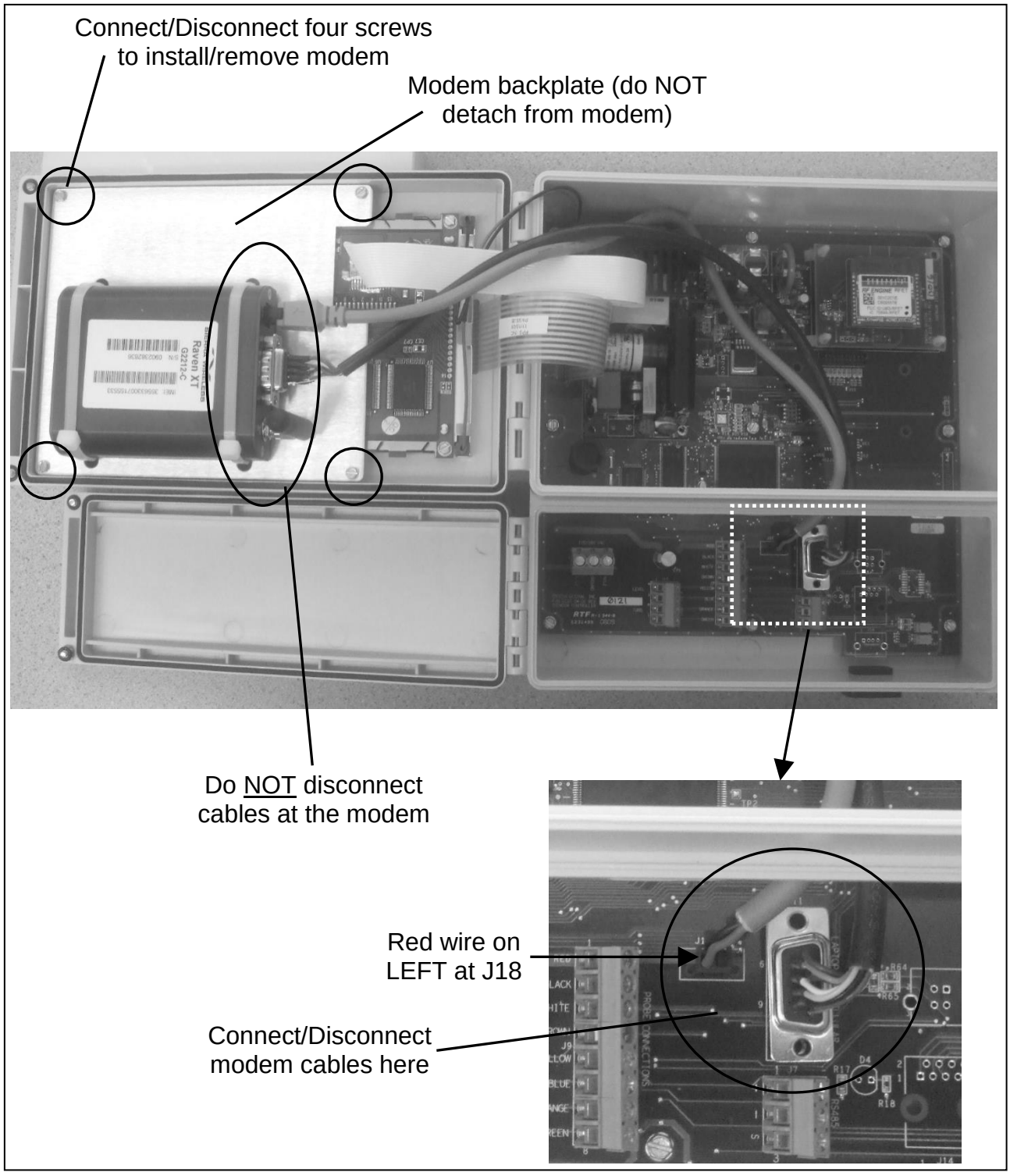


Figure 33: Proper Installation and Removal of Modem

9. Instrument Programming Parameters

Controller and Smart Sensor parameter settings are established at the Modify Settings and Advanced Settings displays. Standard default parameters exist in all instruments until modified by the user.

Some settings, as noted below (Ex: Tank Depth, Zero Adjust), require site-specific values. Other parameters may be changed for convenience or preference (Ex: Units, Interface, Dampening). However, most parameters should be left at the default value unless instructed by a factory technician.

Default values for each parameter discussed below are indicated by parenthesis ( ).

9.1. Modify Settings Display Parameters

Parameters found at this display are the primary instrument settings and may require adjustment to meet the requirements of the installation and process environment.

Note: Accurate values for Tank Depth and Zero Adjust must be entered in order to secure reliable measurements.

9.1.1. Units (*ft*)

The Units parameter establishes the desired engineering units that the instrument will use for all calculations and displayed values.

Options for Units are: Feet (ft), Inches (in), Meters (m), and Centimeters (cm)

9.1.2. Tank Depth (*10.0*)

Tank Depth is the distance from the top of the tank (Typically the surface of the water) to the bottom of the tank at the location of the sensor. Tank Depth is used in conjunction with Zero Adjust to establish the correct empty distance and ensure that the instrument signal corresponds with tank dimensions. (See Figure 27)

The range for Tank Depth is: 3.0 to 32.0 ft

Note: Accurate values for Tank Depth and Zero Adjust must be entered in order to secure reliable measurements.

9.1.3. Zero Adjust (*0.5*)

Zero Adjust locates the sensor position relative to the top of the tank. Use a positive value for Zero Adjust when the sensor is located below the top of the tank. (See Figure 27)

The range for Zero Adjust is: -32.0 to 32.0 ft

Note: Accurate values for Tank Depth and Zero Adjust must be entered in order to secure reliable measurements.

9.1.4. Min Range (*3.0*)

Min Range establishes the dimension of the measurement blanking-zone near the sensor. It is referenced to the top of the tank.

Min Range must be at least the value of Zero Adjust plus 1 foot.

The range for Min Range is: 1.0 ft to 32.0 ft

9.1.5. Auto Gain (*ON*)

This parameter determines whether the Auto Gain function is operational. When activated, Auto Gain continually monitors signal characteristics and adjusts signal amplification in response to changes in the process environment. It is recommended that Auto Gain remain ON unless otherwise advised by a factory-trained technician.

The options for Auto Gain are: ON and OFF

9.1.6. Current Gain (*30*)

With Auto Gain ON, Current Gain is established automatically and is not accessible as a parameter that can be modified manually. With Auto Gain OFF, this parameter establishes the constant level of signal amplification at which the instrument will operate.

The range for Current Gain is: 0 to 100

9.1.7. AG Set Point (10)

The AG Set Point (Auto Gain Set Point) determines the relative signal strength that the Auto Gain routine will seek. Increase this parameter to cause Auto Gain to seek a generally higher level of signal amplification. Decrease this parameter to cause Auto Gain to seek a generally lower level of signal amplification.

The range for AG Set Point is: 5 to 50

9.1.8. Update Rate (*10*)

Update Rate determines the number of signal data sets used to develop the current signal waveform and update the current measurement. This setting effectively establishes the instrument response time, ranging proportionately from approximately 2 – 10 seconds.

The range for Update Rate is: 1 to 20

9.1.9. Interface (*First*)

The Interface parameter establishes the primary Level or Range measurement algorithm.

FIRST Interface causes the instrument to respond to a signal that is nearest to the sensor (typically lighter density material). LAST Interface causes the instrument to respond to a signal that is furthest from the sensor when multiple interfaces are present.

FIRST is the typical selection for wastewater and water treatment clarifiers, thickeners, sedimentation basins and similar processes.

Select LAST algorithm for filter applications to prevent the adverse effect of suspended solids and air-bubbles in the filter water column during backwash.

The options for Interface are: FIRST or LAST

9.1.10. Dampening (*130*)

Dampening establishes the number of updates that are averaged to determine the Current Measurement. This parameter is used to remove the effects of random fluctuations caused by settling or disturbed material and prevents sudden changes in the measurement resulting from the action of rakes and skimmers.

The range for Dampening is: 5 to 255

9.1.11. Settling Zone (*ON*)

When Settling Zone is ON the instrument ignores signal originating to the left of LG Min. This enables the sensor to disregard suspended solids, air/gas bubbles and similar sources of disturbance in the supernatant.

The options for Settling Zone are: ON and OFF

9.1.12. Tank Display (*ON*)

Tank Display allows the user to select a tank diagram for the Tank View Display. There are five common tank designs from which to choose. (See Section 4.4.3 and Figure 12)

The options for Tank Display are: ON and OFF

9.1.13. Trend Display (*ON*)

Trend Display allows the user to activate the Historical Trend Display. (See Section 4.4.4 and Figure 13)

The options for Trend Display are: ON and OFF

9.1.14. Display Contrast (*55*)

Display Contrast allows the user to adjust the LCD Contrast for optimal visibility.

The range for Display Contrast is: 0 to 255

9.2. Advanced Settings Display Parameters

Additional parameters, including those used to set up Analog Output Signals are found at this display. Access this display by pressing the Soft Key next to the *Advanced Settings* prompt at the Modify Settings Display.

9.2.1. Max Range (*11.0*)

Max Range establishes an optional measurement blanking-zone near the bottom of the tank. Its location is referenced from the top of the tank.

When the Tank Depth parameter is changed, Max Range is automatically set to 110% of the Tank Depth value.

The range for Max Range is: 1.0 to 35.2 ft

9.2.2. Measure (*Level*)

Measure determines whether the calculated measurement is the depth of the material (LEVEL) or the distance from the top of the tank to the material (RANGE).

The options for Measure are: LEVEL and RANGE

9.2.3. Wiper Timing (*240*)

Wiper Timing establishes the time (minutes) between wiper cycles. The sensor wiper will also operate automatically on detection of signal loss regardless of the selected Wiper Timing setting. This reduces the need to establish a short wiper timing sequence and prolongs the life of the wiper mechanism.

The range for Wiper Timing is: 0 [OFF] to 240 minutes

9.2.4. Gain Band (*20*)

Gain Band establishes the amount that Current Gain (with Auto Gain ON) can vary once the initial gain level (GB Midpoint) has been established. At the default value, Current Gain can increase or decrease by 20 around the GB Midpoint.

The range for Gain Band is: 5 to 30

9.2.5. Gain Increment (*0.1*)

Gain Increment determines the rate of change in gain as Auto Gain operates to change the Current Gain level over time.

The range for Gain Increment is: 0.1 to 5.0

9.2.6. Save GB Midpoint (MP) *(OFF)*

When turned ON, the Save Gain Band Midpoint option allows the user to manually set the gain midpoint

The options for Save GB MP are: ON and OFF

9.2.7. GB Midpoint *(Auto set)*

Automatic sensor initialization establishes the initial signal amplification (Gain) that is appropriate for the process environment. This value is held in the GB Midpoint register.

With Auto Gain ON, Gain increases and decreases around the Midpoint to maintain optimal signal amplification. The Gain Band Parameter establishes the maximum increase or decrease in Gain above and below the Midpoint.

With Save GB Midpoint (MP) set to ON, the midpoint can be manually set by the user.

The range for GB Midpoint is: 0 to 100

9.2.8. Wall Zone (*0.5*)

This parameter establishes a zone near the bottom of the tank that permits special handling of a dominant signal that originates from the tank floor. The instrument differentiates this signal from other signals in order to correctly calculate measurements.

The range for Wall Zone is: 0.0 to 32.0

9.2.9. Wall Zone AG (*40*)

This parameter limits gain amplification when the primary signal is a reflection from the tank bottom. Since the desire is to track blankets, it prevents over-amplification of the signal in applications with light-density material, or when the tank bottom is the only signal present (tank has no suspended solids blanket or settled solids).

The range for Wall Zone AG is: 0 to 100

9.2.10. Sound Speed (*4862 fps*)

Sound Speed is the transmit velocity the instrument uses to calculate Level and Range Measurements. Changes to Sound Speed may be required to calibrate the instrument for use if the process liquid is extreme in temperature or pressure, or is other than water.

The range for Sound Speed is: 1000 to 6000 fps

9.2.11. Sensitivity (*20*)

Sensitivity determines whether a signal is sufficient for tracking. Lower Sensitivity to promote tracking a less well-defined signal (gradual slope or low amplitude signal). Increase Sensitivity to produce the opposite effect.

The range for Sensitivity is: 0 to 100

9.2.12. LG Min (*2.0*)

LG Min establishes the margin of the left side of the Gate (See Section 7.3 for a description of the Gate and its function).

The range for LG Min is: 0.0 to 32.0

9.2.13. RG Min (*2.0*)

RG Min establishes the margin of the right side of the Gate (See Section 7.3 for a description of the Gate and its function).

The range for RG Min is: 0.0 to 32.0

9.2.14. 4mA Set Point (*0.0*)

The 4mA Set Point establishes the instrument measurement value at which the user expects the sensor to output a current of 4mA. Establish the same Set Point value in the control device that the instrument is connected to.

The range for 4mA Set Point is: 0 to Tank Depth

9.2.15. 20mA Set Point (*10.0*)

The 20mA Set Point establishes the instrument measurement value at which the user expects the sensor to output a current of 20mA. Establish the same Set Point value in the control device that the instrument is connected to.

The range for 20mA Set Point is: 0 to Tank Depth

9.2.16. Echo Loss (*OFF*)

Echo Loss provides an alarm function through the 4 – 20mA current loop signal when this Echo Loss setting is set to ON. The selected Echo Loss Action is executed after loss of echo persists for the time lapse defined by the Echo Delay setting.

The options for Echo Loss are: ON and OFF

9.2.17. Echo Delay (*60*)

Echo Delay establishes the amount of time (in minutes) that the sensor must experience a loss of echo before initiating the Echo Loss Action.

The range for Echo Delay is: 0 to 255 minutes

9.2.18. Echo Loss Action (*Cycle*)

Echo Loss Action determines the state that the current loop adopts in response to loss of echo when the Echo Loss alarm function is activated.

The options for Echo Loss Action are: 4mA, 20mA, and Cycle. When Cycle is selected, the output continually alternates between 4mA and 20mA until the loss of echo condition ceases.

9.2.19. Level Simulation Test

Selecting the Level Simulation Test option provides access to the Simulation Test Setup page. The simulation test provides an opportunity to verify proper operation of the Level analog output loop. The analog loop settings (specifically the 20mA Set Point) should be configured prior to simulation for a test reflective of the desired configuration. The test value carries the sensor's specified units. The allowable test range is from a zero value (output of 4mA) to the sensor's 20mA Set Point value (output of 20mA).

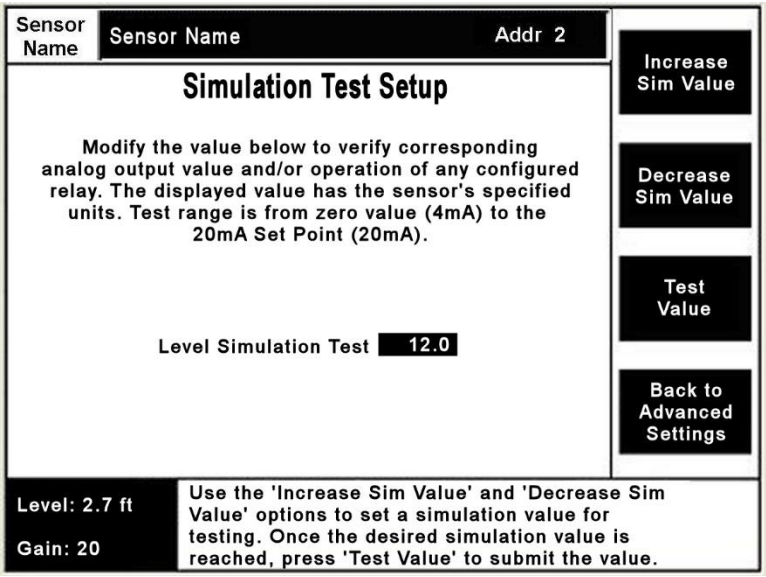


Figure 34: Level Simulation Test Setup Screen

The “Increase Sim Value” and “Decrease Sim Value” options can be used to modify the simulation value. Once the desired output is reached, pressing the “Test Value” option sends the value to the sensor and the scaled analog value will be output on the Level current loop.

For units purchased with integrated relays, the level simulation value will also impact the status of any relays configured for level or range. The relays must be activated and configured prior to performing the simulation test (see Section 11.3 for details on the relays).

Note: This functionality is available on Controller firmware version 2.21 and later in conjunction with Sensor firmware version 39 and later.

9.2.20. Aux Simulation Test

Selecting the Aux Simulation Test option provides access to the Simulation Test Setup page. The simulation test provides an opportunity to verify proper operation of the Auxiliary analog output loop. For sensors equipped with turbidity, the scaled NTU value will be output on the auxiliary loop and for all other sensors, the dispersed solids level will be output. When the dispersed solids level is output, the test value will carry the sensor’s specified units and will be scaled from a zero value (output of 4mA) to the sensor’s 20mA Set Point value (output of 20mA). When turbidity is output, the value will be scaled from 0 NTU to 50 NTU.

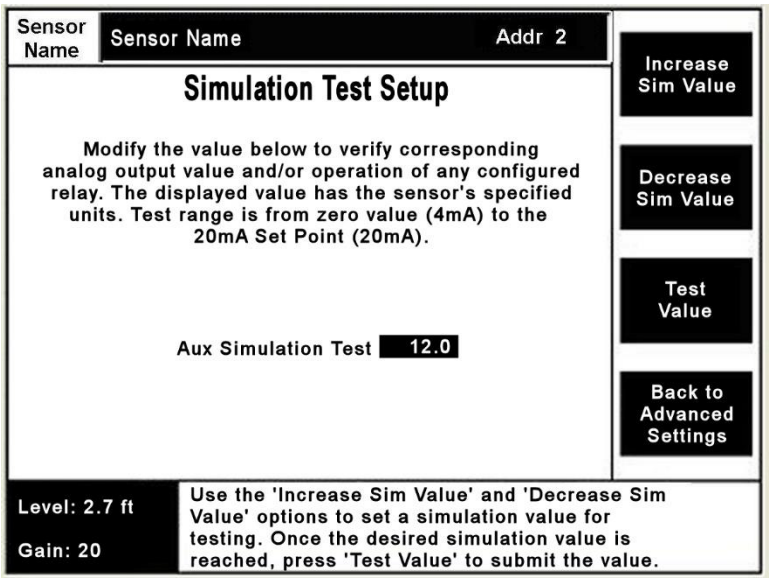


Figure 35: Aux Simulation Test Setup Screen

The “Increase Sim Value” and “Decrease Sim Value” options can be used to modify the simulation value. Once the desired output is reached, pressing the “Test Value” option sends the value to the sensor and the scaled analog value will be output on the Aux current loop.

For units purchased with integrated relays, the simulation value will also impact the status of any relays configured for turbidity. The relays must be activated and configured prior to performing the simulation test (see Section 11.3 for details on the relays).

Note: This functionality is available on Controller firmware version 2.21 and later in conjunction with Sensor firmware version 39 and later.

10. Maintenance and Troubleshooting

10.1. Preventative Maintenance

10.1.1. Sensor Cleaning and Maintenance

1. Standard Sensor (Non Self-Cleaning)

Non Self-Cleaning Sensors are typically used in applications in which the sensor is regularly and periodically rotated out of the water by the action of a surface skimmer. It is expected that this action will provide sufficient cleaning of the face of the sensor to prevent signal degradation for an extended period. However, it is recommended that the sensor face be inspected and cleaned at regular three (3) month intervals to prevent buildup of material, or as needed to preserve signal integrity. When the buildup of material becomes too great, it can adversely affect performance.

If you find that cleaning must take place on a very frequent basis (daily/weekly) or cleaning is more frequent than desired, self-cleaning sensors with wipers are available. Please contact Analytical Technology at (800) 959-0299 for details.

2. Wiper Sensors (Self-Cleaning, including sensors with turbidity option)

The Wiper mechanism and blade are designed to remove air/gas bubbles and light suspended solids that may collect on the face of the sensor and degrade signal quality. Supplemental manual cleaning may be required in processes in which suspended solids attach aggressively to the face of the sensor.

Wiper blade and motor life will vary with process conditions and the user established frequency of operation (Wiper Timing parameter, Section 9.2.3). It is generally expected that the wiper blade assembly will require replacement yearly and the wiper motor will require replacement every two years in typical water and wastewater treatment applications.

It is recommended that the sensor be inspected frequently during the initial three (3) to six (6) months of operation to determine whether supplemental cleaning is needed and that the wiper blade assembly is intact. From these observations, an ongoing preventive maintenance schedule suitable for the application can be established.

CAUTION: Unless determined to be insufficient for the process environment, Wiper Timing (Advanced Settings) should be set to 240 to reduce wiper blade and motor wear. Lowering this parameter will reduce motor assembly life proportionately.

Wiper Assembly Replacement:
The EchoSmart Sensor Wiper Blade Assembly (Part No. 03-0497) is field replaceable.

Remove the wiper by unscrewing in counter-clockwise direction. Secure and retain the stainless steel spacing washer from the wiper shaft for use with the replacement wiper.

Screw the new wiper clockwise until the arm makes contact with the seated spacing washer, plus 1/8th of a turn. **DO NOT OVER TIGHTEN**. Over-tightening may result in the wiper not operating. A ***Wiper Stall*** message will be indicated at the EchoSmart Controller.

3. Sensor Cleaning and Inspection

Remove the sensor from the process using safety procedures, protective clothing and equipment appropriate for the process environment. Protective gloves and eyewear should always be used when there is the possibility of exposure to dangerous or unsanitary materials or conditions.

Carefully remove larger debris, rags and similar material that may have attached to the sensor. Do not rotate the wiper blade by hand. Algae, slime and accumulations of suspended solids in the process liquid should be brushed away using a soft to medium bristle non-metallic brush or soft cloth and mild detergent. For disinfection, use 8 oz. of regular bleach (sodium hypochlorite 8.25% solution) to one gallon of water.

Before returning the sensor for service, operate the wiper system to observe that it rotates in the expected manner and that the wiper blade is secure. In normal operation, the wiper blade with make 1-3 rotations when power is supplied or when the wiper timing setting is changed.

10.1.2. Other Routine Maintenance

Visually inspect the analyzer monthly during normal clarifier “walk downs” to determine that there are no obvious signs of damage to the equipment and that mounting brackets and hardware are secure. Tighten mounting bolts as may be required.

Observe the sensor to assure that it is fully submerged below the surface of the water and that there are no rags or similar debris wrapped around it. Clear rags and debris from the sensor with an extension brush or by flushing with water (see Section 10.1.1 Sensor Cleaning and Maintenance).

If your clarifier employs a surface skimmer, watch skimmer flights as they pass the location of the sensor to assure that the flights contact the sensor shield-rod allowing it to flex freely and rotate the sensor out of the path of the flights. Ensure that the shield is aligned to prevent the skimmer from making contact with the sensor.

10.2. Troubleshooting

The following recommendations address the most often encountered troubleshooting needs with the EchoSmart equipment. If the described procedure does not resolve the problem, contact Analytical Technology for further assistance.

10.2.1. Comm Error Message

A *Comm Error* message indicates that communication between the Controller and Sensor(s) has been interrupted for an extended period of time. Verify that the sensor associated with the alarm is properly powered and that all sensor and communication cables are connected correctly.

In the case of a Wireless Field Network of Sensors, consider metal structures, cabinets and mounting fixtures that may intervene in the path of the RF signal.

For detailed testing and resolution steps, refer to the Communication Troubleshooting document available from the Support → Troubleshooting section of the Entech Design website (www.entechdesign.com). Contact Analytical Technology for further assistance.

10.2.2. Echo Loss Message

An *Echo Loss* message indicates that the instrument does not have a signal that is reliable for measurement. This can occur as a result of the sensor not being submerged in water or as a result of an abnormal process condition (sludge level too near the sensor, excessive off-gassing, unsettled suspended solids in the supernatant, or material or bubbles collecting on the face of the sensor). It can also be the result of incorrect operating parameters installed in the sensor.

Corrective action includes a physical inspection of the sensor(s) and process to determine whether any of the above referenced conditions exist. If a Wiper Sensor is in use, confirm that the wiper arm is in place and that the wiper turns when (1) power is cycled, (2) the sensor Reboot command is called, or (3) the Wiper Timing setting is changed.

Check instrument parameters. Confirm that the Tank Depth, Zero Adjust, Min Range and Max Range settings are correct and that Auto Gain is ON.

For detailed testing and resolution steps, refer to the Echo Loss Troubleshooting document available from the Support → Troubleshooting section of the Entech Design website (www.entechdesign.com). Contact Analytical Technology for assistance if the problem is not resolved.

10.2.3. Validating Message

Validating is the "handshake" process that occurs when an EchoSmart Controller initiates communication with the sensor(s). This takes place when the Controller is initialized or when a sensor is manually added to the sensor database. This step is normally completed rapidly and may not be noticed by the user. If the Validating message continues for an extended period of time, there is a communication problem that may require corrective action (See Section 10.2.4).

10.2.4. Validation Failure Message

If a sensor does not validate as expected, the Controller has been unable to communicate with the sensor, and the Validation Failure message will be displayed. Check all sensor and network cabling and connections and re-check main power to the Controller and all Power Supply Units. If a wireless sensor network is in use, investigate possible impediments to network communications.

10.2.5. Wiper Stalled Message

A Wiper Stalled message will appear if the wiper does not operate when expected or if rotation of the wiper blade is not detected. It may also indicate drag on the wiper motor as a result of debris being attached to the wiper blade or shaft. Visually inspect the sensor to determine that the wiper blade and shaft are free of debris. Verify that the wiper is securely connected to the wiper shaft and that it turns freely (1-3 revolutions) when power is cycled to the sensor or the Wiper Timing parameter is changed. Replace the wiper blade, as indicated in Section 10.1.1.

10.2.6. Wiper Motor Failure Message

This message indicates an internal electronic failure of the wiper motor. Contact Analytical Technology for repair or replacement options.

Note: Wiper motor failure may cause unreliable measurements.

10.2.7. Analog Output Discrepancy

EchoSmart 4-20 mA devices are active (powered) and isolated current loops. Check that no other power or isolation is present on the loop, and confirm that no other electronic devices or electrical elements intervene on the current loop. Check that appropriate signal cable is in use.

EchoSmart allows the user to span the 4-20 mA signal with reference to Level (depth of sludge) or Range (distance from water surface to top of sludge). Confirm that the correct parameter has been entered.

The maximum span is 0.0 to Tank Depth. The 4mA Set Point and 20mA Set Point must be correctly entered to establish the desired span. Check that corresponding Set Point values are entered in the customer data acquisition system.

Disconnect loop cables from the EchoSmart equipment and measure the current output to determine whether it corresponds with the measurement indication from the instrument.

For detailed testing and resolution steps, refer to the Analog Output Troubleshooting document available from the Support → Troubleshooting section of the Entech Design website (www.entechdesign.com). Contact Analytical Technology for assistance if the problem is not resolved.

10.2.8. Sensors Not Detected

If sensors are not detected or a *No Sensors Found* message is reported, confirm that all sensor and communication cables are securely landed at the respective Controller or Power Supply Unit(s) and that main power is ON.

If a Controller operates more than one sensor, confirm that all sensors have been added to the Network as directed in *12.2 Configuring a Sensor Network*, and that each has a unique address designation. If multiple sensors have the same address number, the Controller will not be able to establish communication with those sensors. If unique sensor addresses have not been assigned, power OFF the equipment and follow the steps in 12.2.

If a wired field network is being used, refer to Section 8.1.2, to verify that all connections are made at the proper terminals.

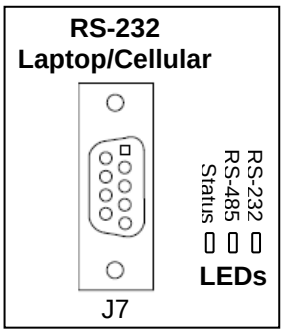
10.2.9. Radio Communications

<u>System-wide communications troubleshooting:</u>

Ensure the radio in the Controller is fully seated. If an external antenna is being utilized, verify the antenna is hand tight and the connecting cable is properly connected to the radio and the antenna. If the Controller is using an external radio unit, ensure the cable connections are made as outlined in Section 11.2.3.

Sensor specific communications troubleshooting:

LEDs located near the serial port of each ESP give an indication of the communication that is occurring in the network. The *Status* LED should be on solid and the *RS-485* LED should flash with each transmitted message.



If the *Status* LED is flashing, cycle power on the ESP.

If the *Status* LED is on solid and the *RS-485* LED is not flashing, verify that the radio is seated properly and cycle power to determine if communication can be re-established.

10.2.10. Persistent "Acquiring Waveform" Message

If an "acquiring waveform" message appears for an extended period of time on the **Echo Profile** screen, a search of the network may be necessary to establish proper communication with the sensor. Go to *Modify Settings* → *Advanced Settings* → *Controller Setup*, select the "Auto Detect Sensors" option and press *Auto Detect Sensors*. After a few seconds, the display will redirect to the **Echo Profile** screen.

This persistent message can also appear if an external device, such as an integrated control system, is constantly requesting information from the sensor(s). Temporarily disconnect the external device to see if waveform data can then be gathered from the sensor. If this resolves the issue, modifications to the external device's polling routine are likely needed.

11. System Options

11.1. Self-Cleaning Wiper Sensor with Turbidity Measurement

This sensor incorporates a scattered light turbidity meter into the EchoSmart Wiper Sensor to provide continuous Level and Turbidity measurements.

11.1.1. Application

This sensor is recommended for use in applications in which there is need for a Level and Turbidity measurements at the location of the sensor. It is specifically recommended for use in water and wastewater treatment clarifiers and thickeners to continuously monitor sludge level and to provide an indication of turbidity at the location of the sensor – typically near the effluent weir.

The Level and Turbidity Sensor is also recommended to measure Media Level, Backwash Expansion and Backwash Turbidity in granular media filters. It may be used separately or in conjunction with the available in-air Water Level Sensor for effective conditional control of filter backwashing.

11.1.2. Principle of Operation

Sludge level measurements use the EchoSmart ultrasonic time-in-flight measurement technique as with all EchoSmart interface level sensors.

Turbidity measurements are provided by a 90º scattered-light turbidity meter located in the combined sensor housing. Sensors are factory calibrated from 0 – 50 NTU. Power to the sensor is provided by an EchoSmart Controller or Power Supply Unit to which it is connected. The measurement indication is displayed on the Controller. Output signals include a 4-20mA proportional signal and RS-485 Modbus RTU digital.

11.1.3. Sensor Cleaning

Sensing surfaces of the sludge level and turbidity sensor are automatically cleaned by a fully integrated wiper system with a replaceable rubber wiper blade. The wiper is operated by an internal motor powered by the EchoSmart Controller or Power Supply Unit.

11.1.4. Installation

The sensor has a ¾ in. NPT female threaded connection to provide simple attachment to a user supplied mounting pipe. The connection is a direct replacement for the standard EchoSmart sensor. In general, locate the sensor in accordance with instructions for ultrasonic sensors as otherwise described in Section 0. Additionally, the sensor may be located near an effluent weir to

optimize the effluent turbidity measurement without adversely affecting sludge level measurements.

In filter applications, sensors are located immediately below the top of the backwash trough to secure measurements during active backwashing and while the filter is on-line. Contact Analytical Technology for additional instructions for proper installation.

11.1.5. Connections

The sensor connection is made in the same manner as an EchoSmart sensor. Refer to Section 4.2.2, Figure 3, and Figure 4 for further connection details when operated by an EchoSmart Controller, or Section 5.1.2, Figure 21, and Figure 22 when operated by an EchoSmart Power Supply Unit.

11.1.6. Turbidity Sensor Calibration

The turbidity sensor is factory calibrated using a resin emulsion turbidity conforming solution.

11.2. Integrated Wireless Radio (RF) Modules

Communication between the Controller and associated Power Supply Units can be achieved with integrated wireless radio modules to eliminate the need for cabling and conduit between units.

11.2.1. General Overview

The radios use a proprietary message structure for communication between units and utilize mesh networking capabilities to achieve redundancy and reliability.

11.2.2. Internal Configuration

In this configuration, the radio module is mounted inside the Controller or Power Supply enclosure. An external antenna is then affixed to the outside of the enclosure with a U.FL to RP-SMA cable connecting the antenna to the module. The module additionally requires a two-wire cable to be connected between the radio's 4-pin terminal strip (J2) and the 8-pin terminal strip on the associated Controller (J9) or Power Supply (J4). The cable should link red to red terminal locations and black to black (see Figure 36).

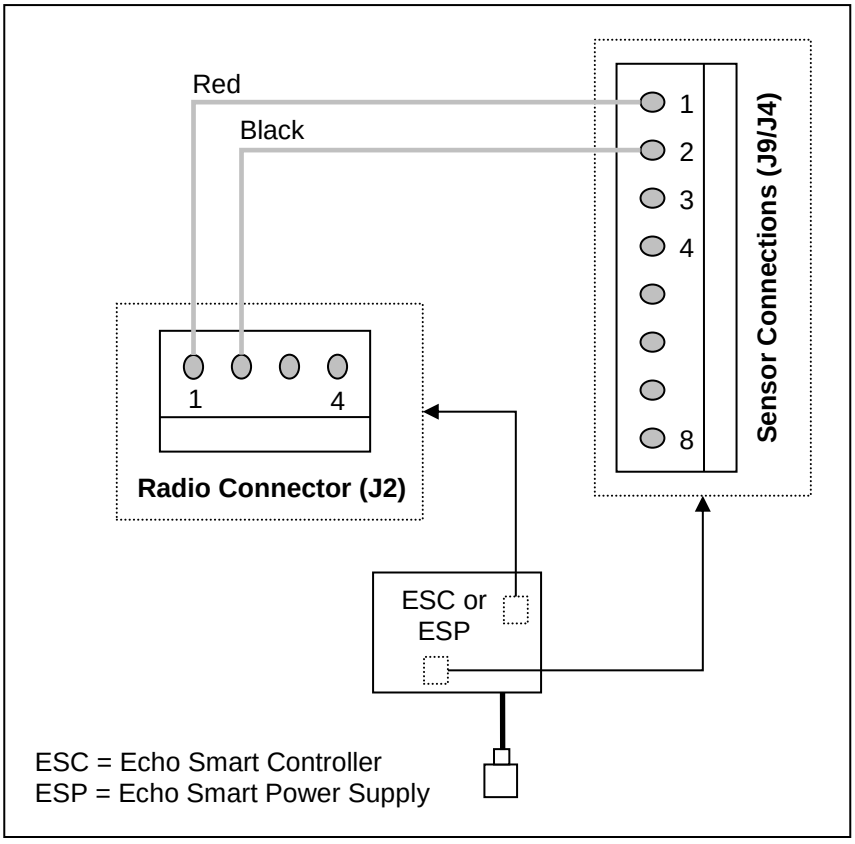


Figure 36: Connections for Wireless Radio Module (Internal)

11.2.3. External Configuration

In this configuration, the radio module is mounted in a separate enclosure that can be located in an optimal location. An external antenna is affixed to the outside of the enclosure with a U.FL to RP-SMA cable connecting the antenna to the module. A four-wire cable is required to connect the radio's 4-pin terminal strip (J2) and the 8-pin terminal strip on the associated Controller (J9) or Power Supply (J4). The cable should link red to red terminal locations, black to black, white to white, and brown to brown (see Figure 37).

This configuration is ideal when Controllers or other units are placed in buildings or other locations that may create less than ideal paths for radio transmissions. The radio can then be located in a more optimal location.

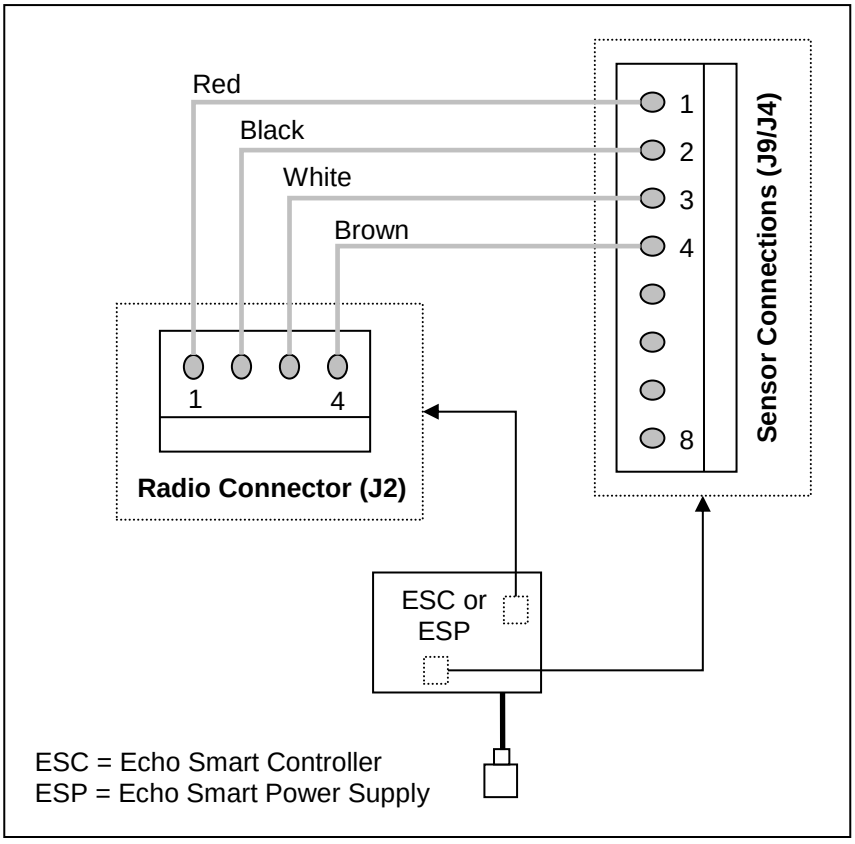


Figure 37: Connections for Wireless Radio Module (External)

11.2.4. Equipment Orientation for Units with Integrated Wireless Radio Modules

Equipment containing the integrated wireless radio modules should be oriented such that the antenna mounting location is on the side of the enclosure with the antenna pointed in the upward direction. See Figure 38.

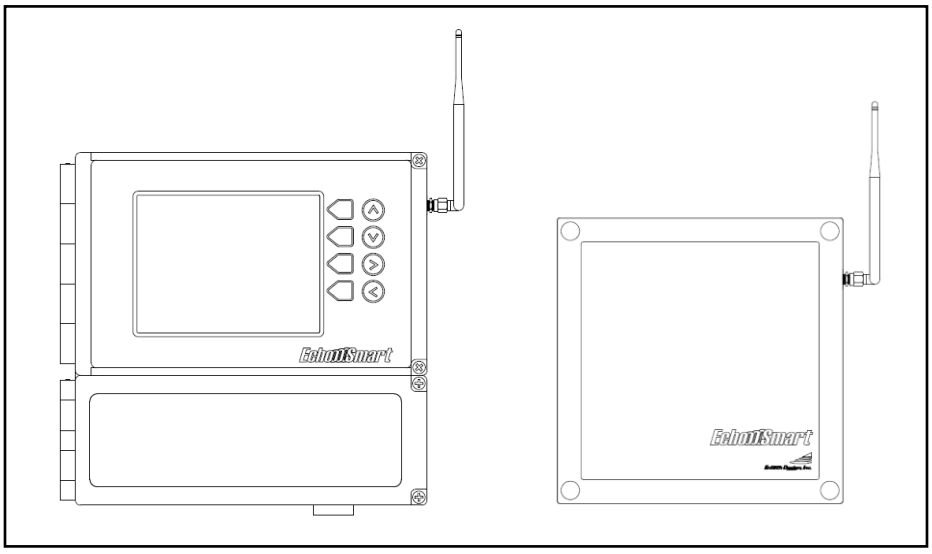


Figure 38: Orientation of Units with Wireless Radio Modules

11.3. Relays

Relays require an additional circuit board installation in the EchoSmart Controller. Relays are not available in the EchoSmart Power Supply Unit.

11.3.1. General Overview

Four SPDT relays may be added as an option to a Controller. Each relay is capable of monitoring the sludge level, turbidity (with optional sensor), or can be configured as a fail-safe alarm. The relays can be assigned to separate sensors or multiple relays can be assigned to one sensor.

11.3.2. Operation

Relay controls (Figure 39) are accessed by pressing the *Set Up Relays* soft key from the Controller Setup Display (Figure 17).

The relay Status must be set to ON in order for the relays to operate. The sensor associated with each relay is listed below the "Status" setting. Each relay can be set to monitor the sludge level, the turbidity value (when installed), or can be set as a fail-safe alarm by cycling through the "Change Assignment" options.

When monitoring sludge level or turbidity, the "Enable >" parameter determines the value at which the relay will be energized and change states while the "Disable <" determines the value at which the relay will de-energize and change states.

When set as a fail-safe alarm, pins 2 and 3 of the relay are energized under normal operating conditions. Pins 2 and 3 are de-energized when the EchoSmart

Controller is powered off or a fault due to loss of echo or a communication error is detected on the associated sensor.

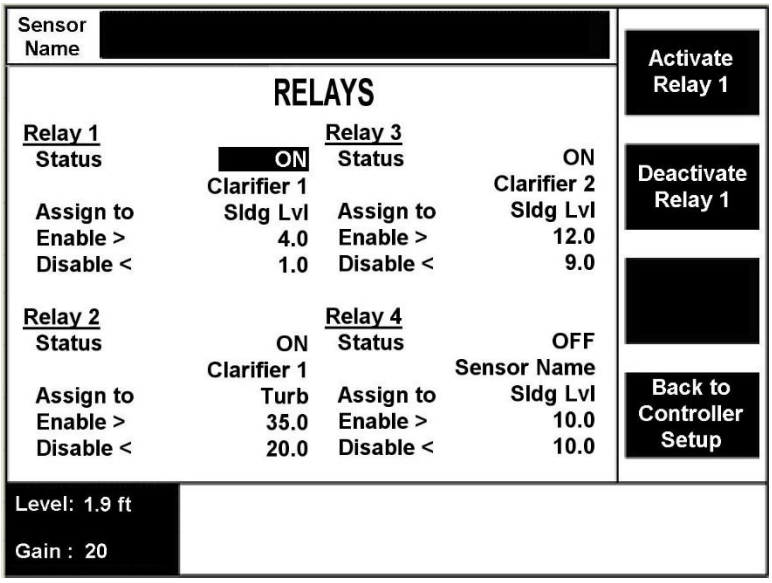


Figure 39: Relays Display

11.3.3. Cabling and Connections

This section pertains to the physical layout and terminal connections for the relays.

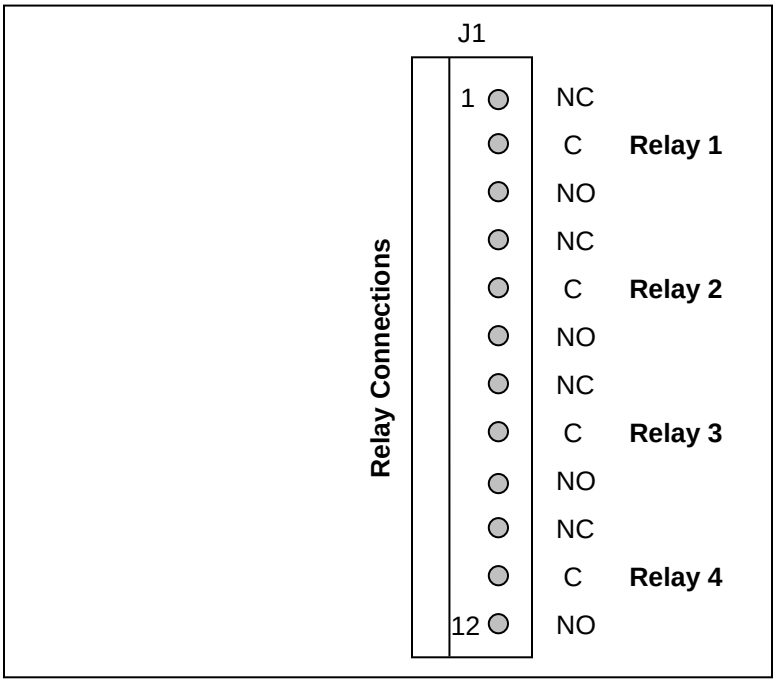


Figure 40: Connections for Relay Board

Relay Connections (J1)

Pin #	*Relay*	*Description*
1	1	Normally Closed
2		Common
3		Normally Open
4	2	Normally Closed
5		Common
6		Normally Open
7	3	Normally Closed
8		Common
9		Normally Open
10	4	Normally Closed
11		Common
12		Normally Open

Figure 41: Table of Relay Connections

11.4. Digital (RS-485) to Analog (4-20mA) Converter

The EchoSmart Controller can be paired with Analytical Technology, Inc.'s Analog Output Module to obtain analog measurements from all networked sensors in one location. (Compatible with EchoSmart Controller Firmware Version 2.20 and later.)

11.4.1. General Overview

The Digital to Analog Converter can be configured with up to sixteen (16) outputs. The Converter utilizes the RS-485 Modbus data from the Controller and generates the corresponding analog output. Each channel can be customized with the sensor address and output value (level, dispersed solids level, or turbidity when applicable).

11.4.2. Specifications

INPUT POWER	18 - 30 VAC
MOUNTING	DIN Rail Mount
OUTPUTS	Up to 16 isolated analog outputs

11.4.3. Cabling and Connections

A shielded two-wire twisted pair should be used between the Controller's RS-485 connector (J7) and the Converter's Serial RS-485 terminal location.

Refer to Figure 42 below for information related to powering and connecting all cables to the Converter.

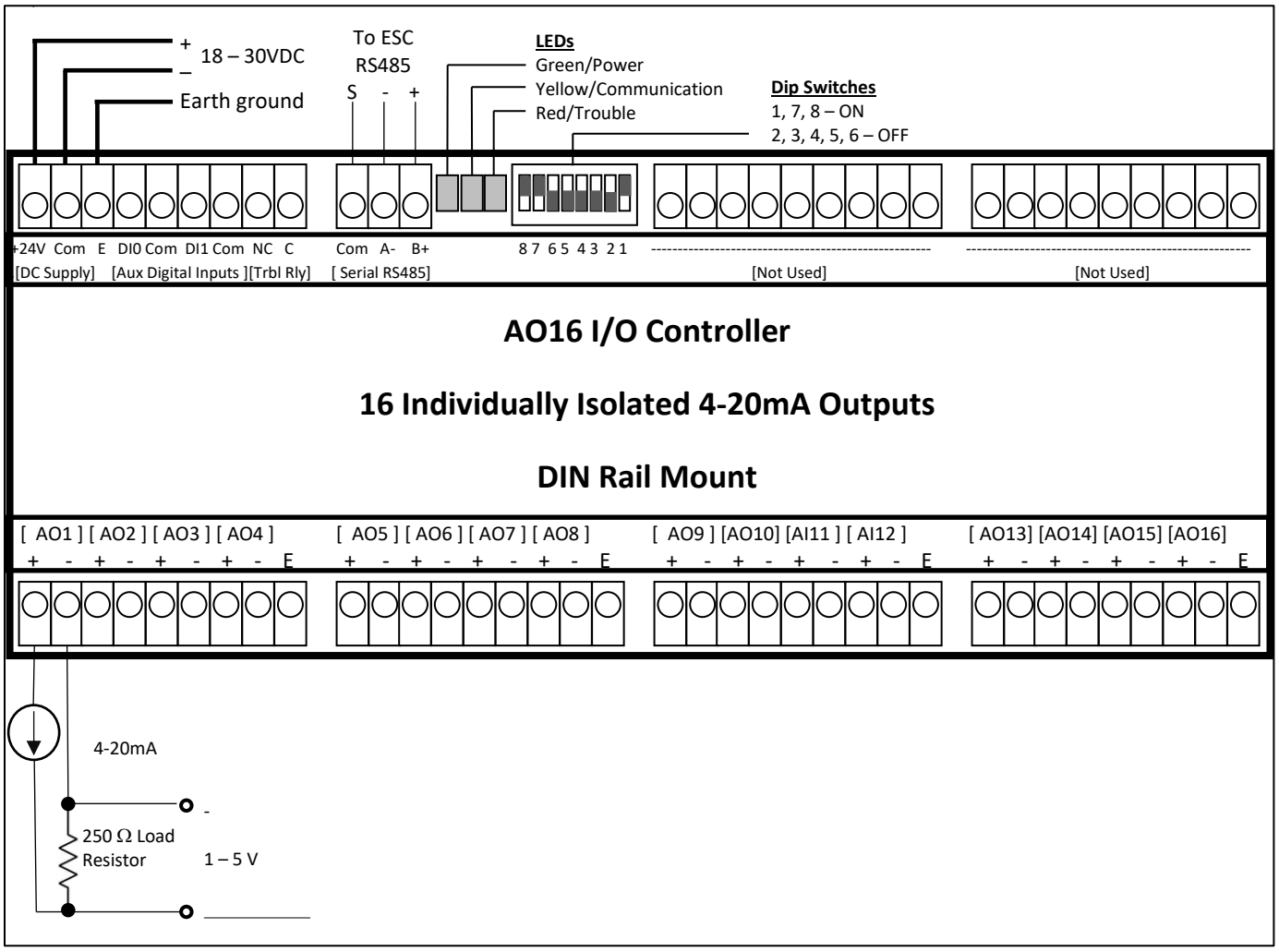


Figure 42: Analog Output Module Connections

11.4.4. Configuring the Converter

The setup menu is accessed from the Controller Setup screen by highlighting the "Digital to Analog Output Setup" option and pressing the button next to "D to A Output Setup". A screen similar to Figure 43 below will appear.

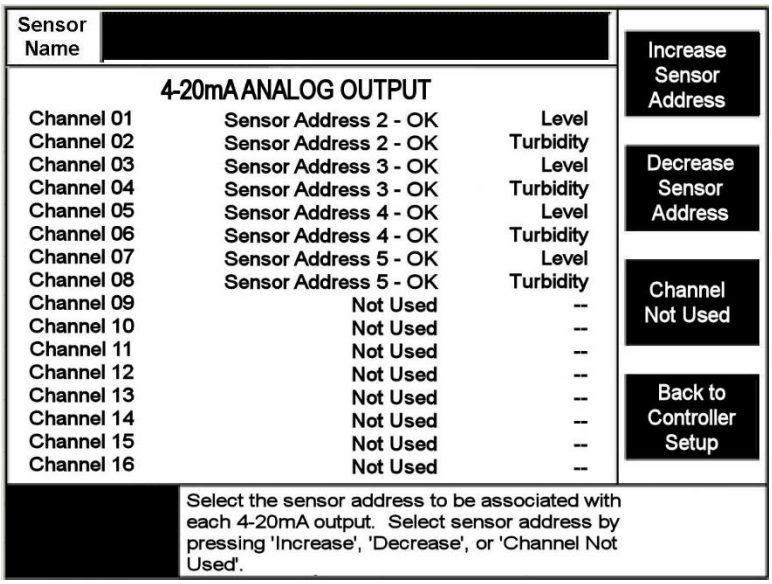


Figure 43: Digital to Analog Converter Setup Screen

Use the “Increase Sensor Address” and “Decrease Sensor Address” options to select which sensor’s data is output on each channel. When scrolling through the addresses, an “OK” message will be reported next to the address when that sensor is in the Controller’s database. Two question marks (??) will be appended to the address when that address is not present in the Controller’s database of sensors, indicating that no value is available for the analog output. In this case, communication needs to be established with the sensor or another address should be selected.

The measurement to be output on each channel can be selected by navigating to the right column. The options are: Level, Dispersed Solids Level, and Turbidity (when applicable).

While any sensor’s output can be assigned to any channel, each unique output can only be assigned to one channel (Ex: the Level output for Sensor Address 2 can only be configured on one of the channels). Only one channel will be updated with each unique output.

Note: If a sensor’s address is changed after configuration of the Analog to Digital Converter has been performed, the configuration will have to be updated to reflect the address change. Sensor address changes cannot be automatically updated on this configuration screen.

11.4.5. Analog Outputs

Each independent analog output is factory calibrated and is optically isolated from the DC Supply and from each other.

The sensor's 4 mA Set Point and 20 mA Set Point (see Section 9.2.14 and 9.2.15) should be scaled to represent the installation environment with consistent scaling at the control device. Set Points for the primary Level measurement are automatically assigned to the output for the dispersed solids level and no additional assignment is required or available. The turbidity value is factory scaled from 0 NTU to 50 NTU and is not user-adjustable.

Figure 44 below describes the analog output value that is reported under various sensor operating conditions.

Condition	**Output**
Normal	Current Scaled Value
Sensor Initializing	Cycle
Loss of Communication with Sensor	2 mA
Echo Loss	4mA, 20mA, or Cycle (see Echo Loss Action setting)
Channel Not Configured	0 mA

Figure 44: Table of Analog Output Behavior

12. Quick Start Guide

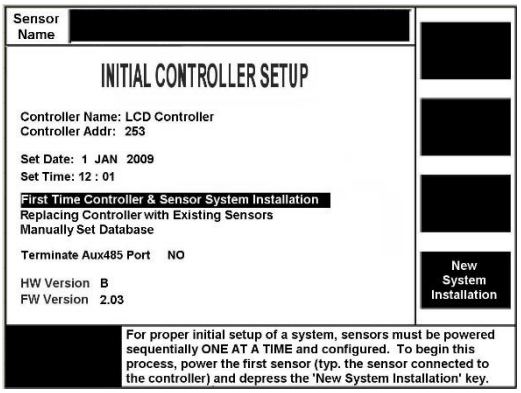
12.1. Configuring a Single Sensor

Follow these instructions when only one sensor is to be operated by the EchoSmart Controller.

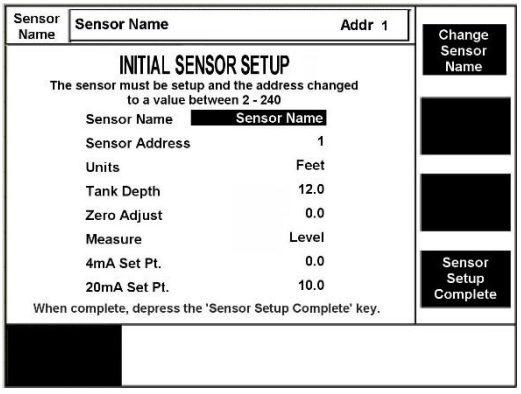
1. Ensure all sensor connections are correct and that power is properly applied to the device.

   IMPORTANT: Disconnect any outside RS-485 device from the ESC prior to initiating Controller Setup to avoid communication errors.

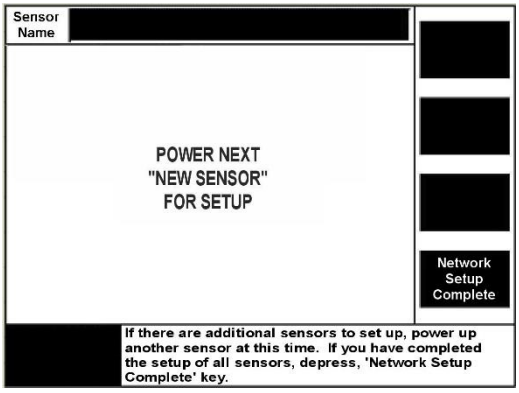
2. From the **Initial Controller Setup** screen, press *New System Installation*. This routine will take approximately 20 seconds to complete.



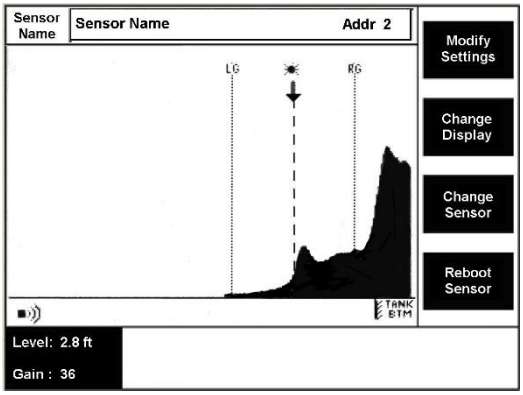
3. Change the Sensor Address to a unique value other than 1 and enter the correct parameters associated with the sensor on the **Initial Sensor Setup** screen – most importantly the Tank Depth, Zero Adjust, and 4-20mA Set Points (if being used). See Section 7.1 for help in determining correct values for Tank Depth and Zero Adjust. Press *Sensor Setup Complete*.



4. When a screen appears with instructions to “Power Next New Sensor for Setup,” press *Network Setup Complete*.



5. You will be directed to the **Echo Profile** screen. The sensor will go through an initialization process and then begin to report the current interface location.



6. If an external RS-485 polling device is to be used, it can now be connected. See Section 8.2.1 for recommendations and information regarding an RS-485 connection.

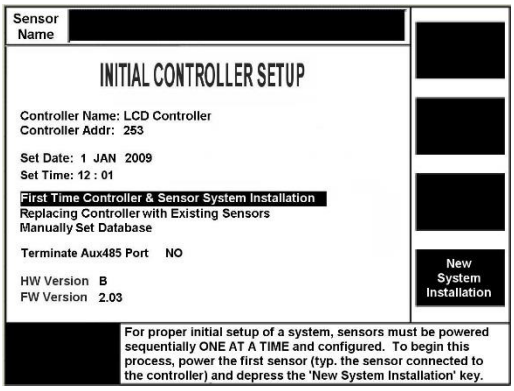
12.2. Configuring a Sensor Network

Follow these instructions when an EchoSmart Controller will communicate with more than one sensor in a Network arrangement.

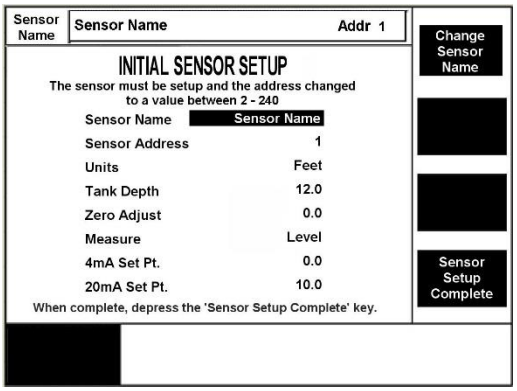
1. Ensure all sensor connections are correct and that power is properly applied to the EchoSmart Controller. If a sensor is not directly connected to the Controller, additionally power the first EchoSmart Power Supply with its sensor. **Sensors must be powered and added to the network one at a time.**

   IMPORTANT: Disconnect any outside RS-485 device from the ESC prior to initiating Controller Setup to avoid communication errors.

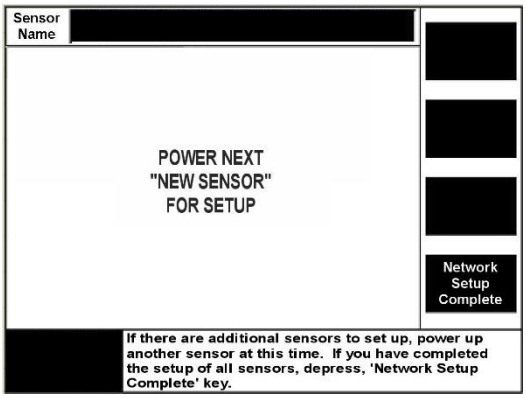
2. From the **Initial Controller Setup** screen, press *New System Installation*. This routine will take approximately 20 seconds to complete.



3. Change the Sensor Address to a unique value other than 1 and enter the correct parameters associated with the sensor on the **Initial Sensor Setup** screen – most importantly the Tank Depth, Zero Adjust, and 4-20mA Set Points (if being used). See Section 7.1 for help in determining correct values for Tank Depth and Zero Adjust. Press *Sensor Setup Complete*.

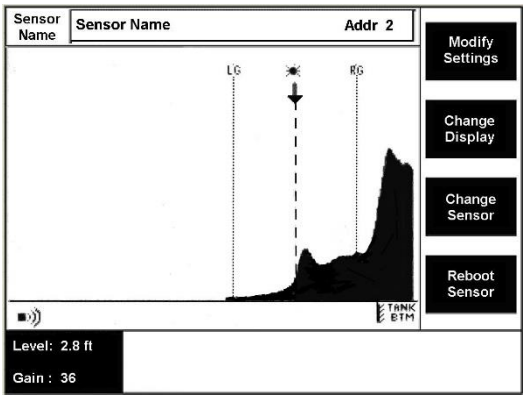


4. When a screen appears with instructions to "Power Next New Sensor for Setup," apply power to the next sensor that needs to be configured.



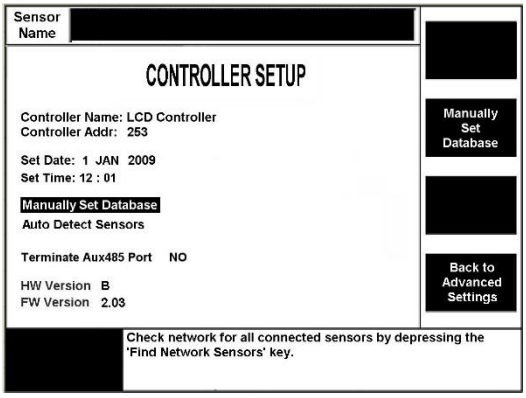
5. Repeat steps 3 and 4 for all sensors in the network, ensuring that each sensor has a unique Sensor Address. Once all have been setup, press *Network Setup Complete*.

6. You will then be directed to the **Echo Profile** screen. The sensors will go through an initialization process and then begin to report the current interface location.



7. To see the sensor name, current measurement, gain value, and turbidity output (when applicable) of all connected sensors, press *Change Display* from the **Echo Profile** screen.

8. If a sensor is not automatically found (once powered) during the network setup process or needs to be added later, go to *Modify Settings* → *Advanced Settings* → *Controller Setup*, highlight the Auto Detect Sensors option, and press *Auto Detect Sensors*.



9. If an external RS-485 polling device is to be used, it can now be connected. See Section 8.2.1 for recommendations and information regarding an RS-485 connection.

12.3. Special Settings for Filter Applications

Two dimensions are needed to set up the EchoSmart unit for filter applications: the distance from the Sensor to the Media (SM), and the Depth of the expandable Media (DM). Installation recommendations and a guide to help determine correct input dimensions are found in Figure 45 below. SM should be measured after installation of the sensor. The setup parameters can then be implemented as follows:

- ☐ **Units**: Set to Inches (or Centimeters)
  A smaller measurement unit provides finer resolution in the output measurement.
- ☐ **Tank Depth**: SM + DM
  (The measured distance from the Sensor to the Media (SM) plus the Depth of the Media (DM)).

- ☐ **Zero Adjust**: Set to zero (0.0)
- ☐ **Min Range**: Set to 12 inches
- ☐ **Update Rate**: Set to 8
- ☐ **Interface**: Set to LAST
- ☐ **Dampening**: Set to 5
- ☐ **Max Range**: SM + 4 inches
  (The measured distance from the Sensor to the Media plus 4 inches)
- ☐ **4mA Set Point**: 0.0
  (This locates the zero Level at the bottom of the expandable media. See Figure 45)
- ☐ **20mA Set Point**: Tank Depth (SM + DM, Figure 45)

Additional notes:

- ☐ The initial measurement and 4-20 mA output should equal the depth of the expandable media (DM). If the output does not match the known media depth, check the SM measurement and adjust the Tank Depth value accordingly.
- ☐ Depth of Media is NOT a directly measured value. Accuracy of this measurement and changes over time depend on a correct starting DM provided by the user.
- ☐ If the Tank Depth value is changed, Max Range will need to be re-calculated and set to the new value **after** the new Tank Depth is entered.
- ☐ If a narrower 4-20 mA span is desired, caution should be taken not to reduce the span such that it does not allow for media expansion during backwash or loss of media over time. The 4-20mA set points for turbidity are factory set to 0-50 NTU. Any data collection devices should be scaled accordingly.
- ☐ All other parameters should be left at factory defaults unless directed by Analytical Technology or one of their representatives.

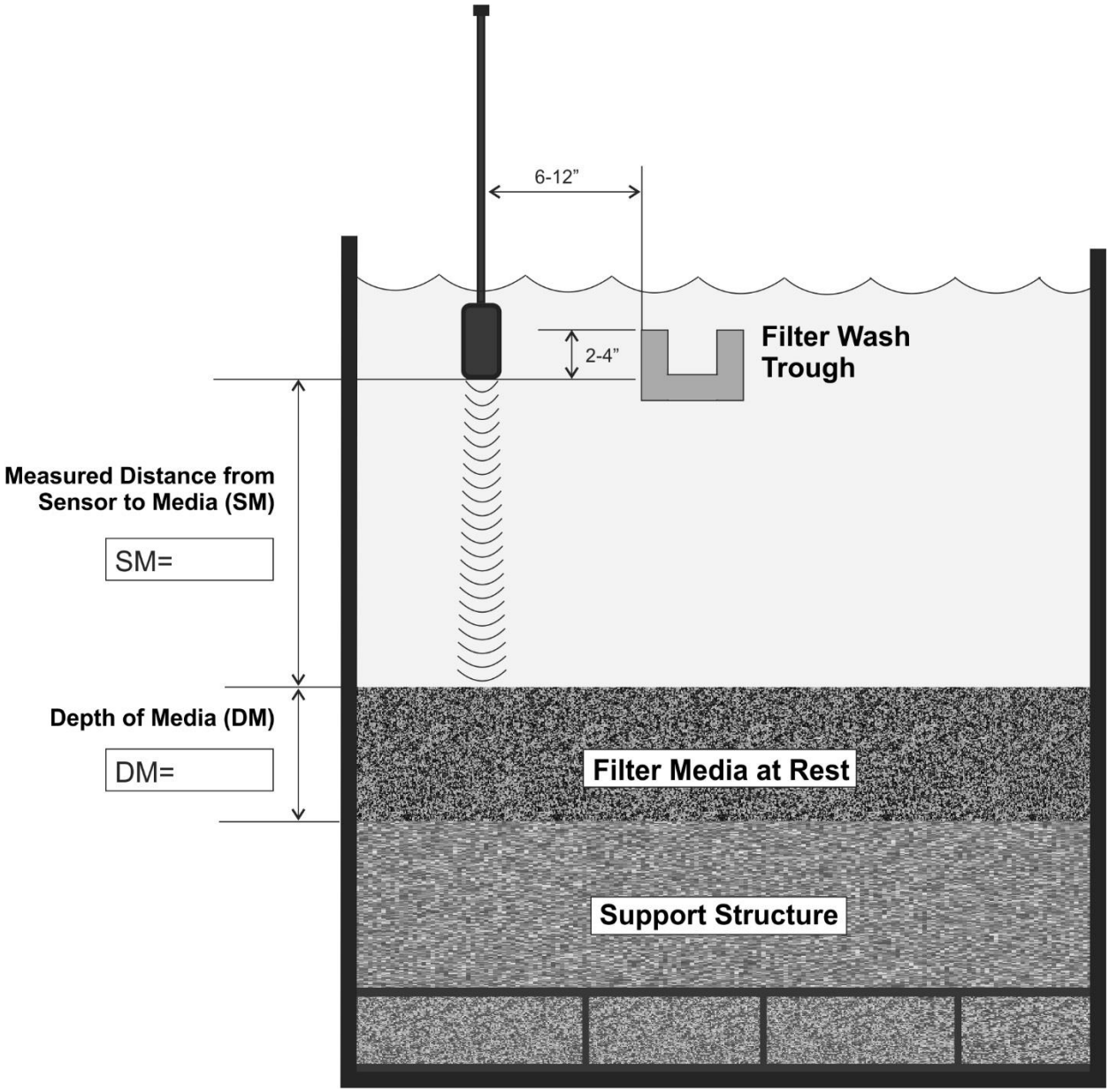


Figure 45: Installation Recommendations for Filter Applications

13. Warranty

Analytical Technology, Inc. (Manufacturer) warrants to the Customer that if any part(s) of the Manufacturer's equipment proves to be defective in materials or workmanship within the earlier of 18 months of the date of shipment or 12 months of the date of start-up, such defective parts will be repaired or replaced free of charge. Inspection and repairs to products thought to be defective within the warranty period will be completed at the Manufacturer's facilities in Collegeville, PA. Products on which warranty repairs are required shall be shipped freight prepaid to the Manufacturer. The product(s) will be returned freight prepaid and allowed if it is determined by the manufacturer that the part(s) failed due to defective materials or workmanship.

This warranty does not cover consumable items, batteries, or wear items subject to periodic replacement including lamps and fuses.

Gas sensors carry a 12 months from date of shipment warranty and are subject to inspection for evidence of misuse, abuse, alteration, improper storage, or extended exposure to excessive gas concentrations. Should inspection indicate that sensors have failed due to any of the above, the warranty shall not apply.

The Manufacturer assumes no liability for consequential damages of any kind, and the buyer by acceptance of this equipment will assume all liability for the consequences of its use or misuse by the Customer, his employees, or others. A defect within the meaning of this warranty is any part of any piece of a Manufacturer's product which shall, when such part is capable of being renewed, repaired, or replaced, operate to condemn such piece of equipment.

This warranty is in lieu of all other warranties (including without limiting the generality of the foregoing warranties of merchantability and fitness for a particular purpose), guarantees, obligations or liabilities expressed or implied by the Manufacturer or its representatives and by statute or rule of law.

This warranty is void if the Manufacturer's product(s) has been subject to misuse or abuse or has not been operated or stored in accordance with instructions, or if the serial number has been removed.

Analytical Technology, Inc. makes no other warranty expressed or implied except as stated above.

WATER QUALITY MONITORS

Dissolved Oxygen
Free Chlorine
Combined Chlorine
Total Chlorine
Residual Chlorine Dioxide
Potassium Permanganate
Dissolved Ozone
pH/ORP
Conductivity
Hydrogen Peroxide
Peracetic Acid
Dissolved Sulfide
Residual Sulfite
Fluoride
Dissolved Ammonia
Turbidity
Suspended Solids
Sludge Blanket Level
MetriNet Distribution Monitor

GAS DETECTION PRODUCTS

NH_3	Ammonia
CO	Carbon Monoxide
H_2	Hydrogen
NO	Nitric Oxide
O_2	Oxygen
CO	Cl2 Phosgene
Br_2	Bromine
Cl_2	Chlorine
ClO_2	Chlorine Dioxide
F_2	Fluorine
I_2	Iodine
H_X	Acid Gases
C_2H_4O	Ethylene Oxide
C_2H_6O	Alcohol
O_3	Ozone
CH_4	Methane (Combustible Gas)
H_2O_2	Hydrogen Peroxide
HCl	Hydrogen Chloride
HCN	Hydrogen Cyanide
HF	Hydrogen Fluoride
H_2S	Hydrogen Sulfide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
SO_2	Sulfur Dioxide
H_2Se	Hydrogen Selenide
B_2H_6	Diborane
GeH_4	Germane
AsH_3	Arsine
PH_3	Phosphine
SiH_4	Silane
HCHO	Formaldehyde
$C_2H_4O_3$	Peracetic Acid
DMA	Dimethylamine

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November 22, 2010

Smart Sensor Probe (SSP) Communications

Protocol

V3.08

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Revision History

Version	Date	List of Changes
1.0	July 14, 2008	Initial Release with ModBus Commands
2.0	October 23, 2008	Addition of Units Command (0x72) and Program Upload Command (0x78)
3.0	October 29, 2008	Addition of Density values to Track Command (0x65)
3.1	April 6, 2009	Addition of Commands for LCD Trend Data (0x79)
3.2	June 24, 2009	Modified calibration commands to support calibration of Turbidity Loop as separate from Level Loop.
	July 24, 2009	Clarification of units for values in trend data.
3.3	August 10, 2009	Added Display Control and Status command 0x7C Added Support for single step waveform control.
3.4	September 16, 2009	Added support for AGM DC, added register 40037. tm
3.5	March 10, 2010	Added support for E&H low power mode and additional Mod Bus commands to support E&H requirements. Sensor code version 9.
3.6	October 21, 2010	Changed definition of Slave ID in 4.1.7. Added User Data Fields 1, 2, 3 & 4 in ModBus commands. Firmware Version 14.
3.7	October 25, 2010	Correct ModBus lengths and register locations for User Data Fields 1, 2, 3, & 4. Also added support for saving Gain Mid Point setting in Manual Gain Command.
3.8	November 22, 2010	Added back Mod Bus registers 40042 & 40043. Added clarification on low power vs. high power after a reset.

1. INTRODUCTION

1.1 Scope of this document

This document outlines the basic communication capabilities of the Entech SSP protocol. The SSP protocol is based on the ModBus protocol but contains extensions and enhancements to facilitate additional features and capabilities.

The SSP protocol is a reply/request and offers services specified by function codes. The SSP function codes are elements of the MODBUS request/reply PDUs. The objective of this document is to describe the function codes used within the framework of SSP transactions.

1.2 References

1. MODBUS Application Protocol Specification V1.1b, dated December 28, 2006, Modbus.org.

2. ModBus Over Serial Line, Specification and Implementation Guide, V1.02, dated December 20, 2006, Modbus.org.

2. TERMS AND ABBREVIATIONS

ADU - Application Data Unit
PDU - Protocol Data Unit
SSP - Smart Sensor Probe (the sensor)
Waveform – A collection of 1024 samples spaced in time to generate a time varying waveform that represents the energy returned to the sensor. (the Spectra)

3. GENERAL DESCRIPTION

3.1 Protocol description

The SSP protocol is a Master-Slaves protocol. Only one master is connected to the bus, and one or several (247 maximum number) slaves' nodes are also connected to the same serial bus. A SSP protocol communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other. The master node initiates only one SSP protocol transaction at the same time.

The SSP protocol follows the basic ModBus protocol, where the client (host) initiates a transaction. Message formats can conform to the ModBus standard or the extended SSP protocol message format. The format of the response depends on the type of transaction message that is generated by the client, if a ModBus request is generated by the client (host), the server (sensor) responds with a ModBus formatted message, if the request is a SSP message the server (sensor) responds with a SSP formatted message. Determination of a ModBus vs. SSP message type is specified by the function code.

Figure 1 shows a typical SSP message. The SSP protocol application data unit (ADU) is built by the client that initiates the SSP protocol transaction. The function code indicates to the server what kind of action to perform and the type of message (SSP protocol or ModBus).

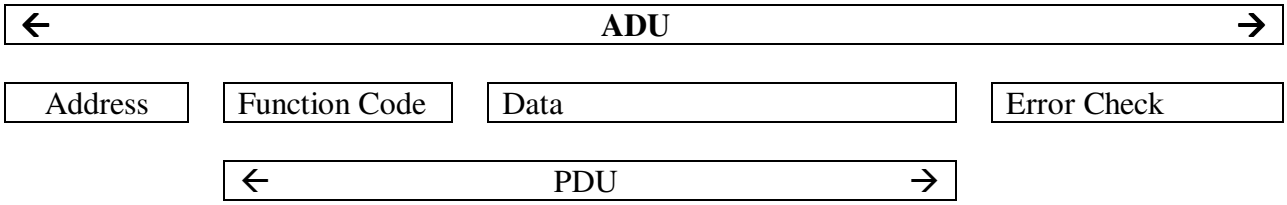

Figure 1: SSP Frame

The function code field of the protocol data unit (PDU) is coded in one byte. Valid codes are in the range of 1 ... 255 decimal (the range 128 – 255 is reserved and used for exception responses). When a message is sent from a Client to a Server device the function code field tells the server what kind of action to perform and the format of the message (SSP protocol or ModBus). Function code "0" is not valid. For ModBus messages sub-function codes are added to some function codes to define multiple actions.

The data field of messages sent from a client to server devices contains additional information that the server uses to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field. The data field may be nonexistent (of zero length) in certain kinds of requests, in this case the server does not require any additional information. The function code alone specifies the action.

Reference 1 provides a complete description of the ModBus standard. Section 4.0 in this document outlines the specific features and capabilities of the ModBus standard that are implemented within the SSP protocol. The definition of SSP protocol messages is defined in section 5.0.

3.2 Maximum Message Length

The SSP sensor supports a maximum packet length of 40 bytes. Therefore the maximum length of the ADU is 40 bytes. Messages longer than that will be ignored by the sensor.

3.3 Sensor Address

All devices on the ModBus have a unique device address. This address is used to determine which device on the network should respond to the received ADU message. The default device address for the SSP sensor is unit 1. This address can be modified using the Sensor Address register as outlined in section 4.2. In addition to the unique device address specified by the Sensor Address register the SSP sensor will also respond to broadcast messages set to device address 0.

3.3.1 Reserved Addresses

Some addresses on the bus are reserved for specific devices. SSP Sensors should not be assigned the reserved addresses. The following SSP Address Assignment Table identifies reserved unit addresses and the range of valid SSP Sensor address.

Device	Hex Address	Decimal Address
Reserved	0x00	0
SSP Sensors	0x01 – 0xF8	1 – 248
Reserved	0xF9 – 0xFC	249 – 252
LCD Controller	0xFD	253
SSP Power Supply	0xFE	254
Broadcast Address	0xFF	255

Address Assignment Table

3.4 Data Encoding

The SSP protocol uses a ‘big-Endian’ representation for addresses and data items. This corresponds with the standard used within the ModBus protocol. This implementation means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. So for example for the value 0x1234 the first byte sent is 0x12 then the second byte is 0x34.

3.5 Transmission Mode

The ModBus protocol defines two serial transmission modes: RTU mode and ASCII mode. The SSP protocol only supports the RTU mode of operation. In this mode each message is transmitted as a continuous stream of bytes. Interruptions in the data stream will be interpreted as the end of message.

3.5.1 RTU Mode Format

The format for each byte is 8 bits, No Parity, 1 Start and 1 Stop bit.

3.5.2 Data Signaling Rate

The baud rate for the SSP Protocol is 9600 baud. Currently this is the only baud rate supported.

3.6 CRC Checking

The protocol includes an error–checking field that is based on a Cyclical Redundancy Checking (CRC) method performed on the message contents. The CRC field checks the contents of the entire message. It is applied regardless of any parity checking method used for the individual characters of the message.

The CRC field contains a 16–bit value implemented as two 8–bit bytes. The CRC field is appended to the message as the last field in the message. When this is done, the low–order byte of the field is appended first, followed by the high–order byte. The CRC high–order byte is the last byte to be sent in the message. The CRC value is calculated by the sending device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

The CRC calculation is started by first pre-loading a 16–bit register to all 1's. Then a process begins of applying successive 8–bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits and the parity bit, do not apply to the CRC.

During generation of the CRC, each 8–bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place. This process is repeated until eight shifts have been performed. After the last (eight) shift, the next 8–bit byte is exclusive ORed with the register's current value, and the

process repeats for eight more shifts as described above. The final content of the register, after all the bytes of the message have been applied, is the CRC value.

The generation of the CRC value agrees and is compatible with the standard generation of the CRC value for the ModBus protocol.

3.7 Electrical Interface

The SSP protocol conforms to the ModBus RS-485 Two-Wire definition.

4. MODBUS PROTOCOL

The SSP protocol implements a sub set of the ModBus public function code definitions. Table 2 identifies the ModBus function codes supported in the SSP protocol.

			Function Code	
		Description	**Code**	**Sub-Code**
Data Access	**Bit Access**	Read Coils	01	
		Write Single Coil	05	
	16 Bit Access	Read Holding Registers	03	
		Write Single Register	06	
		Write Multiple Register	16	
Diagnostic		Get Diagnostic Register	08	1,4,10,11,12,14
		Report Slave ID	17	

Table 2. ModBus Function Codes

In addition to the protocol definitions outlined in section 3 of this document the SSP sensor places a limitation on the maximum length of any ModBus message packet. All ModBus messages must be less than 40 bytes long.

4.1 ModBus Function Codes

The ModBus function codes provide the basic capability to read and write values from and to the SSP sensor. Function codes provide the capability to read/write single bit values (coils) and 16 bit binary values (registers). The ModBus functions supported by the SSP sensor conform to the standard ModBus specification.

4.1.1 Read Bit Value Function (0x01)

This ModBus function code is used to read the status of individual bit values in the SSP sensor. The client (host) specifies the starting address, i.e. the address of the first bit value, and the number of bit values. In the SSP sensor, bit values are addressed starting at zero. Therefore Bit values numbered 1-16 are addressed as 0-15.

The bit values in the response message are packed as one bit value per bit of the data field. Status is indicated as 1= ON and 0= OFF. The LSB of the first data byte contains the output addressed in the query. The other bit values follow toward the high order end of this byte, and from low order to high order in subsequent bytes.

If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Example of the Read Bit Value Function:

Request

This command is requesting the ON/OFF status of discrete coils # 2 to 11 from the slave device with address 01.

`01 01 0001 000A EDCD`

`01`: The Slave Address (1 = `01` hex)
`01`: The Function Code (read Coil Status)
`0001`: The Data Address of the first coil to read. (Coil 2 - 1 = 1 = `01` hex)
`000A`: The total number of coils requested. (coils 2 to 11 = 10 = `0A` hex)
`EDCD`: The CRC (cyclic redundancy check) for error checking.

Response

`01 01 02 0302 38CD`

`01`: The Slave Address (1 = `01` hex)
`01`: The Function Code (read Coil Status)
`02`: The number of data bytes to follow (10 Coils / 8 bits per byte = 2 bytes)
`03`: Coils 2 - 9 (`0000 0011`)
`02`: Coils 10 - 11 (`0000 0010`)
`38CD`: The CRC (cyclic redundancy check).

The more significant bits contain the higher coil variables. This shows that coil 2 is on (`1`) and coil 9 is off (`0`). Due to the number of coils requested, the last data field `02` contains the status of only 2 coils. The three most significant bits in this data field are filled in with zeroes.

4.1.2 Read Holding Registers Function (0x03)

This ModBus function code is used to read the contents of a contiguous block of holding registers in the SSP sensor. The client (host) specifies the starting register address and the number of registers. In the SSP sensor Registers are addressed starting at zero. Therefore registers numbered 1-16 are addressed as 0-15.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Example of Read Holding Register Function

Request

This command is requesting the content of holding registers # 40103 to 40105 from the slave device with address 1.

```
01 03 0066 0003 E5D4
```

01: The Slave Address (1 = 01 hex)
03: The Function Code (read Analog Output Holding Registers)
0066: The Data Address of the first register requested. (40103-40001 = 102 = 66 hex)
0003: The total number of registers requested. (read 3 registers 40103 to 40105)
E5D4: The CRC (cyclic redundancy check) for error checking.

Response

```
01 03 06 3134 0000 0000 9490
```

01: The Slave Address (1 = 01 hex)
03: The Function Code (read Holding Registers)
06: The number of data bytes to follow (3 registers x 2 bytes each = 6 bytes)
3134: The contents of register 40103 (In this case it contains two ASCII chars '1' & '4')
0000: The contents of register 40104
0000: The contents of register 40115
9490: The CRC (cyclic redundancy check).

Since this example was a read of registers 40103 to 40105 which contain a portion of the Sensor Name, the data returned represents ASCII data. Other registers contain other data formats as show elsewhere in this document.

4.1.3 Write Single Bit Value Function (0x05)

This ModBus function code is used to write a single output bit value to either ON (1) or OFF (0) in the SSP sensor. The requested ON/OFF state is specified by a constant in the request data field. A value of 0xFF00 requests the bit value to be ON. A value of 0x0000 requests it to be OFF. All other values are illegal and will not affect the state of the bit value.

The normal response is an echo of the request, returned after the bit value state has been written

Example of a Write Single Bit Value Function

Request

This command is writing the contents of discrete coil # 2 to ON in the slave device with address 1.

`01 05 0001 FF00 DDFA`

`01`: The Slave Address (1 = `01` hex)
`05`: The Function Code (Force Single Coil)
`0001`: The Data Address of the coil. (coil# 2 - 1 = 1 = `01` hex)
`FF00`: The status to write (`FF00` = ON, `0000` = OFF)
`DDFA`: The CRC (cyclic redundancy check) for error checking.

Response

The normal response is an echo of the query, returned after the coil has been written.

`01 05 0001 FF00 DDFA`

`01`: The Slave Address (1 = `01` hex)
`05`: The Function Code (Force Single Coil)
`0001`: The Data Address of the coil. (coil# 2 - 1 = 1 = `01` hex)
`FF00`: The status written (`FF00` = ON, `0000` = OFF)
`DDFA`: The CRC (cyclic redundancy check) for error checking

4.1.4 Write Single Register Function (0x06)

This ModBus function code is used to write a single holding register in the SSP sensor. The client (host) specifies the address of the register to be written. Registers are addressed starting at zero. Therefore register numbered 1 is addressed as 0.

The normal response is an echo of the request, returned after the register contents have been written.

Example of a Write Single Register Function.

Request

This command is writing a 36 to register # 40005 in the slave device with address 1.

```
01 06 0004 0024 C810
```

01: The Slave Address (1 = 01 hex)
06: The Function Code (Preset Single Register)
0004: The Data Address of the register. (# 40005 - 40001 = 4)
0024: The value to write. (36 = 24 hex)
C810: The CRC (cyclic redundancy check) for error checking.

Response

The normal response is an echo of the query, returned after the register contents have been written.

```
01 06 0004 0024 C810
```

01: The Slave Address (1 = 01 hex)
06: The Function Code (Preset Single Register)
0004: The Data Address of the register. (# 40005 - 40001 = 4)
0024: The value written. (36 = 24 hex)
C810: The CRC (cyclic redundancy check) for error checking.

4.1.5 Diagnostics Function (0x08)

This ModBus function provides a series of tests for checking the communication system between a client (host) device and the SSP sensor, or for checking various internal error conditions within the SSP sensor.

The function uses a two–byte sub-function code field in the query to define the type of test to be performed. The server echoes both the function code and sub-function code in a normal response. Some of the diagnostics cause data to be returned from the remote device in the data field of a normal response.

In general, issuing a diagnostic function to the SSP sensor does not affect the running of the level detection function. However, certain diagnostic functions can optionally reset error counters in the remote device.

The SSP sensor can, however, be forced into 'Listen Only Mode' in which it will monitor the messages on the communications system but not respond to them. This can affect the normal response of ModBus messages but it will not affect the operation of SSP Protocol messages.

Table 3 identifies the diagnostic functions and sub codes are implemented in the SSP sensor.

Sub Function Code		Name
Hex	**Dec**	
0x01	1	Restart Communications Option
0x04	4	Force Listen Only Mode
0x0A	10	Clear Counters and Diagnostic Register
0x0B	11	Return Bus Message Count
0x0C	12	Return Bus Communication Error Count
0x0E	14	Return Slave Message Count

Table 3 – Diagnostic Sub-Function Codes

4.1.5.1 Restart Communications Sub-Code (0x01)

On receipt of this sub-code the SSP sensor restarts and initializes the RS485 serial line. In addition all of the communications event counters are cleared. If the RS485 port is currently in Listen Only Mode, no response is returned. This function is the only one that brings the port out of Listen Only Mode. If the port is not currently in Listen Only Mode, a normal response is returned. This occurs before the restart is executed.

When the SSP sensor receives this request, it attempts a restart and executes its power–up confidence tests. Successful completion of the tests will bring the port online.

4.1.5.2 Force Listen Only Mode Sub-Code (0x04)

This sub-code forces the SSP sensor into its Listen Only Mode for ModBus communications. (Note the unit will still respond to SSP protocol messages). This isolates it from the other ModBus devices on the network, allowing them to continue communicating without interruption from the addressed SSP sensor. No response is returned.

When the SSP sensor enters its Listen Only Mode, all active ModBus messages addressed to it or broadcast are monitored, but no actions will be taken and no responses will be sent. The only function that will be processed after the mode is entered will be the Restart Communications function (function code 8, sub-function 1).

4.1.5.3 Clear Counters and Diagnostic Register Sub-Code (0x0A)

This sub-code will clear all counters and the diagnostic register. Counters are also cleared upon power–up.

4.1.5.4 Return Bus Message Count Sub-Code (0x0B)

The response data field returns the quantity of messages that the SSP sensor has detected on the communications system since its last restart, clear counters operation, or power–up. This count includes both ModBus messages and SSP protocol messages.

4.1.5.5 Return Bus Communication Error Count Sub-Code (0x0C)

The response data field returns the quantity of CRC errors encountered by the SSP sensor since its last restart, clear counters operation, or power–up. This count includes both ModBus messages and SSP protocol messages.

4.1.5.6 Return Slave Message Count Sub-Code (0x0E)

The response data field returns the quantity of messages addressed to the SSP sensor, or broadcast, that the SSP sensor has processed since its last restart, clear counters operation, or power–up. This count includes both ModBus messages and SSP protocol messages.

4.1.6 Write Multiple Registers Function (0x10)

This ModBus function code is used to write a block of contiguous registers (1 to 32 registers) in the SSP sensor. The requested written values are specified in the request data field. Data is packed as two bytes per register.

The normal response returns the function code, starting address, and quantity of registers written.

4.1.7 Report Slave ID Function (0x11)

This ModBus function code is used to read the name of the SSP sensor manufacturer, the SSP model number and the contents of the user specific data (Field 1). The data returned shall have the following format:

1. Byte Count. Total number of bytes returned.
2. A 13 Byte string containing the manufacturer name.
3. A 5 byte string containing the SSP model number.
4. A 16 byte string containing the user specific data in field 1.
5. Run status indicator byte. 0x00 = OFF, 0xFF = ON.

4.2 ModBus Data

Data values within the SSP sensor are accessed using either bit values (coil) or register values. Bit values are generally used for ON/OFF or YES/NO conditions and register values are used for all other binary values. Some values are read only, some are write only and some are read and write. Table 4 identifies the specific bit values names and the bit location. Table 5 specifies the specific register names, data type and length.

4.2.1 Bit (Coil) Number Assignment

All bit values are encoded as either ON (0xFF) or OFF (0). As shown on Table 4 some bit values are write only where a Write Single Coil Function is used to control some function. A read o bit values that are specified as write only will always return a 0 value.

Name	Coil #	R/W	Description
Auto Gain	1	R/W	Turns Auto Gain Function Off (0) or On (0xFF).
Measure	2	R/W	Sets measurement mode, Level (0) or Range (0xFF)
Settling Zone	3	R/W	Turns Settling Zone Off (0) or On (0xFF)
Echo Loss	4	R/W	Echo Loss Function Off (0) or On (0xFF)
Force Level 4ma	5	R/W	Force Level Loop to 4 ma No (0), Yes (0xFF)
Force Level 20 ma	6	R/W	Force Level Loop to 20 ma No (0), Yes (0xFF)
Force Turbidity 4 ma	7	R/W	Force Turbidity Loop to 4 ma No (0), Yes (0xFF)
Force Turbidity 20 ma	8	R/W	Force Turbidity Loop to 20 ma No (0), Yes (0xFF)
Composite Waveform	9	R/W	Average Waveform (0), Composite Waveform (0xFF)
Reserved	10	R/W	Future – TBD – Always returns 0.
Waveform Acquisition Control	11	R/W	Off (0) or On (0xFF)
High Power Mode	12	R/W	Power Mode – Low Power (0), Hi Power (0xFF)
Reserved	13-16	R/W	Future – TBD – Always returns 0.
Turbidity Installed	17	R	Turbidity Installed No? (0), Yes (0xFF)
Wiper Installed	18	R	Wiper Motor Installed? No (0), Yes (0xFF)
Wiper Driver Failure	19	R	Wiper driver IC failure No (0), Yes (0xFF)
Wiper Motor Failure	20	R	Wiper motor open circuit or not connected
LOS Alarm	21	R	Loss of signal for more than Echo Delay.
Stabilize Gain Mode	22	R	Sensor Initializing in Stabilize Gain Mode
Stabilize Track Mode	23	R	Sensor Initializing in Stabilize Track Mode
Stabilize Gates Mode	24	R	Sensor Initializing in Stabilize Gates Mode
Initialization Complete	25	R	Initialization Complete
Requires Setup	26	R	Sensor requires setup
Level Loop Active	27	R	Level loop has excite voltage
Turbidity Loop Active	28	R	Turbidity loop has excite voltage
Level Loop Error	29	R	Level loop driver error
Turbidity Loop Error	30	R	Turbidity loop driver error

Echo Delay Timer	31	R	Sensor has detected loss of signal
Waveform Data Ready	32	R	Data in Waveform Registers is ready
Set Default	33	W[1]	Set all parameters to default
Load Parameters	34	W[1]	Load all parameters from FLASH
Save Parameters	35	W[1]	Save all parameters to FLASH
Reset Sensor	36	W[1]	Reset Sensor (same as power on reset)
Turbidity Led Failure	37	R	Turbidity Led open or not connected
Turbidity Driver Fail	38	R	Turbidity driver failure
Reserved	39-40	W[1]	Future – TBD

1 Note: Write only registers always return 0 on a read.

Table 4 – Bit Values

4.2.2 Register Number Assignment

Register values can be encoded in one of several ways. As shown on Table 5 register values can be encoded as data type: UUI, USUI, UINT, BUI, or CHAR. The coding for each type of value is slightly different.

Name	Register	Data	Len	R/W	Description
Track	40001	USUI	1	R	Reported Interface Position
Units	40002	UINT	1	R/W	inch, ft, cm, meter
Tank Depth	40003	UUI	1	R/W	Tank Depth
Zero Adjust	40004	USI	1	R/W	Zero Adjust
Min Range	40005	UUI	1	R/W	Minimum Range
Max Range	40006	UUI	1	R/W	Maximum Range
Sensitivity	40007	UINT	1	R/W	Percentage of Tracking Threshold
Wall Zone	40008	UUI	1	R/W	Wall Zone
Cell Limit	40009	UINT	1	R/W	Movement rate of Gmin & Gmax
Gmin	40010	UUI	1	R/W	Minimum distance to left gate
Gmax	40011	UUI	1	R/W	Minimum distance to right gate
Dampening	40012	UUI	1	R/W	Number of updates to average
Sound Speed	40013	BUI	1	R/W	Speed of Sound in FPS or MPS
Gain Increment	40014	UINT	1	R/W	Basic step change for gain
Wall Zone AG	40015	UINT	1	R/W	Gain control in wall zone
AG Set Point	40016	UINT	1	R/W	Gain control outside of wall zone
Gain Band	40017	UINT	1	R/W	Allowable gain adjustment
SP 4 ma	40018	UUI	1	R/W	4ma output setpoint
SP 20 ma	40019	UUI	1	R/W	20ma output setpoint
EL Action	40020	UINT	1	R/W	Echo Loss Action
Echo Delay	40021	UINT	1	R/W	Echo Delay
CP 4 ma	40022	UINT	1	R/W	4ma Calibration value
CP 20 ma	40023	UINT	1	R/W	20ma Calibration value

Current Gain	40024	UINT	1	R/W	Current Gain
Ping Rate Delay	40025	UINT	1	R/W	Ping Rate Delay
Update Rate	40026	UINT	1	R/W	Update Rate
Smoothing Rate	40027	UINT	1	R/W	Smoothing Rate
Delta Smoothing	40028	UINT	1	R/W	Delta Smoothing Rate
Wiper Delay	40029	UINT	1	R/W	Wiper Timing
Interface	40030	UINT	1	R/W	Selects first (0) or last (1)
Gain Band MP	40031	UINT	1	R/W	Gain Band Mid Point
Sensor Address	40032	UINT	1	R/W	Sensor Address
Op Range Index	40033	UINT	1	R	Sensor Operating Range Index
TCP 4 ma	40034	UINT	1	R/W	4ma Turbidity Calibration value
TCP 20 ma	40035	UINT	1	R/W	20ma Turbidity Calibration value
Turbidity NTU	40036	UINT	1	R	NTU value for Turbidity
Track Percentage	40037	UINT	1	R	Reported Interface Percentage of T.D.
Power Value	40038	UINT	1	R	Power required in milliwatts (mW)
Reserved	40039	UINT	1		
Reserved	40040	UINT	1		
Reserved	40041	UINT	1		
Hardware Version	40042	UINT	1	R	Version number of hardware
Software Version	40043	UINT	1	R	Version number of software
Sensor Name	40101	CHAR	12	R/W	Sensor Name
Serial Number	40113	CHAR	6	R	Sensor serial number.
User Data Field 1	40119	CHAR	8	R/W	User Specific Data (Optional)
User Data Field 2	40127	CHAR	9	R/W	User Specific Data (Optional)
Waveform Data	40201	UINT	512	R	Waveform Data
User Data Field 3	40801	CHAR	48	R/W	User Specific Data (Optional)
User Data Field 4	40849	CHAR	16	R/W	User Specific Data (Optional)

Table 5 – Register Values

4.2.3 Data Format Definitions

The SSP sensor uses different data type definitions for the data contained in the registers. Each register specified in table 5 has also specified the type of data structure associated with the register.

4.2.3.1 Unsigned Integer (UINT) Format

The value in the register is a binary number representing an unsigned integer from 0 to 65535.

4.2.3.2 Units Unsigned Integer (UUI) Format

The units unsigned integer format is used to represent a positive distance measurement. The value in the register represents a dimension based in inches or centimeters. The selection of inches or centimeters is determined by the current setting of the Units register (See Para 4.4.2). The value in the register is a binary number representing an unsigned integer from 0 to 65535.

4.2.3.3 Units Signed Integer (USI) Format

The units signed integer format is used to represent a positive or negative distance measurement. The value in the register represents a dimension based in inches or centimeters. The selection of inches or centimeters is determined by the current setting of the Units register (See Para 4.4.2). The value in the register is a binary number representing a signed integer from -32767 to +32767. The lower 15 bits determines the magnitude of the number, the most significant bit determines the sign of the number. Therefore the value 0x800A would represent the decimal number -10 and the value 0x000A would represent the decimal number +10.

4.2.3.4 Units Scaled Unsigned Integer (USUI) Format

The units scaled unsigned integer format is used to represent distances at a slightly higher degree of precision that what is available using the UUI format. The value in the register represents a dimension based on 1/10 of a foot, 1/10 of an inch, 1/10 of a meter or 1/10 of a centimeter. The selection of feet, inches, meters or centimeters is determined by the current setting of the Units register (See Para 4.4.2). The value in the register is a binary number representing an unsigned integer from 0 to 65535. Therefore the number 345.6 would be represented as 3456 in the USUI format. If the Units register was set to 0 then the number would represent 345.6 inches.

4.2.3.5 Basic Units Unsigned Integer (BUI) Format

The basic units unsigned integer format is used to represent a positive distance measurement. The value in the register represents a dimension based in feet or meters. The selection of feet or meters is determined by the current setting of the Units register (See Para 4.4.2). The value in the register is a binary number representing an unsigned integer from 0 to 65535. Note: This format is similar to the UUI format except that the number represents feet/meters instead of inches/centimeters.

4.2.3.6 Character String (CHAR) Format

The character string format is used to represent ASCII strings. Each register is 16 bits wide and holds two 8 bit ASCII characters. The string is a fixed length long as specified by the number of contiguous registers and is not required to be terminated by a null character.

4.3 Bit Values

Table 4 identifies several bit values. Each of these bit values is referenced by a coil number in the ModBus standard. This section identifies each coil value and the associated function.

4.3.1 Auto Gain (Coil 1)

The auto gain bit determines if the SSP sensor will automatically adapt the operating gain. It the bit is clear (0) then the auto gain function is OFF. If the bit is set (1) then the auto gain function is ON. When the auto gain function is OFF the amount of operating gain can be controlled using the Current Gain register (Register 40027). When the auto gain function is ON the Current Gain register can be used to read the current gain value, but while the auto gain is ON the Current Gain register cannot be used to alter the gain setting.

4.3.2 Measure (Coil 2)

The Measure bit determines if the Track (4.4.1) will be displayed as a level or a range value. If the measure bit is clear (0) then the measurement will be displayed as the level. If the measure bit is set (1) then the measurement will be displayed as the range. Level measurement provides the distance of the interface level from the bottom of the tank. Range measurement provides the distance of the interface level to the top of the tank.

4.3.3 Settling Zone (Coil 3)

If the bit is clear (0) then the settling zone is OFF. If the bit is set (1) then the settling zone is ON.

4.3.4 Echo Loss (Coil 4)

If the Echo Loss bit is set (1) then the SSP sensor will indicate that condition on the 4-20ma current loop when the sensor is unable to determine a valid interface. The method of identifying an echo loss condition is determined by the EL Action register (4.4.20).

4.3.5 Force Level 4ma (Coil 5)

If the Force Level 4ma bit is set (1) then the SSP sensor will send a 4 ma signal on the 4-20ma current loop used for the level information. This bit cannot be set when the Force Level 20ma bit is set.

4.3.6 Force Level 20 ma (Coil 6)

If the Force Level 20ma bit is set (1) then the SSP sensor will send a 20 ma signal on the 4-20ma

current loop used for the level information. This bit cannot be set when the Force Level 4ma bit is set.

4.3.7 Force Turbidity 4 ma (Coil 7)

If the Force Turbidity 4ma bit is set (1) then the SSP sensor will send a 4 ma signal on the 4-20ma current loop used for the turbidity information. This bit cannot be set when the Force Turbidity 20ma bit is set.

4.3.8 Force Turbidity 20 ma (Coil 8)

If the Force Turbidity 20ma bit is set (1) then the SSP sensor will send a 20 ma signal on the 4-20ma current loop used for the turbidity information. This bit cannot be set when the Force Turbidity 4ma bit is set.

4.3.9 Composite Waveform (The Spectra) (Coil 9)

The SSP sensor gathers a number of 1024 waveforms prior to analysis. The number of waveforms collected is determined by the Update register (4.4.26). As each waveform is captured it is added to the prior waveform. The Composite Waveform coil determines how the waveforms are added. If the Composite Waveform coil is set (1) then the resultant waveform is composed of the maximum amplitude for each of the 1024 data points, resulting in the final composite waveform having the maximum detected signal level for each of the 1024 sample points. If the Composite Waveform coil is clear (0) then the waveforms are added by performing an arithmetical average for each of the 1024 data points.

4.3.10 Not Applicable

4.3.11 Waveform Acquisition Control (Coil 11)

The Waveform Acquisition bit allows the sensor to gather waveform data. This bit defaults to the ON (1) state. If the bit is OFF, the sensor will not acquire any waveform data. This bit should be set OFF when uploading waveform data from the sensor to a host device. If the Waveform Acquisition bit is left in the OFF state for more than 1 minute, the sensor will automatically set the Waveform Acquisition bit to the ON state to prevent the sensor from being inadvertently disabled.

4.3.12 High Power Mode (Coil 12)

This bit indicates if the SSP sensor is in high power (full operation) or low power (standby) mode. If the bit is clear (0) then the sensor is in standby mode. While in standby mode the sensor will not perform new measurement or operate the 4-20 ma current loops but will respond to all communication requests. If the bit is set (1) then the sensor is in high power mode and is fully operational.

4.3.13 Turbidity Installed (Coil 17)

This bit indicates if the SSP sensor has been equipped with a turbidity module. If the bit is clear (0) then no turbidity module is installed. If the bit is set (1) then the sensor is equipped with a turbidity module. The coil is read only.

4.3.14 Wiper Installed (Coil 18)

This bit indicates if the SSP sensor has been equipped with a wiper. If the bit is clear (0) then no wiper is installed. If the bit is set (1) then the sensor is equipped with a wiper. The coil is read only.

4.3.15 Wiper Driver Failure (Coil 19)

When set this bit indicates that the sensor has detected a wiper driver IC failure.

4.3.16 Wiper Motor Failure (Coil 20)

When set this bit indicates that the sensor has detected that the wiper motor is open circuited or the motor is not connected.

4.3.17 LOS Alarm (Coil 21)

When set this bit indicates that the SSP sensor has detected a loss of signal condition for more than Echo Delay register (4.4.21) value.

4.3.18 Stabilize Gain Mode (Coil 22)

When set this sensor is in the stabilize gain mode of the initialization phase.

4.3.19 Stabilize Track Mode (Coil 23)

When set the sensor is in the stabilize track mode of the initialization.
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4.3.20 Stabilize Gates Mode (Coil 24)

When set the sensor is in the stabilize gates mode of the initialization phase .
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4.3.21 Initialization Complete (Coil 25)

When set the sensor has completed the initialization phase and is now operating normally.

4.3.22 Requires Setup (Coil 26)

When set this bit indicates that the sensor has been configured at the factory but requires field configuration (Tank Depth, Zero Adjust, etc) prior to initial use.

4.3.23 Level Loop Active (Coil 27)

When set this bit indicates that the 4-20ma Level current loop has the proper voltage applied and is now active. Use this to coil to alarm malfunctions.

4.3.24 Turbidity Loop Active (Coil 28)

When set this bit indicates that the 4-20ma Turbidity current loop has the proper voltage applied and is now active. Use this to coil to alarm malfunctions.

4.3.25 Level Loop Error (Coil 29)

When set this bit indicates that the sensor has detected an error in the driver circuit for the 4-20ma current loop for the level. Use this to coil to alarm malfunctions.

4.3.26 Turbidity Loop Error (Coil 30)

When set this bit indicates that the sensor has detected an error in the driver circuit for the 4-20ma current loop for the turbidity sensor. Use this to coil to alarm malfunctions.

4.3.27 Echo Delay Timer (Coil 31)

When set this bit indicates that the sensor has detected a loss of echo signal, but is waiting for the Echo Delay (4.4.21) to be satisfied to activate the EL Action (4.4.20).

4.3.28 Waveform Data Ready (Coil 32)

When this bit is set the data in the Waveform Registers (Register 40200-40711) is ready to upload to a host. This bit is only set after the Waveform Acquisition Control coil (4.3.11) has been set to 0 and the sensor has placed new data in the Waveform Registers.

4.3.29 Set Default (Coil 33)

The Set Default bit is used to restore all of the sensor parameters back to the factory defaults. To activate this command the user should set the bit to 1. At the completion of the requested action the bit will automatically be reset back to 0. There is no need to reset the bit back to 0.

4.3.30 Load Parameters (Coil 34)

The Load Default bit is used to read all of the saved parameters from the EEPROM and place them in working memory. To activate this command the user should set the bit to 1. At the completion of the requested action the bit will automatically be reset back to 0. There is no need to reset the bit back to 0.

4.3.31 Save Parameters (Coil 35)

The Save Parameters bit is used to save all of the parameters in the working memory to EEPROM. This action is required so that on the next power cycle the sensor will automatically restore all parameter values. To activate this command the user should set the bit to 1. At the completion of the requested action the bit will automatically be reset back to 0. There is no need to reset the bit back to 0.

4.3.32 Reset Sensor (Coil 36)

The Reset Sensor bit is used to cause a complete hardware and software reset of the SSP sensor. To activate this command the user should set the bit to 1. At the completion of the requested action the bit will automatically be reset back to 0. There is no need to reset the bit back to 0. If

the sensor has the auto power selection, the sensor will enter the low power mode after reset.

4.3.33 Turbidity Led Failure (Coil 37)

When set this bit indicates that the sensor has detected that the LED used for the turbidity sensor is open circuited or the turbidity sensor is not connected.

4.3.34 Turbidity Driver Failure (Coil 38)

When set this bit indicates that the sensor has detected that the I.C. driver for the turbidity sensor LED has failed.

4.4 Register Values

Table 5 identifies several data values. Each of these data values is referenced by a register number in the ModBus standard. This section identifies each register and the associated function.

4.4.1 Track (Register 40001)

The track register is used to indicate the location of the detected interface level. The setting of the Units register (4.4.2) determines the base number representation as shown in table 6. In all cases the binary number presented represents times 10 the base measurement (i.e. 200 = 20.0 units). The track register will represent the level measurement of the interface if the measure coil (4.3.1) is clear or it will represent the range measurement of interface if the measure coil is set. See description of USUI format for additional information on the format of the number contained in this register.

4.4.2 Units (Register 40002)

The Units register specifies the base units that the system will use: Metric or English. The Units value determines what units the UUI, USI, USUI, and BUI number will represent. Table 6 identifies how various data formats will be interpreted based on the setting of the Units register.

Register Val	Base	UUI Base	USI Base	USUI Base	BUI Base
0	Feet	Inches	Inches	Feet * 10	Feet
1	Inches	Inches	Inches	Inches * 10	Feet
2	Meters	cm	cm	Meters * 10	Meters
3	cm	cm	cm	cm * 10	Meters

Table 6 – Units Setting

When changing the units register the SSP sensor will automatically rescale all of the registers that are based in UUI, USI, USUI, and BUI units.

4.4.3 Tank Depth (Register 40003)

Tank depth is the distance from the surface of the water to the bottom of the tank. It is a binary number in either inches or centimeters. This is the complete span over which the SSP sensor will be calibrated.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.4 Zero Adjust (Register 40004)

Zero Adjust is an offset value which locates the face of the SSP sensor above or below the surface of the water level of the tank. This value modifies the level/range measurement to adjust for the sensor location. The value can be positive (sensor face installed below the water level) or negative (sensor face installed above the water level – i.e. in a stand pipe).

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.5 Min Range (Register 40005)

Minimum Range is an adjustable value that determines the minimum distance that the sensor will measure. This number is always positive and must be less than tank depth.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.6 Max Range (Register 40006)

Maximum Range is and adjustable value that determines the maximum distance that the sensor will measure. This number is always positive and must be less than 382 inches (9715 cm). Generally this number is set at 110% of tank depth (4.4.3).

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.7 Sensitivity (Register 40007)

Interfaces are detected by analysis of wave form derivatives. Sensitivity is an adjustable threshold that determines which derivatives are valid for tracking. Valid range of numbers is from 0 to 100.

4.4.8 Wall Zone (Register 40008)

The wall zone register determines the size of the wall zone. The wall zone is an adjustable distance above the tank bottom.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.9 Cell Limit (Register 40009)

The Cell Limit register determines the maximum movement of the gates in any one update. Valid range of the number is from 0 to 50.

4.4.10 Gmin (Register 40010)

The Gmin register determines the minimum distance that the left gate can be placed from the current track value.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.11 Gmax (Register 40011)

The Gmax register determines the minimum distance that the right gate can be placed from the current track value.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.12 Dampening (Register 40012)

The Dampening register is used to average the current track location (reported interface location). The dampening value determines the number of updates that will be averaged together to provide a track location. Valid range of the number is from 1 to 100.

4.4.13 Sound Speed (Register 40013)

The Sound Speed register is used to adjust the speed of sound used for all sensor distance measurements.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in feet per second (FPS). If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in meters per second (MPS).

4.4.14 Gain Increment (Register 40014)

The Gain Increment register determines the step size in the auto-gain adjustment. Valid range of the number is from 5 to 50.

4.4.15 Wall Zone AG (Register 40015)

The Wall Zone AG controls the amount of gain applied to amplify the wave form in the Wall Zone (4.4.8) when the auto gain coil is set to 1 (on) (4.3.1). The valid range of the register is 0 to 100 with 10 as default. Lowering this number will decrease the gain applied to the waveform. Raising this number will increase the amount of gain.

4.4.16 AG Set Point (Register 40016)

The AG Set Point controls the amount of gain applied to amplify the wave form not in the Wall Zone (4.4.8) when the auto gain coil is set to 1 (on) (4.3.1). The valid range of the register is 0 to 50 with 10 as default. Lowering this number will decrease the gain applied to the waveform. Raising this number will increase the amount of gain.

4.4.17 Gain Band (Register 40017)

The Gain Band register is the range that the gain can be adjusted from the Gain Band Mid Point. Valid range of number is from 5 to 30.

4.4.18 SP 4 ma (Register 40018)

The 4 ma Set Point (SP) register is used to specify the value that will be used as the 4 ma set point.

If the Measure coil is set for level (4.3.2) the number represents the level measurement. If the Measure coil is set for range then the number represents the range measurement.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.19 SP 20 ma (Register 40019)

The 20 ma Set Point (SP) register is used to specify the value that will be used as the 20 ma set point.

If the Measure coil is set for level (4.3.2) the number represents the level measurement. If the Measure coil is set for range then the number represents the range measurement.

If the Units register (4.4.2) is set for feet or inches then the binary number represents the measurement in inches. If the Units register (4.4.2) is set for meters or centimeters then the number represents the measurement in centimeters.

4.4.20 EL Action (Register 40020)

The Echo Loss (EL) Action register determines what action will be taken on the level current loop if there is a loss of echo. For this action to be valid the Echo Loss coil (4.3.4) must be set ON. Table 7 identifies the valid Echo Loss Actions.

Register Value	Action
0	Force 4 ma level (Drive Low)
1	Force 20 ma level (Drive High)
2	Cycle – Alternate Low and High

Table 7 – Echo Loss Action Values

4.4.21 Echo Delay (Register 40021)

The Echo Delay register determines the number of minutes that the sensor must experience a loss of signal condition before the sensor initiates the Echo Loss Action. If the Echo Loss coil (4.3.4) is turned OFF, the value in the Echo Delay register is ignored and the sensor will not initiate the Echo Loss Action.

4.4.22 CP 4ma (Register 40022)

The 4 ma calibration point (CP) register contains the binary number necessary to write to the hardware to generate a 4 ma signal on the current loop used for the level.

4.4.23 CP 20ma (Register 40023)

The 20 ma calibration point (CP) register contains the binary number necessary to write to the hardware to generate a 20 ma signal on the current loop used for the level.

4.4.24 Current Gain (Register 40024)

When the Current Gain coil (4.3.1) is OFF the Current Gain register is used to control the gain amplification value. In this mode the Current Gain register provides read/write capability. When the Auto Gain coil is ON, the Current Gain register is read only and provides an indication of the current gain value. Valid Range of number is from -4095 to +4095.

4.4.25 Ping Rate Delay (Register 40025)

The sensor normally collects waveform data at a pre-programmed rate. The ping rate delay register is used to add a delay into the waveform collection sequence. Valid range of the register is 0 to 100. The rate for each number is in 10mS units. If the ping rate delay register is set to “0” there is no delay added. If the ping rate delay register is set to “5” there would be a 50mS delay between the collection of each waveform.

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4.4.26 Update Rate (Register 40026)

The Update Rate register is used to determine how many waveforms will be combined into a single waveform that is used for analysis. With a setting of 1, the sensor will average 8 waveforms. The maximum setting of 20 results in a total of 160 waveforms combined into the resulting final waveform. (Note: An update rate of 0 provides a single non combined waveform).

4.4.27 Smoothing Rate (Register 40027)

The Smoothing Rate register is used to smooth the 1024 cells to produce the final waveform for analysis. Valid range of numbers is from 0 to 25. A value of 0 provides no smoothing.

4.4.28 Delta Smoothing (Register 40028)

The Delta Smoothing Rate register is used to smooth the derivative waveform in the same manner as 4.4.27.

4.4.29 Wiper Delay (Register 40029)

The Wiper Delay register determines the number of seconds that the wiper is off between cycles. Valid range of the number is from 0 to 240. A value of 0 indicates that the wiper is OFF and should not be cycled.

4.4.30 Interface (Register 40030)

The Interface register determines how the SSP sensor interprets the waveform data. If the register is set to 0 then the sensor selects the “first” (closest to the sensor) derivative which satisfies the sensitivity threshold (4.4.7). If the register value is set to 1 then the sensor selects the “last” (farthest from the sensor) interface.

4.4.31 Gain Band MP (Register 40031)

The Gain Band Mid Point (MP) register is used to position the gain band. During initialization the sensor calculates a gain band mid point. When auto gain is enabled (4.3.1) the sensor will automatically adjust the gain about this mid point. The amount of adjustment is determined by the Gain Band register (4.4.17).

4.4.32 Sensor Address (Register 40032)

The sensor address register contains the network address for the SSP sensor. Once this register is changed the sensor will then communicate using the new network address.

4.4.33 Op Range Index (Register 40033)

This read only register is used to indicate the operating range that the sensor is currently using. Since the operating range determines the basic sensor sample timing, this register is used to determine the timing used for sample points in the waveform data.

Index	Operating Range	Sample Time
0	5 ft (1.524 m)	2.5016878855 uSec
1	10 ft (3.048 m)	5.003375771 uSec
2	20 ft (6.096 m)	10.006751542 uSec
3	30 ft (9.144 m)	15.010127313 uSec

4.4.34 TCP 4ma (Register 40034)

The 4 ma turbidity calibration point (TCP) register contains the binary number necessary to write to the hardware to generate a 4 ma signal on the current loop used for the turbidity.

4.4.35 TCP 20ma (Register 40035)

The 20 ma turbidity calibration point (TCP) register contains the binary number necessary to write to the hardware to generate a 20 ma signal on the current loop used for the turbidity.

4.4.36 Turbidity NTU (Register 40036)

The Turbidity NTU register returns the current turbidity NTU value times 100 (0-5000). Divide the returned number by 100 to get the actual NTU value. If the turbidity option is not installed and enabled (See Coil #17) then the register returns a 0 value. Trying to write to this register returns an error.

4.4.37 Track Percentage (Register 40037)

The track percentage register returns the current Level in percentage of Tank Depth. The value in the register is 10 times the actual percentage (0-10000). Divide the returned number by 10 to get the actual percentage. Trying to write to this register returns an error.

4.4.38 Power Value (Register 40038)

The power value register returns the power required for the current mode (Standby or High Power – See Coil 12). The value in the register is in milliwatts (mW). Trying to write to this register returns an error.

4.4.39 Hardware Version (Register 40042)

The hardware version register returns the version number of the hardware. Trying to write to this register returns an error.

4.4.40 Software Version (Register 40043)

The software version register returns the version number of the software. Trying to write to this register returns an error.

4.4.41 Sensor Name (Registers 40101 – 40112)

The sensor name is contained in a series of 12 successive registers. Each register contains two ASCII characters.

4.4.42 Serial Number (Registers 40113 – 40118)

The sensor serial number is contained in a series of 6 successive registers. Each register contains two ASCII characters.

4.4.43 User Data Field 1 (Registers 40119 – 40126)

These registers provide a general purpose read and write persistent memory for the end user. Values stored in these registers will be automatically saved into FLASH memory. Reading or writing these registers will not affect the sensor's behavior in any way. Initially the register values are set to 0xFF for each register. (Note: This register is optional and in not available on standard sensor firmware)

4.4.44 User Data Field 2 (Registers 40127 – 40135)

These registers provide a general purpose read and write persistent memory for the end user. Values stored in these registers will be automatically saved into FLASH memory. Reading or writing these registers will not affect the sensor's behavior in any way. Initially the register values are set to 0xFF for each register. (Note: This register is optional and in not available on standard sensor firmware)

4.4.45 Waveform Data (Registers 40201-40712)

Waveform Data exists as a series of 1024 data points. Each data point is a byte value with a valid range of 0-255. Each register is a 16 bit value, each register contains 2 data points. Thus register 40200 contains data points 0 & 1, and register 40711 contains data points 1022 and 1023. When reading multiple register values (ModBus Command 16) you can only access a maximum of 15 consecutive registers.

Prior to reading the Waveform Data registers, the host should disable Waveform Acquisition Controls (4.3.11). Failure to disable this control will corrupt the Waveform Data register. The current status of the waveform data registers can be determined by reading the Waveform Data Ready coil (4.3.27).

4.4.46 User Data Field 3 (Registers 40801 – 40848)

These registers provide a general purpose read and write persistent memory for the end user. Values stored in these registers will be automatically saved into FLASH memory. Reading or writing these registers will not affect the sensor's behavior in any way. Initially the register values are set to 0xFF for each register. (Note: This register is optional and in not available on standard sensor firmware)

4.4.47 User Data Field 4 (Registers 40849 – 40864)

These registers provide a general purpose read and write persistent memory for the end user. Values stored in these registers will be automatically saved into FLASH memory. Reading or writing these registers will not affect the sensor's behavior in any way. Initially the register values are set to 0xFF for each register. (Note: This register is optional and in not available on standard sensor firmware)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

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(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35LT3237	Waterpilot FMX21	Endress+Hauser	FMX21-CE221HDE11A+PRPSZ1	Section 40 91 00	09-I-005
002	1	C40LT0211	Waterpilot FMX21	Endress+Hauser	FMX21-CE221GGE11A+PRPSZ1	Section 40 91 00	09-I-005
003	1	C40LT0411	Waterpilot FMX21	Endress+Hauser	FMX21-CE221GGE11A+PRPSZ1	Section 40 91 00	09-I-005, 4091-265
004							
005							
006							
007							
008							
009							
010							
011							
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040							

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Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71082058	Waterpilot FMX21 FMX21-CE221HDE11A+PRPSZ1	1	PC

010	Approval:	CE	CSA C/US IS Cl.I Div.1 Gr.A-D, Ex ia, zone 1
020	Output:	2	4-20mA HART
045	Probe Tube:	2	316L, d=42mm/1.66in, flush mount
070	Sensor Range:	1H	1bar/100kPa/15psi gauge, 10mH2O/33ftH2O/400inH2O
080	Reference Accuracy:	D	Platinum
090	Calibration; Unit:	E	Sensor range; inH2O/ftH2O
100	Probe Connection:	11	20m cable, shortable, PE
190	Seal:	A	FKM
620	>>Accessory Enclosed:	PR	Cable-mounting-screw NPT1-1/2, 304
		PS	Terminal box IP66/67
895	>>Marking:	Z1	Tagging (TAG), see additional spec.

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Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71082058	Waterpilot FMX21 FMX21-CE221GGE11A+PRPSZ1	1	PC

010	Approval:	CE	CSA C/US IS Cl.I Div.1 Gr.A-D, Ex ia, zone 1
020	Output:	2	4-20mA HART
045	Probe Tube:	2	316L, d=42mm/1.66in, flush mount
070	Sensor Range:	1G	600mbar/60kPa/9psi gauge, 6mH2O/20ftH2O/240inH2O
080	Reference Accuracy:	G	Standard
090	Calibration; Unit:	E	Sensor range; inH2O/ftH2O
100	Probe Connection:	11	20m cable, shortable, PE
190	Seal:	A	FKM
620	>>Accessory Enclosed:	PR	Cable-mounting-screw NPT1-1/2, 304
		PS	Terminal box IP66/67
895	>>Marking:	Z1	Tagging (TAG), see additional spec.

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TI00431P/00/EN/18.22-00
71593286
2022-09-12

Technical Information
Waterpilot FMX21

Hydrostatic level measurement

Compact transmitter for level measurement

Application

The Waterpilot FMX21 is a pressure sensor for hydrostatic level measurement.

Endress+Hauser offers three different versions of the device:
- FMX21 with a stainless steel housing, external diameter of 22 mm (0.87 in): This version is excellently suited to drinking water applications and for use in bore holes and wells with small diameters
- FMX21 with a stainless steel housing, external diameter of 42 mm (1.65 in): Heavy-duty version and easy to clean thanks to flush-mounted process isolating diaphragm, ideally suited to wastewater and wastewater treatment plants
- FMX21 with plastic insulation, external diameter of 29 mm (1.14 in): Robust version for use in salt water and excellently suited to applications on ships (e.g. ballast water tanks)

Your benefits

- High resistance to overload
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Accuracy
  - Standard reference accuracy ±0.2 %
  - PLATINUM version ±0.1 %
- Automatic density compensation to increase accuracy
- Usage in drinking water: KTW, NSF, ACS
- Approvals: ATEX, FM, CSA
- Marine approvals: GL, ABS, BV, DNV
- Extensive range of accessories provides complete measuring point solutions

Endress+Hauser
People for Process Automation

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TEFLON® 55
HART® 55
FieldCare® 55
DeviceCare® 55
iTEMP® 55

About this document

Document function

The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

Symbols

Safety symbols

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE

This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

Direct current

Alternating current

Direct and alternating current

Ground connection
Grounded clamp, which is grounded via a grounding system.

Protective earth (PE)
Ground terminals, which must be grounded prior to establishing any other connections. The ground terminals are located on the inside and outside of the device.

Equipotential connection
A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

Symbols for certain types of information

Permitted
Procedures, processes or actions that are permitted

Preferred
Procedures, processes or actions that are preferred

Forbidden
Procedures, processes or actions that are forbidden

Tip
Indicates additional information

Reference to documentation

Reference to page

Reference to graphic

1., 2., 3.
Series of steps

Result of a step

Help in the event of a problem

Visual inspection

Symbols in graphics

1, 2, 3, ...
Item numbers

1., 2., 3.
Series of steps

A, B, C, ...
Views

A-A, B-B, C-C etc.
Sections

Documentation

The following types of documentation are available in the Download Area of the Endress+Hauser website (www.endress.com/downloads):

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Operating Instructions (BA)

Your reference guide
These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

Brief Operating Instructions (KA)

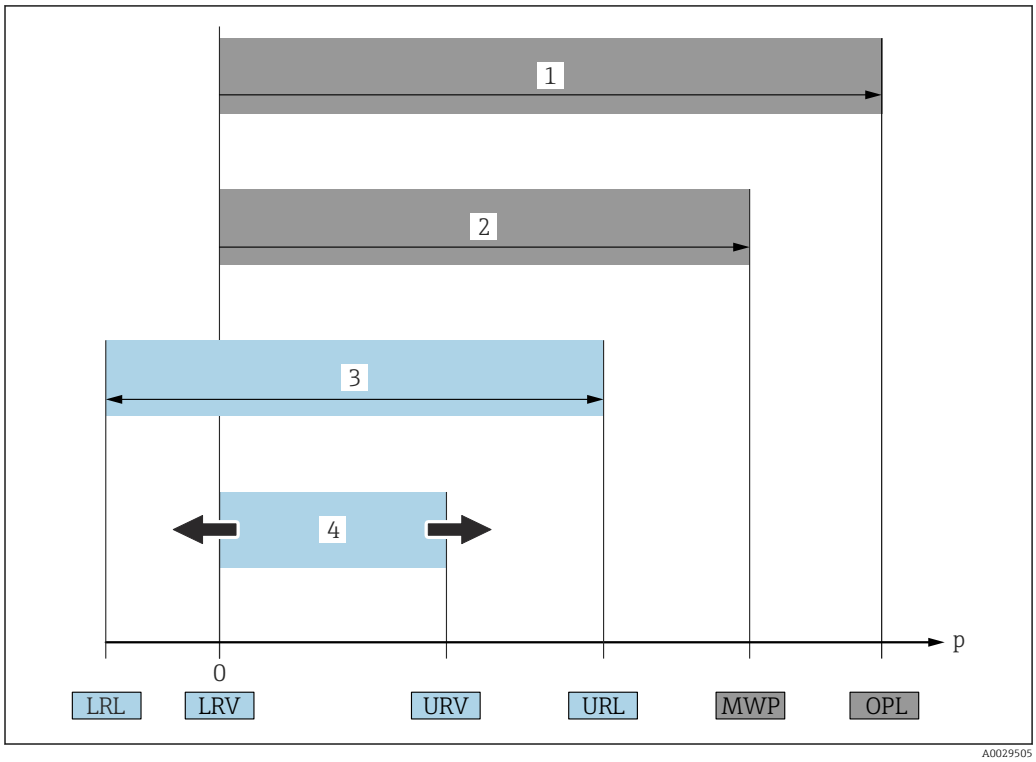
Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

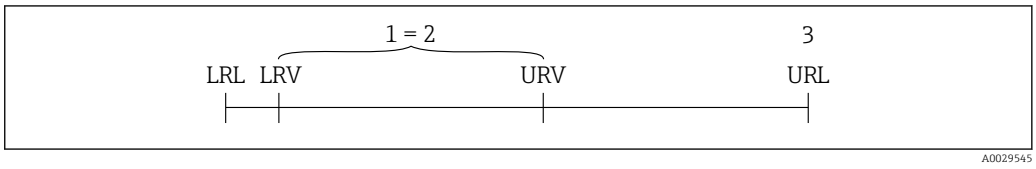
The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Terms and abbreviations



- **OPL (1)**
  The OPL (Over Pressure Limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The OPL may only be applied for a limited period of time.
- **MWP (2)**
  The MWP (Maximum Working Pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The MWP may be applied at the device for an unlimited period.
  The MWP can also be found on the nameplate.
- **Maximum sensor measuring range (3)**
  Span between LRL and URL. This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
- **Calibrated/adjusted span (4)**
  Span between LRV and URV. Factory setting: 0 to URL
  Other calibrated spans can be ordered as customized spans.
- **p**: Pressure
- **LRL**: Lower range limit
- **URL**: Upper range limit
- **LRV**: Lower range value
- **URV**: Upper range value
- **TD (Turn down)**: Example - see the following section
- **PE**: Polyethylene
- **FEP**: Fluorinated ethylene propylene
- **PUR**: Polyurethane

Turn down calculation



1 Calibrated/adjusted span
2 Zero point-based span (4 to 20 mA Analog: customer-specific span can only be set at the factory when ordered)
3 URL sensor

Example

- Sensor:10 bar (150 psi)
- Upper range value (URL) = 10 bar (150 psi)
- Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)
- Lower range value (LRV) = 0 bar (0 psi)
- Upper range value (URV) = 5 bar (75 psi)

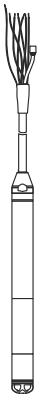
Turn down (TD):

$$TD = \frac{URL}{|URV - LRV|}$$

$$TD = \frac{10\ \text{bar (150 psi)}}{|5\ \text{bar (75 psi)} - 0\ \text{bar (0 psi)}|} = 2$$

In this example, the TD is 2:1.
This span is based on the zero point.

Function and system design

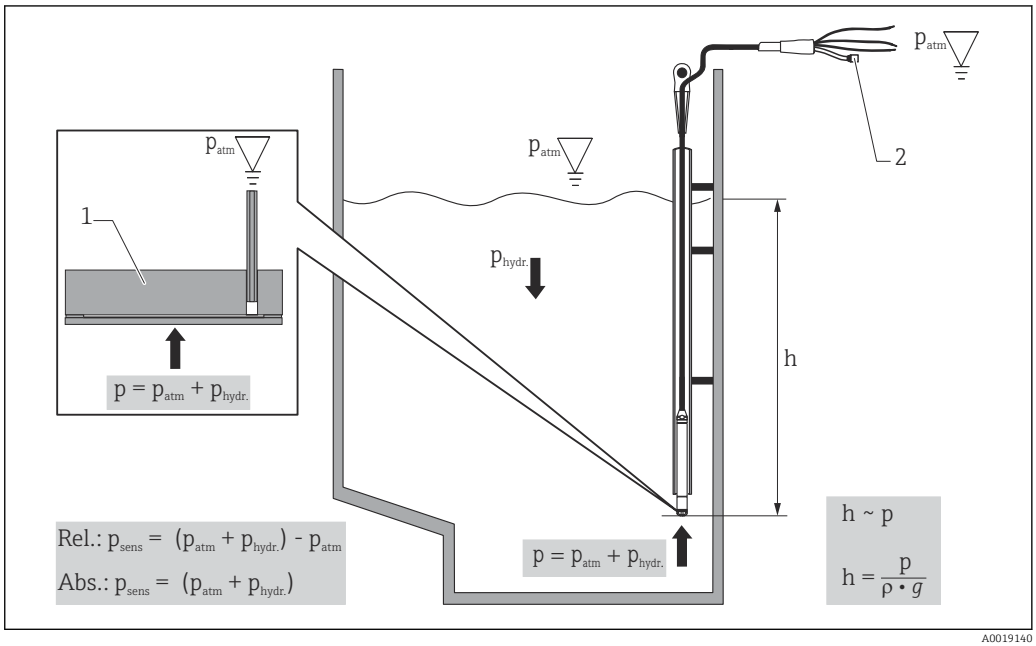
External diameter	22 mm (0.87 in)	42 mm (1.65 in)	Max. 29 mm (1.14 in)
	 A0018640	A0018641	A0018642
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
	NOTICE **The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, cable).** ▶ For applications involving biogas, Endress+Hauser offers the Deltapilot level measuring device.		
Process connection	▪ Suspension clamp ▪ Cable mounting screw with G 1½" A or NPT 1½" thread		
Extension cable	PE, PUR, FEP → 🖹 45		
Seals	▪ FKM Viton ▪ EPDM [1]	FKM Viton	▪ FKM Viton ▪ EPDM [1]
Measuring ranges	▪ Gauge pressure: 0 to 0.1 bar (0 to 1.5 psi) to 0 to 20 bar (0 to 300 psi) ▪ Absolute pressure: 0 to 2 bar (0 to 30 psi) to 0 to 20 bar (0 to 300 psi)		▪ Gauge pressure: 0 to 0.1 bar (0 to 1.5 psi) to 0 to 4 bar (0 to 60 psi) ▪ Absolute pressure: 0 to 2 bar (0 to 30 psi) to 0 to 4 bar (0 to 60 psi)
	▪ Customer-specific measuring ranges; factory-calibrated. ▪ The following output units can be configured: %, mbar, bar, kPa, MPa, mmH_2O, mH_2O, inH_2O, ftH_2O, psi and numerous level units.		
Overload	To 40 bar (600 psi)		To 25 bar (375 psi)
Process temperature range	−10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Reference accuracy	▪ ±0.2 % of set span ▪ Optional: ±0.1 % of set span (PLATINUM version)		
Supply voltage	10.5 to 35 V_{DC}, Ex: 10.5 to 30 V_{DC}		
Output	▪ 4 to 20 mA Analog ▪ 4 to 20 mA HART (can be inverted) with superimposed digital communication protocol HART 6.0, 2-wire		
Options	Drinking water approval	–	
	▪ Wide range of approvals, including ATEX, FM, CSA ▪ Numerous accessories ▪ Integrated Pt100 temperature sensor and TMT71 temperature head transmitter (4 to 20 mA) ▪ Integrated Pt100 temperature sensor and TMT72 temperature head transmitter (4 to 20 mA) ▪ Marine approval		
Specialties	▪ High-precision, robust ceramic measuring cell with long-term stability ▪ Automatic density compensation ▪ Customer-specific cable marking		

1) Recommended for drinking water applications, not suitable for use in hazardous areas.

Measuring principle

The ceramic measuring cell is a dry measuring cell i.e. the pressure acts directly on the robust, ceramic process isolating diaphragm of the Waterpilot FMX21. Changes in air pressure are guided

via a pressure compensation tube through the extension cable to the rear of the ceramic process isolating diaphragm and are compensated for. A pressure-dependent change in capacitance, caused by the movement of the process isolating diaphragm, is measured at the electrodes of the ceramic carrier. The electronics unit then converts this to a signal that is proportional to the pressure and linear to the level.



1 *Ceramic measuring cell*
2 *Pressure compensation tube*
h *Height level*
p *Total pressure = atmospheric pressure + hydrostatic pressure*
ρ *Density of the medium*
g *Acceleration due to gravity*
$P_{hydr.}$ *Hydrostatic pressure*
P_{atm} *Atmospheric pressure*
P_{sens} *Pressure displayed on the sensor*

Temperature measurement

With optional Pt100 resistance thermometer [1)]

For simultaneous measurement of level and temperature, Endress+Hauser offers the device with an optional 4-wire Pt100 resistance thermometer → 🖹 51. The Pt100 is categorized as Accuracy Class B as per DIN EN 60751.

With optional Pt100 and TMT71 temperature head transmitter

To convert the temperature signal to an analog, scalable 4 to 20 mA output signal, Endress+Hauser also offers the TMT71 temperature head transmitter.

Ordering information: → 🖹 49; "Accessories" → 🖹 51. Technical Information TI01393T.

With optional Pt100 and TMT72 temperature head transmitter [1)]

Endress+Hauser also offers the TMT72 temperature head transmitter with HART protocol for converting the temperature signal to an analog, scalable 4 to 20 mA output signal superimposed with HART 6.0. See also: "Density compensation with Pt100 temperature sensor" → 🖹 12

Ordering information: → 🖹 49; "Accessories" → 🖹 51. Technical Information TI01392T.

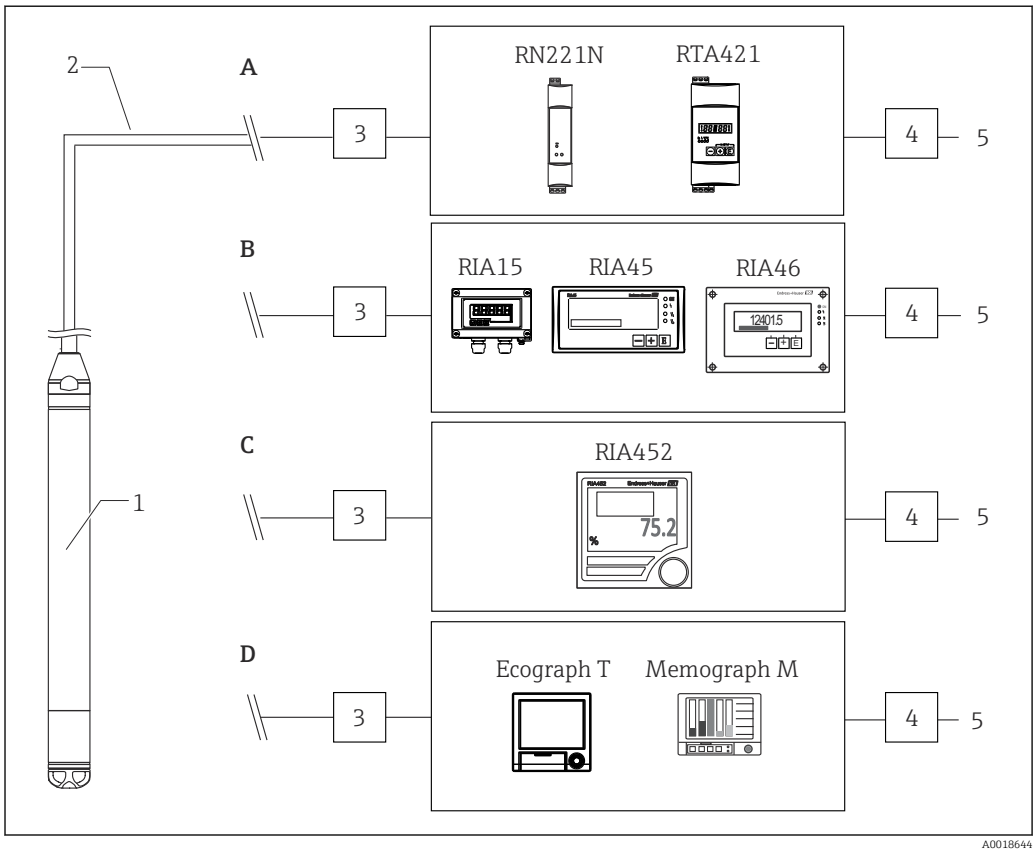
1) Not for use in hazardous areas.

Measuring system

Application examples

As standard, the complete measuring system consists of a device and a transmitter power supply unit with a supply voltage of 10.5 to 30 V_{DC} (hazardous area) or 10.5 to 35 V_{DC} (non-hazardous area).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



1 Device
2 4 to 20 mA or 4 to 20 mA HART
3+4 Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) HAW562; for DIN rail: HAW562/intrinsically safe HAW562Z. Selection in accordance with supply voltage.
5 Power supply

A: Easy and cost-effective measuring point solution: power supplied to the device in hazardous and non-hazardous areas via the RN221N active barrier. Power supply and additional control of two appliances, such as pumps, via the RTA421 limit value switch with local display.

B: The RIA45 evaluation unit (for panel mounting) or the RIA46 evaluation unit (for field installation) offers power supply, local display and two switch outputs. If the RIA15 is used, the basic settings for the HART device can be made via the display module.

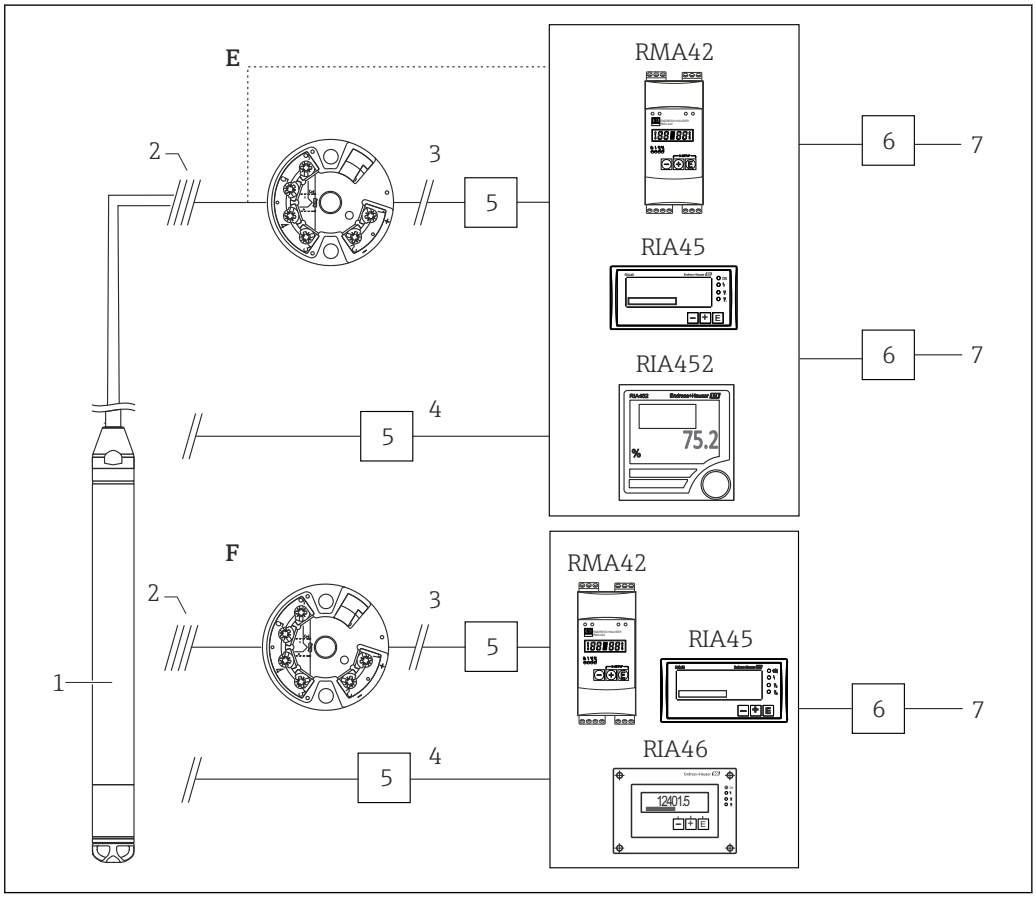
C: If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The RIA452 evaluation unit (for panel mounting) offers this option in addition to numerous other functions.

D: State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M for documentation, monitoring, visualization and archiving purposes.

Application examples with the Pt100

As standard, the complete measuring system consists of a device and a transmitter power supply unit with a supply voltage of 10.5 to 30 V_{DC} (hazardous area) or 10.5 to 35 V_{DC} (non-hazardous area).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:

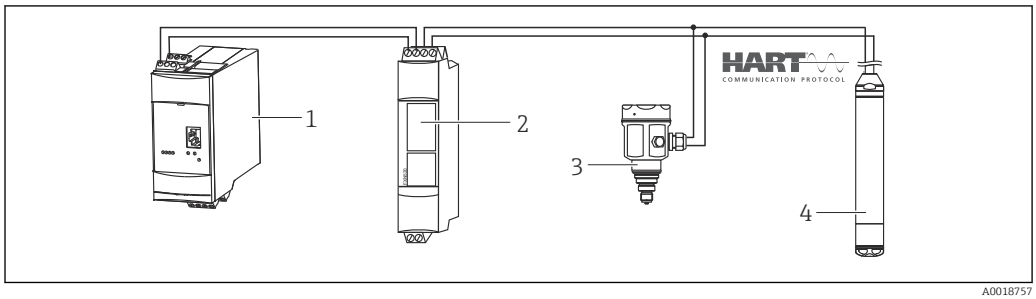


1 *Device*
2 *Connection for integrated Pt100 in the FMX21*
3 *Temperature for 4 to 20 mA or 4 to 20 mA HART*
4 *Level for 4 to 20 mA or 4 to 20 mA HART*
5 *Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) on the sensor side for field installation: HAW569; for DIN rail: HAW562/intrinsically safe HAW562Z. Selection in accordance with supply voltage.*
6 *Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) on the supply side for DIN rail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC). Selection in accordance with supply voltage.*
7 *Power supply*

E: If you wish to measure, display and evaluate the temperature as well as the level, e.g. to monitor the temperature in fresh water for the purpose of detecting temperature limits for germ formation, the options available to you include the following: The optionally available TMT72 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA signal or a 4 to 20 mA HART signal and transfer it to any commonly used evaluation unit. The RMA42, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.

F: If you wish to record and evaluate the level and temperature measured value with one device, use the RMA42, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are HART-compatible.

Level measurement with absolute pressure probe and external pressure signal



A0018757

1 Fieldgate FXA520
2 Multidrop Connector FXN520
3 Cerabar
4 Waterpilot 4 to 20 mA HART

It is advisable to use an absolute pressure probe for applications in which condensation can occur. For level measurement using an absolute pressure probe, the measured value is affected by fluctuations in the ambient pressure. To correct the resulting measured error, you can connect an external absolute pressure sensor (e.g. Cerabar) to the HART signal line, switch the Waterpilot to burst mode and operate the Cerabar in the "Electr. Delta P" mode. The external absolute pressure sensor then calculates the difference between the two pressure signals and can thus determine the level precisely. Only one level measured value can be corrected in this way.

If using intrinsically safe devices, the regulations for interconnecting intrinsically safe circuits as stipulated in IEC60079-14 (proof of intrinsic safety) must be observed.

Density compensation with the Pt100 temperature sensor

The device can correct measured errors that result from fluctuations in the density of the water caused by temperature. Users can choose from the following options:

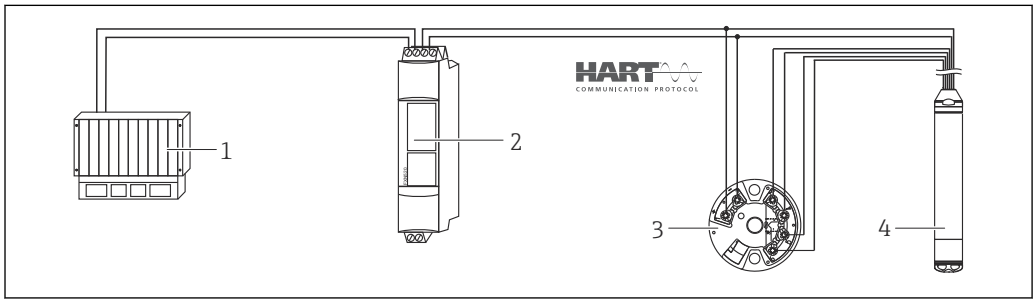
Use the internally measured sensor temperature of the device

The internally measured sensor temperature is calculated in the device for density compensation. The level signal is thus corrected according to the density characteristic line of water.

Use the optional internal temperature sensor for density compensation in a suitable HART master (e.g. PLC)

The device is available with an optional Pt100 temperature sensor. To convert the Pt100 signal to a 4 to 20 mA HART signal, Endress+Hauser also offers the TMT72 temperature head transmitter.

The temperature and pressure signals are queried by a HART master (e.g. PLC), where a corrected level value can be generated using a stored linearization table or density function (of a chosen medium).



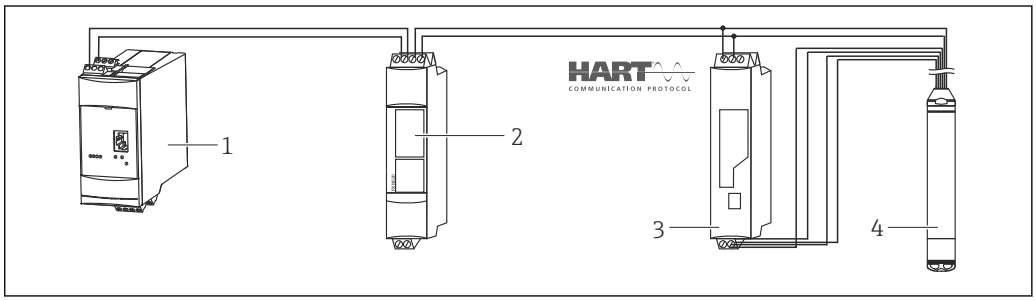
A0018763

1 HART master, e.g. PLC (programmable logic controller)
2 FXN520 Multidrop Connector
3 TMT72 temperature head transmitter
4 Waterpilot FMX21 4 to 20 mA HART

Use an external temperature signal which is transmitted to the device via the HART burst mode

The device is available with an optional Pt100 temperature sensor. With this option, the signal of the Pt100 is evaluated with a HART-compliant temperature transmitter (min. HART 5.0) that supports the BURST mode. The temperature signal can be transmitted to the device in this way. The device uses this signal for density correction of the level signal.

The TMT72 temperature head transmitter is not suitable for this configuration.



1 Fieldgate FXA520
2 Multidrop Connector FXN520
3 HART-compatible temperature transmitter with burst function (e.g. TMT82)
4 Waterpilot FMX21 4 to 20 mA HART

Without additional compensation due to the anomaly of water, errors of up to 4 % may occur at a temperature of +70 °C (+158 °F), for example. With density compensation, this error is less than 0.5 % in the entire temperature range from 0 to +70 °C (+32 to +158 °F).

More information can be found in the Technical Information:

- TI01010T: TMT82 temperature transmitter (4 to 20 mA HART)
- TI00369F: Fieldgate FXA520
- TI00400F: Multidrop Connector FXN520

Communication protocol

- 4 to 20 mA analog
- 4 to 20 mA HART

System integration

The device can be given a tag name.

Input

Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: Temperature

TMT71 temperature head transmitter (optional)

Temperature

TMT72 temperature head transmitter (optional)

Temperature

Measuring range

- Customer-specific measuring ranges or calibration that has been preset in the factory
- Temperature measurement of −10 to +70 °C (+14 to +158 °F) with Pt100 (optional)

Gauge pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
0.1 bar (1.5 psi)	0.01 bar (0.15 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1C
0.2 bar (3.0 psi)	0.02 bar (0.3 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1D
0.4 bar (6.0 psi)	0.04 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1F
0.6 bar (9.0 psi)	0.06 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1G
1.0 bar (15.0 psi)	0.1 bar (1.5 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1H
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

Absolute pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: Change in resistance

TMT71 temperature head transmitter (optional)

Pt100 resistance signal, 4 wire

TMT72 temperature head transmitter (optional)

Pt100 resistance signal, 4 wire

Output

Output signal

Device + Pt100 (optional)

- 4 to 20 mA Analog, 2-wire for hydrostatic pressure measured value.
- 4 to 20 mA HART with superimposed digital communication protocol HART 6.0, 2-wire for hydrostatic pressure measured value.
  Options:
  - Max. alarm (factory setting 22 mA): can be set from 21 to 23 mA
  - Hold measured value: last measured value is held
  - Min. alarm: 3.6 mA
- Pt100: temperature-dependent resistance value

TMT71 temperature head transmitter (optional)

4 to 20 mA analog for temperature measured value, 2-wire

TMT72 temperature head transmitter (optional)

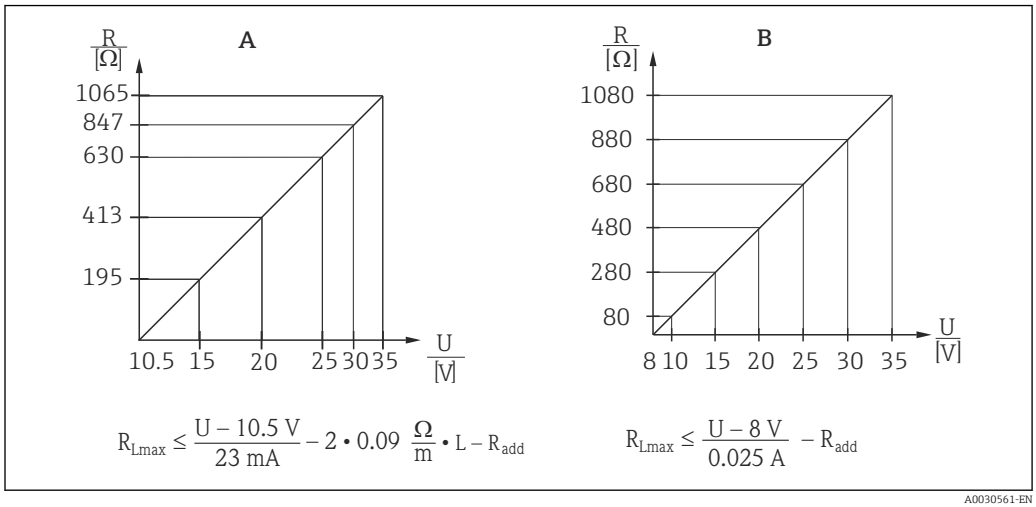
4 to 20 mA HART with superimposed digital communication protocol HART 5.0 for temperature measured value, 2-wire

Signal range

3.8 to 20.5 mA

Maximum load

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for the device and temperature head transmitter. The total resistance resulting from the resistances of the connected devices, the connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value.



A0030561-EN

A Load diagram for device 4 to 20 mA analog for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.

B Load diagram for TMT71 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation

R_{Lmax} Max. load resistance [Ω]

R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]

U Supply voltage [V]

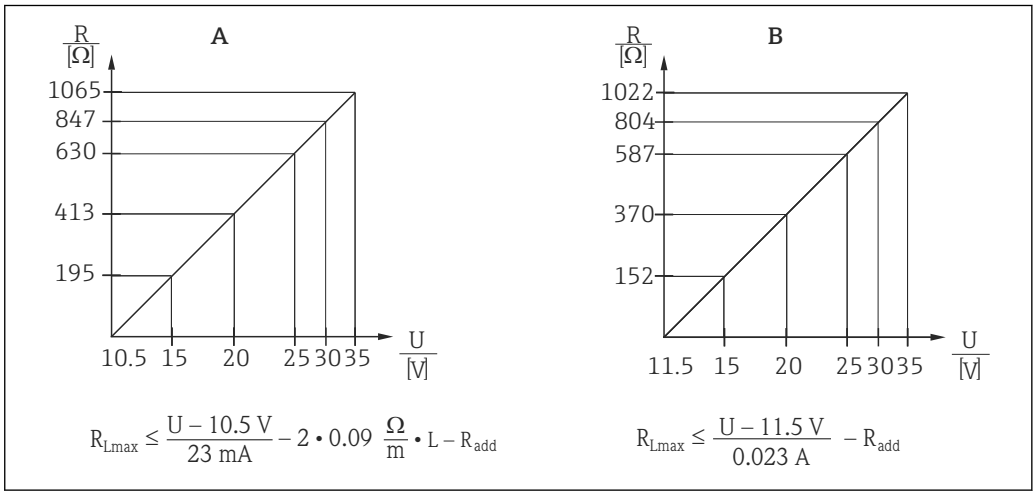
L Basic length of extension cable [m] (cable resistance per wire ≤0.09 Ω/m

When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).

Maximum load

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for the device and temperature head transmitter. The total resistance resulting from the resistances of the connected devices, the

connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value.



A Load diagram for device 4 to 20 mA HART for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.

B Load diagram for TMT72 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation

R_{Lmax} Max. load resistance [Ω]

R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]

U Supply voltage [V]

L Basic length of extension cable [m] (cable resistance per wire ≤0.09 Ω/m

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).
- When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250 Ω must be taken into account.

Damping

- Via HART handheld terminal or PC with operating program: continuously 0 to 999 s
- Factory setting: 2 s

Protocol-specific data

- Manufacturer ID: 17 (11 hex)
- Device type ID: 25 (19 hex)
- Device revision: 01 (01 hex) - SW version 01.00.zz
- HART specification: 6
- DD revision: 01
- Device description files (DTM, DD):
  - www.endress.com
  - www.fieldcommgroup.org
- HART load: min. 250 Ω
- HART device variables. The dynamic variables SV, TV and QV may be assigned to any device variable:
  - Standard process values for SV, TV (second and third device variable) are dependent on the measuring mode: pressure, level
  - Standard process value for QV (fourth device variable) is the sensor temperature: temperature
  - Measured values for PV (first device variable) are dependent on the measuring mode: pressure, level, tank content
- Supported functions:
  - Burst mode
  - Additional transmitter status
  - Device locking
  - Alternative measuring modes
  - Catch variable
  - Long tag

Power supply

⚠ WARNING

Electrical safety is compromised by an incorrect connection!

- When using the measuring device in a hazardous area, the relevant national standards and guidelines as well as the Safety Instructions (XAs) or installation or control drawings (ZDs) must be adhered to. All data relating to explosion protection can be found in separate documentation which is available on request. This documentation is supplied with the devices as standard → 🖹 55

Supply voltage

Device + Pt100 (optional)

- 10.5 to 35 V (non-hazardous area)
- 10.5 to 30 V (hazardous area)

TMT71 temperature head transmitter (optional)

8 to 35 V_{DC}

TMT72 temperature head transmitter (optional)

11.5 to 35 V_{DC}

Power consumption

Device + Pt100 (optional)

- ≤ 0.805 W at 35 V_{DC} (non-hazardous area)
- ≤ 0.690 W at 30 V_{DC} (hazardous area)

TMT71 temperature head transmitter (optional)

≤ 0.875 W at 35 V_{DC}

TMT72 temperature head transmitter (optional)

≤ 0.805 W at 35 V_{DC}

Current consumption

Device + Pt100 (optional)

Max. current consumption: ≤ 23 mA
Min. current consumption: ≥ 3.6 mA

TMT71 temperature head transmitter (optional)

- Max. current consumption: ≤ 25 mA
- Min. current consumption: ≥ 3.5 mA

TMT72 temperature head transmitter (optional)

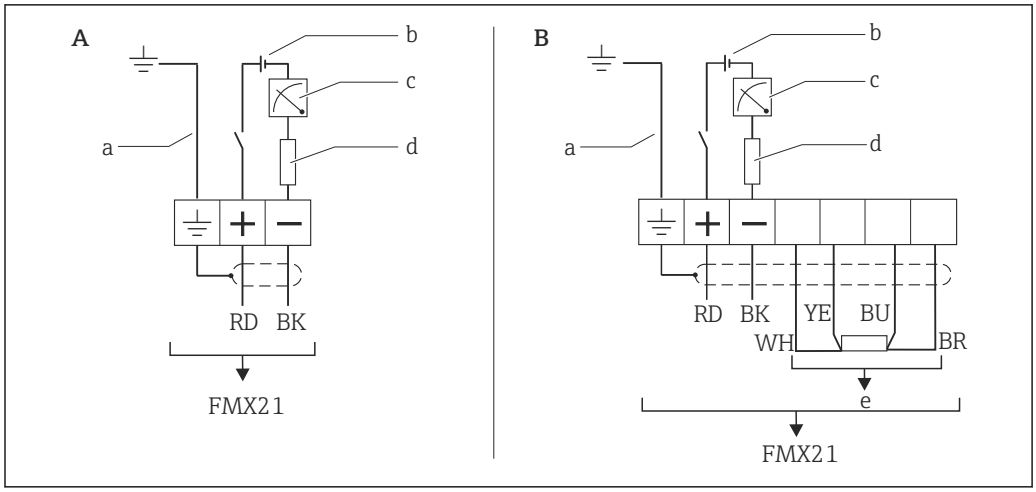
- Max. current consumption: ≤ 23 mA
- Min. current consumption: ≥ 3.5 mA

Connecting the device

- Reverse polarity protection is integrated in the device and the temperature head transmitter. Changing the polarities will not result in damage to the devices.
- The cable must end in a dry room or a suitable terminal box. The terminal box (IP66, IP67) with GORE-TEX® filter from Endress+Hauser is suitable for outdoor installation. The terminal box can be ordered as an accessory via the device order code.

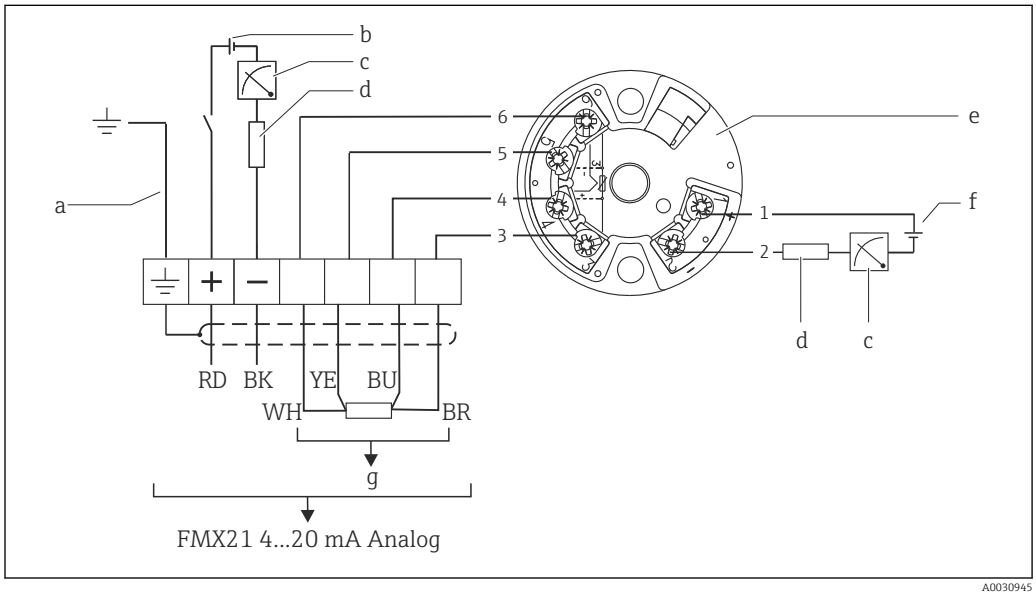
The electrical connection is established with the corresponding wires of the probe cable and with the optional use of the terminal box → 🖹 36 and a power supply (e.g. RN221N active barrier → 🖹 10).

Device with Pt100



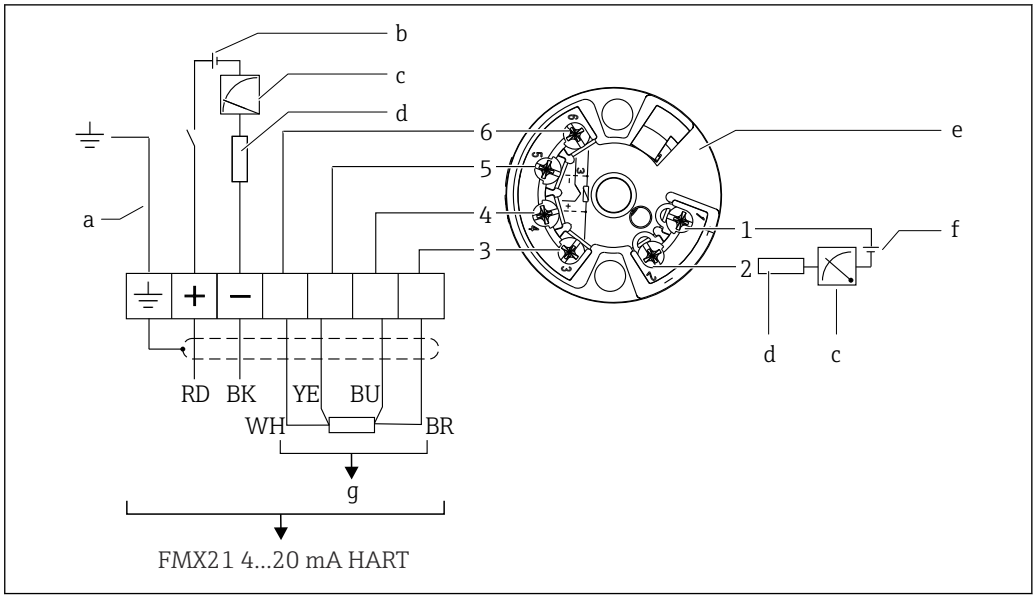
A Device
B Device with Pt100 (not for use in hazardous areas)
a Not for devices with external diameter of 29 mm (1.14 in)
b 10.5 to 30 V_{DC} (hazardous area), 10.5 to 35 V_{DC}
c 4 to 20 mA
d Resistance (R_L)
e Pt100

Device with Pt100 and TMT71 temperature head transmitter



a Not for devices with external diameter of 29 mm (1.14 in)
b 10.5 to 35 V_{DC}
c 4 to 20 mA
d Resistance (R_L)
e TMT71 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)
f 8 to 35 V_{DC}
g Pt100
1 to 6 Pin assignment

Device with Pt100 and TMT72 temperature head transmitter



a *Not for devices with external diameter of 29 mm (1.14 in)*
b *10.5 to 35 V_{DC}*
c *4 to 20 mA*
d *Resistance (R_L)*
e *TMT72 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)*
f *11.5 to 35 V_{DC}*
g *Pt100*
1 to 6 *Pin assignment*

Device with RIA15

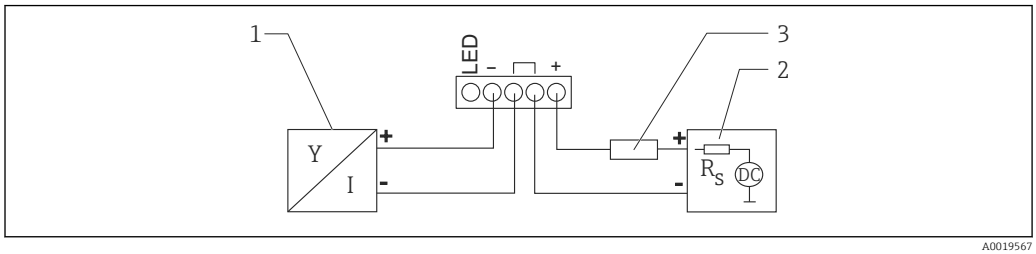
The RIA15 remote display (for Ex or non-Ex area) can be ordered together with the device. See the Product Configurator.

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

The RIA15 process indicator is loop-powered and does not require any external power supply.

The voltage drop to be taken into account is:
- ≤1 V in the standard version with 4 to 20 mA communication
- ≤1.9 V with HART communication
- and an additional 2.9 V if display light is used

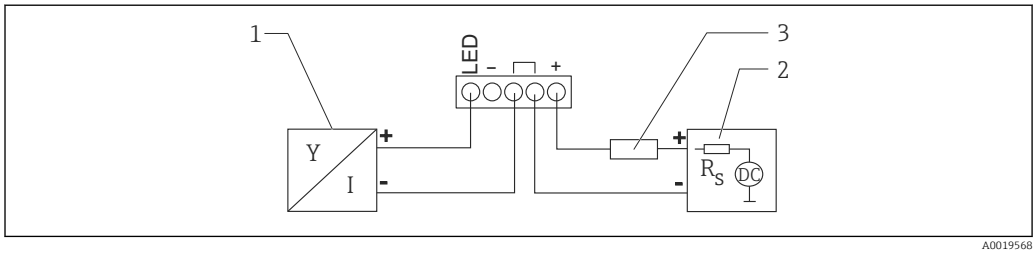
Without backlighting



1 Block diagram; connection of the device with HART communication and RIA15 without backlighting

1 Device
2 Power supply
3 HART resistor

With backlighting



2 Block diagram; connection of the device with HART communication and RIA15 with backlighting

1 Device
2 Power supply
3 HART resistor

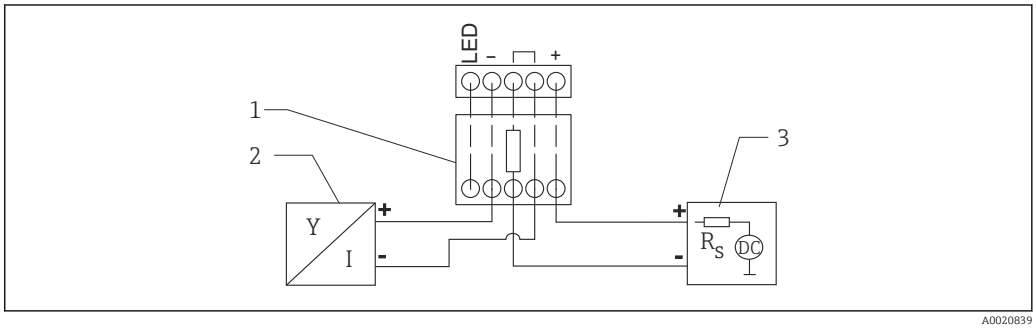
Device, RIA15 with installed HART communication resistor module

The HART communication module for installation in the RIA15 (for Ex or non-Ex areas) can be ordered together with the device.

The **voltage drop** to be taken into account is max. **7 V**

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

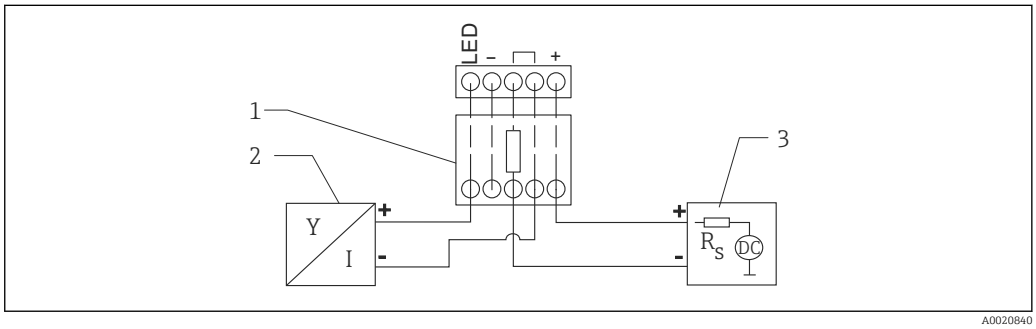
Without backlighting



3 Block diagram; device connection, RIA15 without light, HART communication resistor

1 HART communication resistor module
2 Device
3 Power supply

With backlighting



4 Block diagram; device connection, RIA15 with light, HART communication resistor module

1 HART communication resistor module
2 Device
3 Power supply

Wire colors

RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

Connection data

Connection classification as per IEC 61010-1:
- Overvoltage category 1
- Pollution level 1

Connection data in the hazardous area

See relevant XA.

Terminals in the terminal box

- Three terminals as standard in the terminal box (terminal box can optionally be ordered as an enclosed accessory → 🖹 51)
- 4-terminal strip can be ordered as an accessory, order number: 52008938 cable cross-section 0.08 to 2.5 mm² (28 to 14 AWG)

The 4-terminal strip is not designed for use in hazardous areas incl. CSA GP.

Probe cable

- Overall external diameter: 8 mm (0.31 in)±0.25 mm (0.01 in)
- Pressure compensation tube with Teflon filter: External diameter of 2.5 mm (0.1 in), internal diameter of 1.5 mm (0.06 in)

Cross-section

- Device: 3 x 0.2 mm² (3 x 26 AWG) + pressure compensation tube with Teflon filter
- Device with Pt100 (optional): 7 x 0.2 mm² (7 x 26 AWG) + pressure compensation tube with Teflon filter

Cable resistance

Per wire: ≤ 0.09 Ω/m

Cable specifications

Endress+Hauser recommends using shielded, twisted-pair two-wire cables.

The probe cables are shielded for device versions with outer diameters of 22 mm (0.87 in) and 42 mm (1.65 in).

Device + Pt100 (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)

TMT71 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm² (15 AWG)

TMT72 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm² (15 AWG)

Residual ripple

Device + Pt100 (optional)

No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range.

TMT71 temperature head transmitter (optional)

$U_{ss} \geq 5$ V at $U \geq 13$ V, $f_{max.} = 1$ kHz

Residual ripple

Device + Pt100 (optional)

No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range (according to HART Hardware Specification HCF_SPEC-54 (DIN IEC 60381-1)).

TMT72 temperature head transmitter (optional)

$U_{ss} \geq 3$ V at $U \geq 13$ V, $f_{max.} = 1$ kHz

Performance characteristics

Reference operating conditions

Device + Pt100 (optional)

- As per IEC 60770
- Ambient temperature T_A = constant, in the range of: +21 to +33 °C (+70 to +91 °F)
- Humidity φ = constant, in the range of: 20 to 80 % rH
- Atmospheric pressure p_A = constant, in the range of: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of the measuring cell constant, vertical in the range of ±1 °
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value (only for HART)
- Supply voltage constant: 21 to 27 V_{DC}
- Load: 250 Ω
- Pt100: DIN EN 60770, T_A = +25 °C (+77 °F)

TMT71 temperature head transmitter (optional)

Calibration temperature: +23 °C (+73 °F) ±5 K

TMT72 temperature head transmitter (optional)

Calibration temperature: +25 °C (+77 °F) ±5 K

Reference accuracy

Device + Pt100 (optional)

The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-reproducibility in accordance IEC 60770.

Standard version:
Setting ±0.2 %
- to TD 5:1: < 0.2 % of set span
- from TD 5:1 to TD 20:1 ±(0.02 x TD+0.1)

Platinum version:
- Setting ±0.1 % (optional)
  - to TD 5:1: < 0.1 % of set span
  - from TD 5:1 to TD 20:1 ±(0.02 x TD)
- Class B as per DIN EN 60751
  Pt100: max. ±1 K

TMT71 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

TMT72 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

Resolution

Current output: 1 µA

Reading cycle

HART commands: on average 2 to 3 per second

Long-term stability

Device + Pt100 (optional)

- ≤ 0.1 % of URL/year
- ≤ 0.25 % of URL/5 years

TMT71 temperature head transmitter (optional)

≤ 0.1 K per year

TMT72 temperature head transmitter (optional)

≤ 0.1 K per year

Influence of medium temperature

- Thermal change in the zero output and the output span:
  0 to 30 °C (+32 to 86 °F): < (0.15 + 0.15 x TD)% of set span
  −10 to +70 °C (+14 to 158 °F): < (0.4 + 0.4 x TD)% of set span
- Temperature coefficient (T_K) of the zero output and the output span
  −10 to +70 °C (+14 to 158 °F): 0.1 % / 10 K of URL

Warm-up time

Device + Pt100 (optional)

- Device: < 6 s
- Pt100: 300 s

TMT71 temperature head transmitter (optional)

4 s

TMT72 temperature head transmitter (optional)

4 s

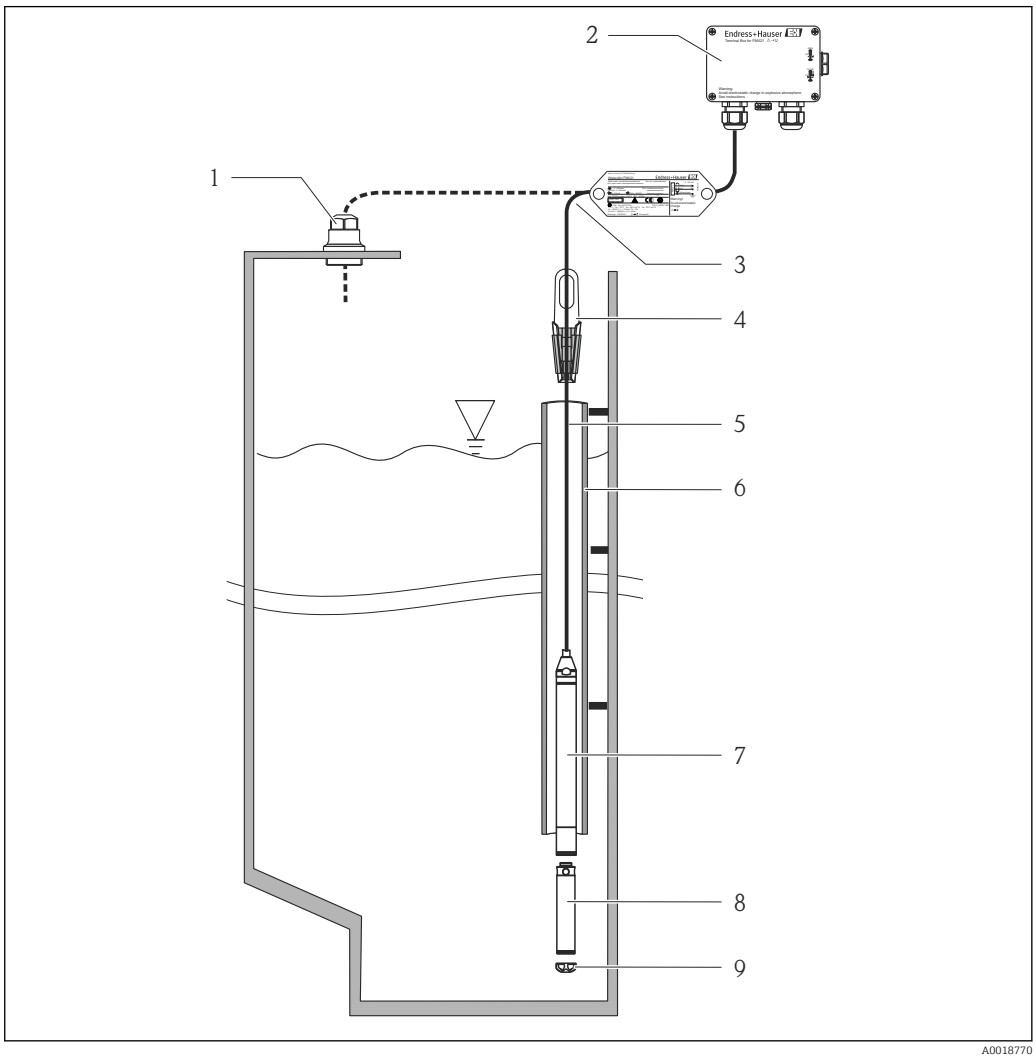
Response time

Device + Pt100 (optional)

- Device: 400 ms (T90 time), 500 ms (T99 time)
- Pt100: 160 s (T90 time), 300 s (T99 time)

Mounting

Installation instructions

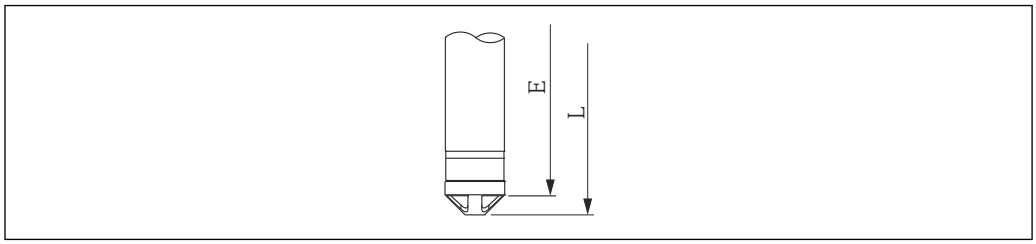


1 *Cable mounting screw can be ordered via the order code or as an accessory → 📄 51*
2 *Terminal box can be ordered via the order code or as an accessory → 📄 51*
3 *Bending radius of extension cable 120 mm (4.72 in)*
4 *Suspension clamp can be ordered via the order code or as an accessory → 📄 51*
5 *Extension cable, cable length → 📄 28*
6 *Guide tube*
7 *Device*
8 *Additional weight can be ordered as an accessory for the device with external diameter of 22 mm (0.87 in) and 29 mm (1.14 in)→ 📄 51*
9 *Protective cap*

Additional installation instructions

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) greater than the external diameter of the selected FMX21.
- To avoid mechanical damage to the measuring cell, the device is equipped with a protection cap.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress +Hauser provides humidity and climatic protection and is suitable for installation outdoors → 📄 51.
- Cable length tolerance: < 5 m (16 ft): ±17.5 mm (0.69 in); > 5 m (16 ft): ±0.2 %
- If the cable is shortened, the filter at the pressure compensation tube must be reattached. Endress +Hauser offers a cable shortening kit for this purpose → 📄 51 (documentation SD00552P/00/A6).

- Endress+Hauser recommends using twisted, shielded cable.
- In shipbuilding applications, measures are required to restrict the spread of fire along cable looms.
- The length of the extension cable depends on the intended level zero point. The height of the protection cap must be taken into consideration when designing the layout of the measuring point. The level zero point (E) corresponds to the position of the process isolating diaphragm.
  Level zero point = E; tip of probe = L (see the following diagram).
  For dimensions, see "Mechanical construction" section.



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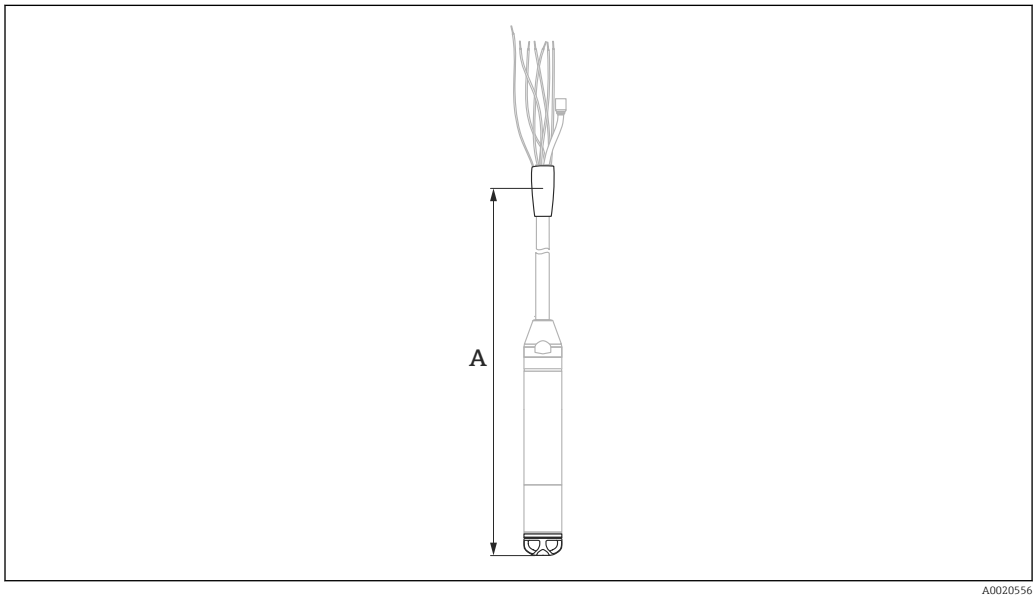
Cable length

- Pay attention to the "Load"
- Cable lengths available for order
  - Customer-specific in meters or feet
  - Limited cable length when performing installation with freely suspended device with cable mounting screw or suspension clamp, as well as for Ex approval: max. 300 m (984 ft).

When using the measuring device in hazardous areas, installation must also comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.



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A Length of extension cable

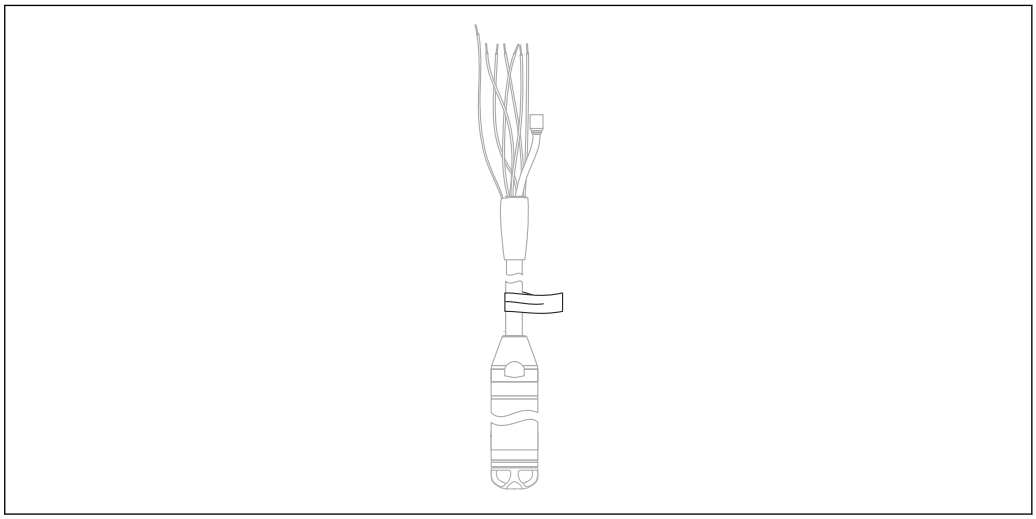
The following cable lengths can be selected in the Product Configurator:
- 10 m cable, can be shortened, PE
- 20 m cable, can be shortened, PE
- ..... m cable, can be shortened, PE
- 30 ft cable, can be shortened, PE
- 60 ft cable, can be shortened, PE
- ..... ft cable, can be shortened, PE
- 10 m cable, can be shortened, FEP
- 20 m cable, can be shortened, FEP
- ..... m cable, can be shortened, FEP
- 30 ft cable, can be shortened, FEP
- 60 ft cable, can be shortened, FEP
- ..... ft cable, can be shortened, FEP
- 10 m cable, can be shortened, PUR

- 20 m cable, can be shortened, PUR
- ..... m cable, can be shortened, PUR
- 30 ft cable, can be shortened, PUR
- 60 ft cable, can be shortened, PUR
- ..... ft cable, can be shortened, PUR

Technical data for cable

- Minimum bending radius: 120 mm (4.72 in)
- Tensile strength: max. 950 N (213.56 lbf)
- Cable extraction force (= tensile force required to extract the cable from the probe):
  - PE, FEP: typically ≥ 400 N (89.92 lbf), PUR: typically ≥ 150 N (33.72 lbf)
  - when used in hazardous area: ≥ 100 N (73.75 lbf)
- UV-resistant (UV = ultraviolet)
- PE: For use in drinking water

Cable marking



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- To make installation easier, Endress+Hauser marks the extension cable if a customer-specific length has been ordered.
- Cable marking tolerance (distance to lower end of level probe):
  Cable length < 5 m (16 ft): ±17.5 mm (0.69 in)
  Cable length > 5 m (16 ft): ±0.2 %
- Material: PET, stick-on label: acrylic
- Immunity to temperature change: −30 to +100 °C (−22 to +212 °F)

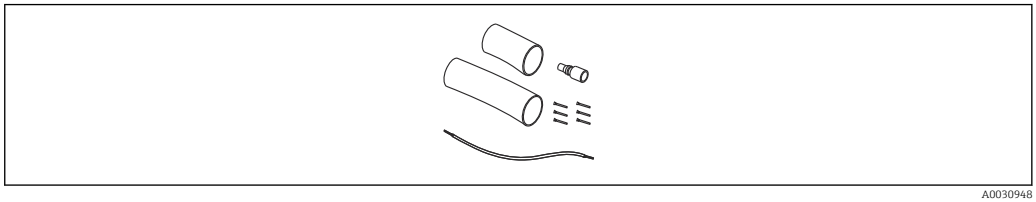
NOTICE

The marking is used exclusively for installation purposes.

▶ The mark must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

Not for the use of the device in hazardous areas.

Cable shortening kit



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The cable shortening kit is used to shorten a cable easily and professionally.

The cable shortening kit is not designed for the device with FM/CSA approval.

- Ordering information: see Product Configurator
- Associated documentation SD00552P/00/A6.

Environment

Ambient temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F) (= medium temperature)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F) (= medium temperature)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −40 to +70 °C (−40 to +158 °F)
- With PUR: −40 to +70 °C (−40 to +158 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT71 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT71 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

Storage temperature range

Device + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −30 to +80 °C (−22 to +176 °F)
- With PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT71 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

TMT72 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

Degree of protection

Device + Pt100 (optional)

IP68, permanently hermetically sealed at 20 bar (290 psi) (~200 m H_2O)

Terminal box (optional)

IP66, IP67

TMT71 temperature head transmitter (optional)

IP00, condensation permitted

When installed in the optional terminal boxes: IP66/IP67

TMT72 temperature head transmitter (optional)

IP00, condensation permitted

Electromagnetic compatibility (EMC)

Device + Pt100 (optional)

- EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.
- Maximum deviation: < 0.5 % of span.

TMT71 temperature head transmitter (optional)

Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial). For details, refer to the Declaration of Conformity.

TMT72 temperature head transmitter (optional)

EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.

Overvoltage protection

FMX21 + Pt100 (optional)

- Integrated overvoltage protection as per EN 61000-4-5 (500 V symmetrical/1000 V asymmetrical)
- Provide overvoltage protection ≥ 1.0 kV, externally if necessary.

TMT71 temperature head transmitter (optional)

Provide overvoltage protection, externally if necessary → 🖹 10.

TMT72 temperature head transmitter (optional)

Provide overvoltage protection, externally if necessary → 🖹 10.

Process

Medium temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F)

TMT71 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +70 °C (−4 to +158 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT71 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

Medium temperature limit

Device + Pt100 (optional)

With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
−20 to +70 °C (−4 to +158 °F)

In hazardous areas incl. CSA GP, the medium temperature limit is −10 to +70 °C (+14 to +158 °F).

With external diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F)

The FMX21 may be operated in this temperature range. The specification values, such as accuracy, may be exceeded.

Pressure specifications

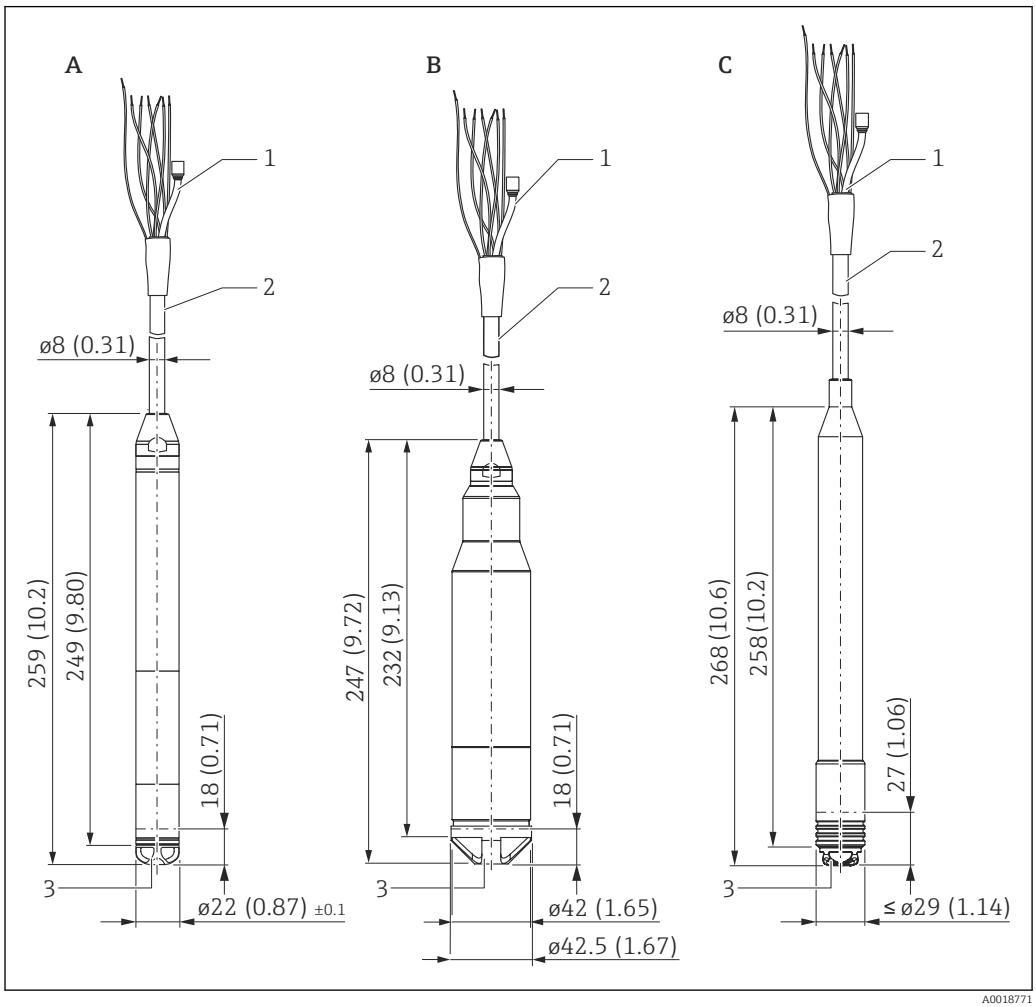
WARNING

The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.

- For pressure specifications, see the "Measuring range" section and the "Mechanical construction" section.
- The measuring device must be operated only within the specified limits!
- The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.
- MWP (maximum working pressure): The MWP (maximum working pressure) is specified on the nameplate. This value refers to a reference temperature of +20 °C (+68 °F) and may be applied to the device for an unlimited time. Observe the temperature dependency of the MWP.
- OPL (Over Pressure Limit): The overpressure limit is the maximum pressure a device may be subjected to during a test. It is greater than the maximum working pressure by a certain factor. In the case of sensor range and process connection combinations where the over pressure limit (OPL) of the process connection is smaller than the nominal value of the sensor, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If you want to use the entire sensor range, select a process connection with a higher OPL value.
- Avoid steam hammering! Steam hammering can cause zero point drift. Recommendation: Residue (such as condensation or drops of water) can remain on the process membrane after CIP cleaning and lead to local steam hammering if steam cleaning is performed again. In practice, drying the process membrane (e.g. by blowing off excess moisture) has proven to be a successful way of avoiding steam hammering.

Mechanical construction

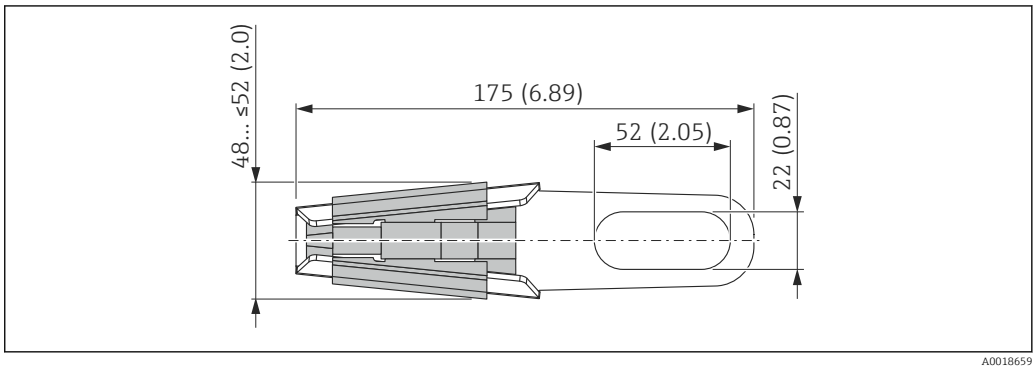
Dimensions of the level probe



Unit of measurement mm (in)

A Probe tube; 316L, outer diameter 22 mm (0.87 in)
B Probe tube; 316L, outer diameter 42 mm, flush mount
C Probe tube; PPS/polyolefin>316L, outer diameter 29 mm, saltwater applications
1 Pressure compensation tube
2 Extension cable (length, see → 28
3 Protective cap

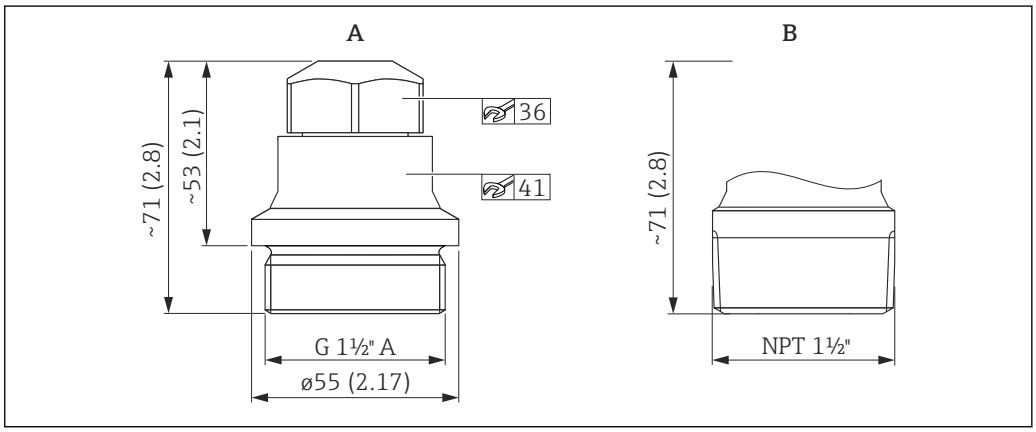
Dimensions of the suspension clamp



Unit of measurement mm (in)

Product Configurator: the suspension clamp is optionally available. → 🖹 51

Dimensions of the cable mounting screw

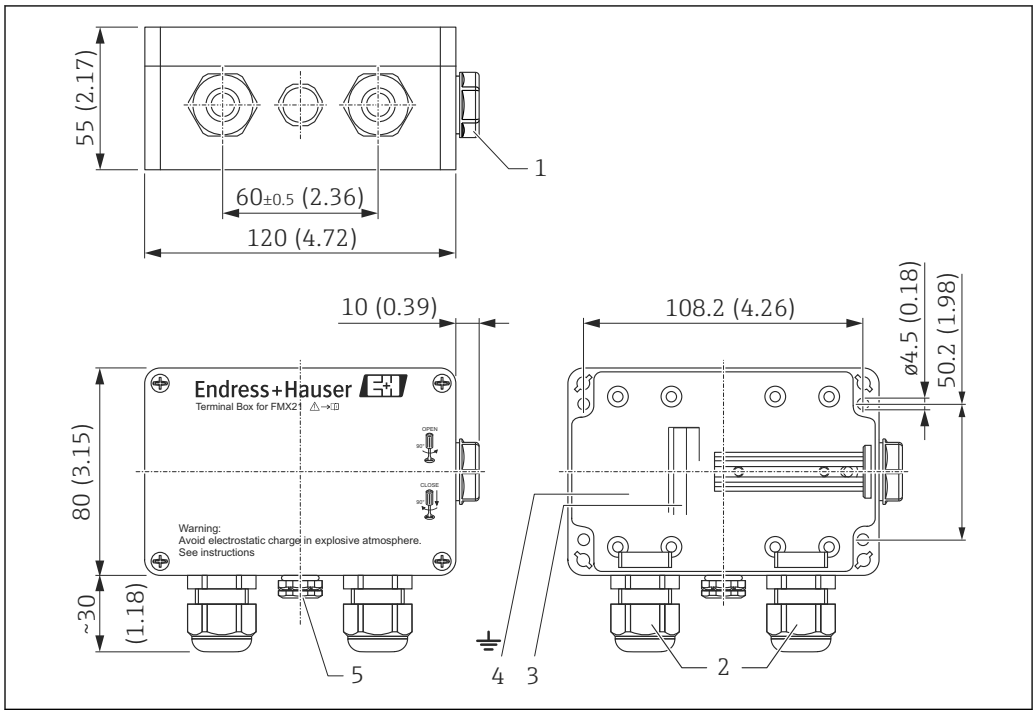


Unit of measurement mm (in)

A G 1½" A → 🖹 51
B NPT 1½" → 🖹 51

- Use only in unpressurized vessels.
- Product Configurator: the cable mounting screw is optionally available.

Dimensions of terminal box IP66, IP67 with filter



Unit of measurement mm (in)

1 *Dummy plug M20x1.5*
2 *Cable gland M20x1.5*
3 *4 to 20 mA; terminals for 0.08 to 2.5 mm (28 to 14 AWG)0.08 to 2.5 mm²*
4 *Ground connection; terminals for 0.08 to 2.5 mm (28 to 14 AWG)0.08 to 2.5 mm²*
5 *GORE-TEX® filter*

Terminal box IP66/IP67 with GORE-TEX® filter incl. 3 integrated terminals. The terminal box is also suitable for the installation of a temperature head transmitter or four other terminals

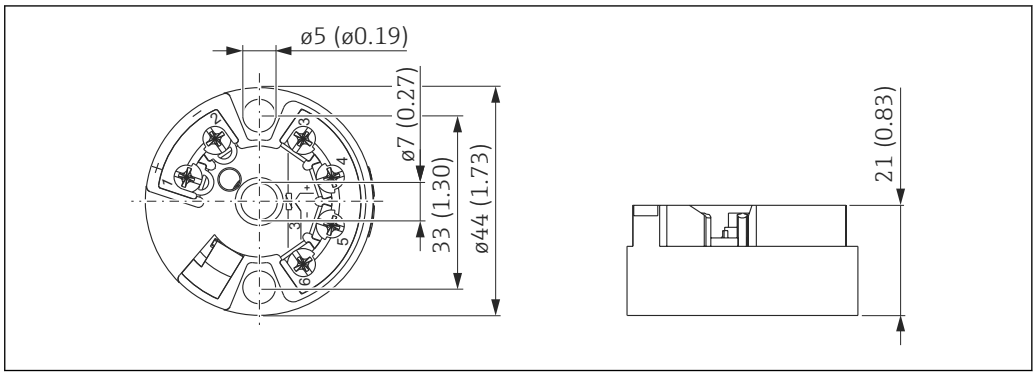
Ordering information:
- Product Configurator: the terminal box is optionally available. → 51
- TMT71: Product Configurator: the temperature head transmitter TMT71 is optionally available. → 51
- TMT72: Product Configurator: the temperature head transmitter TMT72 is optionally available. → 51

The terminal box is not designed for the device with type of protection Ex nA in hazardous areas. If the terminal box is used in a hazardous area, the Safety Instructions of the relevant device must be observed, as well as the applicable regulations for explosion protection.

If the device with optional Pt100 is supplied, a terminal strip is provided with the terminal box for the purpose of wiring the Pt100.

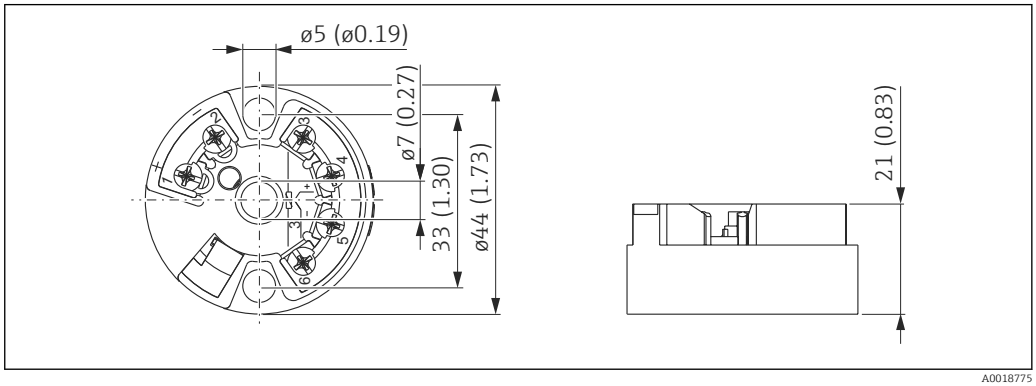
The 4-terminal strip is not designed for use in hazardous areas incl. CSA GP.

Dimensions of the TMT71 temperature head transmitter



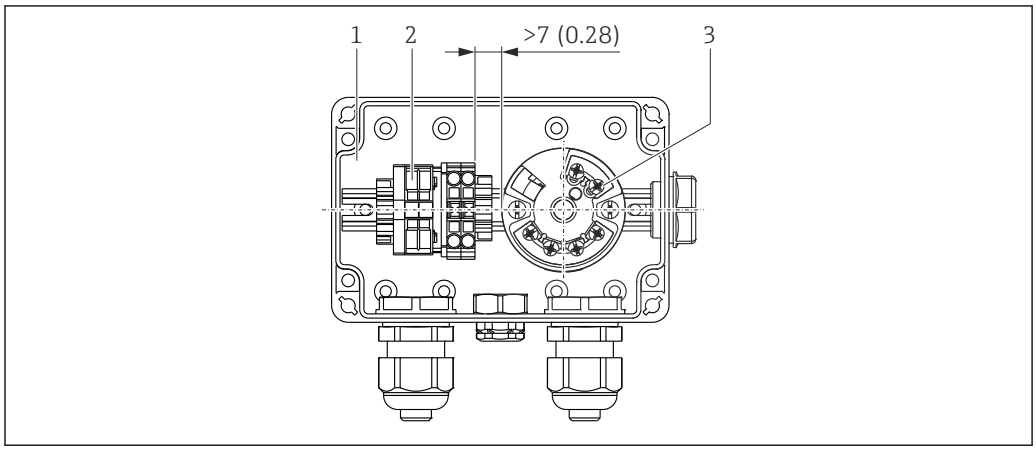
Unit of measurement mm (in)

Dimensions of the TMT72 temperature head transmitter



Unit of measurement mm (in)

Terminal box with integrated TMT71 temperature head transmitter



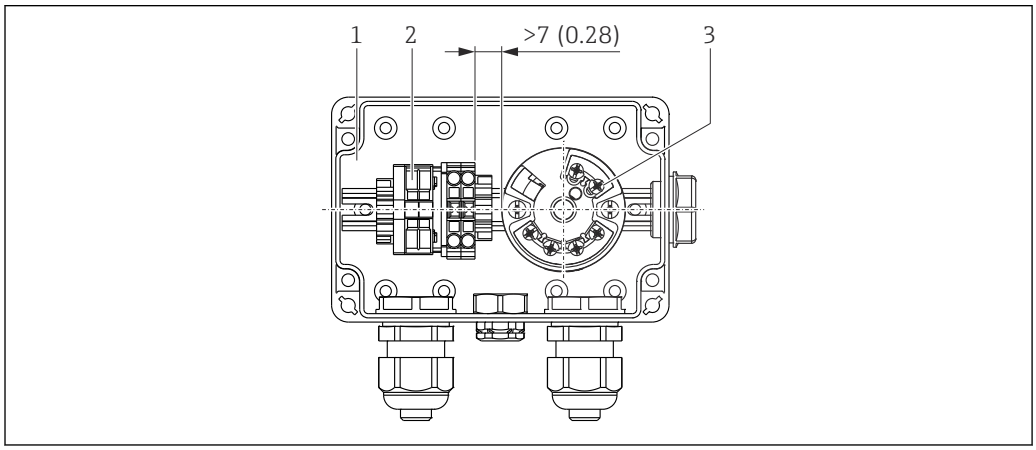
A0018696

Unit of measurement mm (in)

1 Terminal box
2 Terminal strip/terminals
3 TMT71 temperature head transmitter

A distance of > 7 mm (0.28 in) must be maintained between the terminal strip and the TMT71 temperature head transmitter.

Terminal box with integrated TMT72 temperature head transmitter



A0018696

Unit of measurement mm (in)

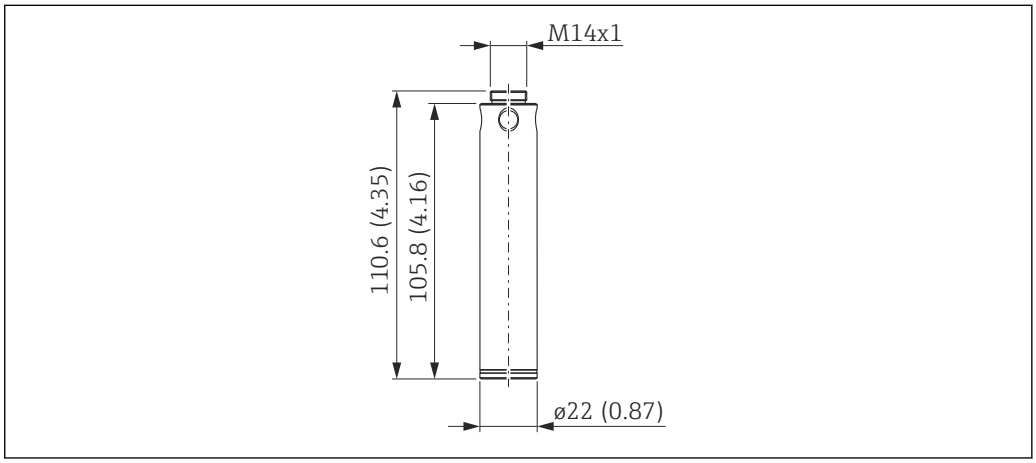
1 Terminal box
2 Terminal strip/terminals
3 TMT72 temperature head transmitter

A distance of > 7 mm (0.28 in) must be maintained between the terminal strip and the TMT72 temperature head transmitter.

Additional weight

For devices with external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube. You can screw several weights together. The weights are screwed directly onto the device. For devices with external diameter of 29 mm (1.14 in), a maximum of 5 weights may be screwed on. In conjunction with the Ex nA approval, a maximum of one additional weight is permitted for devices with external diameter of 29 mm (1.14 in).
- Order number 52006153, Product Configurator: the additional weight is optionally available.

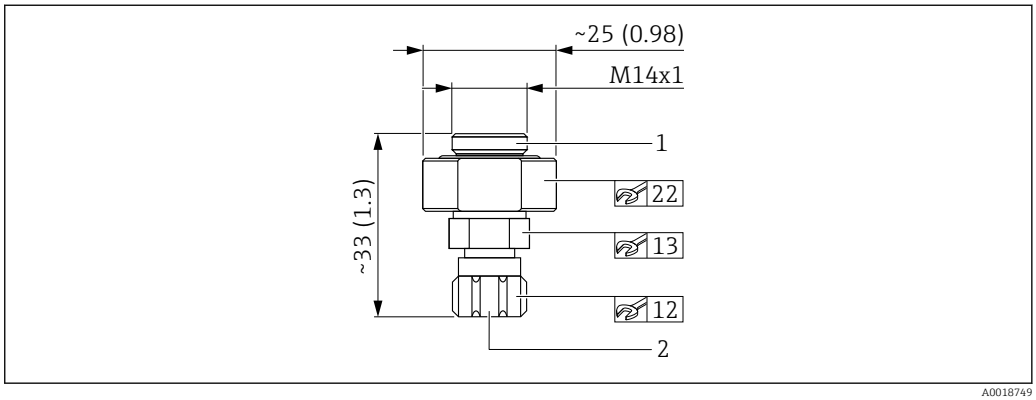


Unit of measurement mm (in)

Testing adapter

For devices with external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

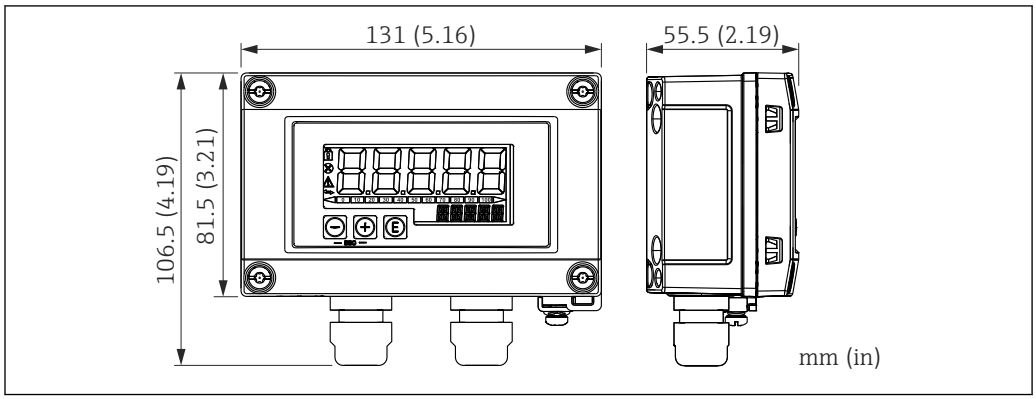
- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for compressed air hose and maximum overload for level probe → 🖹 14
- Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)
- Adapter material: 304 (1.4301)
- Material of quick coupling piece: anodized aluminum
- Order number 52011868
  Product Configurator: the testing adapter is optionally available.



Unit of measurement mm (in)

1 FMX21 level probe connection
2 Compressed air hose connection, internal diameter, quick coupling piece 4 mm (0.16 in)

RIA15 in the field housing

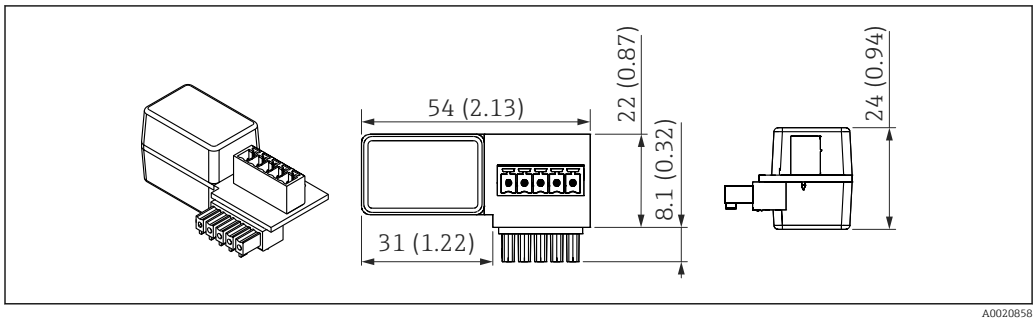


5 Dimensions of RIA15 in field housing. Unit of measurement mm (in)

The RIA15 remote display (for Ex or non-Ex area) can be ordered together with the device. See the Product Configurator.

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

HART communication resistor

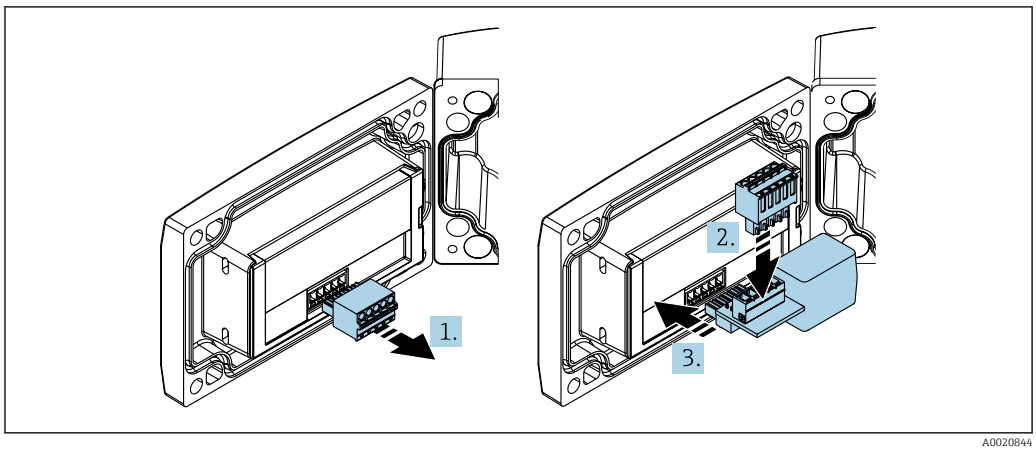


6 Dimensions of HART communication resistor. Unit of measurement mm (in)

A communication resistor is required for HART communication. If this is not already present (e.g. in the power supply RMA, RN221N, RNS221, ...), it can be ordered as an option via the Product Configurator.

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

The HART communication resistor is specially designed for use with the RIA15 and can be attached easily.



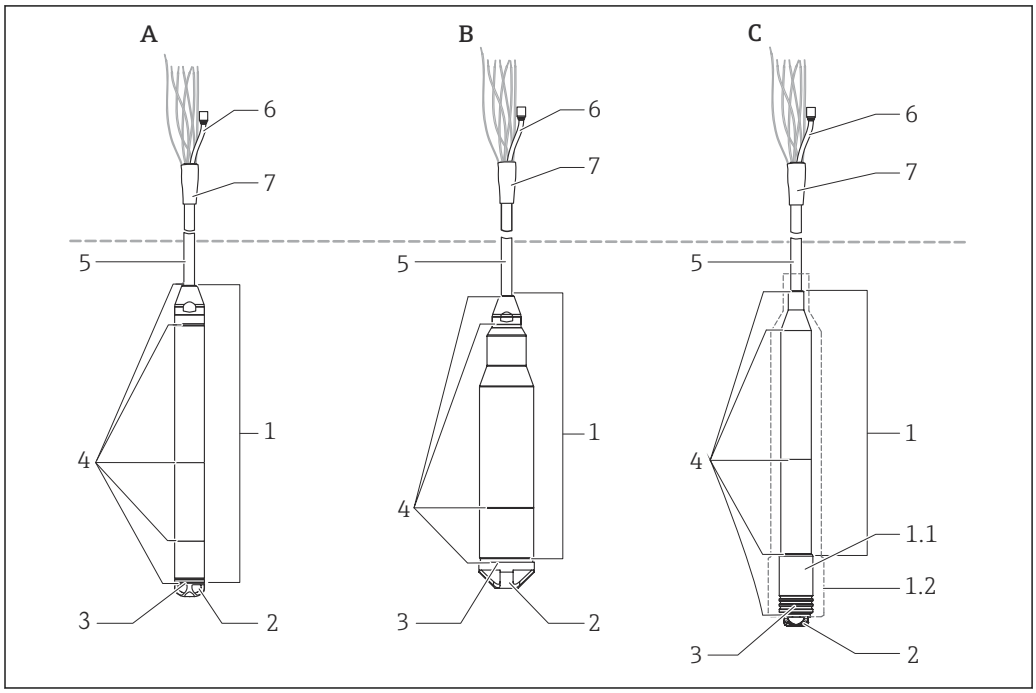
1. Disconnect plug-in terminal block.
2. Insert the terminal block into the slot provided on the HART communication resistor module.

3. Insert the HART communication resistor in the slot in the housing.

Weight

- Level probe, external diameter of 22 mm (0.87 in):
  344 g (12.133 oz)
- Level probe, external diameter of 42 mm (1.65 in):
  1376 g (48.532 oz)
- Level probe, external diameter of 29 mm (1.14 in):
  394 g (13.896 oz)
- Extension cable:
  - PE: 52 g/m (0.035 lbs/1 ft)
  - PUR: 60 g/m (0.040 lbs/1 ft)
  - FEP: 108 g/m (0.072 lbs/1 ft)
- Suspension clamp:
  170 g (5.996 oz)
- Cable mounting screw G 1½" A:
  770 g (27.158 oz)
- Cable mounting screw NPT 1½":
  724 g (25.535 oz)
- Terminal box:
  235 g (8.288 oz)
- TMT71 temperature head transmitter:
  40 g (1.411 oz)
- TMT72 temperature head transmitter:
  40 g (1.411 oz)
- Additional weight:
  300 g (10.581 oz)
- Testing adapter:
  39 g (1.376 oz)

Materials



Materials in contact with process

1 level probe
316L (1.4404/1.4435) [2)]
- **A:** External diameter 22 mm (0.87 in)
- **B:** External diameter 42 mm (1.65 in)
- **C:** External diameter max. 29 mm (1.14 in)

1.1 Sensor sleeve
PPS (Polyphenylene sulfide)

1.2 Heat shrink tube
Polyolefin and hot melt adhesive

The heat-shrink tube around the level probe acts as insulation. It prevents electrical contact between the level probe and the tank. Electrochemical corrosion is thus avoided.

2 Protective cap
- For A and C: with external diameter 22 mm (0.87 in) and 29 mm (1.14 in) (order number: 52008999):
  POM
- For B: device with external diameter 42 mm (1.65 in) (order number: 917755-0000):
  PFA

3 Process ceramic
Al_2O_3 (Aluminum oxide ceramic)

4 Seal
- EPDM
- FKM Viton

5 Seal
Extension cable insulation, choose from:
- PE-LD (Low-density polyethylene)
- FEP (Fluorinated ethylene propylene)
- PUR (Polyurethane)

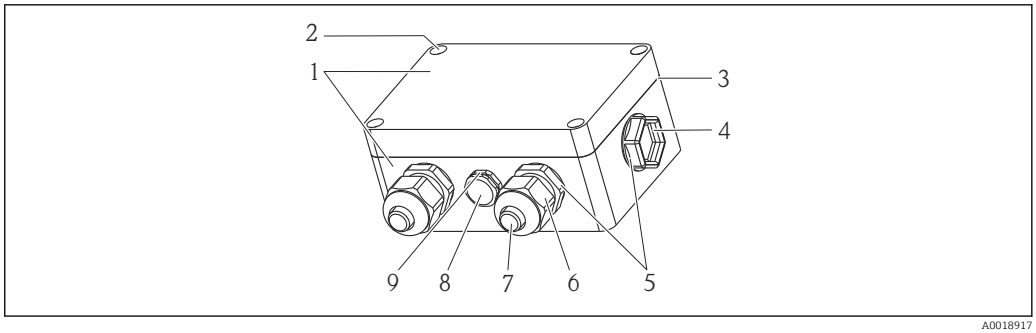
Materials not in contact with process

6 Pressure compensation tube
PA

2) Material 316L (1.4404/1.4435) not in contact with the process in the case of level probe C

7 Heat shrink tube
Polyolefin

Terminal box (not in contact with process)



A0018917

1 Housing
PC

2 Mounting screws (4x)
A2

3 Seal
CR (Chloroprene rubber)

4 Dummy plug M20x1.5
PBT-GF30

5 Cable gland M20x1.5
PE-HD

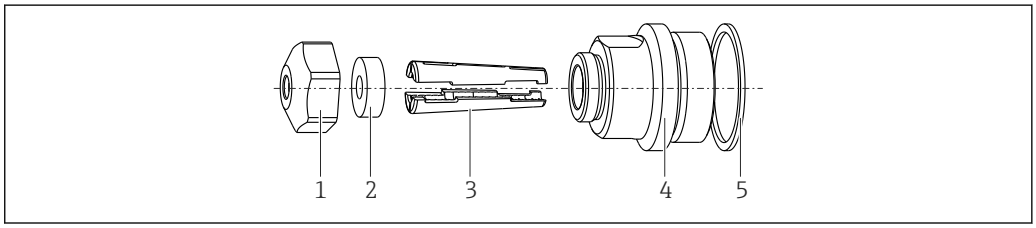
6 Cable gland M20x1.5
PA6

7 Cable gland M20x1.5
PA6-GF30

8 Pressure compensation filter
PA6-GF10, ePTFE

9 Pressure compensation filter, O-ring
Silicone (VMQ)

Cable mounting screw (not in contact with process)



A0018918

1 Cover for cable mounting screw
304 (1.4301)

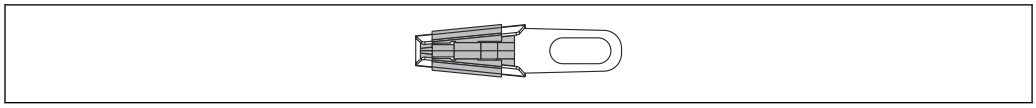
2 Sealing ring
NBR

3 Ferrules
PA66-GF35

4 Adapter for cable mounting screw G 1½" A, NPT 1½"
304 (1.4301)

5 Seal ® Only for G 1½" A
EPDM

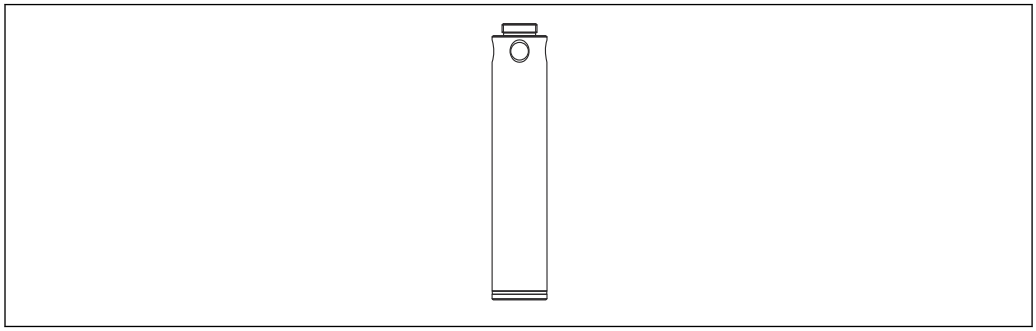
Suspension clamp



A0030950

Material: 316L (1.4404) and fiber-glass reinforced PA (polyamide)

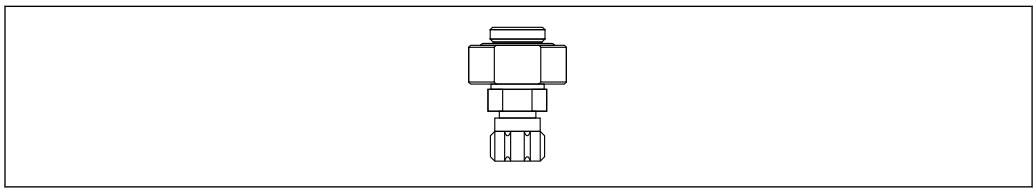
Additional weight



A0030954

Material: 316L (1.4435)

Testing adapter for devices with an external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

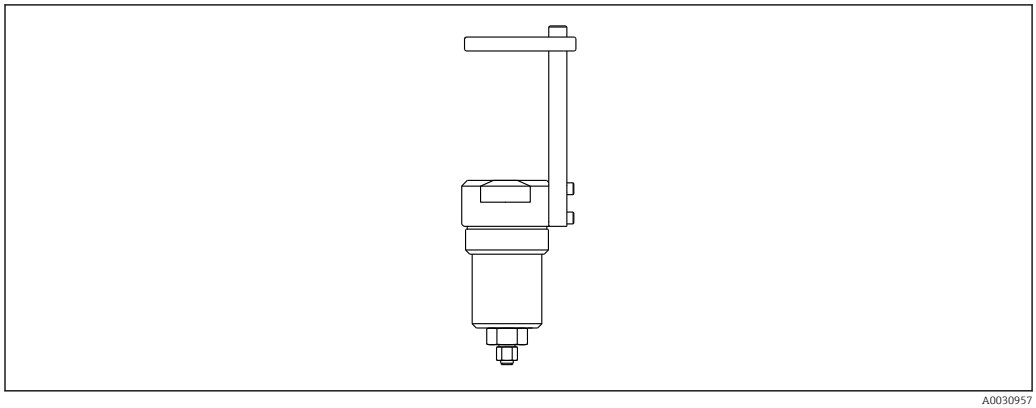


A0030956

Adapter material: 304 (1.4301)

Material of quick coupling piece: anodized aluminum

Testing adapter for devices with an external diameter of 42 mm (1.65 in)



A0030957

Adapter material: 304 (1.4301)

Material of quick coupling piece: anodized aluminum

Extension cable

PE
- Abrasion-resistant extension cable with strain-relief members made of high-strength PE fibers
- Shielded (aluminum)
- Insulated with polyethylene (PE), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

PUR
- Abrasion-resistant extension cable with strain-relief members made of high-strength PE fibers
- Shielded (aluminum)
- Insulated with polyurethane (PUR), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

FEP
- Abrasion-resistant extension cable
- Shielded with galvanized steel wire netting
- Insulated with fluorinated ethylene propylene (FEP), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

Operability

FMX21 4 to 20 mA Analog

No display or other operation facility is required to operate the device. However, the measured values can be read out with optional evaluation units.

FMX21 4 to 20 mA HART

FieldCare

FieldCare is an Endress+Hauser asset management tool based on FDT technology. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard.

FieldCare supports the following functions:
- Configuration of transmitters in online and offline mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Connection options:
- Via Commubox FXA195 and the USB interface of a computer
- Via Fieldgate FXA520

For additional information and free download of FieldCare, see → www.de.endress.com → Download → Text Search: FieldCare

DeviceCare

Function scope

Tool for connecting and configuring Endress+Hauser field devices.

The fastest way to configure Endress+Hauser field devices is with the dedicated "DeviceCare" tool. Together with the device type managers (DTMs) it presents a convenient, comprehensive solution.

For details, see Innovation brochure IN01047S

Field Xpert SFX

Field Xpert SFX is an industrial PDA with integrated 3.5" touchscreen from Endress+Hauser based on Windows Mobile. It offers wireless communication via the optional VIATOR® Bluetooth ® modem as a point-to-point connection to a HART device, or via WiFi and Endress+Hauser's Fieldgate FXA520 to one or more HART devices. Field Xpert also works as a stand-alone device for asset management applications. For details, refer to BA00060S/04/EN.

RIA15

The RIA15 can be used as a local display unit and for the basic commissioning of the Waterpilot FMX21 hydrostatic level sensor via HART.

Certificates and approvals

Current certificates for the product are available on the product page at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.
4. Select **Technical Documentation**.
5. Select **ZE (Certificates)** as the filter

A list of all the certificates appears.

Current approvals for the product are available on the product page at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.
4. Select **Approvals**.

A list of all the approvals appears.

CE mark

The device meets the legal requirements of the relevant EC directives. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

RCM marking

The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products bear the RCM marking on the nameplate.

A0029561

EAC conformity

The measuring system meets the legal requirements of the applicable EAC guidelines. These are listed in the corresponding EAC Declaration of Conformity together with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the EAC mark.

Drinking water approval

The following drinking water approvals can be ordered optionally via the Product Configurator for devices with an outer diameter of 22 mm (0.87 in) with an EPDM seal:

- KTW
- NSF61
- ACS

Marine approval

The following marine approvals can be ordered optionally via the Product Configurator for devices with an outer diameter of 22 mm (0.87 in):

- GL
- ABS
- BV
- DNV

Other standards and guidelines

The applicable European guidelines and standards can be found in the relevant EU Declarations of Conformity. The following standards were also applied:

DIN EN 60770 (IEC 60770):

Transmitters for use in industrial process control systems Part 1: Methods for performance evaluation

Methods for evaluating the performance of transmitters for control and regulation in industrial process control systems.

DIN 16086:

Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets

Procedure for writing specifications in data sheets for electrical pressure measuring instruments, pressure sensors and pressure transmitters.

EN 61326:

Electrical equipment for measurement, control and laboratory use – EMC requirements

EN 61010-1 (IEC 61010-1):

Safety requirements for electrical equipment for measurement, control and laboratory use

EN 60529:

Degrees of protection provided by enclosures (IP code)

Calibration

Factory calibration certificate, 5-point
Product Configurator: the 5-point factory calibration certificate is optionally available.

Calibration unit

The following options can be selected in the Product Configurator:
- Sensor range; %
- Sensor range; mbar/bar
- Sensor range; kPa/MPa
- Sensor range; mm/m H2O
- Sensor range; in H2O/ft H2O
- Sensor range; psi
- Customized pressure; see additional specification
- Customized level; see additional specification

Service

The following options can be optionally selected in the Product Configurator:
- Configured min alarm current
- Configured HART Burst Mode PV
- Adjusted density compensation
- ... m cable marking>installation
- ... ft cable marking>installation
- Special version

Downloading the Declaration of Conformity

www.endress.com → Download

Ordering information

Detailed ordering information is available from the following sources:
- In the Product Configurator on the Endress+Hauser website: www.endress.com-> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser sales organization: www.addresses.endress.com

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Scope of delivery

- Measuring device
- Optional accessories
- Brief Operating Instructions
- Certificates

Test reports, declarations and inspection certificates

All test reports, declarations and inspection certificates are provided electronically in the *W@M Device Viewer*:
Enter the serial number from the nameplate (www.endress.com/deviceviewer)

Product documentation on paper
Test reports, declarations and inspection certificates in hard copy can optionally be ordered with feature 570 "Service", Version I7 "Product documentation on paper". The documents are then provided with the device upon delivery.

Configuration data sheet

Level

The following configuration data sheet must be completed and included with the order if option "K: customized level" has been selected for order code "090: Calibration; unit" in the product structure.

Pressure unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

Output unit (scaled unit)

Mass	Lengths	Volume	Volume	Percent
❑ kg	❑ m	❑ l	❑ gal	❑ %
❑ t	❑ dm	❑ hl	❑ Igal	
❑ lb	❑ cm			
	❑ mm	❑ m^3		
		❑ ft^3		
	❑ ft	❑ in^3		
	❑ inch			

Empty calibration [a]:
Low pressure value (empty) _____ [pressure engineering unit]

Empty calibration [a]:
Low measured value (empty) _____ [scaled unit]

Full calibration [b]:
High pressure value (full) _____ [pressure engineering unit]

Full calibration [b]:
High measured value (full) _____ [scaled unit]

Damping	
Damping:	_____ sec

Pressure

The following configuration data sheet must be completed and included with the order if option "J: customized pressure" has been selected for order code "090: Calibration; unit" in the product structure.

Pressure unit			
❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

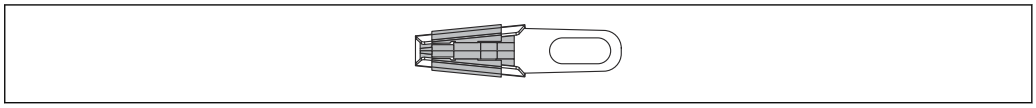
Calibration range / Output		
Lower-range value (LRV):	_____	[pressure engineering unit]
Upper-range value (URV):	_____	[pressure engineering unit)]

Damping	
Damping:	_____ sec

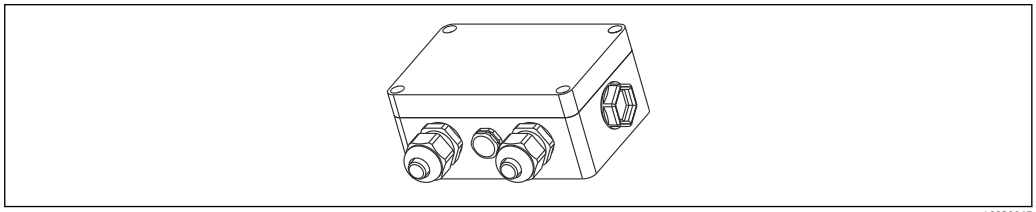
Accessories

- Observe the additional information in the individual sections!
- For additional information, see the sections "Mechanical construction" → 34, "Environment", → 30, "Process" → 32 and "Mounting" → 27.

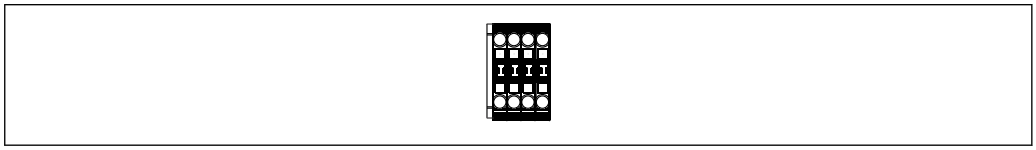
Suspension clamp
For easy installation of the device, Endress+Hauser offers a suspension clamp.
- Product Configurator: the suspension clamp is optionally available
- Order number: 52006151


A0030950

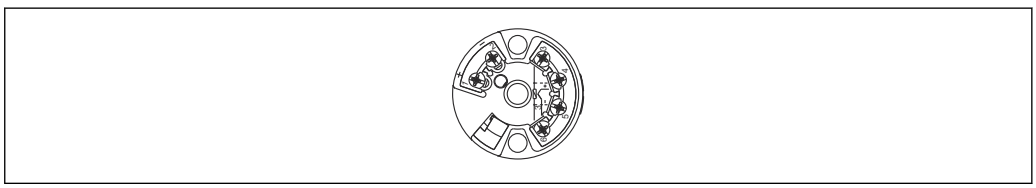
Terminal box
Terminal box for terminal strip, temperature head transmitter and Pt100.
- Product Configurator: the terminal box is optionally available
- Order number: 52006152


A0030967

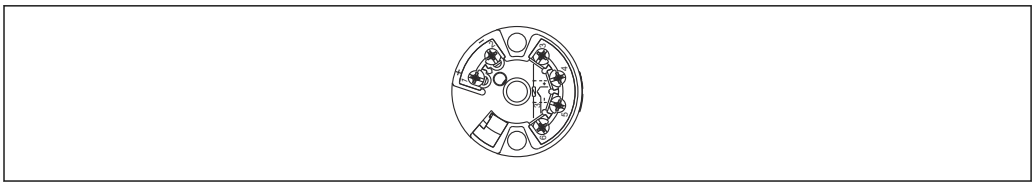
4-terminal strip/terminals
4-terminal strip for wiring
Order number: 52008938


A0030951

Temperature head transmitter TMT71 for FMX21 4 to 20 mA analog
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT71 is optionally available → 51
- Order number: 52008794

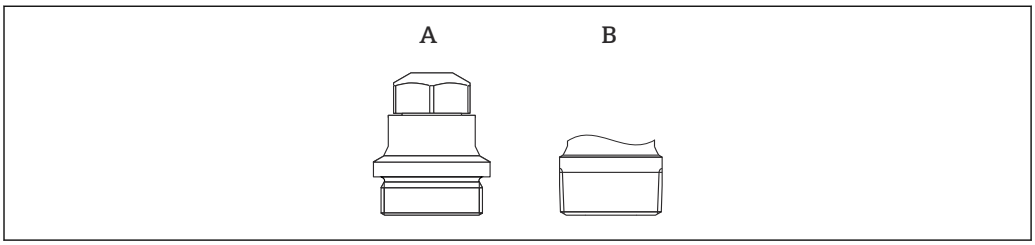

A0030952

Temperature head transmitter TMT72 for FMX21 4 to 20 mA HART
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT72 is optionally available
- Order number: 51001023



A0030952

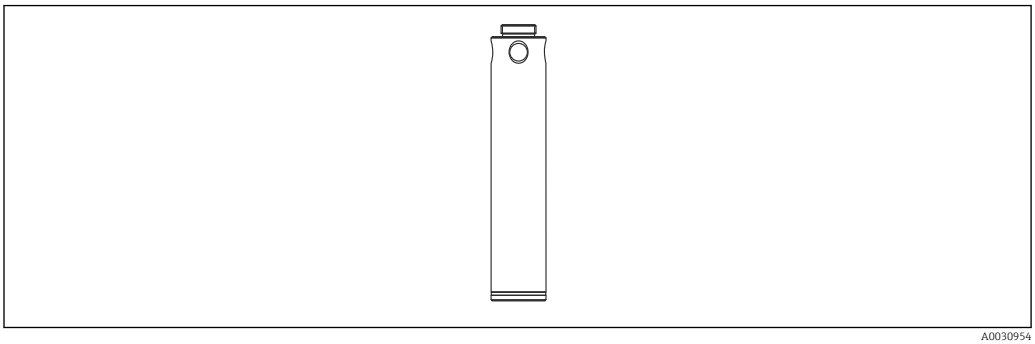
Cable mounting screws
Endress+Hauser offers a cable mounting screw for easy device mounting and to seal the measuring aperture.
- G 1½" A
  Order number: 52008264
- NPT 1½"
  Order number: 52009311
- Product Configurator: the cable mounting screws are optionally available



A0030953

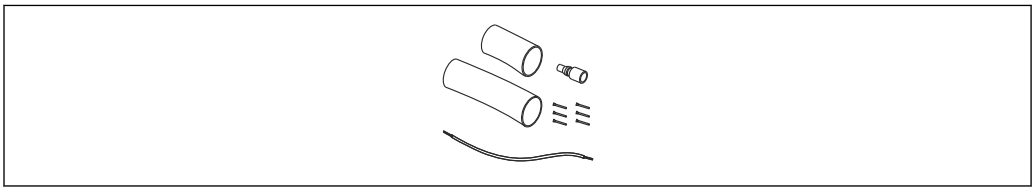
A G 1½" A
B NPT 1½"

Additional weight for device with an outer diameter of 22 mm (0.87 in) or 29 mm (1.14 in)
Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
- Product Configurator: the additional weight is optionally available
- Order number: 52006153



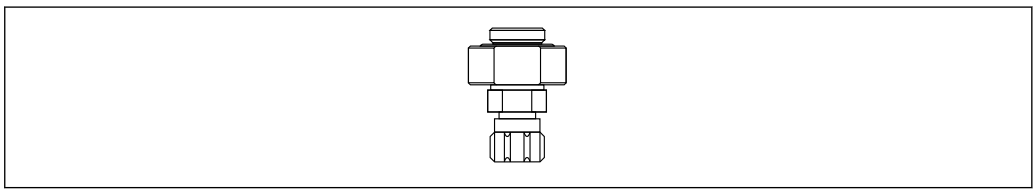
A0030954

Cable shortening kit
The cable shortening kit is used to shorten a cable easily and professionally.
- Product Configurator: the cable shortening kit is optionally available
- Order number: 71222671



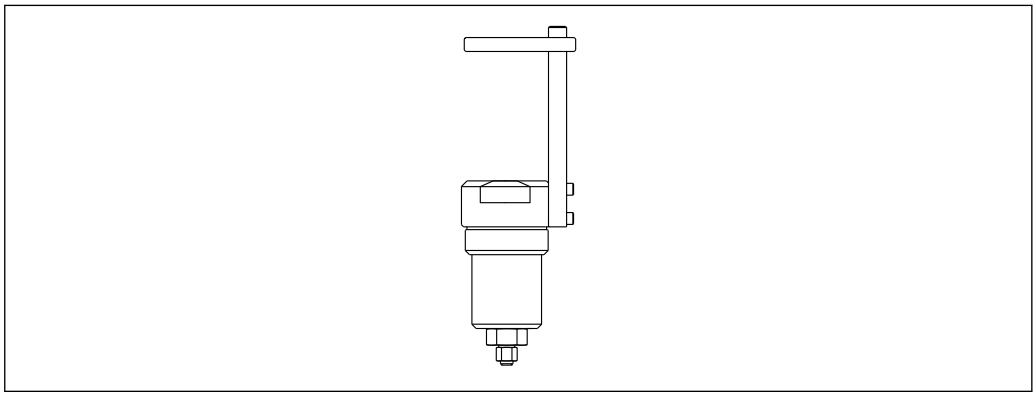
A0030948

Testing adapter for devices with an external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)
Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Product Configurator: the testing adapter is optionally available
- Order number: 52011868



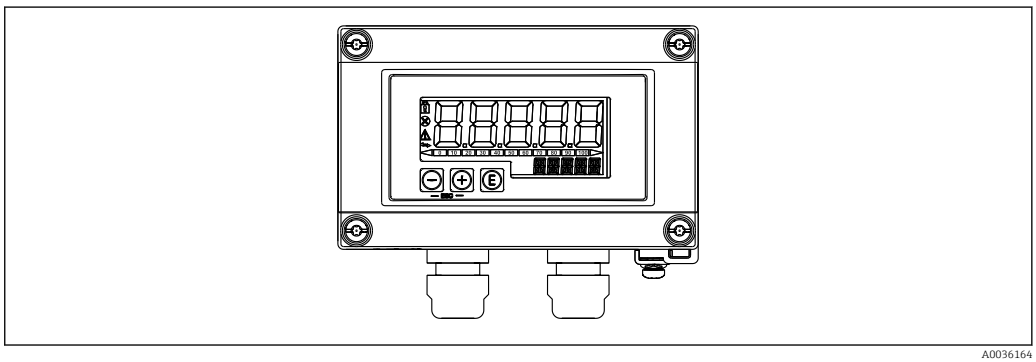
A0030956

Testing adapter for devices with an external diameter of 42 mm (1.65 in)
Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for compressed air hose and maximum overload for level probe
- Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)
- Order number: 71110310



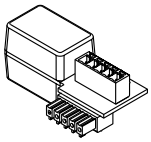
A0030957

RIA15 in the field housing
- Remote display RIA15 non-hazardous
  ↳ Product structure: the display is optionally available
- Remote display RIA15 hazardous
  ↳ Product structure: the display is optionally available



A0036164

HART communication resistor
- HART communication resistor hazardous / non-hazardous area, for use with RIA15
- Product structure: the HART communication resistor is optionally available



A0036165

Service-specific accessories

Accessories	Description
DeviceCare SFE100	Configuration tool for HART, PROFIBUS and FOUNDATION Fieldbus field devices Technical Information TI01134S DeviceCare is available for download at www.software-products.endress.com. You need to register in the Endress+Hauser software portal to download the application.
FieldCare SFE500	FDT-based plant asset management tool FieldCare can configure all smart field units in your plant and helps you manage them. By using the status information, FieldCare is also a simple but effective way of checking the status and condition of the field devices. Technical Information TI00028S

Supplementary documentation

The following document types are also available in the Downloads area of the Endress+Hauser website: www.endress.com → Downloads

Field of Activities

- Pressure measurement: FA00004P/00/EN
- Recording technology: FA00014R/09/EN
- System components: FA00016K/09/EN

Technical Information

- Deltapilot M: TI00437P/00/EN
- Temperature head transmitter iTEMP TMT71: TI01393T
- Temperature head transmitter iTEMP HART TMT72: TI01392T
- RIA15: TI01043K/09/EN

Operating Instructions

- Waterpilot FMX21 4 to 20 mA Analog: BA01605P/00/EN
- Waterpilot FMX21 4 to 20 mA HART: BA00380P/00/EN
- RIA15: BA01170K/09/EN
- Cable shortening kit: SD00552P/00/A6
- Field Xpert: BA01211S/04/EN

Brief Operating Instructions

- Waterpilot FMX21 4 to 20 mA Analog: KA01244P/00/EN - Brief Operating Instructions for the device
- Waterpilot FMX21 4 to 20 mA HART: KA01189P/00/EN - Brief Operating Instructions for the device

Safety Instructions (XA)

Depending on the approval, Safety Instructions (XA) are supplied with the device. The Safety Instructions are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Drinking water approval

- SD00289P/00/A3 (NSF)
- SD00319P/00/A3 (KTW)
- SD00320P/00/A3 (ACS)

Registered trademarks

GORE-TEX® Trademark of W.L. Gore & Associates, Inc., USA.

TEFLON® Trademark of E.I. Du Pont de Nemours & Co., Wilmington, USA.

HART® Registered trademark of the FieldComm Group, Austin, USA

FieldCare® Trademark of Endress+Hauser Process Solutions AG.

DeviceCare® Trademark of Endress+Hauser Process Solutions AG.

iTEMP® Trademark of Endress+Hauser Wetzer GmbH + Co. KG, Nesselwang, D..

www.addresses.endress.com

Endress+Hauser

People for Process Automation

XA01634P-A/00/EN/01.17
CCS/FM10
CSA/A 13.03.17

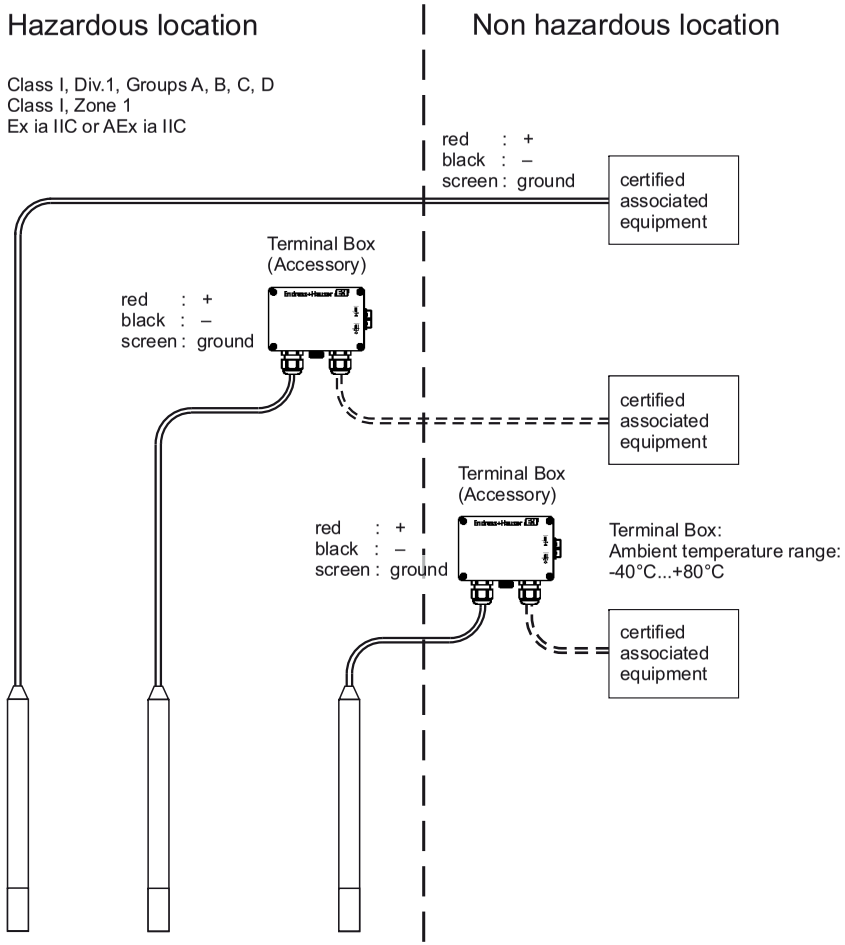
71362367

CSA Control Drawing
960008976 A

Waterpilot FMX21

Endress+Hauser

People for Process Automation



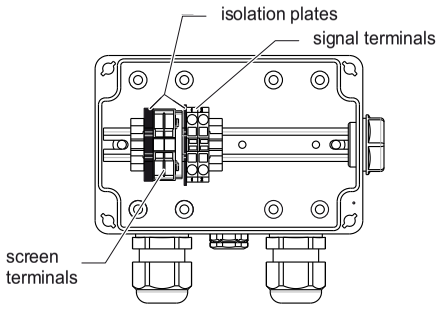
Sensor

Temperature class	Ambient temperature range
T4	-10°C ≤ Ta ≤ +70°C
T5	-10°C ≤ Ta ≤ +55°C
T6	-10°C ≤ Ta ≤ +40°C

Terminal Box

Temperature class	Ambient temperature range
T6	-40°C ≤ Ta ≤ +80°C

Terminal Box (Accessory):



Intrinsically safe (entity), Class I, Div.1, Groups A,B,C,D or Zone 1, IIC Hazardous Location Installations

1. CSA certified apparatus must be installed in accordance with manufacturer instructions.
2. Control room equipment must not use or generate over 250 V.
3. Install per Canadian Electrical Code (Canada) or per National Electric Code ANSI / NFPA 70 and ANSI / ISA-RP 12.06.01 (USA).
4. Sensor entity parameters: Vmax = 30 VDC, Imax = 133 mA, Pmax = 1 W, Ci and Li per following table:

Length of Sensorcable	Ci (10.3 nF +180 pF/m)	Li (1 µH/m)
5 m	11.3 nF	5 µH
10 m	12.2 nF	10 µH
20 m	14.0 nF	20 µH
30 m	15.8 nF	30 µH
50 m	19.4 nF	50 µH
100 m	28.4 nF	100 µH
200 m	46.4 nF	200 µH
300 m	64.4 nF	300 µH

5. CSA certified associated equipment must meet following conditions:
   Voc or Vt ≤ Vmax; Isc or Io ≤ Imax; Po ≤ Pmax,
   $C_a \geq C_i + C_{cable}$; $L_a \geq L_i + L_{cable}$
   Install associated equipment in accordance with the manufacturer instructions.
6. Use supply wires suitable for 5°C above surrounding ambient.
7. Avoid friction and impact sparks. Anchor sensor if necessary, secure against swinging.
8. WARNING: Avoid electrostatic charging of plastic surfaces.
   Do not rub surfaces with a dry cloth. Do not use in media or environments which may generate electrostatic charges on plastic surfaces.
   Avertissement : Eviter le chargement électrostatique des surfaces synthétiques. Ne pas frotter les surfaces avec un chiffon sec. Ne pas utiliser pas dans les médias ou les environnements qui peuvent produire des charges électrostatiques sur les surfaces de plastique.
9. WARNING: Substitution of Components may impair intrinsic safety.
   Avertissement : La substitution de composants peut compromettre la sécurité intrinsèque.
10. Do not remove or move terminal blocks, fastening elements or insulation plates of the terminal box. Do not build in additional components.
11. Connect cable screen to earth ground of the installation.

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71594028

Brief Operating Instructions
Waterpilot FMX21
HART

Hydrostatic level measurement

These Brief Operating Instructions are not a substitute for the Operating Instructions pertaining to the device.

Detailed information is provided in the Operating Instructions and other documentation.

Available for all device versions via:
- Internet: www.endress.com/deviceviewer
- Smartphone/tablet: Endress+Hauser Operations app

Basic safety instructions

Requirements for personnel

The personnel must fulfill the following requirements for its tasks:
- ▶ Trained, qualified specialists must have a relevant qualification for this specific function and task.
- ▶ Personnel must be authorized by the plant owner/operator.
- ▶ Personnel must be familiar with federal/national regulations.
- ▶ Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- ▶ Personnel must follow instructions and comply with general policies.

Intended use

Der Waterpilot FMX21 is a hydrostatic pressure sensor for measuring the level of fresh water, wastewater and salt water. The temperature is measured simultaneously in the case of sensor versions with a Pt100 resistance thermometer.

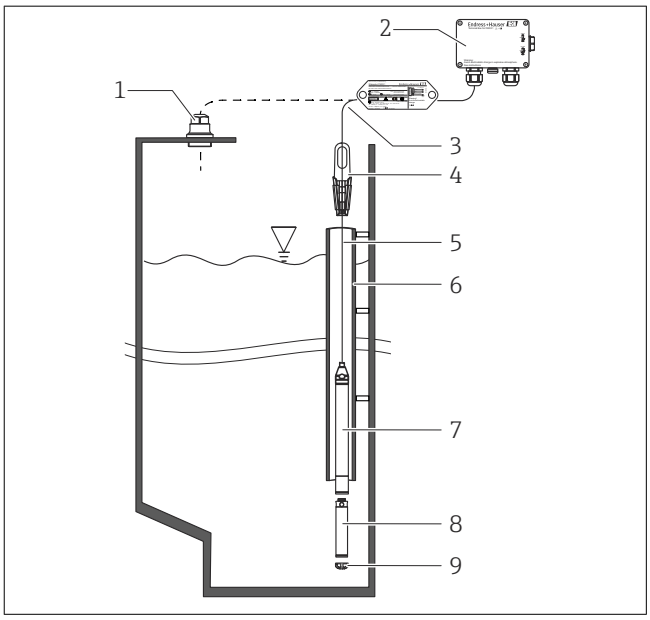
An optional temperature head transmitter converts the Pt100 signal into a 4 to 20 mA signal with superimposed digital communication protocol HART 6.0.

Workplace safety

When working on and with the device:
- ▶ Wear the required personal protective equipment as per national regulations.
- ▶ Before connecting the device: switch off the supply voltage.

Mounting

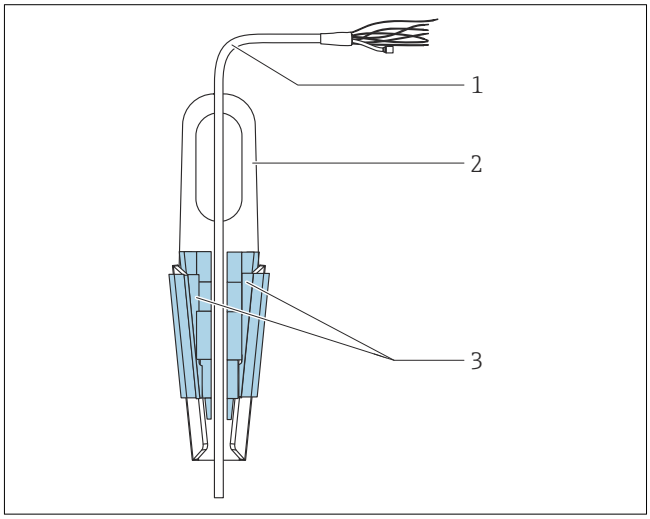
For dimensions, see the Technical Information



1 *Cable mounting screw (can be ordered as an accessory)*
2 *Terminal box (can be ordered as an accessory)*
3 *Bending radius of extension cable > 120 mm (4,72 in)*
4 *Suspension clamp (can be ordered as an accessory)*
5 *Extension cable*
6 *Guide tube*
7 *Device*
8 *Additional weight can be ordered as an accessory for the device with external diameter of 22 mm (0,87 in) and 29 mm (1,14 in)*
9 *Protective cap*

Endress+Hauser
People for Process Automation

Mounting the Waterpilot with a suspension clamp



1 *Extension cable*
2 *Suspension clamp*
3 *Clamping jaws*

1. Mount the suspension clamp (item 2). Take the weight of the extension cable (item 1) and the device into account when selecting the fastening point.
2. Push up the clamping jaws (item 3). Place the extension cable (item 1) between the clamping jaws as shown in the graphic.
3. Hold the extension cable (item 1) in position and push the clamping jaws (item 3) back down. Tap the clamping jaws gently from above to fix them in place.

Mounting the terminal box

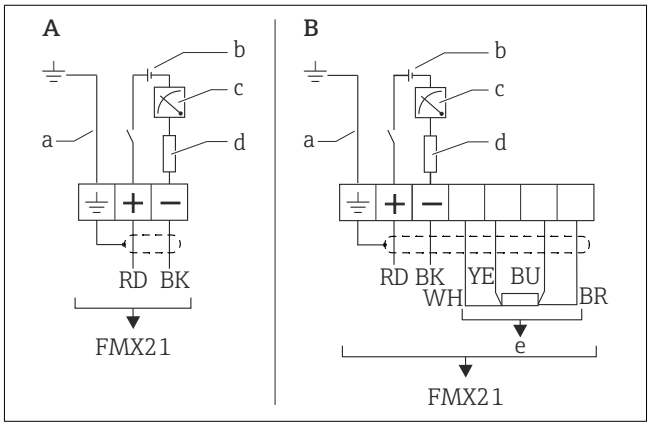
The optional terminal box is mounted using four screws (M4). For the dimensions of the terminal box, see the Technical Information.

Electrical connection

⚠ WARNING

An incorrect connection compromises electrical safety!

- ▶ When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and rules and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). All explosion-protection data are listed in separate documentation. This documentation is supplied with the devices as standard , but can also be requested if required.
- ▶ The supply voltage must match the supply voltage specified on the nameplate .
- ▶ Before connecting the device: switch off the supply voltage.
- ▶ The cable must end in a dry room or a suitable terminal box. The IP66/IP67 terminal box with GORE-TEX® filter from Endress+Hauser is suitable for outdoor installation .
- ▶ Connect the device in accordance with the following diagrams. Reverse polarity protection is integrated in the device and the temperature head transmitter. Changing the polarities will not result in the destruction of the devices.
- ▶ A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.



A *Device*
B *Device with Pt100 (not for use in hazardous areas)*
a *Not for devices with external diameter of 29 mm (1,14 in)*
b *10,5 to 30 V_{DC} (hazardous area), 10,5 to 35 V_{DC}*
c *4 to 20 mA*
d *Resistance (R_L)*
e *Pt100*

Wire colors

RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

Connection data

Connection classification as per IEC 61010-1:
- Overvoltage category 1
- Pollution level 1

Connection data in the hazardous area

See relevant XA.

BA00380P/00/EN/19.22-00
71593280
2022-09-12

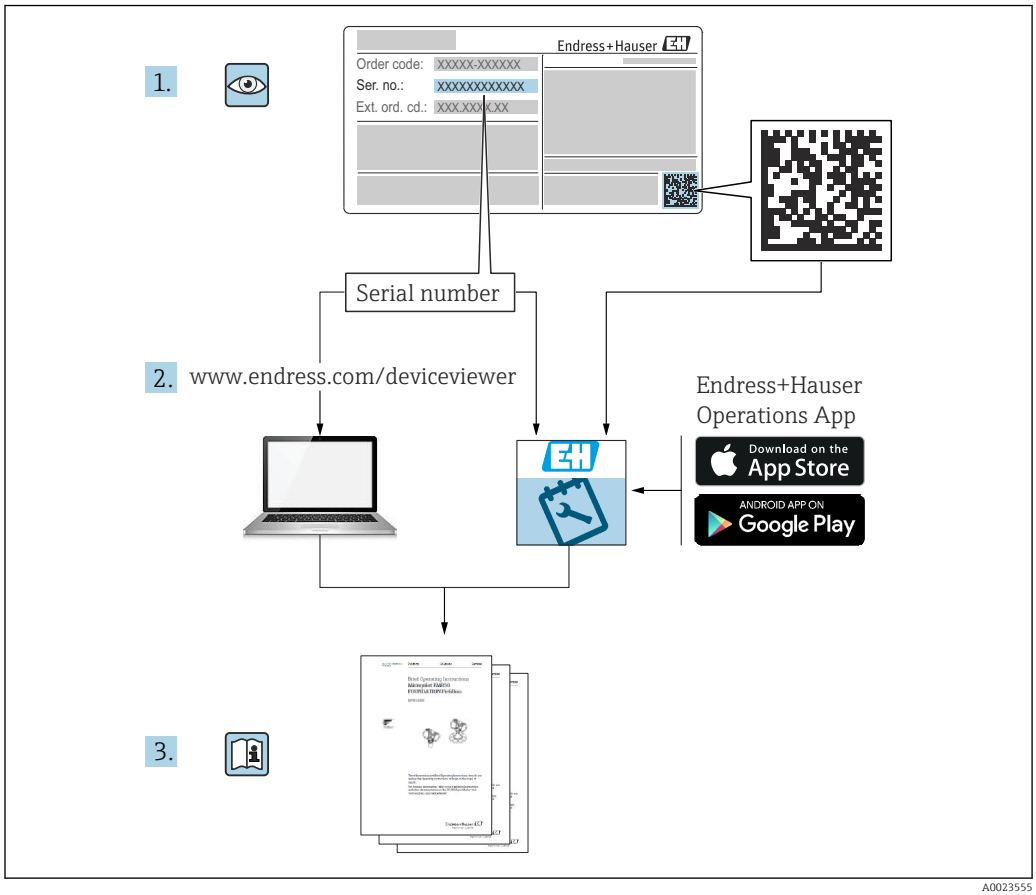
Valid as of version
01.00.zz

Operating Instructions
Waterpilot FMX21

Hydrostatic level measurement
4 to 20 mA HART

HART COMMUNICATION PROTOCOL

Endress+Hauser
People for Process Automation



- Make sure the document is stored in a safe place such that it is always available when working on or with the device.
- To avoid danger to individuals or the facility, read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to this manual.

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1 About this document

1.1 Document function

These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

1.2 Symbols

1.2.1 Safety symbols

⚠ DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE

This symbol contains information on procedures and other facts which do not result in personal injury.

1.2.2 Electrical symbols

⎓
Direct current

~
Alternating current

⎓
Direct and alternating current

⏚ Ground connection
Grounded clamp, which is grounded via a grounding system.

⊜ Protective earth (PE)
Ground terminals, which must be grounded prior to establishing any other connections. The ground terminals are located on the inside and outside of the device.

⏚ Equipotential connection
A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

1.2.3 Tool symbols

Flat blade screwdriver

Phillips screwdriver

Allen key

Open-ended wrench

1.2.4 Symbols for certain types of information

Permitted
Procedures, processes or actions that are permitted

Preferred
Procedures, processes or actions that are preferred

Forbidden
Procedures, processes or actions that are forbidden

Tip
Indicates additional information

Reference to documentation

Reference to page

Reference to graphic

1., 2., 3.
Series of steps

Result of a step

Help in the event of a problem

Visual inspection

1.2.5 Symbols in graphics

1, 2, 3, ...
Item numbers

1., 2., 3.
Series of steps

A, B, C, ...
Views

A-A, B-B, C-C etc.
Sections

1.3 Documentation

The following types of documentation are available in the Download Area of the Endress +Hauser website (www.endress.com/downloads):

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

1.3.1 Technical Information (TI)

Planning aid
The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

1.3.2 Brief Operating Instructions (KA)

Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

1.3.3 Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

1.4 Registered trademarks

1.4.1 GORE-TEX®

Trademark of W.L. Gore & Associates, Inc., USA.

1.4.2 TEFLON®

Trademark of E.I. Du Pont de Nemours & Co., Wilmington, USA.

1.4.3 HART®

Registered trademark of the FieldComm Group, Austin, USA

1.4.4 FieldCare®

Trademark of Endress+Hauser Process Solutions AG.

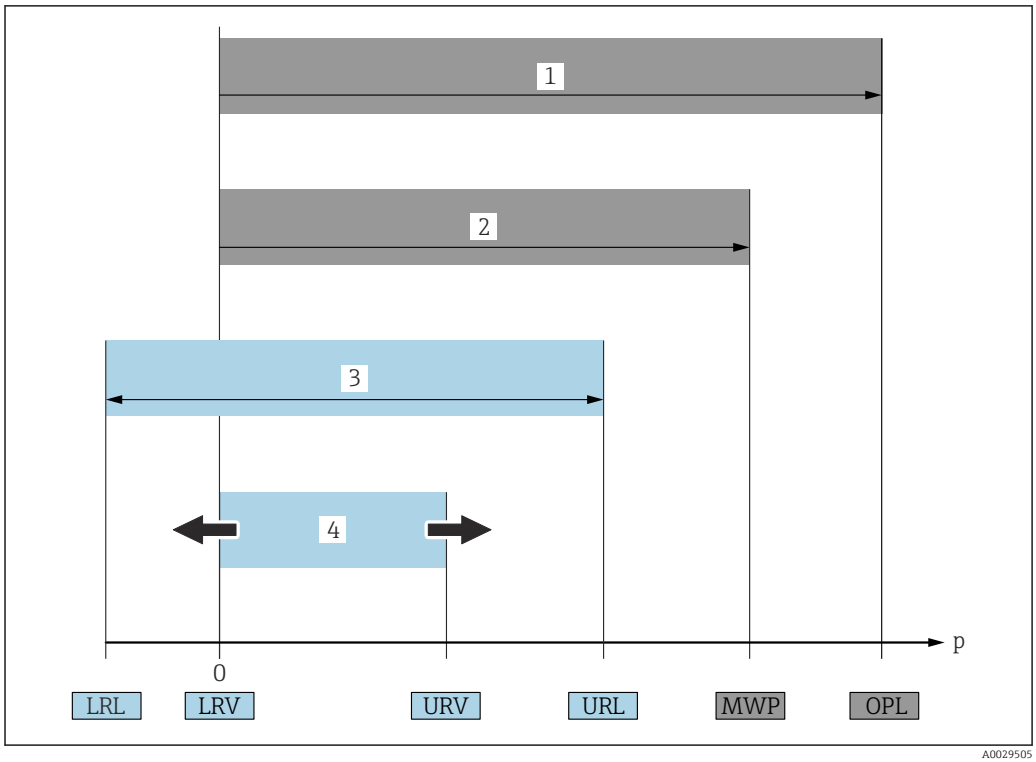
1.4.5 DeviceCare®

Trademark of Endress+Hauser Process Solutions AG.

1.4.6 iTEMP®

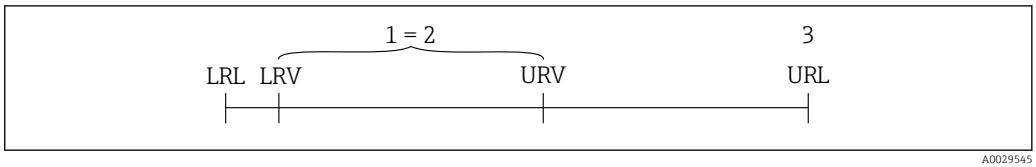
Trademark of Endress+Hauser Wetzer GmbH + Co. KG, Nesselwang, D..

1.5 Terms and abbreviations



- **OPL (1)**
  The OPL (Over Pressure Limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The OPL may only be applied for a limited period of time.
- **MWP (2)**
  The MWP (Maximum Working Pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The MWP may be applied at the device for an unlimited period.
  The MWP can also be found on the nameplate.
- **Maximum sensor measuring range (3)**
  Span between LRL and URL. This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
- **Calibrated/adjusted span (4)**
  Span between LRV and URV. Factory setting: 0 to URL
  Other calibrated spans can be ordered as customized spans.
- **p**: Pressure
- **LRL**: Lower range limit
- **URL**: Upper range limit
- **LRV**: Lower range value
- **URV**: Upper range value
- **TD (Turn down)**: Example - see the following section
- **PE**: Polyethylene
- **FEP**: Fluorinated ethylene propylene
- **PUR**: Polyurethane

1.6 Turn down calculation



1 Calibrated/adjusted span
2 Zero point-based span
3 URL sensor

Example

- Sensor:10 bar (150 psi)
- Upper range value (URL) = 10 bar (150 psi)

Turn down (TD):

$$TD = \frac{URL}{|URV - LRV|}$$

$$TD = \frac{10\ \text{bar (150 psi)}}{|5\ \text{bar (75 psi)} - 0\ \text{bar (0 psi)}|} = 2$$

In this example, the TD is 2:1.
This span is based on the zero point.

- Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)
- Lower range value (LRV) = 0 bar (0 psi)
- Upper range value (URV) = 5 bar (75 psi)

2 Basic safety instructions

2.1 Requirements for personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Personnel must be authorized by the plant owner/operator.
- Be familiar with federal/national regulations.
- Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:
- Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Personnel follow the instructions in this manual.

2.2 Intended use

2.2.1 Application and media

The Waterpilot FMX21 is a hydrostatic pressure sensor for measuring the level of fresh water, wastewater and salt water. The temperature is measured simultaneously in the case of sensor versions with a Pt100 resistance thermometer.

An optional temperature head transmitter converts the Pt100 signal to a 4 to 20 mA signal with superimposed digital communication protocol HART 6.0.

2.2.2 Incorrect use

The manufacturer is not liable for damage caused by improper or non-intended use.

Verification for borderline cases:
- For special fluids and fluids for cleaning, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of fluid-wetted materials, but does not accept any warranty or liability.

2.3 Workplace safety

For work on and with the device:
- Wear the required personal protective equipment according to federal/national regulations.
- Switch off the supply voltage before connecting the device.

2.4 Operational safety

Risk of injury!
- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.
- If, despite this, modifications are required, consult with Endress+Hauser.

Repairs

To ensure continued operational safety and reliability,
- Carry out repairs on the device only if they are expressly permitted.
- Observe federal/national regulations pertaining to repair of an electrical device.
- Use original spare parts and accessories from Endress+Hauser only.

Hazardous area

To eliminate danger to persons or the facility when the device is used in the approval-related area (e.g. explosion protection, pressure vessel safety):
- Check the nameplate to verify if the device ordered can be put to its intended use in the approval-related area.
- Observe the specifications in the separate supplementary documentation that is an integral part of these Instructions.

2.5 Product safety

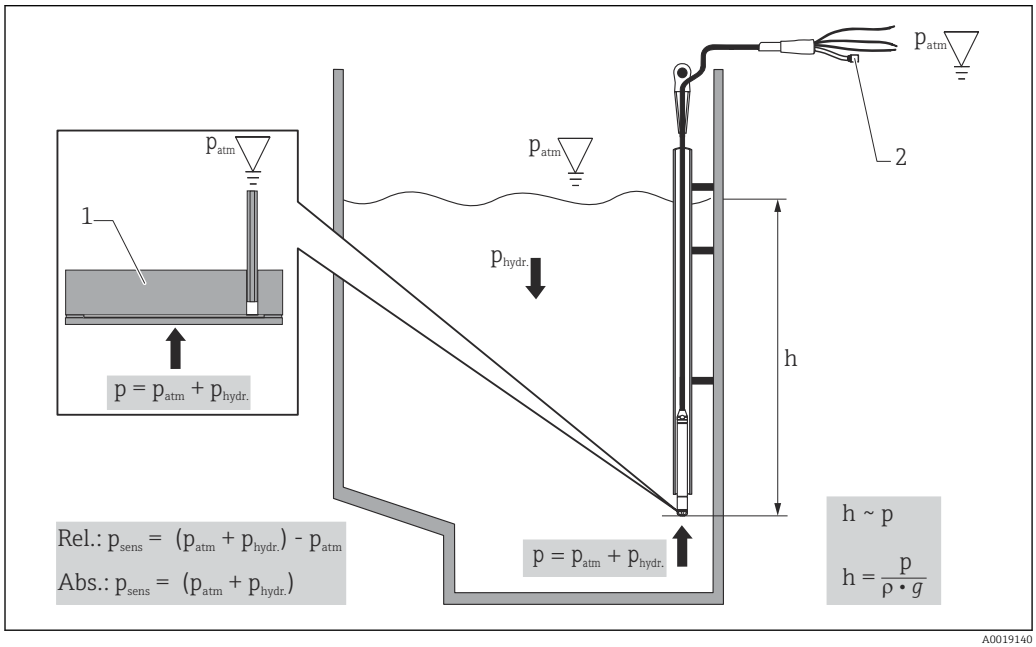
This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EC directives listed in the device-specific EC Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

3 Product description

3.1 Function

The ceramic measuring cell is a dry measuring cell i.e. the pressure acts directly on the robust, ceramic process isolating diaphragm of the Waterpilot FMX21. Changes in air pressure are guided via a pressure compensation tube through the extension cable to the rear of the ceramic process isolating diaphragm and are compensated for. A pressure-dependent change in capacitance, caused by the movement of the process isolating diaphragm, is measured at the electrodes of the ceramic carrier. The electronics unit then converts this to a signal that is proportional to the pressure and linear to the level.



1 *Ceramic measuring cell*
2 *Pressure compensation tube*
h *Height level*
p *Total pressure = atmospheric pressure + hydrostatic pressure*
ρ *Density of the medium*
g *Acceleration due to gravity*
$P_{hydr.}$ *Hydrostatic pressure*
P_{atm} *Atmospheric pressure*
P_{sens} *Pressure displayed on the sensor*

4 Incoming acceptance and product identification

4.1 Incoming acceptance

Check the following during incoming acceptance:

❑ Are the order codes on the delivery note and the product sticker identical?

❑ Are the goods undamaged?

❑ Do the data on the nameplate match the ordering information on the delivery note?

❑ If required (see nameplate): are the Safety Instructions e.g. XA provided?

If one of these conditions is not met, please contact the manufacturer's sales office.

4.2 Product identification

The following options are available for identification of the device:
- Nameplate specifications
- Extended order code with breakdown of the device features on the delivery note
- Enter serial number of nameplates in *W@M Device Viewer* www.endress.com/deviceviewer. All of the information on the measuring device is displayed along with an overview of the scope of technical documentation provided.
- Enter the serial number on the nameplate into the *Endress+Hauser Operations app* or scan the 2-D matrix code on the nameplate with the *Endress+Hauser Operations app*

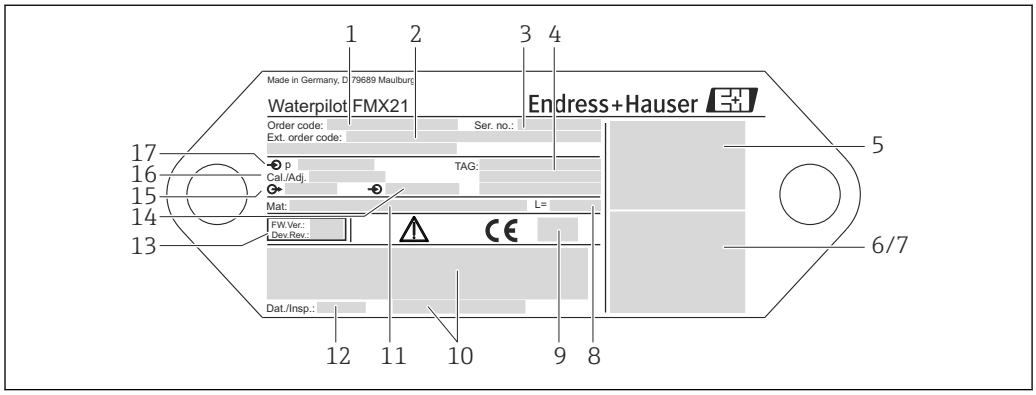
4.2.1 Manufacturer address

Endress+Hauser SE+Co. KG
Hauptstraße 1
79689 Maulburg, Germany

Address of the manufacturing plant: See nameplate.

4.3 Nameplates

4.3.1 Nameplates on extension cable



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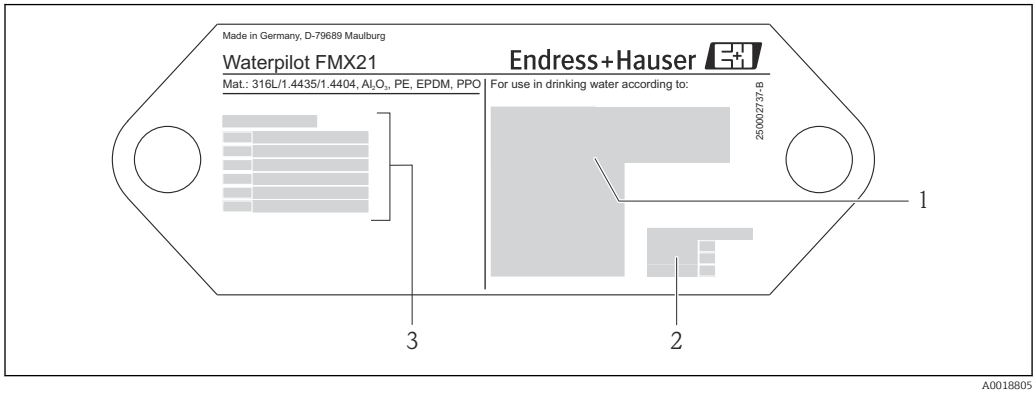
1 *Order code (shortened for reordering); The meaning of the individual letters and digits is explained in the order confirmation details.*
2 *Extended order number (complete)*
3 *Serial number (for clear identification)*
4 *TAG (device tag)*
5 *FMX21 connection diagram*
6 *Pt100 connection diagram (optional)*
7 *Warning (hazardous area), (optional)*
8 *Length of extension cable*
9 *Approval symbol, e.g. CSA, FM, ATEX (optional)*
10 *Text for approval (optional)*
11 *Materials in contact with process*
12 *Test date (optional)*
13 *Software version/device version*
14 *Supply voltage*
15 *Output signal*
16 *Set measuring range*
17 *Nominal measuring range*

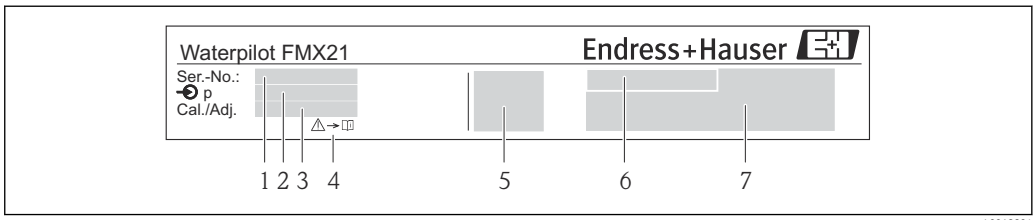
Additional nameplate for devices with approvals



A0018805

1 *Approval symbol (drinking water approval)*
2 *Reference to associated documentation*
3 *Approval number (marine approval)*

4.3.2 Additional nameplate for devices with external diameter 22 mm (0.87 in) and 42 mm (1.65 in)



1 Serial number
2 Nominal measuring range
3 Set measuring range
4 CE mark or approval symbol
5 Certificate number (optional)
6 Text for approval (optional)
7 Reference to documentation

4.4 Identification of sensor type

With gauge pressure or absolute pressure sensors, the "Pos. zero adjust" parameter is displayed in the operating menu. With absolute pressure sensors, the "Calib. offset" parameter is displayed in the operating menu.

4.5 Storage and transport

4.5.1 Storage conditions

Use original packaging.

Store the measuring device in clean and dry conditions and protect from damage caused by shocks (EN 837-2).

Storage temperature range

Device + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −30 to +80 °C (−22 to +176 °F)
- With PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT72 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

4.5.2 Transporting the product to the measuring point

⚠ WARNING

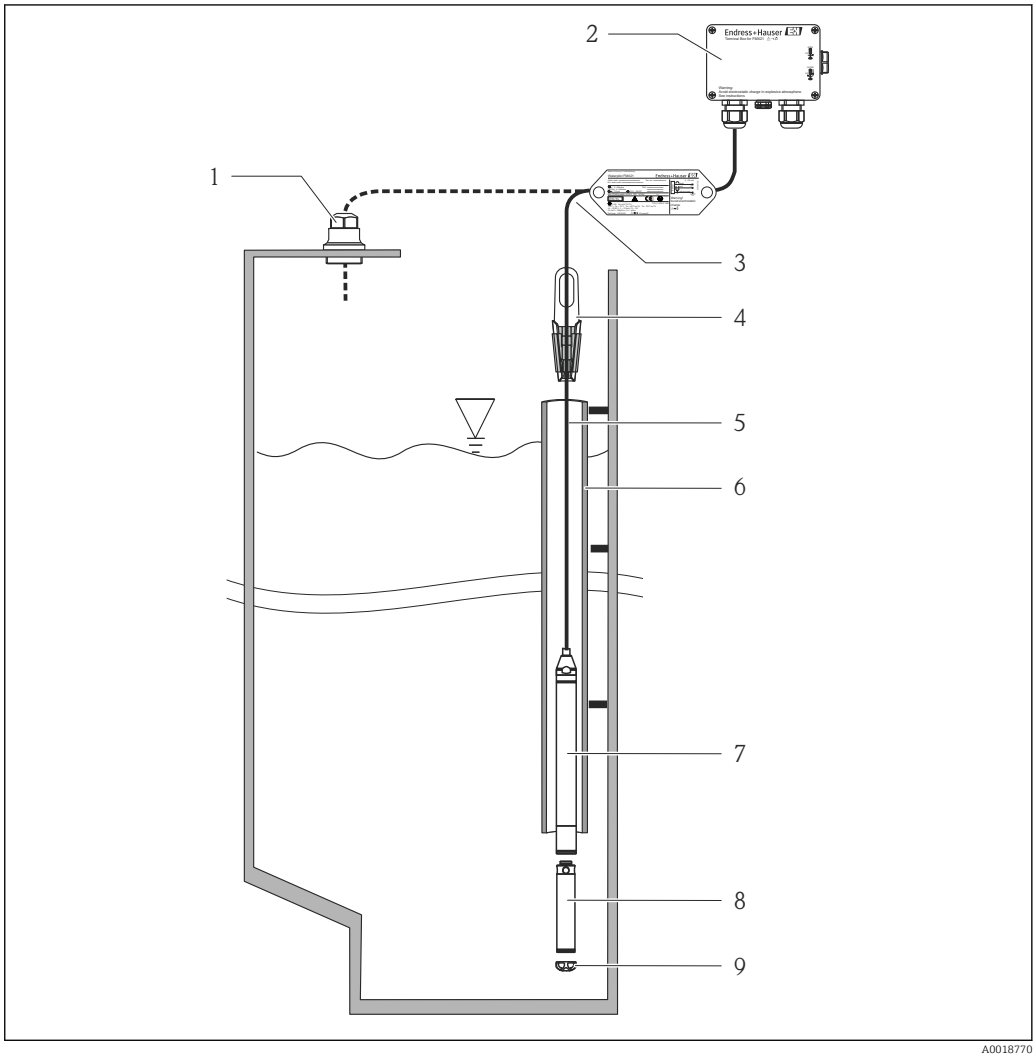
Incorrect transport!

Device or cable may become damaged, and there is a risk of injury!

- ▶ Transport measuring device in the original packaging.
- ▶ Follow the safety instructions and transport conditions for devices weighing more than 18 kg (39.6 lbs).

5 Mounting

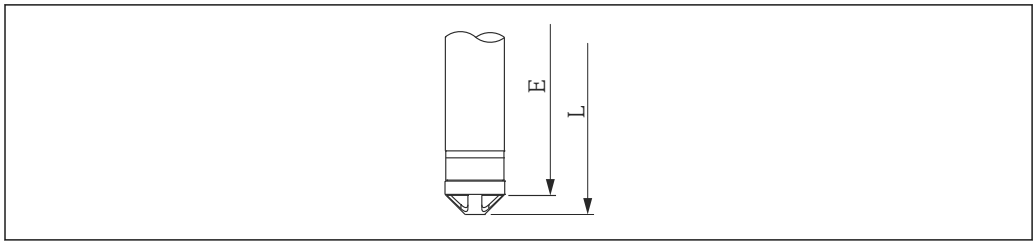
5.1 Mounting requirements



1 *Cable mounting screw (can be ordered as an accessory)*
2 *Terminal box (can be ordered as an accessory)*
3 *Bending radius of extension cable 120 mm (4.72 in)*
4 *Suspension clamp (can be ordered as an accessory)*
5 *Extension cable*
6 *Guide tube*
7 *Device*
8 *Additional weight can be ordered as an accessory for the device with external diameter of 22 mm (0.87 in) and 29 mm (1.14 in)*
9 *Protective cap*

5.2 Additional mounting instructions

- Cable length
  - Customer-specific in meters or feet.
  - Limited cable length when performing installation with freely suspended device with cable mounting screw or mounting clamp, as well as for FM/CSA approval: max. 300 m (984 ft).
- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) greater than the external diameter of the selected FMX21.
- To avoid mechanical damage to the measuring cell, the device is equipped with a protection cap.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides humidity and climatic protection and is suitable for installation outdoors → 126.
- Cable length tolerance: < 5 m (16 ft): ±17.5 mm (0.69 in); > 5 m (16 ft): ±0.2 %
- If the cable is shortened, the filter at the pressure compensation tube must be reattached. Endress+Hauser offers a cable shortening kit for this purpose → 126 (documentation SD00552P/00/A6).
- Endress+Hauser recommends using twisted, shielded cable.
- In shipbuilding applications, measures are required to restrict the spread of fire along cable looms.
- The length of the extension cable depends on the intended level zero point. The height of the protection cap must be taken into consideration when designing the layout of the measuring point. The level zero point (E) corresponds to the position of the process isolating diaphragm. Level zero point = E; tip of probe = L (see the following diagram).



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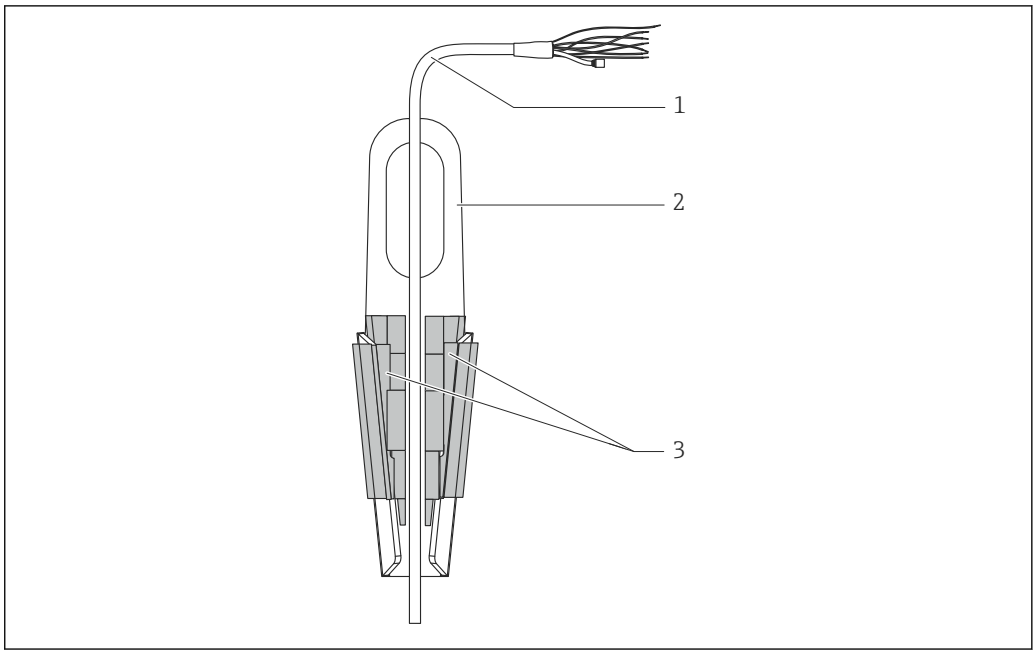
5.3 Dimensions

For dimensions, see the Technical Information

5.4 Mounting the Waterpilot with a suspension clamp

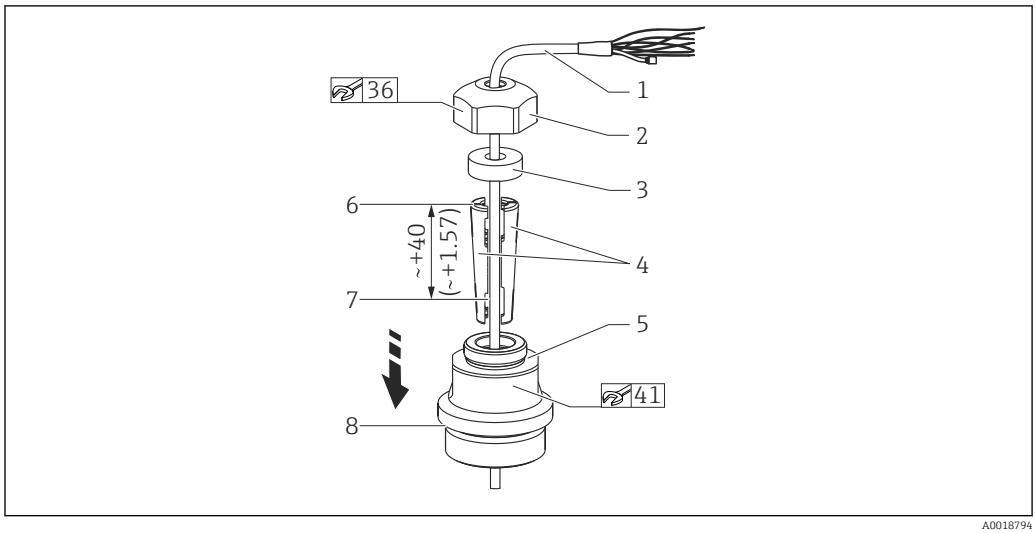


1 Extension cable
2 Suspension clamp
3 Clamping jaws

5.4.1 Mounting the suspension clamp:

1. Mount the suspension clamp (item 2). Take the weight of the extension cable (item 1) and the device into account when selecting the fastening point.
2. Push up the clamping jaws (item 3). Place the extension cable (item 1) between the clamping jaws as shown in the graphic.
3. Hold the extension cable (item 1) in position and push the clamping jaws (item 3) back down. Tap the clamping jaws gently from above to fix them in place.

5.5 Mounting the device with a cable mounting screw



1 *Illustrated with G 1½" thread. Unit of measurement mm (in)*

1 *Extension cable*
2 *Cover for cable mounting screw*
3 *Sealing ring*
4 *Clamping sleeves*
5 *Adapter for cable mounting screw*
6 *Top edge of clamping sleeve*
7 *Desired length of extension cable and Waterpilot probe prior to assembly*
8 *After assembly, item 7 is located next to the mounting screw with G 1½" thread: height of sealing surface of the adapter or NPT 1½" thread height of thread run-out of adapter*

If you want to lower the level probe to a certain depth, position the top edge of the clamping sleeve 40 mm (4.57 in) higher than the required depth. Then push the extension cable and the clamping sleeve into the adapter as described in Step 6 in the following section.

5.5.1 Mounting the cable mounting screw with a G 1½" or NPT 1½" thread:

1. Mark the desired length of extension cable on the extension cable.
2. Insert the probe through the measuring aperture and carefully lower on the extension cable. Fix the extension cable to prevent it from slipping.
3. Slide the adapter (item 5) over the extension cable and screw it tightly into the measuring aperture.
4. Slide the sealing ring (item 3) and cover (item 2) onto the cable from above. Press the sealing ring into the cover.
5. Place the clamping sleeves (item 4) around the extension cable (item 1) at the marked point as illustrated in the graphic.
6. Slide the extension cable with the clamping sleeves (item 4) into the adapter (item 5)
7. Fit the cover (item 2) with the sealing ring (item 3) onto the adapter (item 5) and securely screw together with the adapter.

To remove the cable mounting screw, perform this sequence of steps in reverse.

CAUTION

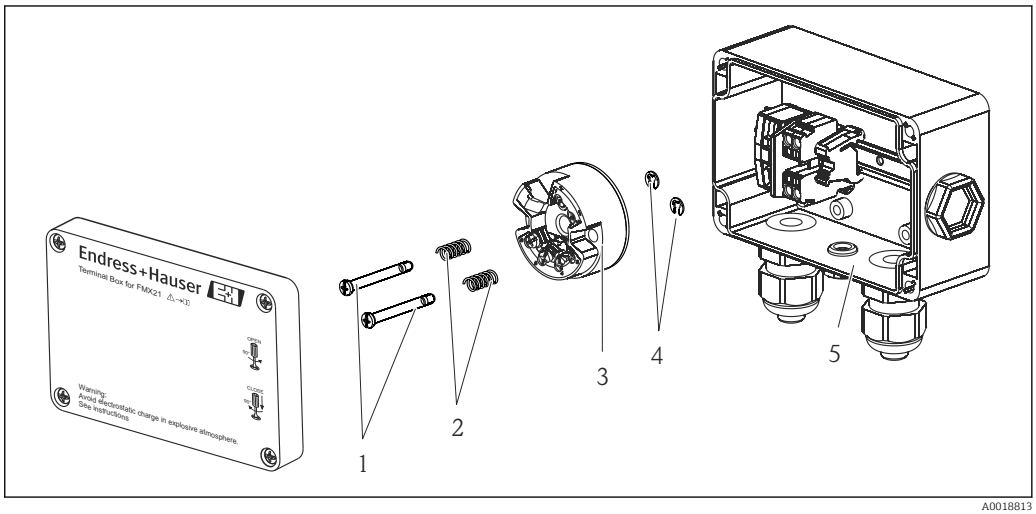
Risk of injury!

- Use only in unpressurized vessels.

5.6 Mounting the terminal box

The optional terminal box is mounted using four screws (M4). For the dimensions of the terminal box, see the Technical Information

5.7 Mounting the TMT72 temperature head transmitter with terminal box



A0018813

1 *Mounting screws*
2 *Mounting springs*
3 *TMT72 temperature head transmitter*
4 *Circlips*
5 *Terminal box*

Only open the terminal box with a screwdriver.

WARNING

Explosion Hazard!

- The TMT72 is not designed for use in hazardous areas.

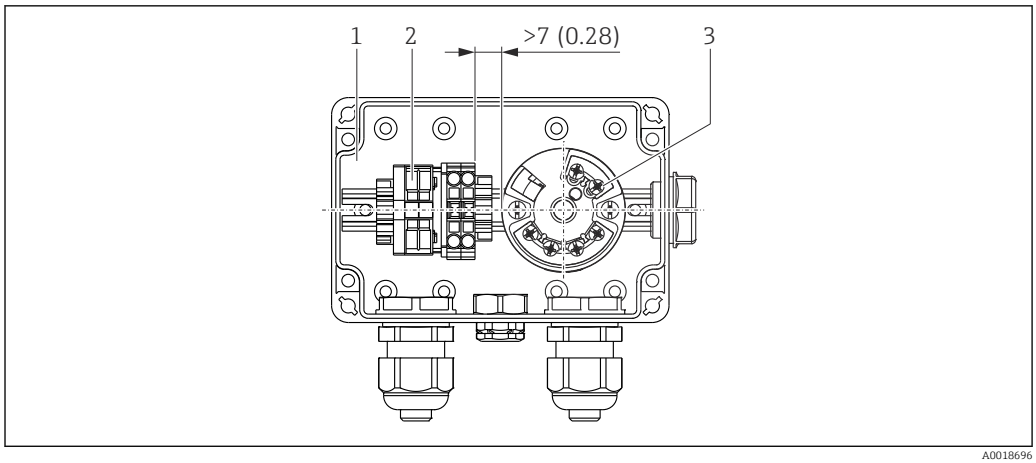
5.7.1 Mounting the temperature head transmitter:

1. Guide the mounting screws (item 1) with the mounting springs (item 2) through the bore of the temperature head transmitter (item 3)
2. Secure the mounting screws with the circlips (item 4). Circlips, mounting screws and springs are included in the scope of delivery for the temperature head transmitter.
3. Screw the temperature head transmitter into the field housing tightly. (Width of screwdriver blade max. 6 mm (0.24 in))

NOTICE

Avoid damage to the temperature head transmitter.

- Do not overtighten the mounting screw.



A0018696

Unit of measurement mm (in)

1 Terminal box
2 Terminal strip
3 TMT72 temperature head transmitter

NOTICE

Incorrect connection!

- A distance of > 7 mm (28 in) must be maintained between the terminal strip and the TMT72 temperature head transmitter.

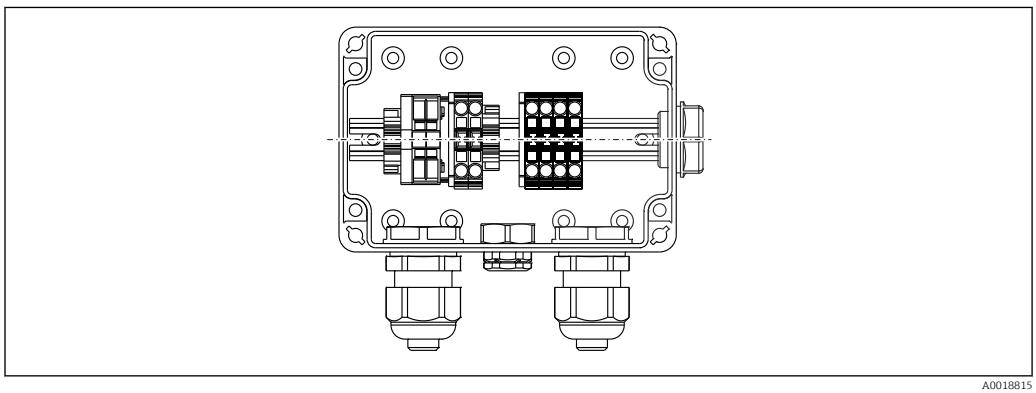
5.8 Mounting the terminal strip for the Pt100 passive (without TMT72)

If the FMX21 with optional Pt100 is supplied without the optional TMT72 temperature head transmitter, a terminal strip is provided with the terminal box for the purpose of wiring the Pt100.

⚠ WARNING

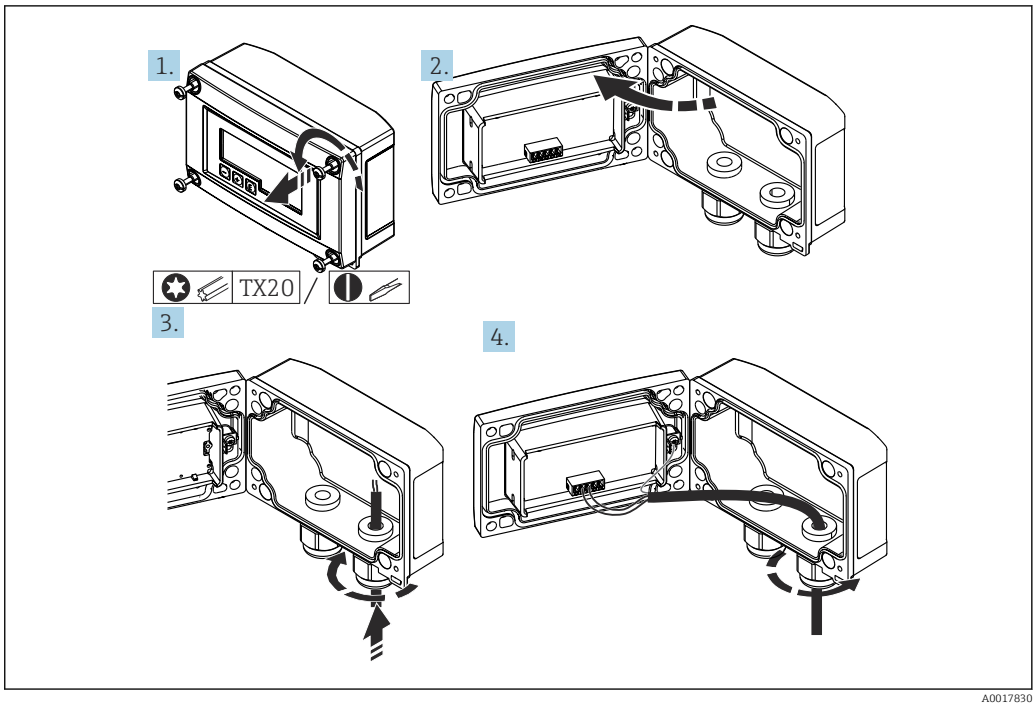
Explosion Hazard!

- The Pt100, as well as the terminal strip, are not designed for use in hazardous areas.



A0018815

5.9 Inserting the cable into the RIA15 field housing



A0017830

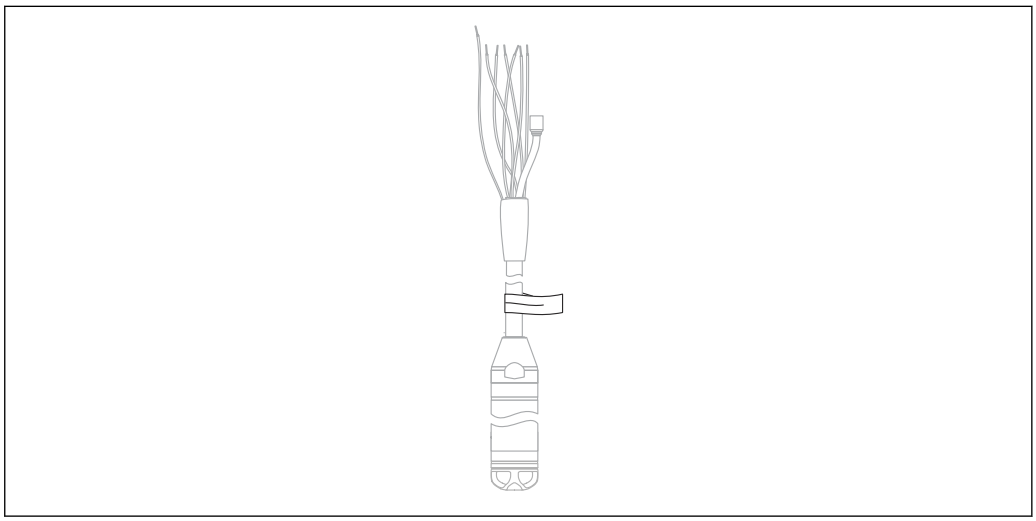
Inserting the cable, field housing, connection without transmitter power supply (example)

1. Release the housing screws
2. Open the housing
3. Open the cable gland (M16) and insert the cable
4. Connect the cable including the functional grounding and close the cable gland

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

If using the communication resistance module in the RIA15, the cable of the device must be inserted into the right gland when connecting the device so that the integrated pressure compensation tube is not pinched.

5.10 Cable marking



A0030955

- To make installation easier, Endress+Hauser marks the extension cable if a customer-specific length has been ordered.
- Cable marking tolerance (distance to lower end of level probe):
  Cable length < 5 m (16 ft): ±17.5 mm (0.69 in)
  Cable length > 5 m (16 ft): ±0.2 %
- Material: PET, stick-on label: acrylic
- Immunity to temperature change: −30 to +100 °C (−22 to +212 °F)

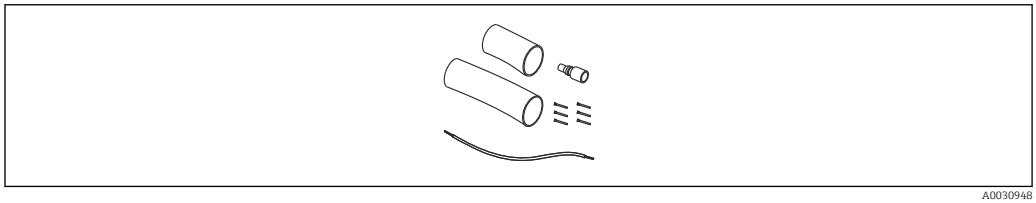
NOTICE

The marking is used exclusively for installation purposes.

▶ The mark must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

Not for the use of the device in hazardous areas.

5.11 Cable shortening kit



A0030948

The cable shortening kit is used to shorten a cable easily and professionally.

The cable shortening kit is not designed for the device with FM/CSA approval.

- Ordering information: see Product Configurator
- Associated documentation SD00552P/00/A6.

5.12 Post-mounting check

- Is the device undamaged (visual inspection)?
- Does the device conform to the measuring point specifications?
  - Process temperature
  - Process pressure
  - Ambient temperature
  - Measuring range
- Are the measuring point identification and labeling correct (visual inspection)?
- Check that all screws are firmly seated

6 Electrical connection

⚠ WARNING

Electrical safety is compromised by an incorrect connection!

- When using the measuring device in a hazardous area, the relevant national standards and guidelines as well as the Safety Instructions (XAs) or installation or control drawings (ZDs) must be adhered to. All data relating to explosion protection can be found in separate documentation which is available on request. This documentation is supplied with the devices as standard

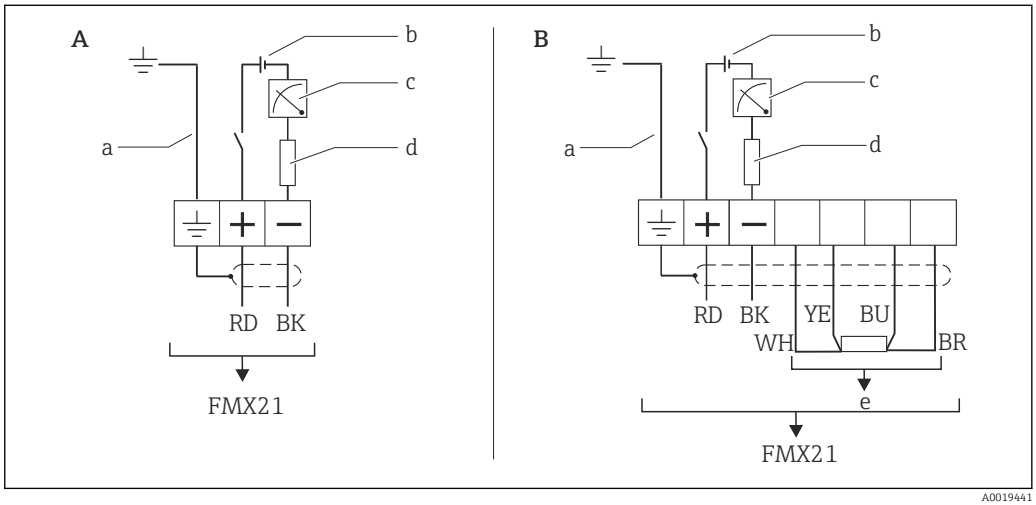
6.1 Connecting the device

⚠ WARNING

Electrical safety is compromised by an incorrect connection!

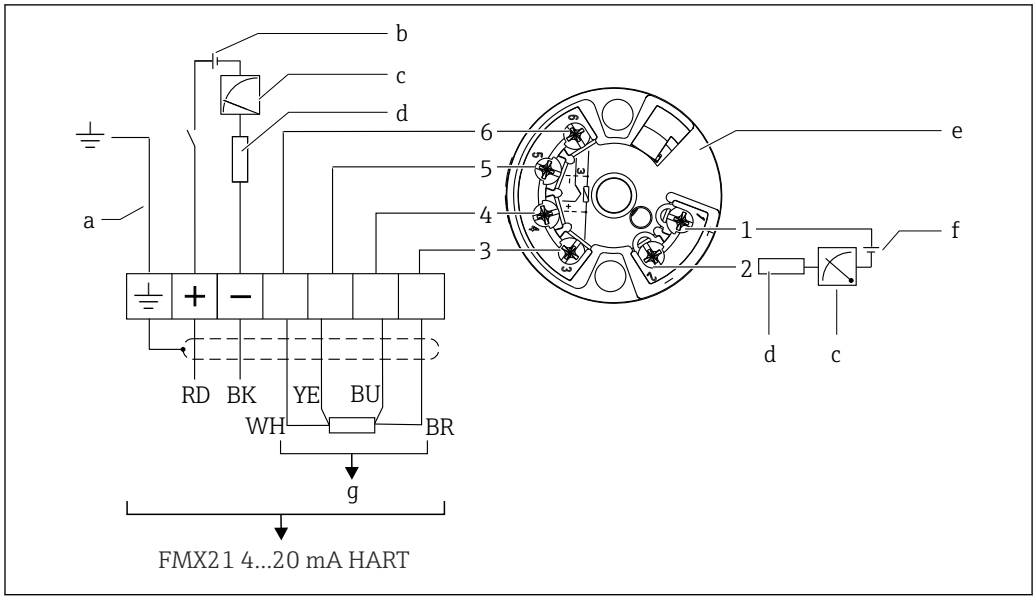
- The supply voltage must match the supply voltage specified on the nameplate
- Switch off the supply voltage before connecting the device.
- The cable must end in a dry room or a suitable terminal box. The IP66/IP67 terminal box with GORE-TEX® filter from Endress+Hauser is suitable for outdoor installation.→ 21
- Connect the device in accordance with the following diagrams. Reverse polarity protection is integrated in the device and the temperature head transmitter. Changing the polarities will not result in the destruction of the devices.
- A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.

6.1.1 Device with Pt100



A Device
B Device with Pt100 (not for use in hazardous areas)
a Not for devices with external diameter of 29 mm (1.14 in)
b 10.5 to 30 V_{DC} (hazardous area), 10.5 to 35 V_{DC}
c 4 to 20 mA
d Resistance (R_L)
e Pt100

6.1.2 Device with Pt100 and TMT72 temperature head transmitter



a *Not for devices with external diameter of 29 mm (1.14 in)*
b *10.5 to 35 V_{DC}*
c *4 to 20 mA*
d *Resistance (R_L)*
e *TMT72 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)*
f *11.5 to 35 V_{DC}*
g *Pt100*
1 to 6 *Pin assignment*

6.1.3 Device with RIA15

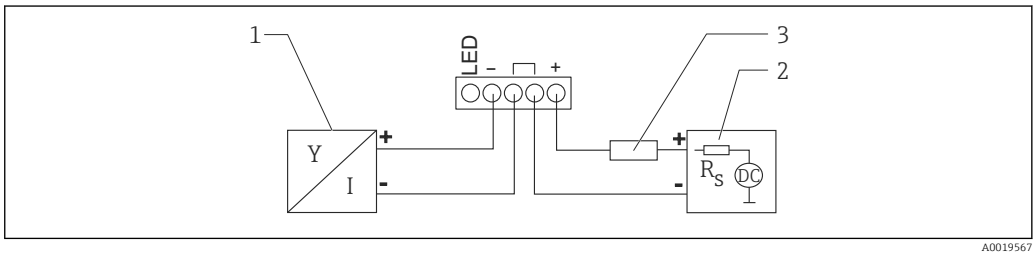
The RIA15 remote display (for Ex or non-Ex area) can be ordered together with the device. See the Product Configurator.

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

The RIA15 process indicator is loop-powered and does not require any external power supply.

The voltage drop to be taken into account is:
- ≤1 V in the standard version with 4 to 20 mA communication
- ≤1.9 V with HART communication
- and an additional 2.9 V if display light is used

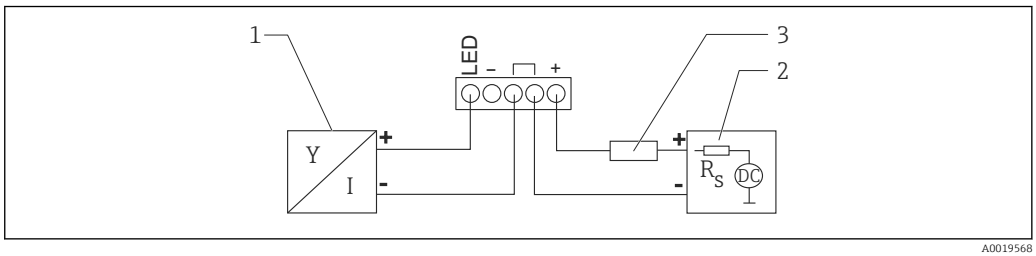
Without backlighting



2 *Block diagram; connection of the device with HART communication and RIA15 without backlighting*

1 Device
2 Power supply
3 HART resistor

With backlighting



3 *Block diagram; connection of the device with HART communication and RIA15 with backlighting*

1 Device
2 Power supply
3 HART resistor

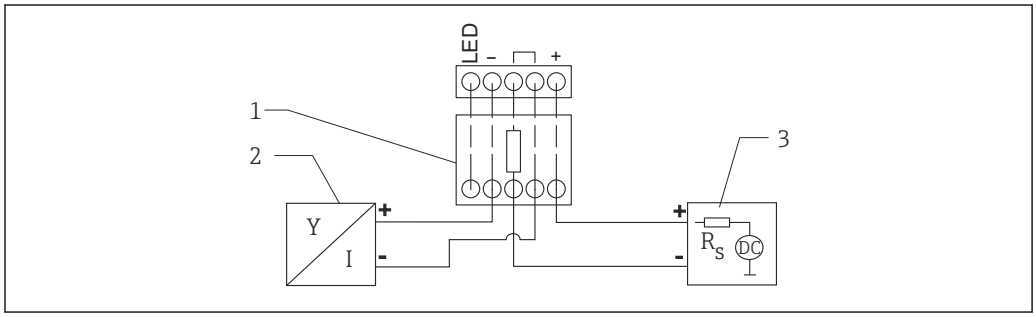
6.1.4 Device, RIA15 with installed HART communication resistor module

The HART communication module for installation in the RIA15 (for Ex or non-Ex areas) can be ordered together with the device.

The **voltage drop** to be taken into account is max. **7 V**

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

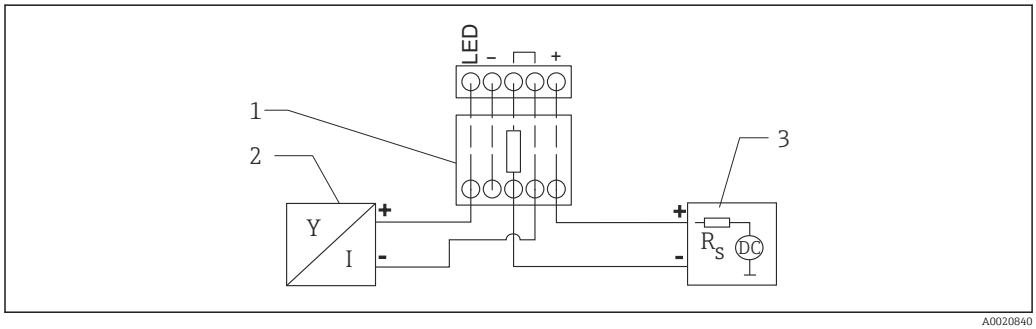
Without backlighting



4 *Block diagram; device connection, RIA15 without light, HART communication resistor*

1 *HART communication resistor module*
2 *Device*
3 *Power supply*

With backlighting



5 *Block diagram; device connection, RIA15 with light, HART communication resistor module*

1 *HART communication resistor module*
2 *Device*
3 *Power supply*

6.1.5 Wire colors

RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

6.1.6 Connection data

Connection classification as per IEC 61010-1:
- Overvoltage category 1
- Pollution level 1

Connection data in the hazardous area

See relevant XA.

6.2 Supply voltage

⚠ WARNING

Supply voltage might be connected!
Risk of electric shock and/or explosion!

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations as well as the Safety Instructions.
- All explosion protection data are given in separate Ex documentation, which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.

6.2.1 Device + Pt100 (optional)

- 10.5 to 35 V (non-hazardous area)
- 10.5 to 30 V (hazardous area)

6.2.2 TMT72 temperature head transmitter (optional)

11.5 to 35 V_{DC}

6.3 Cable specifications

Endress+Hauser recommends using shielded, twisted-pair two-wire cables.

The probe cables are shielded for device versions with outer diameters of 22 mm (0.87 in) and 42 mm (1.65 in).

6.3.1 Device + Pt100 (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)

6.3.2 TMT72 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm^2 (15 AWG)

6.4 Power consumption

6.4.1 Device + Pt100 (optional)

- ≤ 0.805 W at 35 V_{DC} (non-hazardous area)
- ≤ 0.690 W at 30 V_{DC} (hazardous area)

6.4.2 TMT72 temperature head transmitter (optional)

≤ 0.805 W at 35 V_{DC}

6.5 Current consumption

6.5.1 Device + Pt100 (optional)

Max. current consumption: ≤ 23 mA
Min. current consumption: ≥ 3.6 mA

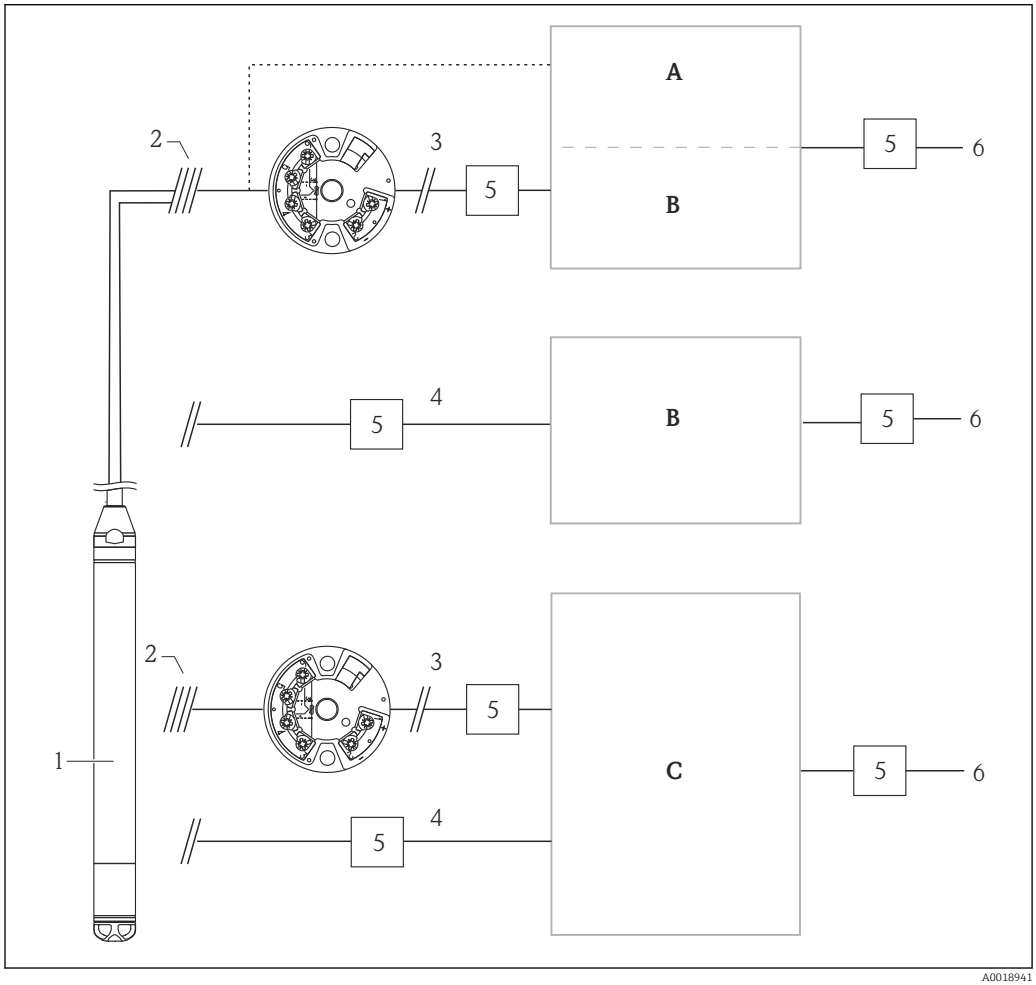
6.5.2 TMT72 temperature head transmitter (optional)

- Max. current consumption: ≤ 23 mA
- Min. current consumption: ≥ 3.5 mA

6.6 Connecting the measuring unit

6.6.1 Overvoltage protection

To protect the Waterpilot and the TMT72 temperature head transmitter from large interference voltage peaks, Endress+Hauser recommends installing overvoltage protection upstream and downstream of the display and/or evaluation unit as shown in the graphic.



A Power supply, display and evaluation unit with one input for Pt100
B Power supply, display and evaluation unit with one input for 4 to 20 mA
C Power supply, display and evaluation unit with two inputs for 4 to 20 mA
1 Device
2 Connection for integrated Pt100 in the FMX21
3 4 to 20 mA HART (temperature)
4 4 to 20 mA HART (level)
5 Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas.)
6 Power supply

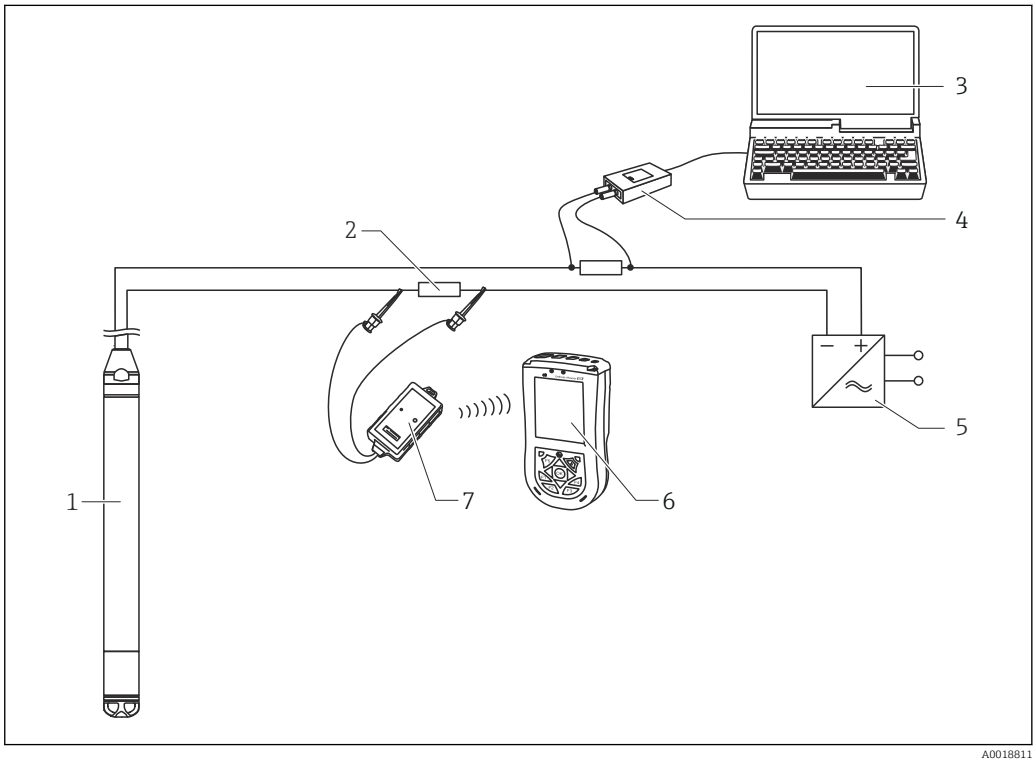
Further information on the TMT72 temperature head transmitter for HART applications from Endress+Hauser can be found in the Technical Information TI01392T.

6.6.2 Connecting the Commubox FXA195

The Commubox FXA195 connects transmitters with the HART protocol to the USB interface of a computer. This enables remote operation of the transmitter using the Endress+Hauser operating program FieldCare/DeviceCare. Power is supplied to the Commubox via the USB port. The Commubox is also suitable for connecting to intrinsically safe circuits. For further information, see the Technical Information TI00404F/00/EN.

6.6.3 Connecting the Field Xpert SFX

Compact, flexible and robust industrial handheld terminal for remote configuration and for obtaining measured values via the HART current output (4 to 20 mA). For details, see Operating Instructions BA00060S/04/EN.



1 *Device*
2 *Required communication resistor ≥ 250 Ω*
3 *Computer with operating tool (e.g. FieldCare)*
4 *Commubox FXA195 (USB)*
5 *Transmitter power supply unit, e.g. RN221N (with communication resistor)*
6 *Field Xpert SFX*
7 *VIATOR Bluetooth modem with connecting cable*

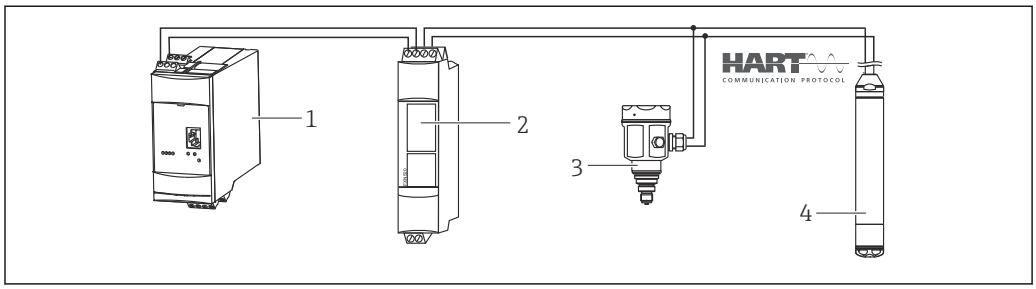
Only use certified operating devices in hazardous area!

WARNING

Explosion Hazard!

- Do not change the battery of the handheld terminal in the hazardous area.
- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs).

6.6.4 Connecting for air pressure compensation with external measured value



1 *Fieldgate FXA520*
2 *Multidrop Connector FXN520*
3 *Cerabar*
4 *Waterpilot FMX21*

For applications in which condensation may occur, the use of an absolute pressure probe is recommended. For level measurement using an absolute pressure probe, the measured value is affected by fluctuations in the ambient air pressure. To correct the resulting measured error, you can connect an external absolute pressure sensor (e.g. Cerabar) to the HART signal line, switch the Waterpilot to burst mode and operate the Cerabar in the "Electr. Delta P" mode.

When you switch on the "Electr. Delta P" application, the external absolute pressure sensor calculates the difference between the two pressure signals and can thus determine the level precisely. Only one level measured value can be corrected in this way.

For additional information, see → 56.

If using intrinsically safe devices, the regulations which apply to interconnecting intrinsically safe circuits as outlined in IEC 60079-14 (proof of intrinsic safety) must be observed.

6.6.5 Connecting an external temperature sensor/temperature head transmitter for density compensation

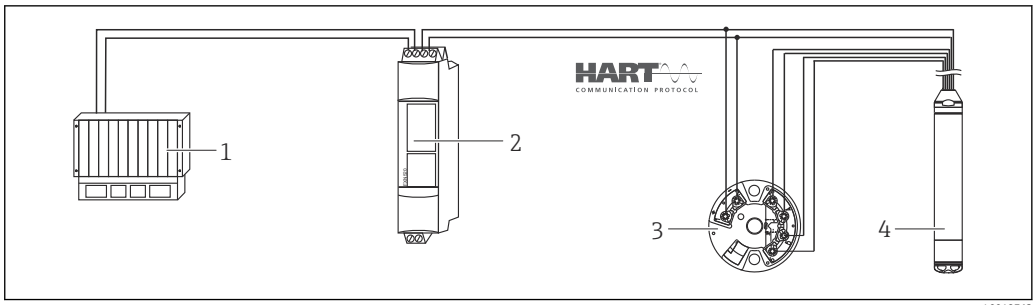
The device can correct measured errors that result from fluctuations in the density of the water caused by temperature. Users can choose from the following options:

Use the internally measured sensor temperature of the device

The internally measured sensor temperature is calculated in the device for density compensation. The level signal is thus corrected according to the density characteristic line of water.

Use the optional internal Pt100 temperature sensor for density compensation in a suitable HART master (e.g. PLC)

The Waterpilot FMX21 is available with an optional Pt100 temperature sensor. To convert the Pt100 signal to a 4 to 20 mA HART signal, Endress+Hauser also offers the TMT72 temperature head transmitter. The temperature and pressure signal is queried by a HART master (e.g. PLC), where a corrected level value can be generated using a stored linearization table or density function (of a chosen medium).

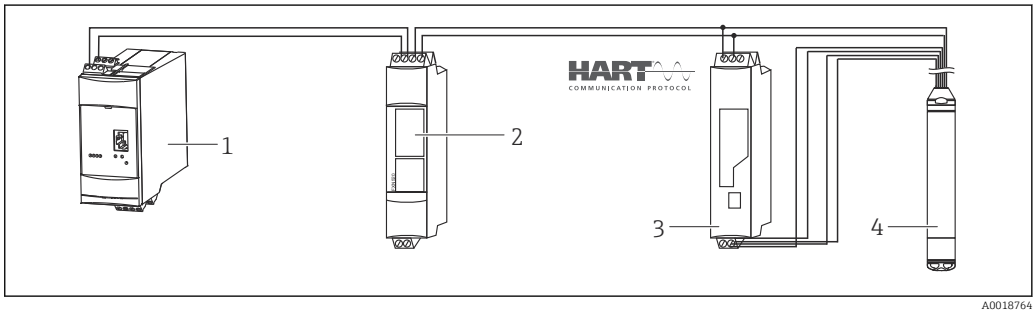


1 *HART master, e.g. PLC (programmable logic controller)*
2 *Multidrop Connector FXN520*
3 *TMT72 temperature head transmitter*
4 *Device*

Use an external temperature signal which is transmitted to the FMX21 via HART burst mode

The device is available with an optional Pt100 temperature sensor. With this option, the signal of the Pt100 is evaluated with a HART-compliant temperature head transmitter (min. HART 5.0) that supports the burst mode. The temperature signal can be transmitted to the device in this way. The device uses this signal for density correction of the level signal.

The TMT72 temperature head transmitter is not suitable for this configuration.



1 *Fieldgate FXA520*
2 *Multidrop Connector FXN520*
3 *HART-compatible temperature transmitter with burst function (e.g. TMT82)*
4 *Device*

Without additional compensation due to the anomaly of water, errors of up to 4 % may occur at a temperature of +70 °C (+158 °F), for example. With density compensation, this error is less than 0.5 % in the entire temperature range from 0 to +70 °C (+32 to +158 °F).

For additional information, see → 58.

For further information on the devices, please refer to the relevant Technical Information:
- TI01010T: temperature transmitter TMT82 (4 to 20 mA HART)
- TI00369F: Fieldgate FXA520
- TI00400F: Multidrop Connector FXN520

6.7 Post-connection check

- Are the device or cables undamaged (visual check)?
- Do the cables used comply with the requirements?
- Do the mounted cables have adequate strain relief?

- Are all cable glands installed, securely tightened and leak-tight?
- Does the supply voltage match the information on the nameplate?
- Is the terminal assignment correct?

7 Operation options

Endress+Hauser offers comprehensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX21 HART and TMT72 temperature head transmitter.

Your Endress+Hauser service organization would be glad to be of service if you have any other questions. Contact addresses are available at: www.endress.com/worldwide

7.1 Overview of operation options

7.1.1 Operation using Endress+Hauser operating program

FieldCare

The FieldCare operating program is an Endress+Hauser asset management tool based on FDT technology. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard.

Hardware and software requirements can be found on the Internet:

www.de.endress.com → Search: FieldCare → FieldCare → Technical data.

FieldCare supports the following functions:
- Configuration of transmitters in online/offline mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Connection options:
- HART via Commubox FXA195 and USB interface of a computer
- HART via Fieldgate FXA520

- Further information on FieldCare and software download can be found on the internet (www.de.endress.com ® Downloads ® Text Search: FieldCare).
- Connecting the Commubox FXA195
- As not all internal device dependencies can be mapped in offline operation, the consistency of the parameters must be checked once again before they are transmitted to the device.

DeviceCare

Function scope

Tool for connecting and configuring Endress+Hauser field devices.

The fastest way to configure Endress+Hauser field devices is with the dedicated "DeviceCare" tool. Together with the device type managers (DTMs) it presents a convenient, comprehensive solution.

For details, see Innovation Brochure IN01047S

7.1.2 Operation via Field Xpert SFX

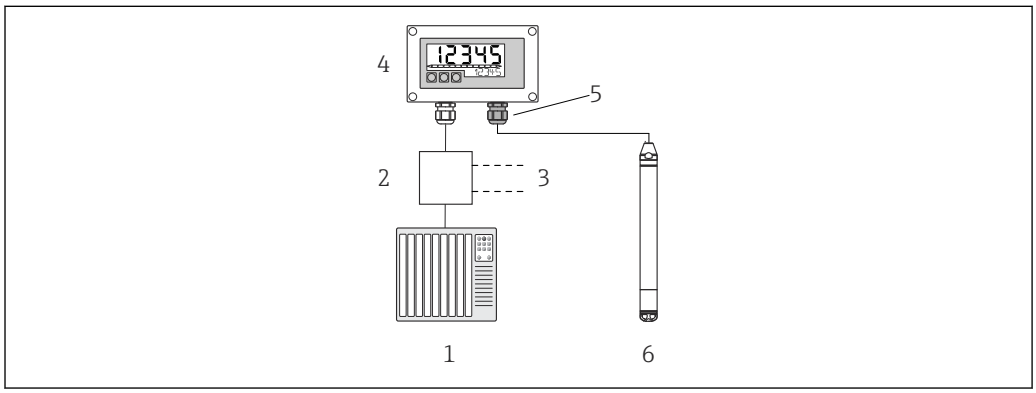
Compact, flexible and robust industrial handheld terminal for remote parameterization and for obtaining measured values via the HART current output or FOUNDATION Fieldbus. For details, see the Operating Instructions BA00060S/04.

7.1.3 Operation via RIA15

The RIA15 can be used as a local display unit and for the basic configuration of the Waterpilot FMX21 hydrostatic level sensor via HART.

The following parameters can be configured on the FMX21 using the 3 operating keys on the front of the RIA15:
- Pressure engineering unit, level, temperature
- Zero adjustment (only for gauge pressure sensors)
- Empty and full pressure adjustment
- Empty and full level adjustment
- Reset to factory defaults

Further information on the operating parameters → 66



6 Remote operation of the device via the RIA15

1 PLC
2 Transmitter power supply, e.g. RN221N (with communication resistor)
3 Connection for Commubox FXA195 and Field Communicator 375, 475
4 Loop-powered RIA15 process indicator
5 Cable gland M16 with pressure compensation membrane
6 Device

7.2 Operating concept

Operation with an operating menu is based on an operation concept with "user roles" .

- **Operator**
  Operators are responsible for the devices during normal "operation". This is usually limited to the reading of process values. If the work with the devices goes beyond reading, it concerns simple, application-specific functions that are used in operation. Should an error occur, these users simply forward the information on the errors but do not intervene themselves.
- **Maintenance**
  Service engineers usually work with the devices in the phases following device commissioning. They are primarily involved in maintenance and troubleshooting activities for which simple settings have to be made on the device. Technicians work with the devices over the entire life cycle of the product. Thus, commissioning and advanced settings and configurations are some of the tasks they have to carry out.
- **Expert**
  Experts work with the devices over the entire life cycle of the device, but, at times, have high device requirements. Individual parameters/functions from the overall functionality of the devices are required for this purpose time and again. In addition to technical, process-oriented tasks, experts can also perform administrative tasks (e.g. user administration). The "Expert" has access to the entire parameter set.

7.3 Structure of the operating menu

- **Operator**
  Submenu: Display/operat.
  Contains parameters that are needed to configure the measured value display (selecting the values displayed, display format, etc.). With this submenu, users can change the measured value display without affecting the actual measurement.
- **Maintenance**
  Submenu: Setup
  Contains all the parameters that are needed to commission measuring operations. This submenu has the following structure:
  - **Standard setup parameters**
    A wide range of parameters, which can be used to configure a typical application, is available at the start. The measuring mode selected determines which parameters are available. After making settings for all these parameters, the measuring operation should be completely configured in the majority of cases.
  - **"Extended setup" submenu**
    The "Extended setup" submenu contains additional parameters for more in-depth configuration of the measurement operation, for conversion of the measured value and for scaling the output signal. This menu is split into additional submenus depending on the measuring mode selected.
- **Maintenance**
  Submenu: Diagnostics
  Contains all the parameters required to detect and analyze operating errors. This submenu has the following structure:
  - **Diagnostic list**
    Contains up to 10 currently active error messages.
  - **Event logbook**
    Contains the last 10 error messages (no longer pending).
  - **Instrument info**
    Contains information for identifying the device.
  - **Measured values**
    Contains all current measured values.
  - **Simulation**
    Is used to simulate pressure, level, current and alarm/warning.
  - **Enter reset code**
- Expert
  Submenu: Expert
  Contains all the parameters of the device (including those already in one of the other submenus). The "Expert" submenu is structured by the function blocks of the device. It thus contains the following submenus:
  - **System**
    Contains all the device parameters that do not pertain either to the measurement or to integration into a control system.
  - **Measurement**
    Contains all parameters for configuring the measurement.
  - **Output**
    Contains all parameters for configuring the current output.
  - **Communication**
    contains all parameters for configuring the HART interface.
  - **Diagnosis**
    Contains all parameters required to detect and analyze operating errors.

7.4 Locking/unlocking operation

Once you have entered all the parameters, you can lock your entries against unauthorized and undesired access.

The "Operator code" parameter is used to lock/unlock the device.

Operator code

Navigation	Setup → Extended setup → Operator code
Read permission	Operator/Maintenance/Expert
Write permission	Operator/Maintenance/Expert
Description	Use this function to enter a code to lock or unlock operation.
User entry	▪ To lock: Enter a number ≠ the release code (value range: 1 to 65535). ▪ To unlock: Enter the release code.
Factory setting	0
Note	The release code is "0" in the order configuration. Another release code can be defined in the "Code definition" parameter. If the user has forgotten the release code, the release code can be made visible by entering the number "5864". The release code is defined in the "Code definition" parameter.

Code definition

Navigation	Setup → Extended setup → Code definition
Read permission	Operator/Maintenance/Expert
Write permission	Operator/Maintenance/Expert
Description	Use this function to enter a release code with which the device can be unlocked.
User entry	A number from 0 to 9999
Factory setting	0
Note	The device setup can also be disabled on the RIA15 via a 4-digit user code. Additional information is available in the RIA15 Operating Instructions BA01170K.

7.5 Resetting to factory settings (reset)

By entering a certain code, you can completely or partially reset the entries for the parameters to the factory settings [1]. Enter the code via the "Enter reset code" parameter (menu path: "Diagnosis" → "Enter reset code").

There are various reset codes for the device. The following table illustrates which parameters are reset by the particular reset codes. To perform a reset, operation must be unlocked (see the "Locking/unlocking operation" section).→ 37

Any customer-specific configuration carried out at the factory is not affected by a reset (customer-specific configuration remains). If you want to change the customer-specific configuration carried out at the factory, please contact Endress+Hauser Service. As there is no separate service level, the order code and serial number can be changed without a specific release code.

Reset code [2]

- **62** (PowerUp reset (warm start))
  - The device is restarted.
  - Data is read back anew from the EEPROM (process is reinitialized).
  - Any simulation which may be running is ended.
- **333** (User reset)
  - This code resets all the parameters apart from: device tag, linearization table, operating hours, event logbook, current trim 4 mA , current trim 20 mA
  - Any simulation which may be running is ended.
  - The device is restarted.
- **7864** (Total reset)
  - This code resets all the parameters apart from: operating hours, event logbook
  - Any simulation which may be running is ended.
  - The device is restarted.

After a "Total reset" in FieldCare you have to press the "refresh" button in order to ensure that the measuring units are also reset.

1) The factory setting for the individual parameters is specified in the parameter description
2) To be entered in "System" → "Management" → "Enter reset code"

8 Integrating device via HART® protocol

Version data for the device
- Firmware version: 01.00.zz
  - On the title page of the Operating Instructions
  - On the nameplate
  - **Firmware Version** parameter: Diagnosis → Instrument info → Firmware Version
- Manufacturer ID: 17 (0x11)
  Manufacturer ID parameter: Diagnosis → Instrument info → Manufacturer ID
- Device type code: 36 (0x24)
  Device ID parameter: Diagnosis → Instrument info → Device ID
- HART protocol revision: 6.0

- Device revision: 1
  - On the nameplate
  - **Device revision** parameter: Diagnosis → Instrument info → Device revision

The suitable device description file (DD) for the individual operating tools is listed in the table below, along with information on where the file can be acquired.

Operating tools
- FieldCare
  - www.endress.com → Download area
  - CD–ROM (contact Endress+Hauser)
  - DVD (contact Endress+Hauser)
- AMS Device Manager (Emerson Process Management)
  www.endress.com → Download area
- SIMATIC PDM (Siemens)
  www.endress.com → Download area
- Field Communicator 375, 475 (Emerson Process Management)
  Use update function of handheld terminal

8.1 HART process variables and measured values

The following numbers are assigned to the process variables in the factory:

Process variable	Pressure	Level	
		Linear	Table active
First process variable (Primary variable)	0 (Pressure measured)	8 (Level before linearization)	9 (Tank content)
Second process variable (Secondary variable)	2 (Corrected press.)	0 (Pressure measured)	8 (Level before linearization)
Third process variable (Tertiary variable)	3 (Sensor pressure)	2 (Corrected press.)	0 (Pressure measured)
Fourth process variable (Quaternary variable)	4 (Sensor temp.)		

The assignment of the device variables to the process variable is displayed in the **Expert → Communication → HART output** menu.

The assignment of the device variables to the process variable (SV, TV, QV) can be changed using HART command 51.

An overview of the possible device variables can be found in the following section.

8.2 Device variables and measured values

The following measured values are assigned to the individual device variables:

Device variable code	Device variable	Measured value	Operating mode
0	PRESSURE_1_FINAL_VALUE	Pressure measured	All
1	PRESSURE_1_AFTER_DAMPING	Pressure af. damp	All
2	PRESSURE_1_AFTER_CALIBRATION	Corrected pressure	All
3	PRESSURE_1_AFTER_SENSOR	Corrected pressure	All
4	MEASURED_TEMPERATURE_1	Sensor temp.	All
8	MEASURED_LEVEL_AFTER_ SIMULATION	Level before lin.	Only level
9	MEASURED_TANK_CONTENT_AFTER_ SIMULATION	Tank content	Only level
10	CORRECTED_MEASUREMENT_ DENSITY	Process density	Only level
12	HART_INPUT_VALUE [1)]	HART input value	-
251	None (no device variable is mapped)	-	All (but only for quaternary variable)

1) Cannot be selected as an output

The device variables can be queried by a HART® master using HART® command 9 or 33.

9 Commissioning

NOTICE

If a pressure smaller than the minimum permitted pressure or greater than the maximum permitted pressure is present at the device, the following messages are output in succession:

- ▶ "S140 Working range P" or "F140 Working range P" (depending on the setting in the "Alarm behav. P" parameter)
- ▶ "S841 Sensor range" or "F841 Sensor range" (depending on the setting in the "Alarm behav. P" parameter)
- ▶ "S971 Adjustment" (depending on setting in "Alarm behav. P" parameter

9.1 Function check

Before commissioning your measuring point, ensure that the post-installation and post-connection checks have been performed:

- "Post-installation check" checklist
- "Post-connection check" checklist

9.2 Unlocking/locking configuration

If the device is locked to prevent configuration, it must first be unlocked.

9.2.1 Locking/unlocking software

If the device is locked via the software (device access code), the key symbol appears in the measured value display. If an attempt is made to write to a parameter, a prompt for the device access code appears. To unlock, enter the user-defined access code.

9.3 Commissioning

Commissioning comprises the following steps:

- Function check
- Selection of the measuring mode and pressure unit
- Position adjustment
- Configuring measurement:
  - Pressure measurement
  - Level measurement

9.4 Selecting the measuring mode

The device is configured for the "Pressure" measuring mode as standard. The measuring range and the unit in which the measured value is transmitted correspond to the data on the nameplate.

WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

- ▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

Measuring mode

Navigation Setup → Measuring mode

Write permission Operator/Maintenance/Expert

Description Select the measuring mode.
The operating menu is structured differently depending on the measuring mode selected.

Options
- Pressure
- Level

Factory setting Level

9.5 Selecting the pressure engineering unit

Press. eng. unit

Navigation Setup → Press. eng. unit

Write permission Operator/Maintenance/Expert

Description Select the pressure unit. If a new pressure unit is selected, all pressure-specific parameters are converted and displayed with the new unit.

Options
- mbar, bar
- mmH2O, mH2O, inH2O
- ftH2O
- Pa, kPa, MPa
- psi
- mmHg, inHg
- kgf/cm^2

Factory setting mbar or bar depending on the nominal measuring range of the sensor module, or as per order specifications.

9.6 Position adjustment

A pressure shift resulting from the orientation of the device can be corrected by the position adjustment.

Pos. zero adjust (gauge pressure sensor)

Navigation Setup → Pos. zero adjust

Write permission Operator/Maintenance/Expert

Description Pos. zero adjustment – the pressure difference between zero (set point) and the measured pressure need not be known.

Options
- Confirm
- Cancel

Example
- Measured value = 2.2 mbar (0.033 psi)
- You correct the measured value via the "Pos. zero adjust" parameter with the "Confirm" option. This means that you are assigning the value 0.0 to the pressure present.
- Measured value (after pos. zero adjust) = 0.0 mbar
- The current value is also corrected.

Factory setting Cancel

Calib. offset

Write permission Maintenance/Expert

Description Position adjustment – the pressure difference between the set point and the measured pressure must be known.

Example
- Measured value = 982.2 mbar (14.73 psi)
- You correct the measured value with the value entered, e.g. 2.2 mbar (0.033 psi) via the "Calib. offset" parameter. This means that you are assigning the value 980 mbar (14.7 psi) to the pressure present.
- Measured value (after pos. zero adjustment) = 980 mbar (14.7 psi)
- The current value is also corrected.

Factory setting 0.0

9.7 Configuring the damping

The output signal follows measured value changes with the delay time. This can be configured via the operating menu.

Damping

Navigation Setup → Damping

Write permission Operator/Maintenance/Expert
(if the "Damping" DIP switch is set to "on")

Description Enter damping time (time constant τ) ("Damping" DIP switch set to "on")
Display damping time (time constant τ) ("Damping" DIP switch set to "off").
The damping affects the speed at which the measured value reacts to changes in pressure.

Input range 0.0 to 999.0 s

Factory setting 2 s or according to order specifications

9.8 Configuring pressure measurement

9.8.1 Calibration with reference pressure (wet calibration)

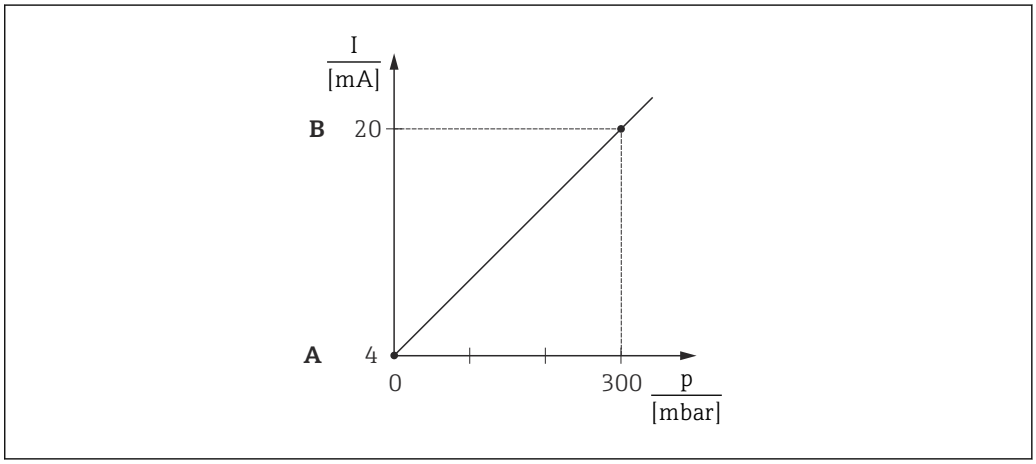
Example:

In this example, a device with a 400 mbar (6 psi) sensor module is configured for the 0 to +300 mbar (0 to 4.5 psi) measuring range, i.e. 0 mbar and 300 mbar (4.5 psi) are assigned, respectively, to the 4 mA value and the 20 mA value.

Prerequisite:

The pressure values 0 mbar and 300 mbar (4.5 psi) can be specified. The device is already mounted, for example.

Due to the orientation of the device, there may be pressure shifts in the measured value, i.e. the measured value is not zero in an unpressurized state. For information on how to perform position adjustment, see → 43.



A See step 3
B See step 4

1. Select the "Pressure" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The pressure for the LRV (4 mA value) is present at the device, here 0 mbar for example. Select the "Get LRV" parameter. Confirm the value present at the device by selecting "Apply". The pressure value present at the device is assigned to the lower current value (4 mA).
   ↳ Menu path: Setup → Extended setup → Current output → Get LRV

4. The pressure for the URV (20 mA value) is present at the device, here 300 mbar (4.5 psi) for example. Select the "Get URV" parameter. Confirm the value present at the device by selecting "Apply". The pressure value present at the device is assigned to the upper current value (20 mA).
   ↳ Menu path: Setup → Extended setup → Current output → Get URV

The measuring range is configured for 0 to +300 mbar (0 to 4.5 psi).

9.8.2 Calibration without reference pressure (dry calibration)

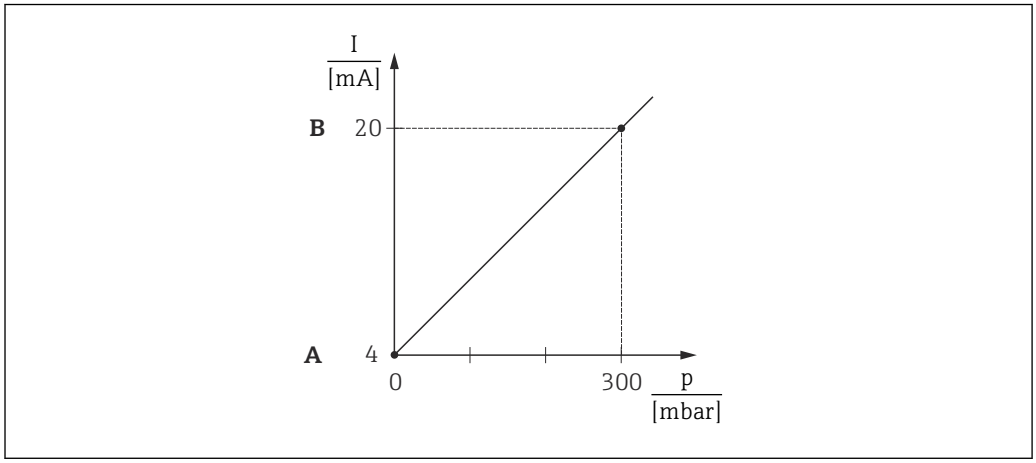
Example:

In this example, a device with a 400 mbar (6 psi) sensor module is configured for the 0 to +300 mbar (0 to 4.5 psi) measuring range, i.e. 0 mbar and 300 mbar (4.5 psi) are assigned, respectively, to the 4 mA value and the 20 mA value.

Prerequisite:

This is a theoretical calibration, i.e. the pressure values for the lower and upper range are known.

Due to the orientation of the device, there may be pressure shifts in the measured value, i.e. the measured value is not zero in an unpressurized state. For information on how to perform position adjustment, see → 43.



A See step 3
B See step 4

1. Select the "Pressure" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING
Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. Select the "Set LRV" parameter. Enter the value for the "Set LRV" parameter (here 0 mbar) and confirm. This pressure value is assigned to the lower current value (4 mA).
   ↳ Menu path: Setup → Extended setup → Current output → Set LRV

4. Select the "Set URV" parameter. Enter the value for the "Set URV" parameter (here 300 mbar (4.5 psi)) and confirm. This pressure value is assigned to the upper current value (20 mA).
   ↳ Menu path: Setup → Extended setup → Current output → Set URV

The measuring range is configured for 0 to +300 mbar (0 to 4.5 psi).

9.9 Configuring level measurement

9.9.1 Information on level measurement

You have a choice of two methods for calculating the level: "In pressure" and "In height". The table in the "Overview of level measurement" section that follows provides you with an overview of these two measuring tasks.

- The limit values are not checked, i.e. the values entered must be appropriate for the sensor module and the measuring task for the device to be able to measure correctly.
- Customer-specific units are not possible.
- The values entered for "Empty calib./Full calib.", "Empty pressure/Full pressure", "Empty height/Full height" and "Set LRV/Set URV" must be at least 1 % apart. The value will be rejected, and a message displayed, if the values are too close together.

9.9.2 Overview of level measurement

"In pressure" level selection
Calibration is performed by entering two pressure/level value pairs.
- Via the "Output unit" parameter: select %, level, volume or mass units
- Description:
  - Calibration with reference pressure (wet calibration) → 📄 49
  - Calibration without reference pressure (dry calibration) → 📄 47
- The measured value display and the "Level before lin" parameter display the measured value.

"In height" level selection
Calibration is performed by entering the density and two height/level value pairs.
- Via the "Output unit" parameter: select %, level, volume or mass units
- Description:
  - Calibration with reference pressure (wet calibration) → 📄 53
  - Calibration without reference pressure (dry calibration) → 📄 51
- The measured value display and the "Level before lin" parameter display the measured value.

9.9.3 "In pressure" level selection Calibration without reference pressure (dry calibration)

Example:

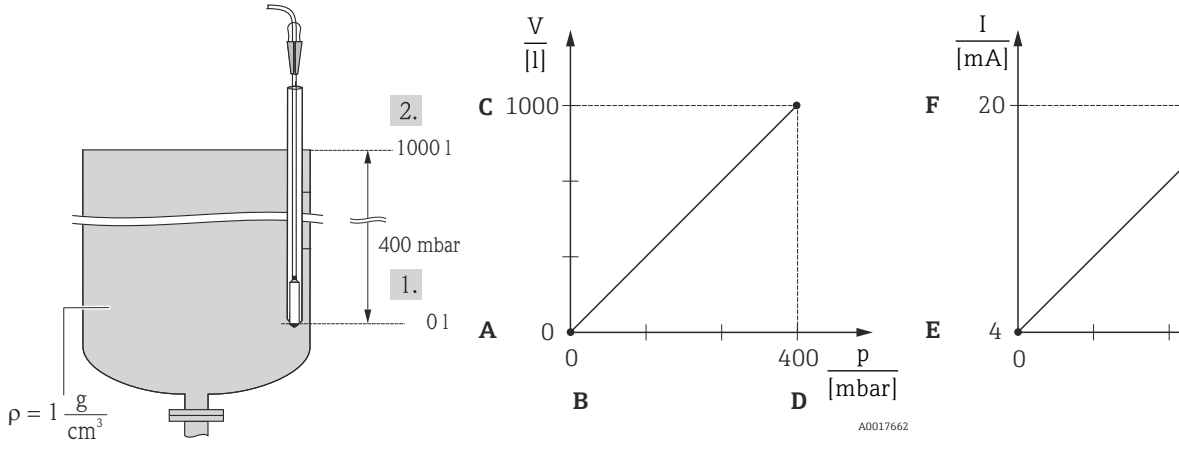
In this example, the volume in a tank should be measured in liters. The maximum volume of 1 000 l (264 gal) corresponds to a pressure of 400 mbar (6 psi).

The minimum volume of 0 liters corresponds to a pressure of 0 mbar since the process membrane of the probe is at the start of the level measuring range.

Prerequisite:

- The measured variable is in direct proportion to the pressure.
- This is a theoretical calibration i.e. the pressure and volume values for the lower and upper calibration point must be known.

- The values entered for "Empty calib./Full calib.", "Empty pressure/Full pressure" and "Set LRV/Set URV" must be at least 1% apart. The value will be rejected, and a message displayed, if the values are too close together. Further limit values are not checked, i.e. the values entered must be appropriate for the sensor module and the measuring task for the device to be able to measure correctly.
- Due to the orientation of the device, there may be pressure shifts in the measured value, i.e. when the vessel is empty or partly filled, the measured value is not zero. For information on how to perform position adjustment, see → 📄 43.



1 *See steps 6 and 7*
2 *See steps 8 and 9*

A See step 6
B See step 7
C See step 8
D See step 9

E See step 11
F See step 12

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. Select the "In pressure" level mode via the "Level selection" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Level selection
4. Select a volume unit via the "Output unit" parameter, here "l" (liters) for example.
   ↳ Menu path: Setup → Extended setup → Level → Output unit
5. Select the "Dry" option via the "Calibration mode" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Calibration mode
6. Enter the volume value for the lower calibration point via the "Empty calib." parameter, here 0 liters for example.
   ↳ Menu path: Setup → Extended setup → Level → Empty calib.
7. Enter the pressure value for the lower calibration point via the "Empty pressure" parameter, here "0 mbar" for example.
   ↳ Menu path: Setup → Extended setup → Level → Empty pressure

8. Enter the volume value for the upper calibration point via the "Full calib." parameter, here 1 000 l (264 gal) for example.
   ↳ Menu path: Setup → Extended setup → Level → Full calib.
9. Enter the pressure value for the upper calibration point via the "Full pressure" parameter, here 400 mbar (6 psi) for example.
   ↳ Menu path: Setup → Extended setup → Level → Full pressure
10. "Adjust density" contains the factory setting 1.0 but can be changed if required. The value pairs subsequently entered must correspond to this density
    ↳ Menu path: Setup → Extended setup → Level → Adjust density
11. Set the volume value for the lower current value (4 mA) via the "Set LRV" parameter (0 l).
    ↳ Menu path: Setup → Extended setup → Current output → Set LRV
12. Set the volume value for the upper current value (20 mA) via the "Set URV" parameter (1 000 l (264 gal)).
    ↳ Menu path: Setup → Extended setup → Current output → Set URV
13. If the process uses a medium other than that on which the calibration was based, the new density must be specified in the "Process density" parameter.
    ↳ Menu path: Setup → Extended setup → Level → Density → Process
14. If density correction is required, assign the temperature probe in the "Auto dens. corr." parameter. A density correction is only possible for water. A temperature-density curve that is saved in the device is used. For this reason, the "Adjust density" (step 10) and "Process density" (step 13) parameters are not used here.
    ↳ Menu path: Expert → Application → Auto dens. corr.

The measuring range is configured for 0 to 1 000 l (0 to 264 gal).

For this level mode, the measured variables %, level, volume and mass are available, see "Output unit" → 96.

9.9.4 "In pressure" level selection Calibration with reference pressure (wet calibration)

Example:

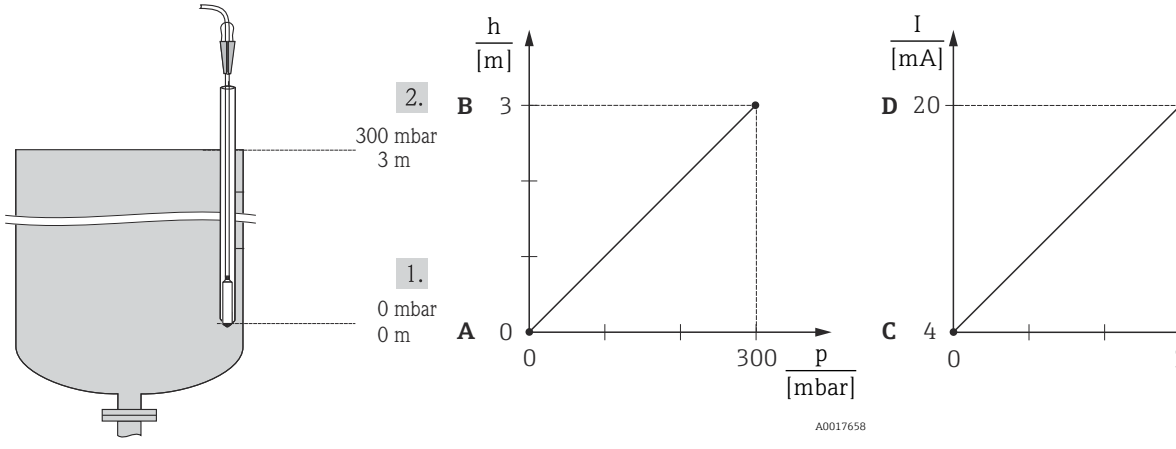
In this example, the level in a tank should be measured in "m". The maximum level is 3 m (9.8 ft).

The pressure range is derived from the level and the density of the medium. In this situation, the device sets the pressure range to 0 to +300 mbar (0 to 4.5 psi).

Prerequisite:

- The measured variable is in direct proportion to the pressure.
- The tank can be filled and emptied.

The values entered for "Empty calib./Full calib." and "Set LRV/Set URV" and the pressures present must be at least 1 % apart. The value will be rejected, and a message displayed, if the values are too close together. Other limit values are not checked, i.e. the values entered must be appropriate for the sensor and the measuring task for the device to be able to measure correctly.



1 *See step 9*
2 *See step 10*

A See step 9
B See step 10

C See step 11
D See step 12

1. Perform "position adjustment" → 📄 43.
2. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

► If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

3. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
4. Select the "In pressure" level mode via the "Level selection" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Level selection.
5. If density correction is required, assign the temperature probe in the "Auto dens. corr." parameter. A density correction is only possible for water. A temperature-density curve that is saved in the device is used. For this reason, the "Adjust density" (step 8) and "Process density" (step 13) parameters are not used here.
   ↳ Menu path: Expert → Application → Auto dens. corr.
6. Select a level unit via the "Output unit" parameter, here "m" for example.
   ↳ Menu path: Setup → Extended setup → Level → Output unit
7. Select the "Wet" option via the "Calibration mode" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Calibration mode
8. If the calibration is performed with a medium other than the process medium, enter the density of the calibration medium in the "Adjust density" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Adjust density

ℹ The process density can be changed only if automatic density correction is switched off (see step 5).

9. The hydrostatic pressure for the lower calibration point is present at the device, here "0 mbar" for example. Select the "Empty calib." parameter. Enter the level value, here 0 m for example. By confirming the value, you assign the pressure value present to the lower level value.
   ↳ Menu path: Setup → Extended setup → Level → Empty calib.

10. The hydrostatic pressure for the upper calibration point is present at the device, here 300 mbar (4.35 psi) for example.Select the "Full calib." parameter. Enter the level value, here 3 m (9.8 ft) for example. By confirming the value, you assign the pressure value present to the upper level value.
    ↳ Menu path: Setup → Extended setup → Level → Full calib.
11. Use the "Set LRV" parameter to set the level value for the lower current value (4 mA), here "0 m" for example.
    ↳ Menu path: Setup → Extended setup → Current output → Set LRV
12. Use the "Set URV" parameter to set the level value for the upper current value (20 mA) (3 m (9.8 ft)).
    ↳ Menu path: Setup → Extended setup → Current output → Set URV
13. If the process uses a medium other than that on which the calibration was based, the new density must be specified in the "Process density" parameter.
    ↳ Menu path: Setup → Extended setup → Level → Process density.

The process density can be changed only if automatic density correction is switched off (see step 5).

The measuring range is configured for 0 to 3 m (0 to 9.8 ft).

For this level mode, the measured variables %, level, volume and mass are available, see "Output unit" → 96.

9.9.5 "In height" level selection Calibration without reference pressure (dry calibration)

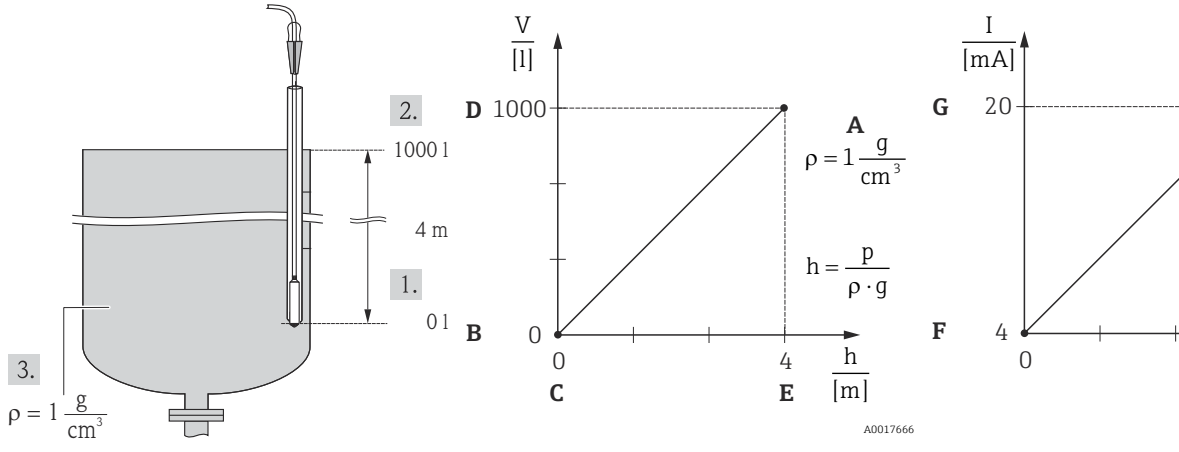
Example:

In this example, the volume in a tank should be measured in liters. The maximum volume of 1 000 l (264 gal)corresponds to a level of 4 m (13 ft). The minimum volume of 0 liters corresponds to a level of 0 m since the process membrane of the probe is at the start of the level measuring range.

Prerequisite:

- The measured variable is in direct proportion to the pressure.
- This is a theoretical calibration i.e. the height and volume values for the lower and upper calibration point must be known.

- The values entered for "Empty calib./Full calib.", "Empty height/Full height" and" Set LRV/Set URV" must be at least 1% apart. The value will be rejected, and a message displayed, if the values are too close together. Other limit values are not checked, i.e. the values entered must be appropriate for the sensor and the measuring task for the device to be able to measure correctly.
- Due to the orientation of the device, there may be pressure shifts in the measured value, i.e. when the vessel is empty or partly filled, the measured value is not zero. For information on how to perform position adjustment, see → 43.



1 *See steps 10 and 11*
2 *See steps 13 and 14*
3 *See step 12*

A See step 12
B See step 8
C See step 9
D See step 10
E See step 11

F See step 13
G See step 14

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. Select the "In height" level mode via the "Level selection" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Level selection.
4. If density correction is required, assign the temperature probe in the "Auto dens. corr." parameter.
   ↳ Menu path: Setup → Extended setup → Level → Level selection.
5. Select a volume unit via the "Output unit" parameter, here "l" (liters) for example. A density correction is only possible for water. A temperature-density curve that is saved in the device is used. For this reason, the "Adjust density" (step 12) and "Process density" (step 15) parameters are not used here.
   ↳ Menu path: Setup → Extended setup → Level → Output unit
6. Select a volume unit via the "Output unit" parameter, here "l" (liters) for example.
   ↳ Menu path: Setup → Extended setup → Level → Output unit
7. Select a level unit via the "Height unit" parameter, here "m" for example.
   ↳ Menu path: Setup → Extended setup → Level → Height unit
8. Select the "Dry" option via the "Calibration mode" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Calibration mode
9. Enter the volume value for the lower calibration point via the "Empty calib." parameter, here 0 liters for example.
   ↳ Menu path: Setup → Extended setup → Level → Empty calib.
10. Enter the height value for the lower calibration point via the "Empty height" parameter, here 0 m for example.
    ↳ Menu path: Setup → Extended setup → Level → Empty height

11. Enter the volume value for the upper calibration point via the "Full calib." parameter, here 1 000 l (264 gal) for example.
    ↳ Menu path: Setup → Extended setup → Level → Full calib.
12. Enter the height value for the upper calibration point via the "Full height" parameter, here 4 m (13 ft) for example.
    ↳ Menu path: Setup → Extended setup → Level → Full height
13. Enter the density of the medium via the "Adjust density" parameter, here "1 g/cm³" (1 SGU) for example.
    ↳ Menu path: Setup → Extended setup → Level → Adjust density
14. Set the volume value for the lower current value (4 mA) via the "Set LRV" parameter (0 l).
    ↳ Menu path: Setup → Extended setup → Current output → Set LRV
15. Set the volume value for the upper current value (20 mA) via the "Set URV" parameter (1 000 l (264 gal)).
    ↳ Menu path: Setup → Extended setup → Current output → Set URV
16. If the process uses a medium other than that on which the calibration was based, the new density must be specified in the "Process density" parameter.
    ↳ Menu path: Setup → Extended setup → Level → Process density

The process density can only be changed if automatic density correction is switched off (see Step 4).

The measuring range is configured for 0 to 1 000 l (0 to 264 gal).

For this level mode, the measured variables %, level, volume and mass are available, see "Output unit" → 96.

9.9.6 "In height" level selection Calibration with reference pressure (wet calibration)

Example:

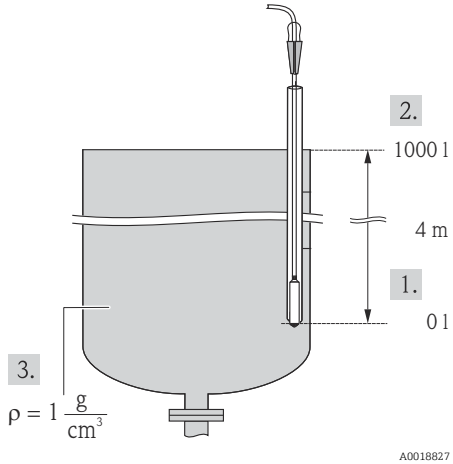
In this example, the volume in a tank should be measured in liters. The maximum volume of 1 000 l (264 gal) corresponds to a level of 4 m (13 ft).

The minimum volume of 0 liters corresponds to a level of 0 m since the process membrane of the probe is at the start of the level measuring range. The density of the medium is 1 g/cm³ (1 SGU).

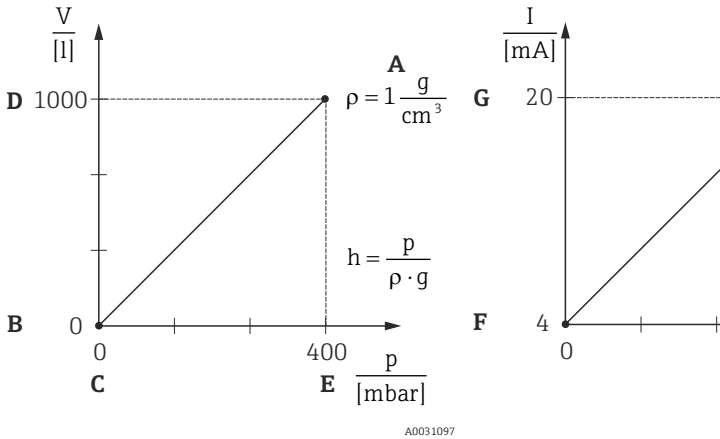
Prerequisite:

- The measured variable is in direct proportion to the pressure.
- The tank can be filled and emptied.

The values entered for "Empty calib./Full calib." and" Set LRV/Set URV" and the pressures present must be at least 1% apart. The value will be rejected, and a message displayed, if the values are too close together. Other limit values are not checked, i.e. the values entered must be appropriate for the sensor and the measuring task for the device to be able to measure correctly.



1 *See step 9*
2 *See step 10*
3 *See step 11*



A See step 11
B See step 9
C See step 9
D See step 10
E See step 10
F See step 12
G See step 13

1. Perform "position adjustment" → 📄 43.
2. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

3. Select the "In height" level mode via the "Level selection" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Level selection.
4. If density correction is required, assign the temperature probe in the "Auto dens. corr." parameter. A density correction is only possible for water. A temperature-density curve that is saved in the device is used. For this reason, the "Adjust density" (step 11) and "Process density" (step 14) parameters are not used here.
   ↳ Menu path: Expert → Application → Auto dens. corr.
5. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
6. Select a volume unit via the "Output unit" parameter, here "l" (liters) for example.
   ↳ Menu path: Setup → Extended setup → Level → Output unit
7. Select a height unit via the "Height unit" parameter, here "m" for example.
   ↳ Menu path: Setup → Extended setup → Level → Height unit
8. Select the "Wet" option via the "Calibration mode" parameter.
   ↳ Menu path: Setup → Extended setup → Level → Calibration mode
9. The hydrostatic pressure for the lower calibration point is present at the device, here "0 mbar" for example. Enter the volume value for the lower calibration point via the "Empty calib." parameter, here "0 liters" for example.
   ↳ Menu path: Setup → Extended setup → Level → Empty calib.
10. The hydrostatic pressure for the upper calibration point is present at the device, here "400 mbar (6 psi)" for example. Enter the volume value for the upper calibration point via the "Full calib." parameter, here 1 000 l (264 gal) for example.
    ↳ Menu path: Setup → Extended setup → Level → Full calib.

11. If the calibration is performed with a medium other than the process medium, enter the density of the calibration medium in the "Adjust density" parameter. Here 1 g/cm³ (1 SGU), for example.
    ↳ Menu path: Setup → Extended setup → Level → Adjust density

The process density can only be changed if automatic density correction is switched off (see Step 4).

12. Set the volume value for the lower current value (4 mA) via the "Set LRV" parameter (0 l).
    ↳ Menu path: Setup → Extended setup → Current output → Set LRV
13. Set the volume value for the upper current value (20 mA) via the "Set URV" parameter (1 000 l (264 gal)).
    ↳ Menu path: Setup → Extended setup → Current output → Set URV
14. If the process uses a medium other than that on which the calibration was based, the new density must be specified in the "Process density" parameter.
    ↳ Menu path: Setup → Extended setup → Level → Process density.

The process density can only be changed if automatic density correction is switched off (see Step 4).

The measuring range is configured for 0 to 1 000 l (0 to 264 gal).

For this level mode, the measured variables %, level, volume and mass are available, see "Output unit" → 🖹 96.

9.9.7 Calibration with partially filled vessel (wet calibration)

Example:

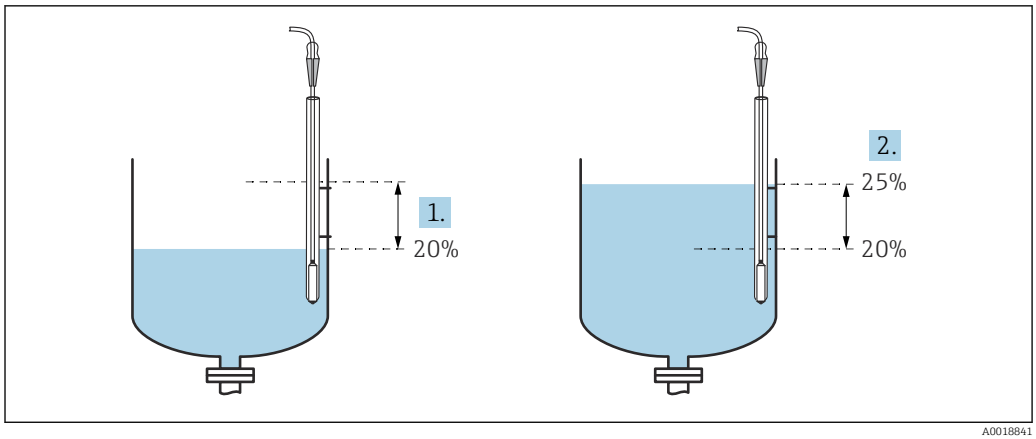
This example describes a wet calibration for situations in which it is not possible to empty the vessel and then fill it to 100 %.

During this wet calibration, a level of 20 % is used as the calibration point for "Empty" and a level of "25 %" is used as the calibration point for "Full".

The calibration is then extended to 0 to 100 % and the lower range value (LRV)/upper range value (URV) are adapted accordingly.

Prerequisite:

- The default value in level mode for the calibration mode is "Wet".
- This value can be configured: Menu path: Setup → Extended setup → Level → Calibration mode



1 See step 2
2 See step 3

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- ▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

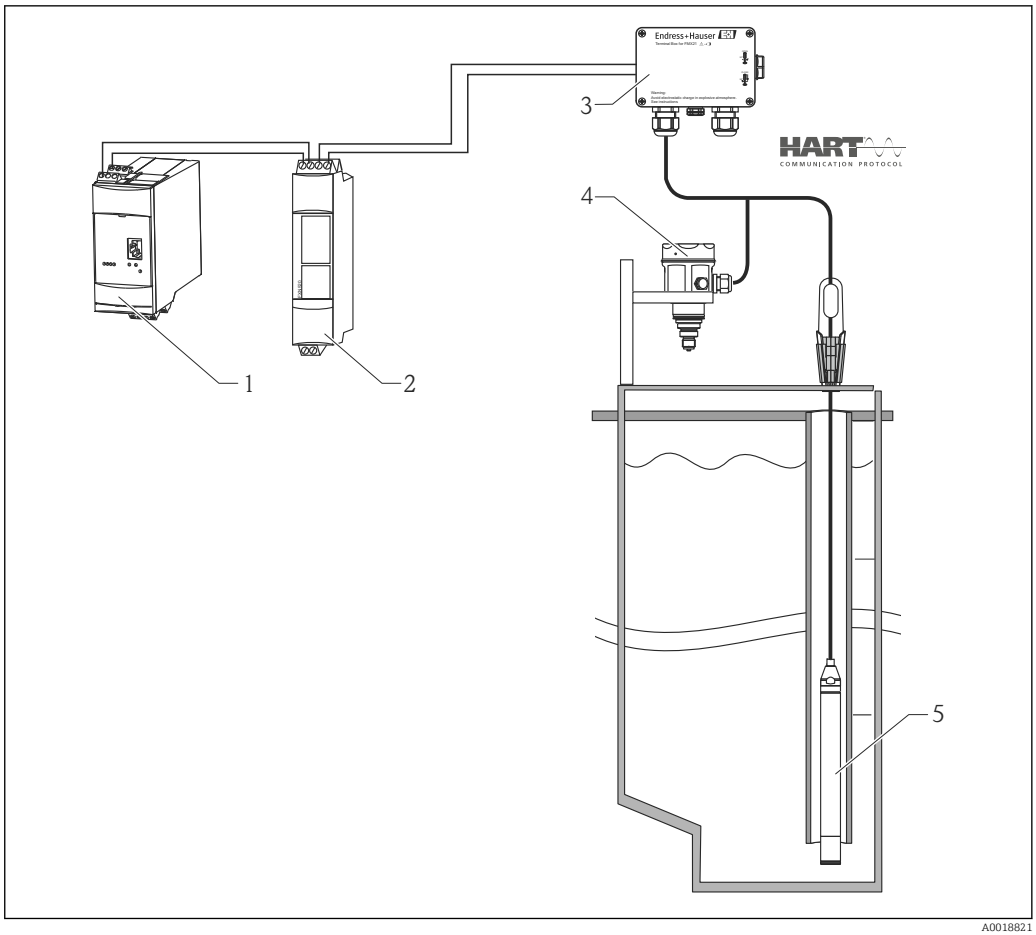
2. Set the value for "Empty calib." with the differential pressure for the level, e.g. 20 %
   ↳ Menu path: Setup → Extended setup → Level → Empty calib.
3. Set the value for "Full calib." with the differential pressure for the level, e.g. 25 %
   ↳ Menu path: Setup → Extended setup → Level → Full calib.
4. The values for the pressure when the vessel is full or empty are measured automatically during adjustment. As the transmitter automatically sets the pressure values that are best suited for an "Empty calibration" and a "Full calibration" to the minimum and maximum pressure that triggers the output current, the correct upper range value (URV) and lower range value (LRV) must be set.

If the process uses a medium other than that on which the calibration was based, the new density must be specified in the "Process density" parameter. In this case, you have to enter the various densities via the following menu path:
- Setup → Extended setup → Level → Adjust density (034) (e.g. 1.0 kg/l1.0 kg/l for water)
- Setup → Extended setup → Level → Process density (035) (e.g. 0.8 kg/l for oil)

9.9.8 Level measurement with absolute pressure probe and external pressure signal (electrical differential pressure)

Example:

In this example, a Waterpilot FMX21 and a Cerabar M (each with an absolute pressure measuring cell) are connected via the common communication bus. The level can thus be measured in a deep well, with simultaneous compensation for the effect of atmospheric pressure.



1 *Fieldgate FXA520*
2 *Multidrop Connector FXN520*
3 *Terminal box (can be ordered as an accessory)*
4 *Cerabar M absolute pressure (level)*
5 *Waterpilot absolute pressure (pressure)*

Sensor level adjustment (Waterpilot)

1. Select the "Pressure" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The sensor is unpressurized, perform a position adjustment → 🖹 43
4. Switch on the burst mode via the "Burst mode" parameter.
   ↳ Menu path: Expert → Communication → HART config
5. Set the output current to "Fixed" 4 mA via the "Current mode" parameter.
   ↳ Menu path: Expert → Communication → HART config
6. Via the "Bus address" parameter, set an address that is not equal to "0", e.g. the bus address = 1. (HART 5.0 master: range 0 to 15, where address = "0" calls up the "Signaling" setting; HART 6.0 master: range 0 to 63)
   ↳ Menu path: Expert → Communication → HART config

Sensor level adjustment (Cerabar)

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

► If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The sensor is unpressurized, perform a position adjustment → 📄 43
4. Set the output current to "Fixed" 4 mA via the "Current mode" parameter.
   ↳ Menu path: Expert → Communication → HART config
5. Via the "Bus address" parameter, set an address that is not equal to "0", e.g. the bus address = 2. (HART 5.0 master: range 0 to 15, where address = "0" calls up the "Signaling" setting; HART 6.0 master: range 0 to 63)
   ↳ Menu path: Expert → Communication → HART config
6. Activate the reading of a value sent externally in burst mode via the "Electr. Delta P" parameter.
   ↳ Menu path: Expert → Application
7. Perform level adjustment (wet or dry)

Result: The measured value output by the atmospheric pressure sensor equals the level in the deep well (differential signal) and can be read out by means of a HART request for the address of the atmospheric pressure sensor.

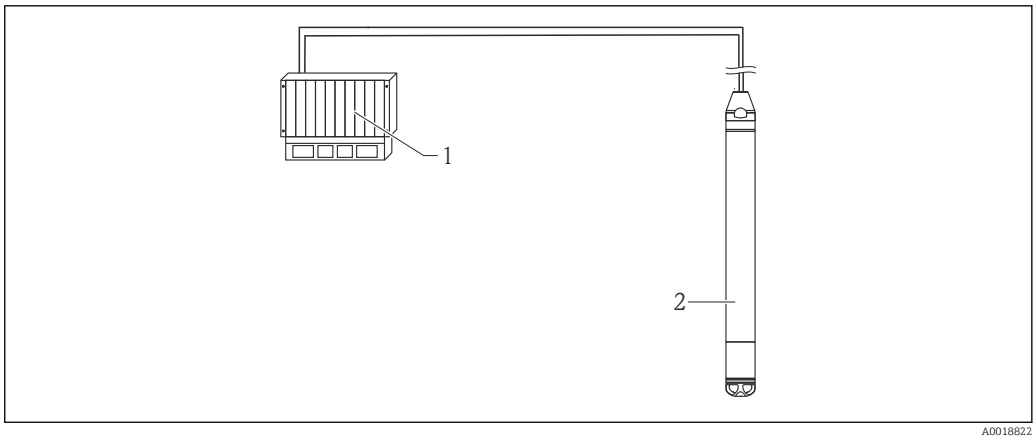
- It is not permissible to reverse the assignment of the measuring points to the direction of communication.
- The measured value of the transmitting device (via burst) must always be greater than the measured value of the receiving device (via "Electr. Delta P" mode).
- Adjustments that involve an offset in the pressure values (e.g. position adjustment, trim) must always suit the individual sensor and the sensor's orientation irrespective of the "Electr. Delta P" application.
- Other settings result in non-permitted use of the "Electr. Delta P" mode and can lead to incorrect measured values.

9.10 Automatic density compensation

9.10.1 Automatic density compensation with the internally measured sensor temperature

Example:

In this example, the device is used for level measurement in water. The change in the water density caused by changing temperatures is automatically factored into the level signal by activating the automatic density compensation.



1 HART master, e.g. PLC (programmable logic controller)
2 Device

Device adjustment for level measurement

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

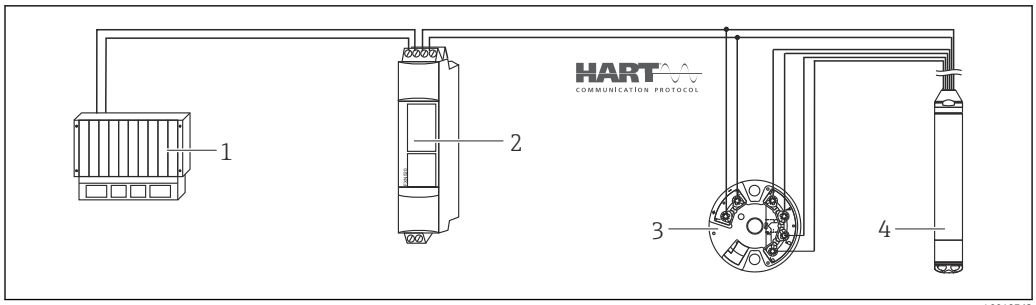
2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The sensor is unpressurized, perform a position adjustment → 📄 43
4. Set the "Auto dens. corr." parameter to Sensor temperature.
   ↳ Menu path: Expert → Application
5. Perform level adjustment (wet or dry)

The measured value output by the device corresponds to the level in the deep well corrected by means of the density characteristic line of water.

9.10.2 Automatic density compensation using an integrated Pt100 for calculation in a suitable HART master (e.g. PLC)

Example:

In this example, the device with an integrated Pt100 is connected via the common communication bus to any temperature head transmitter with HART communication (e.g. TMT72). The temperature and pressure signal is transmitted to the HART master (e.g. PLC), where a corrected level value can be generated using a stored linearization table or density function (of a chosen medium). A pressure signal and a temperature signal can thus be generated with a chosen density function to compensate for a level.



1 *HART master, PLC (programmable logic controller)*
2 *Multidrop Connector FXN520*
3 *TMT72 temperature head transmitter*
4 *Device*

Device adjustment for level measurement

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- ▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The sensor is unpressurized, perform a position adjustment → 📄 43
4. Set the output current to "Fixed" 4 mA via the "Current mode" parameter.
   ↳ Menu path: Expert → Communication → HART config
5. Perform level adjustment (wet or dry)
6. Via the "Bus address" parameter, set an address that is not equal to "0", e.g. the bus address = 1. (HART 5.0 master: range 0 to 15, where address = "0" calls up the "Signaling" setting; HART 6.0 master: range 0 to 63)
   ↳ Menu path: Expert → Communication → HART config

The output current of the temperature head transmitter used must also be set to "Fixed" and have a HART address other than zero (e.g. address = 2).

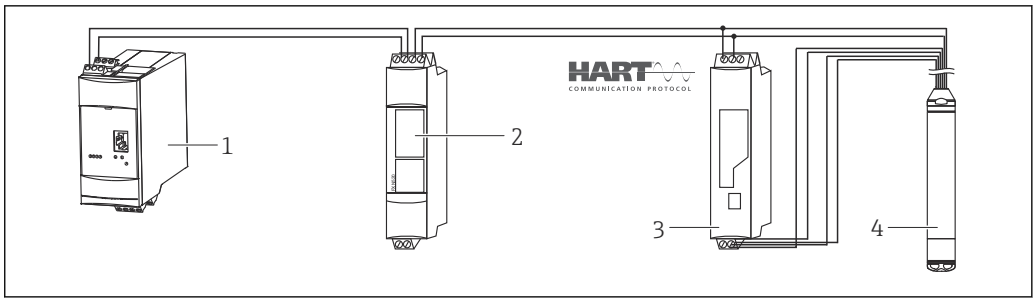
- ▶ Switch on the burst mode via the "Burst mode" parameter.
  ↳ Menu path: Expert → Communication → HART config

By balancing the pressure signal and temperature signal in a suitable HART master (e.g. PLC), a corrected level value can be determined for any medium by using a suitable density function.

9.10.3 Automatic density compensation using an external temperature signal for calculation in the device

Example:

In this example, the device with an integrated Pt100 is connected to a HART-compliant temperature transmitter via the common communication bus. With this option, the signal of the Pt100 is evaluated with a HART-compliant temperature head transmitter (min. HART 5.0) that supports the burst mode. The change in the water density caused by changing temperatures is automatically factored into the level signal by activating the automatic density compensation.



1 *Fieldgate FXA520*
2 *Multidrop Connector FXN520*
3 *HART-compatible temperature transmitter (e.g. TMT82)*
4 *Device*

Configuring the HART-compliant temperature head transmitter (min. HART 5.0) with burst function

The output current of the temperature transmitter used should be set to "Fixed" and a HART address other than zero (e.g. address = 1) must be set. The burst function must then be switched on with HART command 1. This step should be performed before the procedure described below in order to avoid a HART input error of the device being output during commissioning.

1. Select the "Level" measuring mode via the "Measuring mode" parameter.
   ↳ Menu path: Setup → Measuring mode

⚠ WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

2. Select a pressure unit via the "Press. eng. unit" parameter, here "mbar" for example.
   ↳ Menu path: Setup → Press. eng. unit
3. The sensor is unpressurized, perform a position adjustment → 📄 43
4. Set the "Auto dens. corr." parameter to "External value".
   ↳ Menu path: Expert → Application
5. Perform level adjustment (wet or dry)

Result: The measured value output by the Waterpilot corresponds to the level in the deep well corrected by means of the density characteristic line of water.

The TMT72 temperature head transmitter is not suitable for this configuration.

9.11 Linearization

9.11.1 Semi-automatic entry of a linearization table

Example:

In this example, the volume in a tank with a conical outlet should be measured in m^3.

Prerequisite:

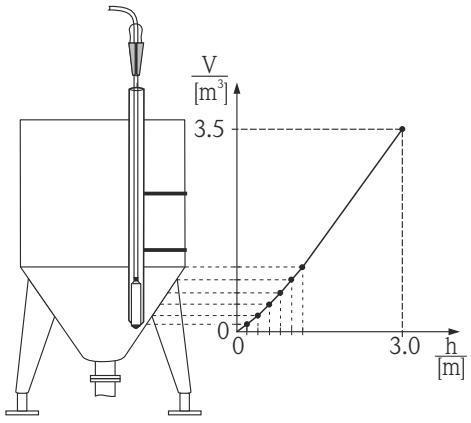
- The tank can be filled or emptied. The linearization characteristic must rise or fall continuously.
- The "Level" measuring mode has been selected.
- A level calibration has been performed.
- For a description of the parameters mentioned, see the "Description of device parameters" section → 88.

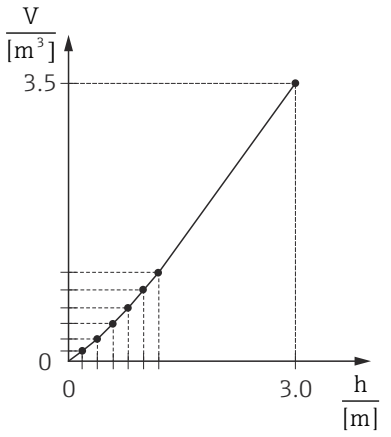
WARNING

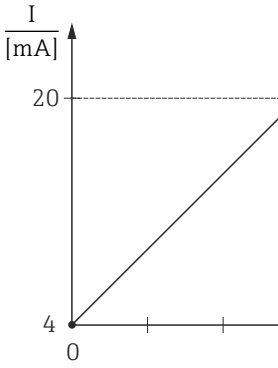
Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

► If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.







1. Select the "Semiautom. entry" option via the "Lin. mode" parameter.
   ↳ Menu path: Setup → Extended setup → Linearization → Lin. mode
2. Via the parameter select "Unit after lin." e.g. m^3.
   ↳ Menu path: Setup → Extended setup → Linearization → Unit after lin.
3. Fill the tank to the height of the 1st point.
4. The following options are available:
   ↳ Enter the number of the point in the table using the "Line-numb" parameter e.g. 1.
   Menu path: Setup → Extended setup → Linearization → Line-numb
   The current level is displayed via the "X-value" parameter.
   Menu path: Setup → Extended setup → Linearization → X-val
   Using the "Y-val." parameter, enter the corresponding volume value, here 0 m^3 for example, and confirm the value.
   Menu path: Setup → Extended setup → Linearization → Y-val
5. To enter another point in the table, continue filling the tank and select the "Next point" option via the "Edit table" parameter. Enter the next point as explained in Step 4.
   ↳ Menu path: Setup → Extended setup → Linearization → Edit table
6. Once all the points have been entered in the table, select the "Activate table" option via the "Lin. mode" parameter.
   ↳ Menu path: Setup → Extended setup → Linearization → Lin. mode

The measured value after linearization is displayed.

- Error message F510 "Linearization" and alarm current as long as the table is being entered and until the table is activated.
- The lower range value (= 4 mA) is defined by the smallest point in the table. The upper range value (= 20 mA) is defined by the largest point in the table.
- Using the parameters "Set LRV" and "Set URV", you can change the allocation of the volume/mass values to the current values.

9.11.2 Manual entry of a linearization table

Example:

In this example, the volume in a tank with a conical outlet should be measured in m^3.

Prerequisite:

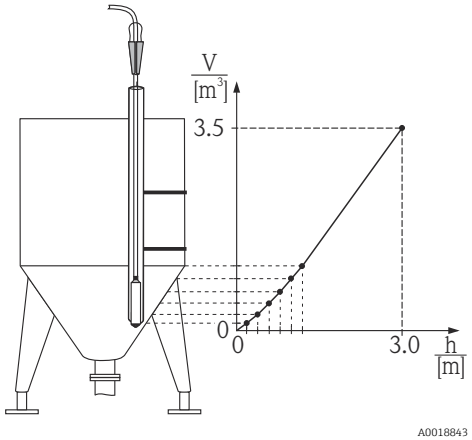
- This is a theoretical calibration, i.e. the points for the linearization table are known.
- The "Level" measuring mode has been selected.
- A level calibration has been performed.
- The linearization characteristic must rise or fall continuously.
- For a description of the parameters mentioned, see the "Description of device parameters" section → 88.

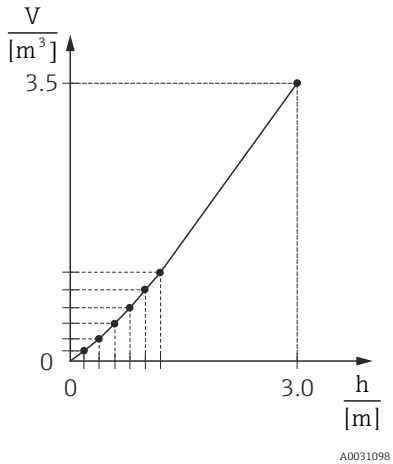
WARNING

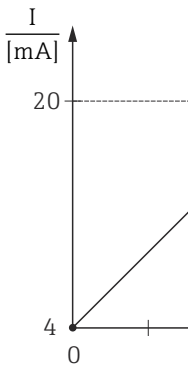
Changing the measuring mode affects the span (URV)

This situation can result in product overflow.

▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.







1. Select the "Manual entry" option via the "Lin. mode" parameter.
   ↳ Menu path: Setup → Extended setup → Linearization → Lin. mode
2. Via the parameter select "Unit after lin." e.g. m^3.
   ↳ Menu path: Setup → Extended setup → Linearization → Unit after lin.

3. The following options are available:
   ↳ Enter the number of the point in the table using the "Line-numb" parameter e.g. 1.
   Menu path: Setup → Extended setup → Linearization → Line-numb
   The level is entered via the "X-value" parameter, here 0 m for example. Confirm your entry.
   Menu path: Setup → Extended setup → Linearization → X-val
   Using the "Y-val." parameter, enter the corresponding volume value, here 0 m^3 for example, and confirm the value.
   Menu path: Setup → Extended setup → Linearization → Y-val
4. To enter another point in the table, select the "Next point" option via the "Edit table" parameter. Enter the next point as explained in Step 3.
   ↳ Menu path: Setup → Extended setup → Linearization → Edit table
5. Once all the points have been entered in the table, select the "Activate table" option via the "Lin. mode" parameter.
   ↳ Menu path: Setup → Extended setup → Linearization → Lin. mode

The measured value after linearization is displayed.

- Error message F510 "Linearization" and alarm current as long as the table is being entered and until the table is activated.
- Error message F511/F512 "Linearization" and alarm current as long as the linearization table consists of fewer than 2 points.
- The lower range value (= 4 mA) is defined by the smallest point in the table. The upper range value (= 20 mA) is defined by the largest point in the table.
- Using the parameters "Set LRV" and "Set URV", you can change the allocation of the volume/mass values to the current values.

9.12 Manual entry of a linearization table via operating tool

Using an operating tool based on FDT technology (e.g. FieldCare), you can enter the linearization using a module specially designed for this purpose. This provides you with an overview of the selected linearization, even during entry. In addition, it is possible to configure different tank shapes in FieldCare ("Device operation" → "Device functions" → "Additional functions" → "Linearization table" menu).

The linearization table may also be entered manually point by point in the operating tool menu (see Section → 88).

9.13 Backing up or duplicating the device data

The following options are available to you with an operating tool that is based on FDT technology (e.g. FieldCare):
- Storage/recovery of configuration data.
- Duplication of device parameters.
- Transfer of all relevant parameters when replacing electronic inserts.

Use the following parameter for this:

Download select. (visible only in FieldCare)	
Navigation	Expert → System → Management → Download select.
Write permission	Operator/Maintenance/Expert

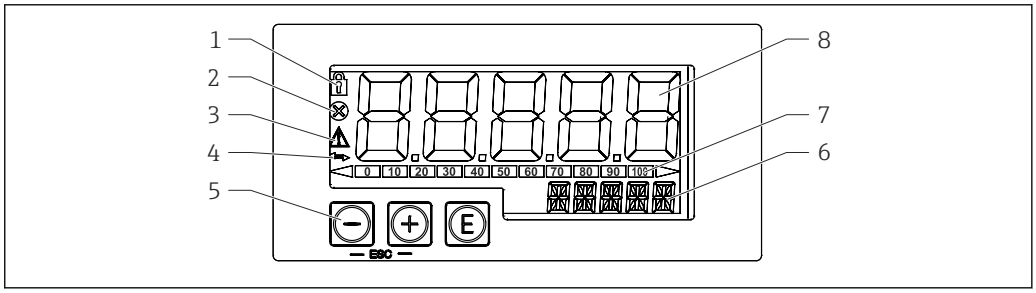
Description Selection of data packages for up/download function in Fieldcare and PDM.

Prerequisite DIP switch set to "SW" and "Damping" set to "on". If you download using the factory setting "Configuration copy", all parameters required for a measurement will be downloaded. The functionality of the "Electronics replace" setting is reserved for Endress+Hauser Service and can be accessed only if the correct device access code is entered.

Options
- Configuration copy: This option overwrites general configuration parameters with the exception of the serial number, order number, calibration, position adjustment, application and tag information.
- Device replacement: This option overwrites general configuration parameters with the exception of the serial number, order number, calibration and position adjustment.
- Electronics replace: This option overwrites general configuration parameters.

Factory setting Configuration copy

9.14 Operation and settings via RIA15



7 Display and operating elements of the process indicator

1 Symbol: operating menu disabled
2 Symbol: error
3 Symbol: warning
4 Symbol: HART communication active
5 Operating keys "-", "+", "E"
6 14-segment display for unit/TAG
7 Bar graph with indicators for under range and over range
8 5-digit 7-segment display for measured value, digit height 17 mm (0.67 in)

The device is operated using three operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

Ⓔ
Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu

⊕, ⊖
Selecting and setting/changing values in the operating menu; pressing the '-' and '+' keys simultaneously takes the user back up a menu level. The configured value is not saved.

9.14.1 Operating functions

The operating functions of the process indicator are divided into the following menus. The individual parameters and settings are described in the "Commissioning" section.

If the operating menu is disabled by means of a user code, the individual menus and parameters can be displayed but not changed. To change a parameter, the user code must be entered. As the display unit can only display digits in the 7-segment display and not alphanumeric characters, the procedure for number parameters is different to that for text parameters. If the operating position contains only numbers as parameters, the operating position is displayed in the 14-segment display and the configured parameter is displayed in the 7-segment display. To edit, press the 'E'-button followed by the user code. If the operating position contains text parameters, only the operating position is initially displayed in the 14-segment display. If the 'E' button is pressed again, the configured parameter is displayed in the 14-segment display. To edit, press the '+' button followed by the user code.

- Setup (SETUP)
  Basic device settings
- Diagnostics (DIAG)
  Device information, display of error messages
- Expert (EXPRT)
  Expert settings for device setup. The Expert menu is protected from editing by an access code (default 0000).

9.14.2 Operating modes

The process indicator can be used in two different operating modes:

- 4 to 20 mA mode:
  In this operating mode, the process indicator is incorporated into the 4 to 20 mA current loop and measures the transmitted current. The variable calculated based on the current value and range limits is displayed in digital form on the 5-digit LCD. In addition, the associated unit and a bar graph can be displayed.
- HART mode:
  The indicator is powered via the current loop.
  The device can be adjusted under the "Level" menu (see operating matrix). The measured value displayed corresponds to the measured level.
  HART communication operates according to the master/slave principle.

For additional information, see BA01170K.

9.14.3 Operating matrix

After power-up:

▶ Press the E key twice
  ↳ The "Level" menu is then available

Using the following operating matrix, a display in percent can be set. To do this, select "Mode" parameter => 4-20 and "Unit" parameter =>%

The LEVEL menu is only visible if the RIA15 has been ordered with the "Level" option and the indicator is operated in the HART mode (MODE = HART). The basic settings for the device can be made via the RIA15 with this menu.

Menu Setup → Level (LEVEL)
- RIA15 parameter: LEVEL [3)]
- Corresponds to device parameter: Level before linearization
- Visible with "Level" option, MODE = HART, device is connected
- Description:
  This menu contains the parameters for configuring the pressure measuring device for hydrostatic level measurement.
  The basic settings for the device can be made via the RIA15 with this menu.

Once the LEVEL menu item is opened, the following parameters are automatically adjusted in the device for easier operation:
- Measuring mode: Level
- Calibration mode: Dry
- Level selection: In pressure
- Lin mode: Linear

It is possible to reset these parameters to the factory default settings by performing a reset.

Menu Setup → Level (LEVEL) → PUNIT
- RIA15 parameter: PUNIT
- Corresponds to device parameter: Press. eng. unit
- Values (default in bold)
  - **mbar** [4)]
  - **bar** [4)]
  - kPa
  - PSI
- Description: Use this function to select the unit for pressure

Menu Setup → Level (LEVEL) → LUNIT
- RIA15 parameter: LUNIT
- Corresponds to device parameter: Output unit
- Values (default in bold)
  - **%**
  - m
  - inch
  - feet
- Description: Use this function to select the unit for level

Menu Setup → Level (LEVEL) → TUNIT
- RIA15 parameter: TUNIT
- Corresponds to device parameter: Temperature unit
- Values (default in bold)
  - **°C**
  - °F
  - K
- Description: Use this function to select the unit for temperature

3) If the measured value that is read out is too large, it is displayed as "9999.9", for example. To display a valid measured value, the pressure unit (PUNIT) (or level unit (LUNIT)) must be set to suit the measuring range.
4) Default: depends on the sensor nominal range or as per order specifications

Menu Setup → Level (LEVEL) → ZERO
- RIA15 parameter: ZERO
- Corresponds to device parameter: Pos. zero adjust
- Values (default in bold)
  - **NO**
  - YES
- Visible with: gauge pressure sensor
- Description:
  - For performing a position adjustment (gauge pressure sensor).
  - The value 0.0 is assigned to the pressure value present. The current value is also corrected.

Menu Setup → Level (LEVEL) → P_LRV
- RIA15 parameter: P_LRV
- Corresponds to device parameter: Empty pressure
- Values (default in bold)
  - -1999.9 to 9999.9
  - **Gauge pressure sensor: Sensor LRL**
  - Absolute pressure sensor: 0
- Description:
  Pressure empty calibration using keys -, +, E. More in-depth description / valid value range: any value in the range indicated [3) 5)]. Number of decimal places depends on the configured pressure unit.

Menu Setup → Level (LEVEL) → P_URV
- RIA15 parameter: P_URV
- Corresponds to device parameter: Full pressure
- Values (default in bold)
  - -1999.9 to 9999.9
  - **Sensor URL**
- Description:
  Pressure full calibration using keys -, +, E. More in-depth description / valid value range: any value in the range indicated [3) 5)]. Number of decimal places depends on the configured pressure unit.

Menu Setup → Level (LEVEL) → EMPTY
- RIA15 parameter: EMPTY
- Corresponds to device parameter: Empty calibration
- Values (default in bold)
  - -1999.9 to 9999.9
  - **0**
- Description:
  Level empty calibration using keys -, +, E. More in-depth description / valid value range: any value in the range indicated [3) 5)] Number of decimal places depends on the configured level unit.

Menu Setup → Level (LEVEL) → FULL
- RIA15 parameter: FULL
- Corresponds to device parameter: Full calibration
- Values (default in bold)
  - -1999.9 to 9999.9
  - **100**
- Description:
  Level full calibration using keys -, +, E. More in-depth description / valid value range: any value in the range indicated [3) 5)]. Number of decimal places depends on the configured level unit.

5) The values entered for "Empty calib./Full calib.", "Empty pressure/Full pressure" and "Set LRV/Set URV" must be at least 1% apart. The value will be rejected, and a message displayed, if the values are too close together. Further limit values are not checked, i.e. the values entered must be appropriate for the sensor module and the measuring task for the device to be able to measure correctly.

Menu Setup → Level (LEVEL) → LEVEL
- RIA15 parameter: LEVEL
- Corresponds to device parameter: Level before linearization
- Values (default in bold)
  Measured value
- Description:
  Displays the measured level. Number of decimal places depends on the configured level unit.

Menu Setup → Level (LEVEL) → RESET
- RIA15 parameter: RESET
- Corresponds to device parameter: Enter reset code
- Values (default in bold)
  - **No**
  - YES
- Description:
  Reset the device to factory settings

Any additional settings such as linearizations must be made using FieldCare or DeviceCare.

Additional information is available in the RIA15 Operating Instructions BA01170K.

10 Diagnostics and troubleshooting

10.1 Troubleshooting

Device is not responding
- Supply voltage does not match the specification on the nameplate.
  ↳ Apply correct voltage.
- Supply voltage has incorrect polarity.
  ↳ Correct the polarity.
- Connecting cables are not in contact with the terminals.
  ↳ Check the connection of the cables and correct if necessary.

Output current < 3.6 mA
Signal line is not wired correctly.
Electronics module is defective.
↳ Check wiring.

Device measures incorrectly
Configuration error
↳ Check and correct parameter configuration (see below).

HART communication is not working
- Communication resistor missing or incorrectly installed.
  ↳ Install the communication resistor (250 Ω) correctly.
- Commubox is connected incorrectly.
  ↳ Connect Commubox correctly.
- Commubox is not set to "HART".
  ↳ Set Commubox selector switch to "HART".

RIA15 no display
- The polarity of the supply voltage is wrong
  ↳ Correct the polarity
- Connecting cables are not in contact with the terminals
  ↳ Ensure electrical contact between the cable and the terminal
- RIA15 defective
  ↳ Replace RIA15

RIA15 start sequence keeps running through
Supply voltage too low
↳ Increase supply voltage
↳ Switch off backlight

10.2 Diagnostic events in the operating tool

10.2.1 Diagnostic message

Faults detected by the self-monitoring system of the measuring device are displayed as a diagnostic message in alternation with the measured value display.

Status signals

The table lists the messages that may occur. The ALARM STATUS parameter shows the message with the highest priority. The device has four different status information codes according to NE107:

F Failure
A device error has occurred. The measured value is no longer valid.

M Maintenance required
Maintenance is required. The measured value is still valid.

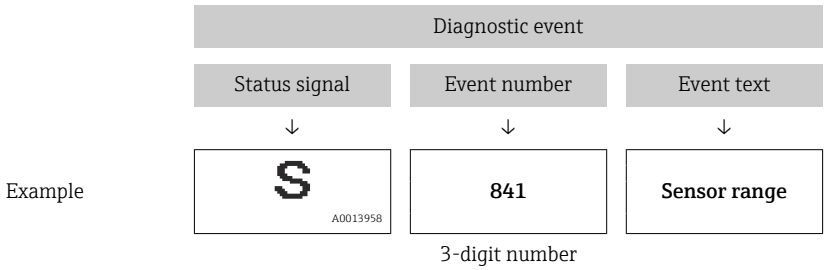
C Function check
The device is in the service mode (e.g. during a simulation).

S Out of specification
The device is being operated:
- Outside its technical specifications (e.g. during warm-up or cleaning)
- Outside of the configuration carried out by the user (e.g. level outside configured span)

Diagnostic event and event text

The fault can be identified by means of the diagnostic event.

The event text helps you by providing information about the fault.



If two or more diagnostic messages are pending simultaneously, only the message with the highest priority is shown.

Other diagnostic messages that are pending can be viewed in the **Diagnostic list** submenu → 122.

Past diagnostic messages that are no longer pending are shown in the **Event logbook** submenu → 123.

10.2.2 Diagnostic event in the RIA15

A device diagnostic event is not directly shown in the RIA15. The fault F911 only appears directly on the RIA15 in the event of a device alarm.

Displaying a diagnostic event in the RIA15

1. Navigate to: DIAG/TERR
2. Press E
3. Press +
4. Press E
5. Press + 3 times
6. Press E
   ↳ The device diagnostic event is shown on the RIA15 display.

10.2.3 List of diagnostic events

General messages

Code: 0
- Description: no fault
- Cause: -
- Corrective measure: -

"F" messages

Code: F002
- Description: Sensor unknown
- Cause: Sensor does not suit the device (electronic sensor module nameplate)
- Corrective measure: Contact Endress+Hauser Service

Code: F062
- Description: Sensor conn.
- Cause:
  - Sensor defective
  - Electromagnetic effects are greater than specifications in the technical data. This message appears for a short time only
- Corrective measure:
  - Check the sensor module cable
  - Contact Endress+Hauser Service

Code: F081
- Description: Initialization
- Cause:
  - Sensor defective
  - Electromagnetic effects are greater than specifications in the technical data. This message appears for a short time only
- Corrective measure:
  - Check sensor cable
  - Contact Endress+Hauser Service

Code: F083
- Description: Memory content
- Cause:
  - Sensor defective
  - Electromagnetic effects outside the permitted range. This message appears for a short time only
- Corrective measure:
  - Restart the device
  - Contact Endress+Hauser Service

Code: F140
- Description: Working range P
- Cause:
  - Overpressure and low pressure present
  - Electromagnetic effects outside the permitted range
  - Faulty sensor.
- Corrective measure:
  - Check the process pressure
  - Check the sensor range

Code: F261
- Description: Electronic module
- Cause:
  - Main electronics defective.
  - Fault in the main electronics.
- Corrective measure: Restart the device

Code: F282
- Description: Memory
- Cause:
  - Fault in the main electronics.
  - Main electronics defective.
- Corrective measure: Restart the device

Code: F283
- Description: Memory content
- Cause:
  - Main electronics defective
  - Electromagnetic effects are greater than specifications in the technical data.
  - The supply voltage is disconnected when writing.
  - An error occurred when writing.
- Corrective measure: Perform a reset

Code: F411
- Description: Up-/download
- Cause:
  - Upload/download
  - During the download, the data are not correctly transmitted to the processor, e.g. because of open cable connections, spikes (ripple) on the supply voltage or electromagnetic effects
- Corrective measure:
  - Repeat download
  - Use other file
  - Perform a reset

Code: F510
- Description: Linearization
- Cause: The linearization table is being edited.
- Corrective measure:
  - Conclude entries
  - Select "linear"

Code: F511
- Description: Linearization
- Cause: The linearization table consists of less than 2 points.
- Corrective measure:
  - Table too small
  - Correct table
  - Activate table

Code: F512
- Description: Linearization
- Cause: The linearization table is not monotonic increasing or decreasing.
- Corrective measure:
  - Table not monotonic
  - Correct table
  - Activate table

Code: F841
- Description: Sensor range
- Cause:
  - Overpressure or low pressure present
  - Sensor defective
- Corrective measure:
  - Check the pressure value
  - Contact Endress+Hauser Service

Code: F882
- Description: Input signal
- Cause: External measured value is not received or displays a failure status.
- Corrective measure:
  - Check the bus
  - Check the source device
  - Check the setting

"M" messages

Code: M002
- Description: Sens. unknown
- Cause: Sensor module does not suit the device (electronic sensor nameplate). Device continues measuring.
- Corrective measure: Contact Endress+Hauser Service

Code: M283
- Description: Memory content
- Cause:
  - Cause as indicated for F283
  - Correct measurement can continue as long as you do not need the peakhold indicator function.
- Corrective measure: Perform a reset

Code: M431
- Description: Adjustment
- Cause: The adjustment performed would cause the nominal sensor range to be exceeded or undershot.
- Corrective measure:
  - Check the measuring range
  - Check position adjustment
  - Check the setting

Code: M434
- Description: Scaling
- Cause:
  - Values for calibration (e.g. lower range value and upper range value) are too close together.
  - Lower range value and/or upper range value exceed or fall below the sensor range limits.
  - The sensor was replaced and the customer-specific configuration does not suit the sensor module.
  - Unsuitable download carried out.
- Corrective measure:
  - Check the measuring range
  - Check the setting
  - Contact Endress+Hauser Service

Code: M438
- Description: Data set
- Cause:
  - The supply voltage is disconnected when writing.
  - An error occurred when writing.
- Corrective measure:
  - Check the setting
  - Restart the device

Code: M882
- Description: Input signal
- Cause: External measured value displays a warning status.
- Corrective measure:
  - Check the bus
  - Check the source device
  - Check the setting

"C" messages

Code: C412
- Description: Backup in progress
- Cause: Downloading
- Corrective measure: Wait for download to complete

Code: C482
- Description: Simul. output
- Cause: Simulation of the current output is switched on, i.e. the device is not measuring at present.
- Corrective measure: End the simulation

Code: C484
- Description: Error simul.
- Cause: Fault state simulation is switched on, i.e. the device is not measuring at present.
- Corrective measure: End the simulation

Code: C485
- Description: Simulation value
- Cause: Simulation is switched on, i.e. the device is not measuring at present.
- Corrective measure: End the simulation

Code: C824
- Description: Process pressure
- Cause:
  - Overpressure or low pressure present.
  - Electromagnetic effects outside the permitted range. (This message appears for a short time only)
- Corrective measure:
  - Check the pressure value
  - Restart the device
  - Perform a reset

"S" messages

Code: S110
- Description: Working range T
- Cause:
  - Excess temperature or low temperature present
  - Electromagnetic effects outside the permitted range
  - Sensor defective
- Corrective measure:
  - Check the process temperature
  - Check the temperature range

Code: S140
- Description: Working range P LP/HP
- Cause:
  - Overpressure or low pressure present
  - Electromagnetic effects outside the permitted range
  - Sensor defective
- Corrective measure:
  - Check the process pressure
  - Check the sensor range

Code: S822
- Description: Process temp. LP/HP
- Cause:
  - The temperature measured in the sensor is greater than the upper nominal temperature of the sensor
  - The temperature measured in the sensor is lower than the lower nominal temperature of the sensor
- Corrective measure:
  - Check the temperature
  - Check the setting

Code: S841
- Description: Sensor range
- Cause:
  - Overpressure or low pressure present
  - Sensor defective
- Corrective measure:
  - Check the pressure value
  - Contact Endress+Hauser Service

Code: S971
- Description: Adjustment
- Cause:
  - The current is outside the permitted range 3.8 to 20.5 mA
  - The present pressure value is outside the configured measuring range (but may be within the sensor module range)
  - The adjustment performed would cause the sensor nominal range to be exceeded or undershot.
- Corrective measure:
  - Check the pressure value
  - Check the measuring range
  - Check the setting

10.3 Troubleshooting specific to the device with optional Pt100

No measuring signal
- 4 to 20 mA cable not connected correctly
  ↳ Connect device as per → 📄 25
- No power supplied via the 4 to 20 mA cable
  ↳ Check current loop
- Supply voltage too low (min. 10.5 V_{DC})
  ↳ Check supply voltage
  ↳ Overall resistance greater than max. load resistance
- Device is defective
  ↳ Replace the device

Temperature measured value is inaccurate/incorrect (only for device with Pt100)
Pt100 connected in 2-wire circuit, cable resistance was not compensated for, cable not correct
↳ Compensate for the cable resistance
↳ Connect Pt100 as 3-wire or 4-wire circuit

10.4 Troubleshooting specific to TMT72 temperature head transmitter

No measuring signal
- 4 to 20 mA cable not connected correctly
  ↳ Connect device as per → 📄 25
- No power supplied via the 4 to 20 mA cable
  ↳ Check current loop
- Supply voltage too low (min. 10.5 V_{DC})
  ↳ Check supply voltage
  ↳ Overall resistance greater than max. load resistance

Failure current ≤ 3.6 mA or ≥ 21 mA
- Pt100 not connected correctly
  ↳ Connect device as per → 📄 25
- 4 to 20 mA cable not connected correctly
  ↳ Connect device as per → 📄 25
- Pt100 resistance thermometer defective
  ↳ Replace the device
- Temperature head transmitter defective
  ↳ Replace the temperature head transmitter

Measured value is inaccurate/incorrect
Pt100 connected in 2-wire circuit, cable resistance was not compensated for
↳ Compensate for the cable resistance
↳ Connect Pt100 as 3-wire or 4-wire circuit

10.5 Response of output to errors

The behavior of the current output in the event of errors is defined in the following parameters:
- "Alarm behav. P (050)"
- "Output fail mode (190)"
- "High Alarm Curr. (052)"

10.6 Firmware history

Date	Firmware version	Modifications	Documentation
05.2009	01.00.zz	Original firmware. Compatible with: ▪ FieldCare version 2.02.00 and higher ▪ Field Communicator DXR375 with Device Rev.: 1, DD Rev.: 1	BA00380P/00/EN/03.09
			BA00380P/00/EN/07.09
			BA00380P/00/EN/08.09
			BA00380P/00/EN/13.11
			BA00380P/00/EN/14.13
			BA00380P/00/EN/15.15
			BA00380P/00/EN/16.16
			BA00380P/00/EN/17.16
			BA00380P/00/EN/18.18

11 Maintenance

- Terminal box: Keep the GORE-TEX® filter free from contamination
- Device extension cable: Keep the Teflon filter in the pressure compensation tube free from contamination
- Check the process membrane for buildup at suitable intervals.

11.1 Exterior cleaning

Please note the following points when cleaning the device:

- The cleaning agents used should not corrode the surface and the seals.
- Mechanical damage to the process membrane, e.g. due to sharp objects, must be avoided.
- Only clean the terminal box with water or with a cloth dampened with very diluted ethanol.

12 Repair

12.1 General information

12.1.1 Repair concept

Repairs are not envisaged for the device.

12.1.2 Replacing a device

Once a complete device has been replaced, the parameters can be transferred back into the device using FieldCare:

Prerequisite: The configuration of the old device was saved previously to the computer using FieldCare.

You can continue to measure without performing a new calibration.

12.2 Spare parts

All the spare parts for the measuring device, along with the order code, are listed in the *W@M Device Viewer* (www.endress.com/deviceviewer) and can be ordered. If available, users can also download the associated Installation Instructions.

Measuring device serial number:
- Located on the device and spare part nameplate.
- Can be read out via the "Serial number" parameter in the "Instrument info" submenu.

12.3 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the web page for information:
   http://www.endress.com/support/return-material
   ↳ Select the region.
2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

12.4 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

13 Overview of the operating menu

Depending on the parameter configuration, not all submenus and parameters are available. Information on this can be found in the parameter description under "Prerequisite".

Setup	Description
Operating mode	→ 91
Press. eng. unit	→ 93
Corrected press.	→ 95
Pos. zero adjust (relative pressure sensor)	→ 92
Calib. offset (absolute pressure sensor)	→ 92
Empty calib. ("Level" measuring mode and "Calibration mode" = wet)	→ 97
Full calib. ("Level" measuring mode and "Calibration mode" = wet")	→ 98
Set LRV ("Pressure" measuring mode)	→ 94
Set URV ("Pressure" measuring mode)	→ 94
Damping	→ 92
Level before Lin ("Level" measuring mode)	→ 100
Pressure af.damp	→ 95

Setup →	Extended setup	Description
	Code definition	→ 88
	Device tag	→ 89
	Operator code	→ 88

Setup →	Extended setup →	Level ("Level" measuring mode)	Description
		Level selection	→ 96
		Output unit	→ 96
		Height unit	→ 96
		Calibration mode	→ 97
		Empty calib.	→ 97
		Empty pressure	→ 97
		Empty height	→ 98
		Full calib.	→ 98
		Full pressure	→ 98
		Full height	→ 99
		Adjust density	→ 99
		Process density	→ 99
		Level before lin	→ 100

Setup →	Extended setup →	Linearization	Description
		Lin. mode	→ 101
		Unit after lin.	→ 101
		Line-numb:	→ 101

Setup →	Extended setup →	Linearization	Description
		X-val	→ 102
		Y-val	→ 102
		Edit table	→ 102
		Tank description	→ 103
		Tank content	→ 103

Setup →	Extended setup →	Current output	Description
		Alarm behav. P	→ 106
		Output fail mode	→ 106
		Max. alarm curr.	→ 106
		Set min. current	→ 107
		Output current	→ 106
		Get LRV (only "Pressure")	→ 107
		Set LRV	→ 107
		Get URV (only "Pressure")	→ 107
		Set URV	→ 108

Diagnosis	Description
Diagnostic code	→ 120
Last diag. code	→ 120
Min. meas. press.	→ 120
Max. meas. press.	→ 120

Diagnosis →	Diagnostics List	Description
	Diagnostic 1	→ 122
	Diagnostic 2	→ 122
	Diagnostic 3	→ 122
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Diagnosis →	Event logbook	Description
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13.1 Overview of parameters in the "Expert" menu

The following table lists all of the parameters that can be included in the "Expert" menu. The page reference indicates where a description of the parameter can be found in the manual.

Depending on the device version and the parameter configuration, not all submenus and parameters are available in every device. Information on this can be found in the parameter description under "Prerequisite".

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Expert →	Diagnosis→	Event logbook	Description
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		Last diag. 4	→ 123
		Last diag. 5	→ 123
		Last diag. 6	→ 123
		Last diag. 7	→ 123
		Last diag. 8	→ 123
		Last diag. 9	→ 123
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Expert →	Diagnosis→	Simulation	Description
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		Sim. tank cont.	→ 🖹 125
		Sim. current	→ 🖹 125
		Sim. alarm/warning	→ 🖹 125

14 Description of device parameters

14.1 Expert → System

Operator code

Write permission Operators/Service engineers/Expert

Description Use this function to enter a code to lock or unlock operation.

User entry
- To lock: Enter a number ≠ the release code (value range: 1 to 9999).
- To unlock: Enter the release code.

Note The release code is "0" in the order configuration. Another release code can be defined in the "Code definition" parameter. If the user has forgotten the release code, the release code can be visible by entering the number "5864".

Factory setting 0

Code definition

Write permission Operators/Service engineers/Expert

Description Use this function to enter a release code with which the device can be unlocked.

Options A number from 0 to 9999

Factory setting 0

14.2 Expert → System → Instrument info

Cust. tag number

Write permission Operators/Service engineers/Expert

Description Enter the device tag, e.g. TAG number (max. 8 alphanumeric characters).

Factory setting No entry or according to order specifications

Device tag

Write permission Operators/Service engineers/Expert

Description Enter the device tag, e.g. TAG number (max. 32 alphanumeric characters).

Factory setting No entry or according to order specifications

Serial number

Write permission Parameter is read only. Only Endress+Hauser Service has write permission.

Description Displays the serial number of the device (11 alphanumeric characters).

Firmware Version

Write permission No write permissions. Parameter is read only.

Description Displays the firmware version.

Ext. order code

Write permission Parameter is read only. Only Endress+Hauser Service has write permission.

Description Displays extended order number.

Factory setting According to order specifications

Order identifier

Write permission Parameter is read only. Only Endress+Hauser Service has write permission.

Description Displays the order identifier.

Factory setting According to order specifications

ENP version

Write permission No write permissions. Parameter is read only.

Description Displays the ENP version
(ENP = electronic nameplate)

Electr.serial no.

Write permission No write permissions. Parameter is read only.

Description Displays the serial number of the main electronics (11 alphanumeric characters).

Sensor serial no.

Write permission No write permissions. Parameter is read only.

Description Displays the serial number of the main electronics (11 alphanumeric characters).

14.3 Expert → System → Management

Enter reset code

Write permission Operators/Service engineers/Expert

Description Reset parameters completely or partially to the factory values or order configuration by entering a reset code, see "Resetting to factory settings (reset)" section.→ 39

Factory setting 0

14.4 Expert → Measurement → Measuring mode

Measuring mode

WARNING

Changing the measuring mode affects the span (URV)
This situation can result in product overflow.
- ▶ If the measuring mode is changed, the setting for the span (URV) must be checked in the "Setup" operating menu and readjusted if necessary.

Write permission Operators/Service engineers/Expert

Description Select the measuring mode. The operating menu is structured differently depending on the measuring mode selected.

Options
- Pressure
- Level

Factory setting Pressure or according to order specifications

14.5 Expert → Measurement → Basic setup

Pos. zero adjust

Write permission Operators/Service engineers/Expert

Description Position adjustment – the pressure difference between zero (set point) and the measured pressure need not be known.

Example
- Measured value = 2.2 mbar (0.033 psi)
- You correct the measured value via the "Pos. zero adjust" parameter with the "Confirm" option. This means that you are assigning the value 0.0 to the pressure present.
- Measured value (after position adjustment) = 0.0 mbar
- The current value is also corrected.

Options
- Confirm
- Cancel

Factory setting Cancel

Calib. offset

Write permission Service engineers/Expert

Description Position adjustment – the pressure difference between the set point and the measured pressure must be known.

Example
- Measured value = 982.2 mbar (14.73 psi)
- You correct the measured value with the value entered (e.g. 2.2 mbar (0.033 psi)) via the "Calib. Offset" parameter. This means that you are assigning the value 980.0 (14.7 psi) to the pressure present.
- Measured value (after pos. zero adjust) = 980.0 mbar (14.7 psi)
- The current value is also corrected.

Factory setting 0.0

Damping

Write permission Operators/Service engineers/Expert
(if the "Damping" DIP switch is set to "on")

Description Enter damping time (time constant τ).
The damping affects the speed at which the measured value reacts to changes in pressure.

Input range 0.0 to 999.0 s

Factory setting 2.0 sec. or according to order specifications

Press. eng. unit

Write permission Operators/Service engineers/Expert

Description Select the pressure engineering unit. If a new pressure engineering unit is selected, all pressure-specific parameters are converted and displayed with the new unit.

Options
- mbar, bar
- mmH2O, mH2O, inH2O
- ftH2O
- Pa, kPa, MPa
- psi
- mmHg, inHg
- kgf/cm^2

Factory setting mbar or bar depending on the nominal measuring range of the sensor module, or as per order specifications

Temp. eng. unit

Write permission Service engineers/Expert

Description Select the unit for the temperature measured values.

Options
- °C
- °F
- K

Note The setting affects the unit for the "Sensor temp." parameter.

Factory setting °C

Sensor temp.

Write permission No write permissions. Parameter is read only.

Description Displays the temperature currently measured in the sensor module. This can deviate from the process temperature.

14.6 Expert → Measurement → Pressure

Set LRV

Write permission Operators/Service engineers/Expert

Description Set the pressure value, level or content for the lower current value (4 mA).

Factory setting
- 0.0 % in Level measuring mode
- 0.0 mbar/bar or in accordance with ordering information in Pressure measuring mode

Set URV

Write permission Operators/Service engineers/Expert

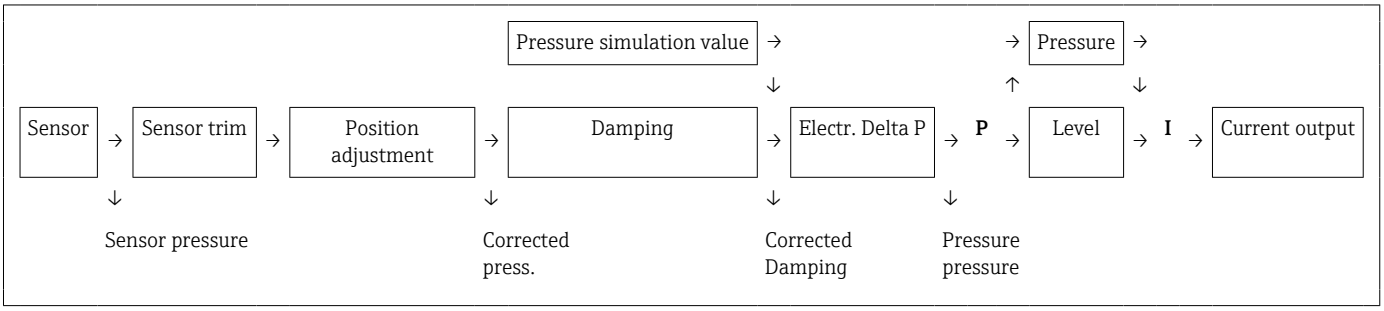
Description Set the pressure value, level or content for the upper current value (20 mA).

Factory setting
- 100.0 % in Level measuring mode
- URL Sensor or according to ordering information in Pressure measuring mode

Meas. pressure

Write permission No write permissions. Parameter is read only.

Description Displays the measured pressure after sensor trim, position adjustment and damping.



Sensor pressure

Write permission No write permissions. Parameter is read only.

Description Displays the measured pressure before the sensor trim.

Corrected press.

Write permission No write permissions. Parameter is read only.

Description Displays the measured pressure after sensor trim and position adjustment.

Pressure af.damp

Write permission No write permissions. Parameter is read only.

Description Displays the measured pressure after sensor trim, position adjustment and damping.

14.7 Expert → Measurement → Level

Level selection

Write permission Operator/Maintenance/Expert

Description Select the method for calculating the level

Options
- In pressure
  If this option is selected, specify two pressure/level value pairs. The level value is displayed directly in the unit that you select via the "Output unit" parameter.
- In height
  If this option is selected, specify two height/level value pairs. From the measured pressure, the device first calculates the height using the density. This information is then used to calculate the level in the "Output unit" selected using the two value pairs specified.

Factory setting In pressure

Output unit

Description Select the unit for the measured value display for the level before linearization.

Note The selected unit is used only to describe the measured value i.e. when a new output unit is selected, the measured value is not converted.

Example
- Current measured value: 0.3 ft
- New output unit: m
- New measured value: 0.3 m

Options
- %
- mm, cm, dm, m
- ft, inch
- m^3, in^3
- l, hl
- ft^3
- gal, Igal
- kg, t
- lb

Factory setting %

Height unit

Write permission Operator/Maintenance/Expert

Description Select the height unit. The measured pressure is converted to the selected height unit using the "Adjust density" parameter.

Prerequisite "Level selection" = In height

Options
- mm
- m
- in
- ft

Factory setting m

Calibration mode

Write permission Operator/Maintenance/Expert

Description Select the calibration mode.

Options
- Wet
  Wet calibration is performed by filling and emptying the vessel. In the event of two different levels, the level, volume, mass or percentage value entered is assigned to the pressure measured at this point in time ("Empty calib." and "Full calib." parameters).
- Dry
  Dry calibration is a theoretical calibration. For this calibration, you specify two pressure-level value pairs or height-level value pairs via the following parameters: "Empty calib.", "Empty pressure", "Empty height", "Full calib.", "Full pressure", "Full height".

Factory setting Wet

Empty calib.

Write permission Operator/Maintenance/Expert

Description Enter the output value for the lower calibration point (vessel is empty). The unit defined in "Output unit" must be used.

Note
- In the case of wet calibration, the level (e.g. vessel empty or partially filled) must actually be available. The associated pressure is then automatically recorded by the device.
- In the case of dry calibration, the level (vessel empty) does not have to be available. For the "In pressure" level selection, the associated pressure must be entered in the "Empty pressure" parameter. For the "In height" level selection, the associated height must be entered in the "Empty height" parameter.

Factory setting 0.0

Empty pressure

Write permission Operator/Maintenance/Expert

Description Enter the pressure value for the lower calibration point (vessel empty). See also "Empty calib.".

Prerequisite
- "Level selection" = In pressure
- "Calibration mode" = Dry -> entry
- "Calibration mode" = Wet -> display

Factory setting 0.0

Empty height

Write permission Operator/Maintenance/Expert

Description Enter the height value for the lower calibration point (vessel empty). The unit is selected via the "Height unit" parameter.

Prerequisite
- "Level selection" = In height
- "Calibration mode" = Dry -> entry
- "Calibration mode" = Wet -> display

Factory setting 0.0

Full calib.

Write permission Operator/Maintenance/Expert

Description Enter the output value for the upper calibration point (vessel full). The unit defined in "Output unit" must be used.

Note
- In the case of wet calibration, the level (e.g. vessel full or partially filled) must actually be available. The associated pressure is then automatically recorded by the device.
- In the case of dry calibration, the level (vessel full) does not have to be available. For the "In pressure" level selection, the associated pressure must be entered in the "Full pressure" parameter. The associated height has to be entered in the "Full height" parameter for the "In height" level selection.

Factory setting 100.0

Full pressure

Write permission Operator/Maintenance/Expert

Description Enter the pressure value for the upper calibration point (vessel full). See also "Full calib.".

Prerequisite
- "Level selection" = In pressure
- "Calibration mode" = Dry -> entry
- "Calibration mode" = Wet -> display

Factory setting URL of the sensor module

Full height

Write permission Operator/Maintenance/Expert

Description Enter the height value for the upper calibration point (vessel full). The unit is selected via the "Height unit" parameter.

Prerequisite
- "Level selection" = In height
- "Calibration mode" = Dry -> entry
- "Calibration mode" = Wet -> display

Factory setting Upper range limit (URL) is converted to a level unit

Density unit

Write permission Maintenance/Expert

Description The measured pressure is converted to a height using the "Height unit", "Adjust density" and "Process density" parameters.

Factory setting g/cm^3

Adjust density

Write permission Operator/Maintenance/Expert

Description Enter the density of the medium used to perform the calibration. The measured pressure is converted to a height using the "Height unit" and "Adjust density" parameters.
Input: Auto dens. corr. = Off
Display: Auto dens. corr. ≠ Off

Factory setting 1.0

Process density

Write permission Operator/Maintenance/Expert

Description Enter a new density value for density correction. The calibration was carried out with the medium water, for example. Now the vessel is to be used for another medium with another density. The calibration is corrected appropriately by entering the new density value in the "Process Density" parameter.
Input: Auto dens. corr. = Off
Display: Auto dens. corr. ≠ Off

Note If, after completing a wet calibration, you change to dry calibration using the "Calibration mode" parameter, the density for the "Adjust density" and "Process density" parameters must be entered correctly before changing the calibration mode.

Factory setting 1.0

Level before lin.

Write permission No write permissions. Parameter is read only.

Description Displays the level value prior to linearization.

14.8 Expert → Measurement → Linearization

Lin. mode

Write permission Operators/Service engineers/Expert

Description Select the linearization mode.

Options
- Linear
  The level is output without being converted beforehand. "Level before lin" is output.
- Erase table
  The existing linearization table is deleted.
- Manual entry (sets the table to edit mode, an alarm is output):
  The value pairs of the table (X-value and Y-value) are entered manually.
- Semi-automatic entry (sets the table to edit mode, an alarm is output):
  The vessel is emptied or filled in stages in this entry mode. The device automatically records the level value (X-value). The associated volume, mass or % value is entered manually (Y-value).
- Activate table
  The table entered is activated and checked with this option. The device shows the level after linearization.

Factory setting Linear

Unit after lin.

Write permission Operators/Service engineers/Expert

Description Select volume unit, mass, height or % (unit of the Y-value).

Options
- %
- cm, dm, m, mm
- hl
- in^3, ft^3, m^3,
- l
- in, ft
- kg, t
- lb
- gal
- Igal

Factory setting %

Line-numb

Write permission Operators/Service engineers/Expert

Description Enter the number of the current point in the table. Subsequent entries in "X-val" and "Y-val" relate to this point.

Input range 1...32

X-val

Write permission Operators/Service engineers/Expert

Description Enter the X-value (level before linearization) for the specific point in the table and confirm.

Note
- If "Lin. mode" = "Manual", the level value must be entered.
- If "Lin. mode" = "Semiautomatic", the level value is displayed and must be confirmed by entering the paired Y-value.

Y-value

Write permission Operators/Service engineers/Expert

Description Enter the Y-value (value after linearization) for the specific point in the table. The unit is determined by "Unit after lin.".

Note The linearization table must be monotonic (increasing or decreasing).

Edit table

Write permission Operators/Service engineers/Expert

Description Select the function for entering the table.

Options
- Next point: Enter the next point.
- Current point: stay on the current point to correct a mistake for example.
- Last input point: skip back to previous point to correct a mistake for example.
- Insert point: Insert an additional point (see example below).
- Delete point: Delete the current point (see example below).

Example

Add point, in this case between the 4th and 5th point for example
- Select point 5 via the "Line-numb" parameter.
- Select the "Insert point" option via the "Edit table" parameter.
- Point 5 is displayed for the "Line-numb" parameter. Enter new values for the "X-val" and "Y-val" parameters.

Delete point, in this case the 5th point for example
- Select point 5 via the "Line-numb" parameter.
- Select the "Delete point" option via the "Edit table" parameter.
- The 5th point is deleted. All of the following points are pushed up one number i.e. following deletion, the 6th point becomes Point 5.

Factory setting Current point

Tank description

Write permission Operators/Service engineers/Expert

Description Enter the tank description (max. 32 alphanumeric characters)

Tank content

Write permission No write permissions. Parameter is read only.

Description Displays the level value after linearization.

14.9 Expert → Measurement → Sensor limits

LRL sensor

Write permission No write permissions. Parameter is read only.

Description Displays the lower-range limit of the sensor.

URL sensor

Write permission No write permissions. Parameter is read only.

Description Displays the upper-range limit of the sensor.

14.10 Expert → Measurement → Sensor trim

Lo trim measured

Write permission Parameter is read only. Only Endress+Hauser Service has write permission.

Description Displays the reference pressure present to be accepted for the lower calibration point.

Hi trim measured

Write permission Parameter is read only. Only Endress+Hauser Service has write permission.

Description Displays the reference pressure present to be accepted for the upper calibration point.

Lo trim sensor

Write permission No write permissions. Parameter is read only.

Description Sensor module recalibration by entering a target pressure while simultaneously and automatically accepting a reference pressure present for the lower calibration point.

Hi trim sensor

Write permission No write permissions. Parameter is read only.

Description Sensor module recalibration by entering a target pressure while simultaneously and automatically accepting a reference pressure present for the upper calibration point.

14.11 Expert → Output → Current output

Output current

Write permission Operators/Service engineers/Expert

Description Displays the current current value.

Alarm behav. P

Write permission Operators/Service engineers/Expert

Description Configure the response of the current output if sensor module limits are overshot or undershot.

Options
- Warning
  The device continues to measure. An error message is displayed.
- Alarm
  The output signal assumes a value that can be specified by the "Output fail mode" function.

Factory setting Warning

Output fail mode

Write permission Operators/Service engineers/Expert

Description Select Output fail mode. In the event of an alarm, the current assumes the current value specified with this parameter.

Options
- Max: can be set from 21 to 23 mA, see also "High alarm curr."
- Hold: last measured value is held.
- Min: 3.6 mA

Factory setting Max (22 mA)

Max. alarm curr.

Write permission Operators/Service engineers/Expert

Description Enter the current value for maximum alarm current. See also "Output fail mode".

Input range 21 to 23 mA

Factory setting 22 mA

Set min. current

Write permission Operators/Service engineers/Expert

Description Enter lower current limit.
Some switching units accept no current smaller than 4.0 mA.

Options
- 3.8 mA
- 4.0 mA

Factory setting 3.8 mA

Get LRV

Write permission Operators/Service engineers/Expert

Description Set the lower-range value – reference pressure is present at the device. The pressure for the lower current value (4 mA) is present at the device. Use the "Confirm" option to assign the lower current value to the applied pressure value.

Prerequisite: Pressure measuring mode

Options
- Cancel
- Confirm

Factory setting Cancel

Set LRV

Write permission Operators/Service engineers/Expert

Description Set the pressure value, level or content for the lower current value (4 mA).

Factory setting
- 0.0 % in Level measuring mode
- 0.0 mbar/bar or in accordance with ordering information in Pressure measuring mode

Get URV (pressure measuring mode)

Write permission Operators/Service engineers/Expert

Description Set the upper-range value – reference pressure is present at the device. The pressure for the upper current value (20 mA) is present at the device. Use the "Confirm" option to assign the applied pressure value to the upper current value.

Prerequisite: Pressure measuring mode

Options
- Cancel
- Confirm

Factory setting Cancel

Set URV

Write permission Operators/Service engineers/Expert

Description Set the pressure value, level or content for the upper current value (20 mA).

Factory setting
- 100.0 % in Level measuring mode
- URL Sensor or according to ordering information in Pressure measuring mode

Startcurrent

Write permission Service engineers/Expert

Description Entry of the start current. This setting also applies in the HART Multidrop mode.

Options
- 12 mA
- Max alarm (22 mA, cannot be set)

Factory setting 12 mA

Curr. trim 4mA

Write permission Service engineers/Expert

Description Enter the pressure value for the lower point (4 mA) of the current partial regression lines. Using this parameter and "Curr. trim 20 mA", you can adapt the current output to the transmission conditions.

Options Carry out the current trim for the lower point as follows.
- Select the "Current" option in the "Simulation mode" parameter.
- In the "Sim current" parameter, configure the "4 mA value".
- Enter the current value measured using the switching unit in the "Curr. trim 4mA" parameter.

Input range Measured current ±0.2 mA

Factory setting 4 mA

Curr. trim 20mA

Write permission Service engineers/Expert

Description Enter the pressure value for the upper point (20 mA) of the current partial regression lines. Using this parameter and "Curr. Trim 4 mA", you can adapt the current output to the transmission conditions.

Options Carry out the current trim for the upper point as follows:
- Select the "Current" option in the "Simulation mode" parameter.
- In the "Sim current" parameter, configure the value "20 mA".
- Enter the current value measured using the switching unit in the "Curr. trim 20mA" parameter.

Input range Measured current ±1 mA

Factory setting 20 mA

Offset trim 4mA

Write permission Service engineers/Expert

Description Display/enter the difference between 4 mA and the value entered for the parameter "Curr. trim 4mA".

Factory setting 0

Offset trim 20mA

Write permission Service engineers/Expert

Description Display/enter the difference between 20 mA and the value entered for the parameter "Curr. trim 20mA".

Factory setting 0

14.12 Expert→ Communication → HART config.

Burst mode

Write permission Service engineers/Expert

Description Switching burst mode on and off.

Options
- On
- Off

Factory setting Off

Burst option

Write permission Service engineers/Expert

Description You can use this parameter to define which command is sent to the master.

Options
- 1 (HART command 1)
- 2 (HART command 2)
- 3 (HART command 3)
- 9 (HART command 9)
- 33 (HART command 33)

Factory setting 1 (HART command 1)

Current mode

Write permission Service engineers/Expert

Description Configure current mode for HART communication.

Options
- Signaling
  Measured value transmission by the current value
- Fixed
  Fixed current 4.0 mA (Multidrop mode)
  (Measured value transmission via HART digital communication only)

Factory setting Signaling

Bus address

Write permission Service engineers/Expert

Description Use this function to enter the address via which a data exchange is to take place via HART protocol. (HART 5.0 master: Range 0 to 15, where address = 0 calls up the "Signaling" setting; HART 6.0 master: Range 0 to 63)

Factory setting 0

Preamble number

Write permission Service engineers/Expert

Description Use this function to enter the number of preambles in the HART protocol. (Synchronization of the modem components along a transmission path, each modem component could "swallow" one byte, at least 2 bytes must be the preamble.)

Input range 2...20

Factory setting 5

14.13 Expert→ Communication → HART info

Device type code

Write permission No write permissions. Parameter is read only.

Description Display of the numerical ID of the device
Waterpilot FMX21: 36

Device revision

Write permission No write permissions. Parameter is read only.

Description Display of Device Revision (e.g. 1)

Manufacturer ID

Write permission No write permissions. Parameter is read only.

Description Displays the HART manufacturer ID in a decimal digit format.
Here: 17 (Endress+Hauser)

HART version

Write permission No write permissions. Parameter is read only.

Description Displays HART version .
Waterpilot FMX21: 6

Description

Write permission Service engineers/Expert

Description Enter the tag description (max. 16 alphanumeric characters)

HART message

Write permission Service engineers/Expert

Description Enter the message (max. 32 alphanumeric characters) Upon request from the master, this message is sent via the HART protocol.

HART date

Write permission Service engineers/Expert

Description Enter the date of the last configuration change.

Factory setting DD/MM/YY (date of the final test)

14.14 Expert→ Communication → HART output

Primary value is

Write permission No write permissions. Parameter is read only.

Description Indicates which measured value is transmitted via the HART protocol as the primary process value.

Factory setting Depending on the selected measuring mode, the following measured values can be displayed:
- "Pressure" measuring mode: "Meas. pressure"
- "Level" measuring mode, Lin. mode "Linear": "Level before Lin"
- "Level" measuring mode, Lin. mode "Activate table": "Tank content"

Primary value

Write permission No write permissions. Parameter is read only.

Description The primary value is displayed.

Secondary val.is

Write permission No write permissions. Parameter is read only.

Description Indicates which measured value is transmitted via the HART protocol as the secondary process value. The process value is configured via HART command 51.

Factory setting
- "Pressure" measuring mode: "Corrected press."
- "Level" measuring mode, "Linear" lin. mode: "Meas. pressure"
- "Level" measuring mode, Lin. mode "Activate table": "Level before linearization"

Display Depending on the selected measuring mode, the following measured values can be displayed:
- "Meas. pressure"
- "Sensor pressure"
- "Corrected press."
- "Pressure af.damp"
- "Sensor temp."
- "Level before Lin"
- "Tank content"
- "Process density" (corrected)

Secondary value

Write permission No write permissions. Parameter is read only.

Description The secondary value is displayed.

Third value is

Write permission No write permissions. Parameter is read only.

Description Indicates which measured value is transmitted via the HART protocol as the third process value. The process value is configured via HART command 51.

Factory setting
- "Pressure" measuring mode: "Sensor pressure"
- "Level" measuring mode, "Linear" lin. mode: "Corrected press."
- "Level" measuring mode, "Activate table" lin. mode: "Meas. pressure"

Display Depending on the selected measuring mode, the following measured values can be displayed:
- "Meas. pressure"
- "Sensor pressure"
- "Corrected press."
- "Pressure af.damp"
- "Sensor temp."
- "Level before Lin"
- "Tank content"
- "Process density" (corrected)

Third value is

Write permission No write permissions. Parameter is read only.

Description The third value is displayed.

4th value is

Write permission No write permissions. Parameter is read only.

Description Indicates which measured value is transmitted via the HART protocol as the fourth process value. The process value is configured via HART command 51.

Factory setting
- "Pressure" measuring mode: "Sensor temp"
- "Level" measuring mode, "Linear" lin. mode: "Sensor temp."
- "Level" measuring mode, "Activate table" lin. mode: "Sensor temp."

Display Depending on the selected measuring mode, the following measured values can be displayed:

- "Meas. pressure"
- "Sensor pressure"
- "Corrected press."
- "Pressure af.damp"
- "Sensor temp."
- "Level before Lin"
- "Tank content"
- "Process density" (corrected)

4th value

Write permission No write permissions. Parameter is read only.

Description The fourth value is displayed.

14.15 Expert→ Communication → HART input

HART input value

Write permission No write permissions. Parameter is read only.

Description Display of the HART input value

HART input stat.

Write permission No write permissions. Parameter is read only.

Description Display of the HART input status
Bad / Uncertain / Good

HART input unit

Write permission No write permissions. Parameter is read only.

Description Display of the unit for the HART input value.

Display
- Unknown
- mbar, bar
- mmH2O, ftH2O, inH2O
- Pa, hPa, kPa, MPa
- psi
- mmHg, inHg
- Torr
- g/cm^2, kg/cm^2
- lb/ft^2
- atm
- ˚C, ˚F, K, R

Factory setting Unknown

HART input form.

Write permission Operators/Service engineers/Expert

Description Number of decimal places of the displayed input value.

Options

- x.x
- x.xx
- x.xxx
- x.xxxx
- x.xxxxx

Factory setting

x.x

14.16 Expert → Application

Electr. Delta P

Write permission Operators/Service engineers/Expert

Description For switching the Electr. Delta P application off or on with an external or constant value.

Options
- Off
- External value
- Constant

Factory setting Off

Fixed ext. value

Write permission Operators/Service engineers/Expert

Description Use this function to enter the constant value. The value refers to "HART input unit"

Factory setting 0.0

Auto dens. corr.

Write permission Operators/Service engineers/Expert

Description For switching the auto dens. corr. application off or on with an external or internal temperature value.
Before performing a calibration (dry or wet), auto-density compensation must be switched on if this function is to be used. As soon as "Auto dens. corr." is switched on, the field for entering the "Process density" and "Adjust density" is disabled.
The calibration density remains the last value until it is overwritten by a calibration. The process density remains the last value until it is overwritten when the system recalculates the value.
Automatic density compensation is performed for the 0 to 70 °C (32 to 158 °F) temperature range. The density values for water are used for this density compensation.

Prerequisite Level mode

Options
- Off
- Sensor temperature
- External value (only if Off or Constant is selected for Electr. Delta P)

Factory setting
- Off
- On (if the option "IC" was selected in the "Service" order code when ordering)

14.17 Expert → Diagnosis

Diagnostic code

Write permission No write permissions. Parameter is read only.

Description Displays the diagnostic message with the highest priority currently present.

Last diag. code

Write permission No write permissions. Parameter is read only.

Description Displays the last diagnostic message that occurred and was rectified.

Note
- Digital communication: the last message is displayed.
- Use the "Reset logbook" parameter to clear the messages listed in the parameter "Last diag. code".

Reset logbook

Write permission Service engineers/Expert

Description Use this parameter to reset all messages of the parameter "Last diag. code" and the event logbook "Last diag. 1" to "Last diag. 10".

Options
- Cancel
- Confirm

Factory setting Cancel

Min. meas. press.

Write permission No write permissions. Parameter is read only.

Description Displays the lowest pressure value measured (peakhold indicator). You can reset this indicator by means of the "Reset peakhold" parameter.

Max. meas. press.

Write permission No write permissions. Parameter is read only.

Description Displays the highest pressure value measured (peakhold indicator). You can reset this indicator by means of the "Reset peakhold" parameter.

Reset peakhold

Write permission Service engineers/Expert

Description You can reset the "Min. meas. press." and "Max. meas. press." indicators with this parameter.

Options
- Cancel
- Confirm

Factory setting Cancel

Operating hours

Write permission No write permissions. Parameter is read only.

Description Displays the hours of operation. This parameter cannot be reset.

Config. counter

Write permission Operators/Service engineers/Expert

Description Displays the configuration counter.
This counter is increased by one every time a parameter or group is changed. The counter counts up to 65535 and then starts again at zero.

14.18 Expert → Diagnosis → Diagnostic list

Diagnostic 1 (075)
Diagnostic 2 (076)
Diagnostic 3 (077)
Diagnostic 4 (078)
Diagnostic 5 (079)
Diagnostic 6 (080)
Diagnostic 7 (081)
Diagnostic 8 (082)
Diagnostic 9 (083)
Diagnostic 10 (084)

Write permission No write permissions. Parameter is read only.

Description This parameter contains up to ten diagnosis messages that are currently pending, arranged in order of priority.

14.19 Expert → Diagnosis→ Event logbook

Last diag. 1 (085)
Last diag. 2 (086)
Last diag. 3 (087)
Last diag. 4 (088)
Last diag. 5 (089)
Last diag. 6 (090)
Last diag. 7 (091)
Last diag. 8 (092)
Last diag. 9 (093)
Last diag. 10 (094)

Write permission
No write permissions. Parameter is read only.

Description
This parameter contains the last 10 diagnosis messages to occur and be rectified. They can be reset using the "Reset logbook" parameter.
Errors which have occurred multiple times are displayed once only.
Errors may also appear multiple times if another error has occurred in the meantime. The messages are displayed in chronological order.

14.20 Expert → Diagnosis → Simulation

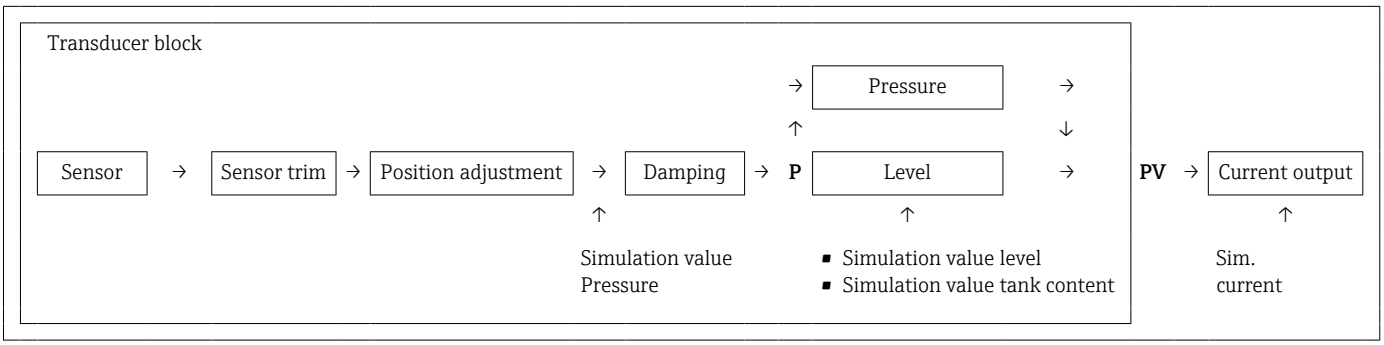
Simulation mode

Write permission Operators/Service engineers/Expert

Description Switch on simulation and select the simulation mode. When changing the measuring mode or the "Lin. mode" level type or when the device is restarted, any simulation that may be running is switched off.

Options
- None
- Pressure →see this table, "Sim. pressure" parameter
- Level, → see this table, "Sim. level" parameter
- Tank content, → see this table, "Sim. tank cont." parameter
- Current, → see this table, "Sim. current" parameter
- Alarm/warning, → see this table, "Sim. error no."

Factory setting None



Sim. pressure

Write permission Operators/Service engineers/Expert

Description Enter the simulation value. See also "Simulation mode".

Prerequisite "Simulation mode" = Pressure

Value at switch-on Current pressure measured value

Sim. level

Write permission Operators/Service engineers/Expert

Description Enter the simulation value. See also "Simulation mode".

Prerequisite "Measuring mode" = Level and "Simulation mode" = Level

Value at switch-on Current level measured value

Sim. tank cont.

Write permission Operators/Service engineers/Expert

Description Enter the simulation value. See also "Simulation mode".

Prerequisite "Measuring Mode" = level, Lin mode "Activate table" and "Simulation Mode" = Tank content

Value at switch-on Current tank content

Sim. current

Write permission Operators/Service engineers/Expert

Description Enter the simulation value. See also "Simulation mode".

Prerequisite "Simulation Mode" = Current value

Value at switch-on Current current value

Sim. alarm/warning

Write permission Operators/Service engineers/Expert

Description Enter the simulation value. See also "Simulation mode".

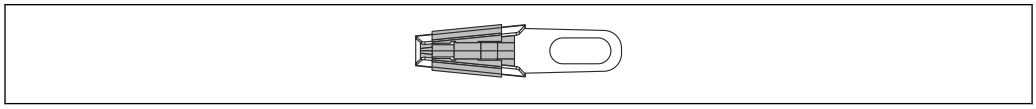
Prerequisite "Simulation Mode" = Alarm/Warning

Factory setting: 484 (Simulation active)

15 Accessories

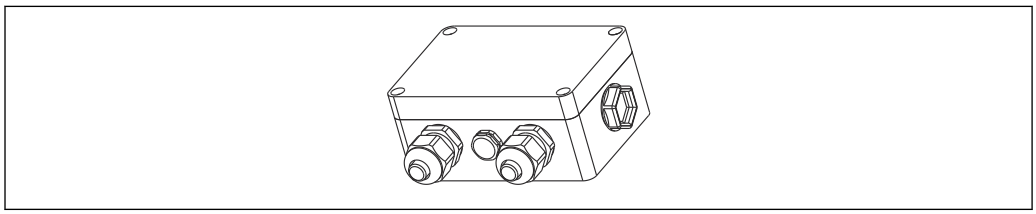
- Observe the additional information in the individual sections!
- For additional information, see the sections "Mechanical construction" (in the Technical Information), "Environment", → 137, "Process" → 139 and "Mounting" → 17.

Suspension clamp
For easy installation of the device, Endress+Hauser offers a suspension clamp.
- Product Configurator: the suspension clamp is optionally available
- Order number: 52006151



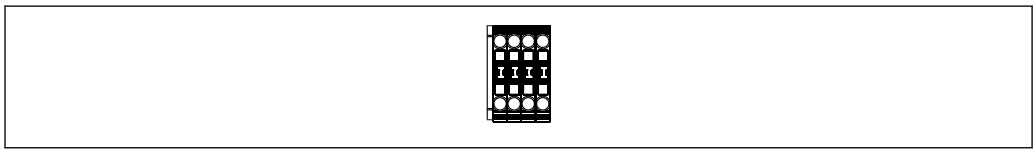
A0030950

Terminal box
Terminal box for terminal strip, temperature head transmitter and Pt100.
- Product Configurator: the terminal box is optionally available
- Order number: 52006152



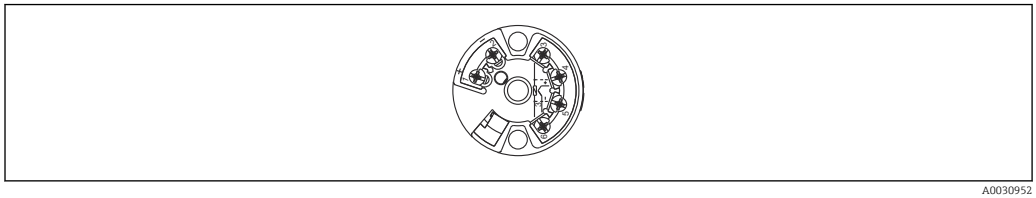
A0030967

4-terminal strip/terminals
4-terminal strip for wiring
Order number: 52008938



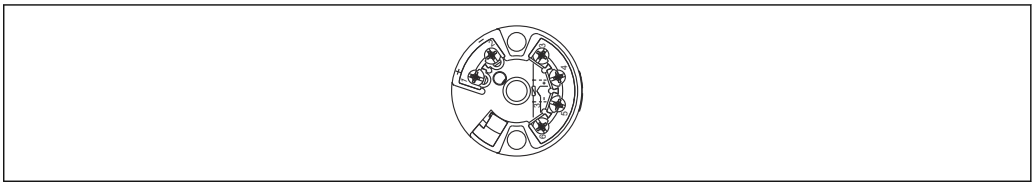
A0030951

Temperature head transmitter TMT71 for FMX21 4 to 20 mA analog
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT71 is optionally available → 126
- Order number: 52008794



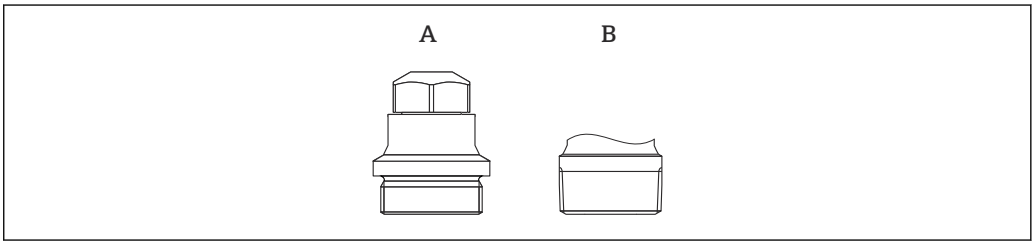
A0030952

Temperature head transmitter TMT72 for FMX21 4 to 20 mA HART
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT72 is optionally available
- Order number: 51001023



A0030952

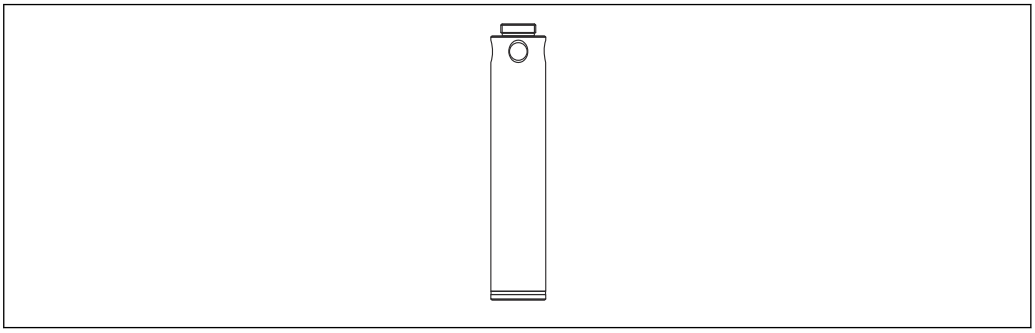
Cable mounting screws
Endress+Hauser offers a cable mounting screw for easy device mounting and to seal the measuring aperture.
- G 1½" A
  Order number: 52008264
- NPT 1½"
  Order number: 52009311
- Product Configurator: the cable mounting screws are optionally available



A0030953

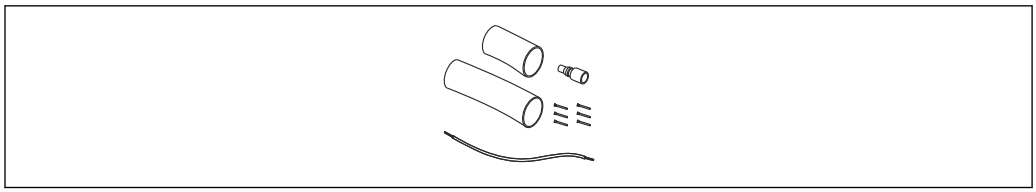
A G 1½" A
B NPT 1½"

Additional weight for device with an outer diameter of 22 mm (0.87 in) or 29 mm (1.14 in)
Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
- Product Configurator: the additional weight is optionally available
- Order number: 52006153



A0030954

Cable shortening kit
The cable shortening kit is used to shorten a cable easily and professionally.
- Product Configurator: the cable shortening kit is optionally available
- Order number: 71222671

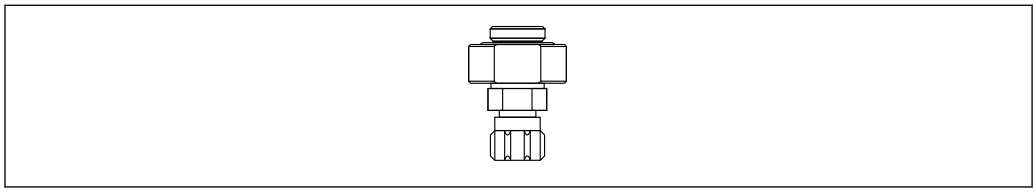


A0030948

Testing adapter for devices with an external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

Endress+Hauser offers a testing adapter to ease function-testing of the level probes.

- Product Configurator: the testing adapter is optionally available
- Order number: 52011868

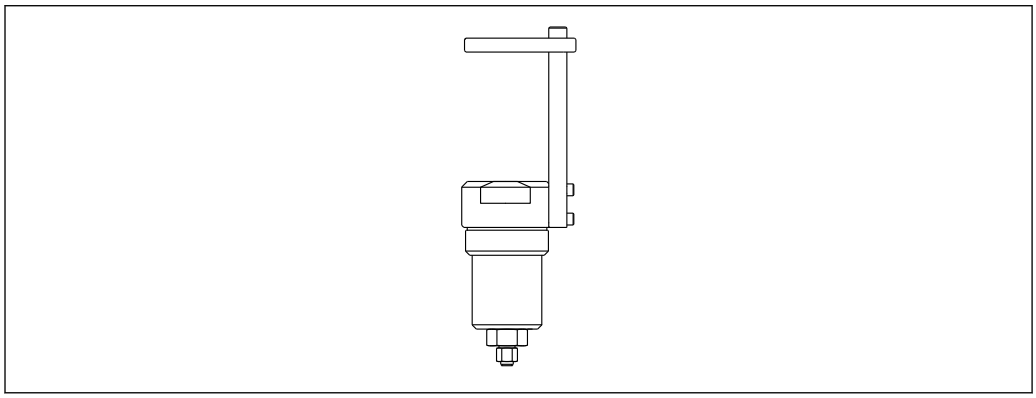


A0030956

Testing adapter for devices with an external diameter of 42 mm (1.65 in)

Endress+Hauser offers a testing adapter to ease function-testing of the level probes.

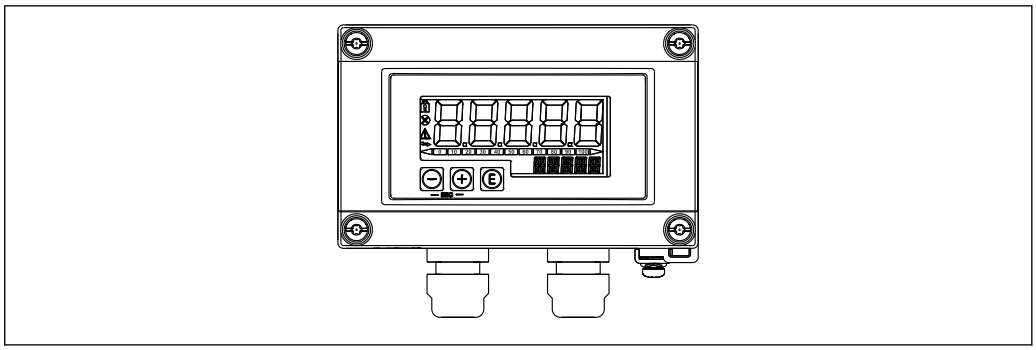
- Observe the maximum pressure for compressed air hose and maximum overload for level probe
- Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)
- Order number: 71110310



A0030957

RIA15 in the field housing

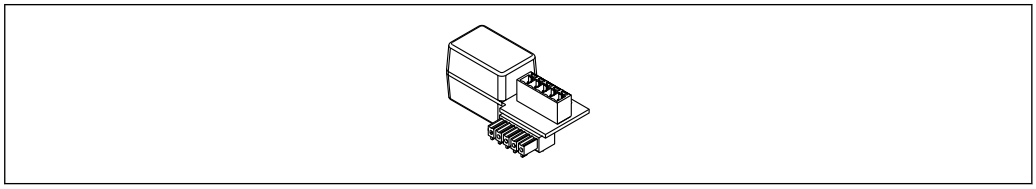
- Remote display RIA15 non-hazardous
  ↳ Product structure: the display is optionally available
- Remote display RIA15 hazardous
  ↳ Product structure: the display is optionally available



A0036164

HART communication resistor

- HART communication resistor hazardous / non-hazardous area, for use with RIA15
- Product structure: the HART communication resistor is optionally available



A0036165

15.1 Service-specific accessories

Accessories	Description
DeviceCare SFE100	Configuration tool for HART, PROFIBUS and FOUNDATION Fieldbus field devices Technical Information TI01134S DeviceCare is available for download at www.software-products.endress.com. You need to register in the Endress+Hauser software portal to download the application.
FieldCare SFE500	FDT-based plant asset management tool FieldCare can configure all smart field units in your plant and helps you manage them. By using the status information, FieldCare is also a simple but effective way of checking the status and condition of the field devices. Technical Information TI00028S

16 Technical data

16.1 Input

16.1.1 Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: Temperature

TMT72 temperature head transmitter (optional)

Temperature

16.1.2 Measuring range

- Customer-specific measuring ranges or calibration that has been preset in the factory
- Temperature measurement of −10 to +70 °C (+14 to +158 °F) with Pt100 (optional)

Gauge pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
0.1 bar (1.5 psi)	0.01 bar (0.15 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1C
0.2 bar (3.0 psi)	0.02 bar (0.3 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1D
0.4 bar (6.0 psi)	0.04 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1F
0.6 bar (9.0 psi)	0.06 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1G
1.0 bar (15.0 psi)	0.1 bar (1.5 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1H
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

Absolute pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

16.1.3 Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: Change in resistance

TMT72 temperature head transmitter (optional)

Pt100 resistance signal, 4 wire

16.2 Output

16.2.1 Output signal

Device + Pt100 (optional)

- 4 to 20 mA HART with superimposed digital communication protocol HART 6.0, 2-wire for hydrostatic pressure measured value.
  Options:
  - Max. alarm (factory setting 22 mA): can be set from 21 to 23 mA
  - Hold measured value: last measured value is held
  - Min. alarm: 3.6 mA
- Pt100: temperature-dependent resistance value

TMT72 temperature head transmitter (optional)

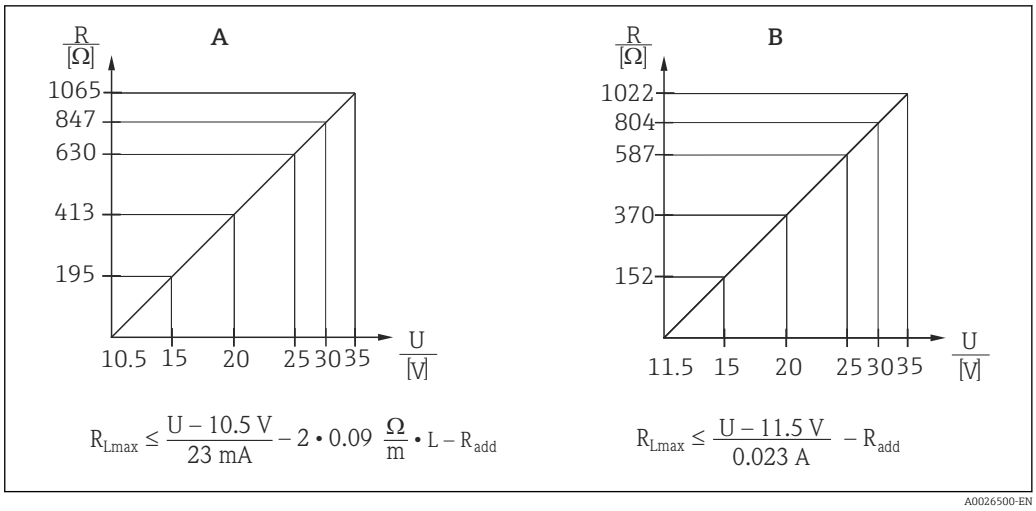
4 to 20 mA HART with superimposed digital communication protocol HART 5.0 for temperature measured value, 2-wire

16.2.2 Signal range

3.8 to 20.5 mA

16.2.3 Maximum load

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for the device and temperature head transmitter. The total resistance resulting from the resistances of the connected devices, the connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value.



A Load diagram for device 4 to 20 mA HART for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.

B Load diagram for TMT72 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation

R_{Lmax} Max. load resistance [Ω]

R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]

U Supply voltage [V]

L Basic length of extension cable [m] (cable resistance per wire ≤0.09 Ω/m

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).
- When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250 Ω must be taken into account.

16.2.4 Protocol-specific data

- Manufacturer ID: 17 (11 hex)
- Device type ID: 25 (19 hex)
- Device revision: 01 (01 hex) - SW version 01.00.zz
- HART specification: 6
- DD revision: 01
- Device description files (DTM, DD):
  - www.endress.com
  - www.fieldcommgroup.org
- HART load: min. 250 Ω
- HART device variables. The dynamic variables SV, TV and QV may be assigned to any device variable:
  - Standard process values for SV, TV (second and third device variable) are dependent on the measuring mode: pressure, level
  - Standard process value for QV (fourth device variable) is the sensor temperature: temperature
  - Measured values for PV (first device variable) are dependent on the measuring mode: pressure, level, tank content
- Supported functions:
  - Burst mode
  - Additional transmitter status
  - Device locking
  - Alternative measuring modes
  - Catch variable
  - Long tag

16.3 Performance characteristics

16.3.1 Reference operating conditions

Device + Pt100 (optional)

- As per IEC 60770
- Ambient temperature T_A = constant, in the range of: +21 to +33 °C (+70 to +91 °F)
- Humidity φ = constant, in the range of: 20 to 80 % rH
- Atmospheric pressure p_A = constant, in the range of:
  860 to 1060 mbar (12.47 to 15.37 psi)
- Position of the measuring cell constant, vertical in the range of ±1 °
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value (only for HART)
- Supply voltage constant: 21 to 27 V_{DC}
- Load: 250 Ω
- Pt100: DIN EN 60770, T_A = +25 °C (+77 °F)

TMT72 temperature head transmitter (optional)

Calibration temperature: +25 °C (+77 °F) ±5 K

16.3.2 Reference accuracy

Device + Pt100 (optional)

The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-reproducibility in accordance IEC 60770.

Standard version:
Setting ±0.2 %
- to TD 5:1: < 0.2 % of set span
- from TD 5:1 to TD 20:1 ±(0.02 x TD+0.1)

Platinum version:
- Setting ±0.1 % (optional)
  - to TD 5:1: < 0.1 % of set span
  - from TD 5:1 to TD 20:1 ±(0.02 x TD)
- Class B as per DIN EN 60751
  Pt100: max. ±1 K

TMT72 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

16.3.3 Resolution

Current output: 1 µA

Reading cycle

HART commands: on average 2 to 3 per second

16.3.4 Long-term stability

Device + Pt100 (optional)

- ≤ 0.1 % of URL/year
- ≤ 0.25 % of URL/5 years

TMT72 temperature head transmitter (optional)

≤ 0.1 K per year

16.3.5 Influence of medium temperature

- Thermal change in the zero output and the output span:
  0 to 30 °C (+32 to 86 °F): < (0.15 + 0.15 x TD)% of set span
  −10 to +70 °C (+14 to 158 °F): < (0.4 + 0.4 x TD)% of set span
- Temperature coefficient (T_K) of the zero output and the output span
  −10 to +70 °C (+14 to 158 °F): 0.1 % / 10 K of URL

16.3.6 Warm-up time

Device + Pt100 (optional)

- Device: < 6 s
- Pt100: 300 s

TMT72 temperature head transmitter (optional)

4 s

16.3.7 Response time

Device + Pt100 (optional)

- Device: 400 ms (T90 time), 500 ms (T99 time)
- Pt100: 160 s (T90 time), 300 s (T99 time)

16.4 Environment

16.4.1 Ambient temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F) (= medium temperature)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F) (= medium temperature)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −40 to +70 °C (−40 to +158 °F)
- With PUR: −40 to +70 °C (−40 to +158 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

16.4.2 Storage temperature range

Device + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −30 to +80 °C (−22 to +176 °F)
- With PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT72 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

16.4.3 Degree of protection

Device + Pt100 (optional)

IP68, permanently hermetically sealed at 20 bar (290 psi) (~200 m H_2O)

Terminal box (optional)

IP66, IP67

TMT72 temperature head transmitter (optional)

IP00, condensation permitted

16.4.4 Electromagnetic compatibility (EMC)

Device + Pt100 (optional)

- EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.
- Maximum deviation: < 0.5 % of span.

TMT72 temperature head transmitter (optional)

EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.

16.4.5 Overvoltage protection

FMX21 + Pt100 (optional)

- Integrated overvoltage protection as per EN 61000-4-5 (500 V symmetrical/1000 V asymmetrical)
- Provide overvoltage protection ≥ 1.0 kV, externally if necessary.

TMT72 temperature head transmitter (optional)

Provide overvoltage protection, externally if necessary (see Technical Information).

16.5 Process

16.5.1 Medium temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F)

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

16.5.2 Medium temperature limit

Device + Pt100 (optional)

With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
−20 to +70 °C (−4 to +158 °F)

In hazardous areas incl. CSA GP, the medium temperature limit is −10 to +70 °C (+14 to +158 °F).

With external diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F)

The FMX21 may be operated in this temperature range. The specification values, such as accuracy, may be exceeded.

16.5.3 Pressure specifications

⚠ WARNING

The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.

- For pressure specifications, see the "Measuring range" section and the "Mechanical construction" section.
- The measuring device must be operated only within the specified limits!
- The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.
- MWP (maximum working pressure): The MWP (maximum working pressure) is specified on the nameplate. This value refers to a reference temperature of +20 °C (+68 °F) and may be applied to the device for an unlimited time. Observe the temperature dependency of the MWP.
- OPL (Over Pressure Limit): The overpressure limit is the maximum pressure a device may be subjected to during a test. It is greater than the maximum working pressure by a certain factor. In the case of sensor range and process connection combinations where the over pressure limit (OPL) of the process connection is smaller than the nominal value of the sensor, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If you want to use the entire sensor range, select a process connection with a higher OPL value.
- Avoid steam hammering! Steam hammering can cause zero point drift. Recommendation: Residue (such as condensation or drops of water) can remain on the process membrane after CIP cleaning and lead to local steam hammering if steam cleaning is performed again. In practice, drying the process membrane (e.g. by blowing off excess moisture) has proven to be a successful way of avoiding steam hammering.

16.6 Additional technical data

See Technical Information TI00431P.

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People for Process Automation

Certificate of Compliance

Certificate: 2095331 **Master Contract:** 1510799

Project: 70122961 **Date Issued:** 2017-03-15

Issued to: **Endress + Hauser GmbH + Co. KG**
Haupstrasse 1
Maulburg, Baden-Württemberg 79690
GERMANY
Attention: Detlef Ramin

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Issued by: *Anil Sodhi*
Anil Sodhi

PRODUCTS

CLASS 2258 04 - PROCESS CONTROL EQUIPMENT-Intrinsically Safe, Entity - For Hazardous Locations
CLASS 2258 84 - PROCESS CONTROL EQUIPMENT - Intrinsically Safe Entity - For Hazardous Locations - Certified to US Standards

Class I, Division 1, Groups A, B, C and D
Ex ia IIC
Class I Zone 0, AEx ia IIC

The pressure transmitter type Waterpilot FMX21-CE... (with suffixes), input rated 30VDC, 4-20mA maximum; Ambient Temperature Range -10°C to 70°C; intrinsically safe with entity parameters Ui or Umax =30VDC, Li (sensor+cable) = 1 µH/m, Ci (sensor+cable) = 10,3 nF + 180 pF/m when connected per installation drawing 96008976, Temperature Code T6/T5/T4 at maximum ambient temperature of 40°C/55°C/70°C.

CLASS 2252 05 - PROCESS CONTROL EQUIPMENT
CLASS 2252 85 - PROCESS CONTROL EQUIPMENT - Certified to U.S. Standards

Pressure transmitter, Waterpilot FMX21-CD... (with suffixes) rated 10,5...35 VDC, 4..20 mA, 0,805 W

Certificate: 2095331 **Master Contract:** 151079

Project: 70122961 **Date Issued:** 2017-03-15

APPLICABLE REQUIREMENTS

CSA C22.2 No. 0-2010	-	General Requirements - Canadian Electrical Code, Part II
CAN/CSA C22.2 No. 61010-1-12	-	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
CSA C22.2 No. 157-92 (R2006)	-	Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations
CAN/CSA C22.2 No. 60079-0:15	-	Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements
CAN/CSA C22.2 No. 60079-11:14	-	Electrical Apparatus for Explosive Gas Atmospheres - Part 11: Intrinsic Safety "i"
CAN/CSA C22.2 No. 60529-04	-	Degrees of protection provided by enclosures (IP Code)
ANSI/ISA-61010-1 (82.02.01)	-	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1 General Requirements
ANSI/ISA 60079-0 (12.00.01): 2013	-	Electrical Apparatus for Use in Class I, Zone 0, 1 & 2 Hazardous (Classified) Locations: General requirements
ANSI/ISA 60079-11 (12.02.01): 2014	-	Electrical Apparatus for Use in Class I, Zone 0, 1 & 2 Hazardous (Classified) Locations - Intrinsic Safety “i”
FM 3600:2011	-	Approval Standard for Electrical Equipment for use in Hazardous (Classified) Locations General Requirements
FM 3610:2012	-	Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations
ANSI/IEC 60529-2004	-	Degrees of protection provided by enclosures (IP Code)

Supplement to Certificate of Compliance

Certificate: 2095331 **Master Contract:** 151079

The products listed, including the latest revision described below, are eligible to be marked in accordance with the referenced Certificate.

Product Certification History

Project	Date	Description
70122961	2017-03-15	Update Report 2095331 to include the change of HART microprocessor and change in order code for this HART communication as an option. Update of applicable standards to most recent editions.
2351450	2010-10-19	Update to report 2095331 to cover alternative sensor PCB layouts, modifications of components and foam potting.
2095331	2009-05-04	Original cCSAus certification for Waterpilot FMX21

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Test Report

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People for Process Automation

Final Inspection Report

Order information

Customer name	OPTIMAL CONTROL SYSTEMS INC
Customer purchase order	24-0411
Sales order number / Item	3004226593/0010
Internal order number / Item	3021464422000010

Device information

Description	Waterpilot FMX21
TAG	C35LT3237
Serial number	W900B515122
Order code	FMX21-502X5/0
Extended order code	FMX21-CE221HDE11A+PRPSZ1

Additional information

Output type	4-20 mA HART
Software version	01.00
Sensor range	0...400 inH2O
Adjusted measuring range	0...400 inH2O
Maximum permissible error	±0.1 %
Output mode	linear

Procedure

Test specification	P0043, Comparison of unit under test (UUT) with standard
Test rig	104

Measuring condition

Ambient temperature	22.8 °C ±1 °C
Ambient pressure	990.7 mbar ±0.2 mbar
Ambient humidity	47.8 % rel. ±10 % rel.
UUT orientation	

Execution

Greenwood, 2024-09-16, 155448

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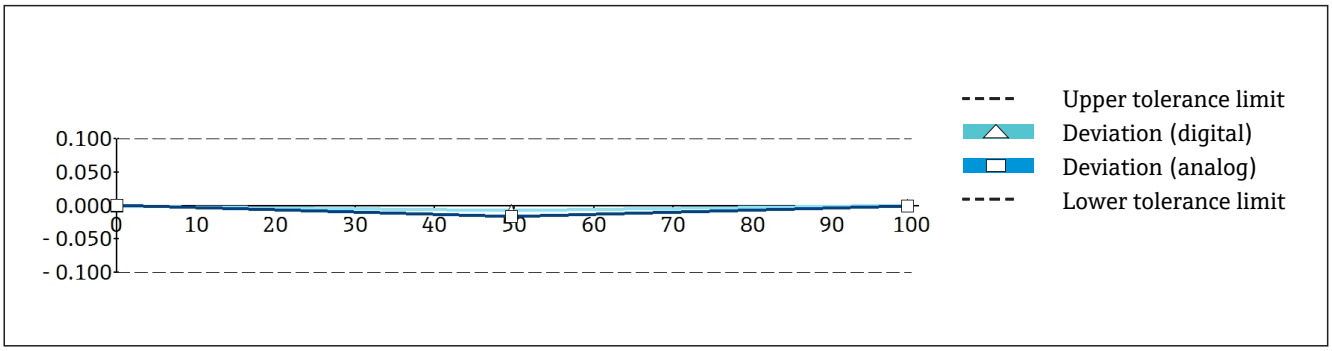
People for Process Automation

Final Inspection Report

Test result

Deviation
% of set span



Test point [%]	Reference pressure [inH2O]	UUT output (digital) [inH2O]	Measure-ment error (digital) [%]	Measure-ment error (digital) [inH2O]	Reference pressure (Iout calc.) [mA]	UUT output (analog) [mA]	Measure-ment error (analog) [%]
0	0.00400	0.00368	-0.00008	-0.00032	4.00016	4.00018	0.00011
50	198.258	198.228	-0.00740	-0.03000	11.93032	11.92775	-0.01609
99	397.416	397.418	0.00054	0.00200	19.89664	19.89663	-0.00005

Hereby we confirm that all applicable tests according to the Quality plan (IP00007P) have been performed successfully.

Test	Procedure number	Test description
Contract review	TS00001F	As required in ISO 9001
Incoming goods inspection	TS00003F	Verification of conformance to the specified requirements
Printed circuit boards test	TS00009F	In-circuit test and functional test
Functional test of sensor	TS00022P	Verification of sensor function
Calibration of instrument	TS00023P	Measurement, adjustment and verification of lower range value, upper range value and output signal
High voltage test	TS00002F	Used voltage used is chosen depending on operating voltage, terminals and approvals in accordance to the valid national / international standards
Final check of instrument	TS00024P	Verification of general functionality and customer specific settings
Outgoing visual check	TS00006F	Visual inspection of completeness and correctness of the instrument and the markings
Logistical verification	TS00005F	Automatic verification in the delivery phase via barcode that the instrument correspond to the order

Hereby we confirm that all measuring equipment used to assure the quality of the products has been calibrated and is traceable to national or international standards.

Test Report

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People for Process Automation

Final Inspection Report

Order information

Customer name	OPTIMAL CONTROL SYSTEMS INC
Customer purchase order	24-0411
Sales order number / Item	3004226593/0020
Internal order number / Item	3021464422000020

Device information

Description	Waterpilot FMX21
TAG	C40LT0211
Serial number	W900B615122
Order code	FMX21-50305/0
Extended order code	FMX21-CE221GGE11A+PRPSZ1

Additional information

Output type	4-20 mA HART
Software version	01.00
Sensor range	0...240 inH2O
Adjusted measuring range	0...240 inH2O
Maximum permissible error	±0.2 %
Output mode	linear

Procedure

Test specification	P0043, Comparison of unit under test (UUT) with standard
Test rig	104

Measuring condition

Ambient temperature	22.8 °C ±1 °C
Ambient pressure	990.8 mbar ±0.2 mbar
Ambient humidity	46.7 % rel. ±10 % rel.
UUT orientation	

Execution

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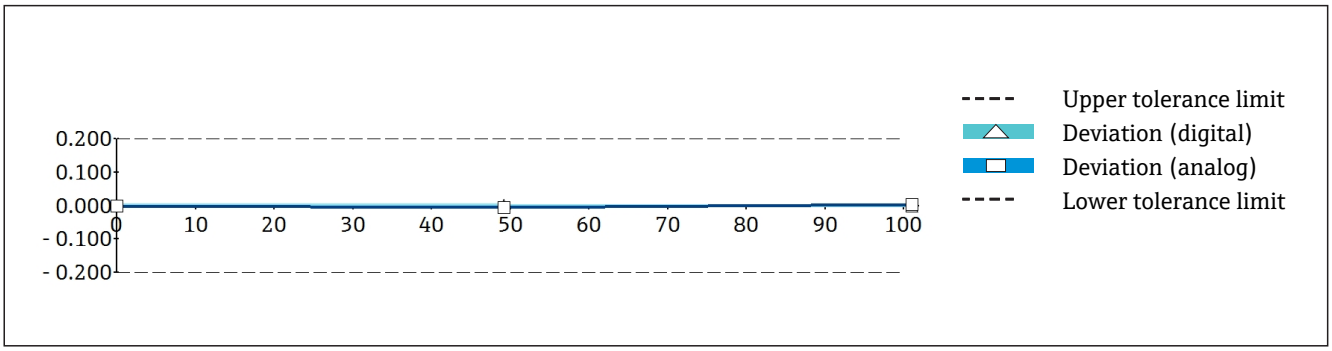
Final Inspection Report

Test result

Deviation
% of set span



Test point [%]	Reference pressure [inH2O]	UUT output (digital) [inH2O]	Measure-ment error (digital) [%]	Measure-ment error (digital) [inH2O]	Reference pressure (Iout calc.) [mA]	UUT output (analog) [mA]	Measure-ment error (analog) [%]
0	0.00240	0.00378	0.00058	0.00138	4.00016	4.00006	-0.00062
49	118.165	118.166	0.00023	0.00100	11.87768	11.87689	-0.00497
101	241.824	241.823	-0.00055	-0.00100	20.12160	20.12225	0.00406

Hereby we confirm that all applicable tests according to the Quality plan (IP00007P) have been performed successfully.

Test	Procedure number	Test description
Contract review	TS00001F	As required in ISO 9001
Incoming goods inspection	TS00003F	Verification of conformance to the specified requirements
Printed circuit boards test	TS00009F	In-circuit test and functional test
Functional test of sensor	TS00022P	Verification of sensor function
Calibration of instrument	TS00023P	Measurement, adjustment and verification of lower range value, upper range value and output signal
High voltage test	TS00002F	Used voltage used is chosen depending on operating voltage, terminals and approvals in accordance to the valid national / international standards
Final check of instrument	TS00024P	Verification of general functionality and customer specific settings
Outgoing visual check	TS00006F	Visual inspection of completeness and correctness of the instrument and the markings
Logistical verification	TS00005F	Automatic verification in the delivery phase via barcode that the instrument correspond to the order

Hereby we confirm that all measuring equipment used to assure the quality of the products has been calibrated and is traceable to national or international standards.

Test Report

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People for Process Automation

Final Inspection Report

Order information

Customer name	OPTIMAL CONTROL SYSTEMS INC
Customer purchase order	24-0411
Sales order number / Item	3004226593/0020
Internal order number / Item	3021464422000020

Device information

Description	Waterpilot FMX21
TAG	C40LT0411
Serial number	W900B715122
Order code	FMX21-50305/0
Extended order code	FMX21-CE221GGE11A+PRPSZ1

Additional information

Output type	4-20 mA HART
Software version	01.00
Sensor range	0...240 inH2O
Adjusted measuring range	0...240 inH2O
Maximum permissible error	±0.2 %
Output mode	linear

Procedure

Test specification	P0043, Comparison of unit under test (UUT) with standard
Test rig	104

Measuring condition

Ambient temperature	22.8 °C ±1 °C
Ambient pressure	990.8 mbar ±0.2 mbar
Ambient humidity	46.7 % rel. ±10 % rel.
UUT orientation	

Execution

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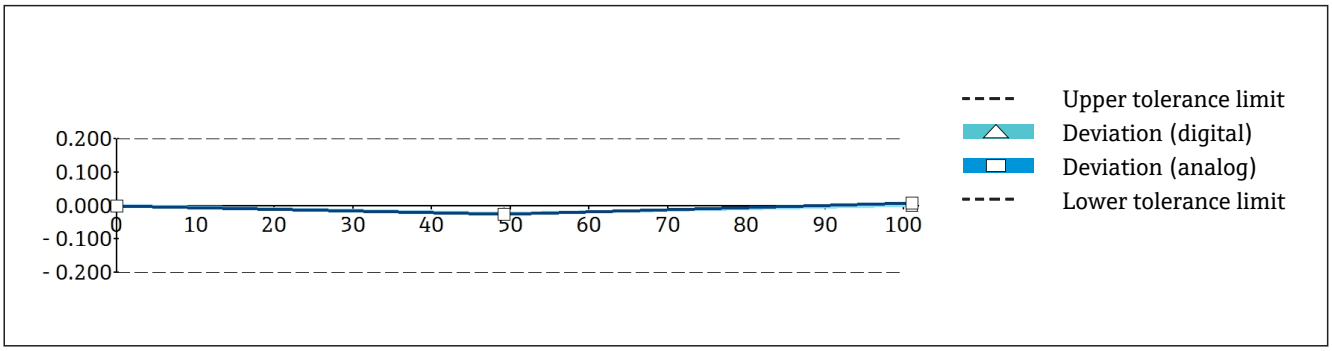
Final Inspection Report

Test result

Deviation
% of set span



Test point [%]	Reference pressure [inH2O]	UUT output (digital) [inH2O]	Measure-ment error (digital) [%]	Measure-ment error (digital) [inH2O]	Reference pressure (Iout calc.) [mA]	UUT output (analog) [mA]	Measure-ment error (analog) [%]
0	0.00240	0.00477	0.00099	0.00237	4.00016	3.99992	-0.00147
49	118.152	118.098	-0.02237	-0.05400	11.87680	11.87273	-0.02542
101	241.824	241.824	0.00007	0.00000	20.12160	20.12282	0.00761

Hereby we confirm that all applicable tests according to the Quality plan (IP00007P) have been performed successfully.

Test	Procedure number	Test description
Contract review	TS00001F	As required in ISO 9001
Incoming goods inspection	TS00003F	Verification of conformance to the specified requirements
Printed circuit boards test	TS00009F	In-circuit test and functional test
Functional test of sensor	TS00022P	Verification of sensor function
Calibration of instrument	TS00023P	Measurement, adjustment and verification of lower range value, upper range value and output signal
High voltage test	TS00002F	Used voltage used is chosen depending on operating voltage, terminals and approvals in accordance to the valid national / international standards
Final check of instrument	TS00024P	Verification of general functionality and customer specific settings
Outgoing visual check	TS00006F	Visual inspection of completeness and correctness of the instrument and the markings
Logistical verification	TS00005F	Automatic verification in the delivery phase via barcode that the instrument correspond to the order

Hereby we confirm that all measuring equipment used to assure the quality of the products has been calibrated and is traceable to national or international standards.

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35PI3240	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH160#	Section 40 91 00	09-I-003, 4091-304A
002	1	C35PI3241	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH100#	Section 40 91 00	09-I-003, 4091-304A
003	1	C40PI0501A	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
004	1	C40PI0501B	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
005	1	C40PI0502A	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
006	1	C40PI0502B	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
007	1	C40PI0601A	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
008	1	C40PI0601B	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH15#	Section 40 91 00	09-I-005, 4091-304A
009	1	C40PI1001	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH160#	Section 40 91 00	09-I-006, 4091-304A
010	1	C40PI1002	1279 Duragauge Pressure Gauge	Ashcroft	451279SSL04LXNDTSNH160#	Section 40 91 00	09-I-006, 4091-304A
011							
012							
013							
014							
015							
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040							

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ASHCROFT®
Trust the shield.®

1279 Duragauge® Pressure Gauge

FEATURES

- Custom dial printing options
- Micrometer adjustable pointer
- ***PLUS!***™ Performance option dampens vibration, shock and pulsation effects
- Pressure range from vacuum to 30,000 psi

TYPICAL USES

- Refineries
- Chemical and petrochemical plants
- Offshore oil rigs
- Water and wastewater pressure control
- Pulp and water
- Mining and metals
- Equipment skids
- Specialized OEM equipment
- Cryogenics

1279
4½″ dial size

CE UKCA CRN

SPECIFICATIONS

Accuracy:	±0.5% of span (ASME B40.100 Grade 2A)
Size:	4½″
Range:	Vacuum, compound to 30,000 psi
Process Connection Location:	Lower, back, side, top
Process Connection:	¼ NPT, ½ NPT, 9/16 -18 UNF-2B Aminco® (high pressure connection)
Case Style:	Solid front with pressure relief back
Window:	Glass (STD.), acrylic, shatter proof glass, non-glare glass (OPT.)
Movement:	Rotary, adjustable, 400 SS, Teflon™ coated
Movement Materials:	400 SS, Teflon™ coated pinion gear and segment
Dial:	Aluminum, white background, black scale
Pointer:	Micrometer, adjustable, aluminum
Weather Protection:	Case / IP Rating / Ordering Code
	Dry / Case not sealed, recommended for weather protected environment only / S
	Dry, field fillable / IP66 / SH
	Liquid filled / IP66 / SL
Dampening Options:	Liquid: glycerin, silicone, Halocarbon®, ***PLUS!***™ Performance
Mounting:	Stem, surface, flush (STD.), pipe, remote (OPT.)
Approvals:	CE/UKCA, CRN

WETTED COMPONENTS

Bourdon Tube	Process Connection	Joints
316L Stainless steel	316L Stainless steel	Welded
316L Stainless steel	Steel	Welded
K-Monel® 500	Monel® 400, Steel	Welded
C510 Pho. Bronze	Brass	Silver Brazed

KEY BENEFITS

- **Available with a wide variety of accessory and diaphragm seal assemblies**
- **Available with high process temperature dissipation siphons**

MIN/MAX TEMPERATURE LIMITS

Version	Ambient	Process	Storage
Dry	-20 °F to 200 °F (-29 °C to 93 °C)	-20 °F to 250 °F (-29 °C to 121 °C)	-40 °F to 250 °F (-40 °C to 121 °C)
PLUS!™	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Glycerin fill	20 °F to 150 °F (-7 °C to 66 °C)	20 °F to 150 °F (-7 °C to 66 °C)	0 °F to 150 °F (-18 °C to 66 °C)
Silicone fill	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Halocarbon® fill	-40 °F to 150 °F (-40 °C to 66°C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)

NON-WETTED COMPONENTS

Case	Ring	Pressure Relief Back
Phenolic	Threaded, Polycarbonate (meets UL 94 V-0)	Polycarbonate (Meets UL 94 V-0)

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150 °F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250 °F (121 °C). Liquid-filled gauges can withstand 200 °F (93 °C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68 °F (20 °C) will be affected by approximately .4% per 25 °F. Gauges with welded joints will withstand 750 °F (400 °C), 450 °F (232 °C) with silver brazed joints for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250 °F (121 °C), a diaphragm seal or capillary or siphon is recommended.

All specifications are subject to change without notice. All sales subject to standard terms and conditions. Ashcroft®, Duragauge®, DuraVis™, Plus!™, Trust the Shield® are trademarks and Gold Service℠ is a service mark of Ashcroft Inc. The following non-Ashcroft trademarks are the property of their respective owners: Aminco®, Halocarbon®, Monel®, Teflon™. For more information, see Ashcroft Brands & Trademarks
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ASHCROFT®
Trust the shield.®

1279 Duragauge® Pressure Gauge

ORDERING CODE Example:	451279	S	SH	04	L	XLL	15#
Dial Size/Model Code							
451279 - 4½″ solid front	451279						
System (tube and process connection)							
A - Bronze tube, brass process connection, Max. pressure connection 1,000 psi							
P - K-Monel® 500 tube, Monel® 400 process connection, Max. pressure 30,000 psi							
R - 316L SS tube, steel process connection, Max. pressure 20,000 psi							
S - 316 SS tube, 316L SS process connection, Max. pressure 20,000 psi		S					
Case Design							
S - Solid front case, dry							
SH - Solid front case, dry (IP66 NEMA 4X)			SH				
SL - Solid front case, liquid filled (glycerin STD.)							
Process Connection Sizes							
02 - ¼ NPT Male, N/A for ranges over 20,000 psi							
04 - ½ NPT Male, N/A for ranges over 20,000 psi				04			
09 - 9/16 18 UNF-2B, Aminco® high pressure fitting, pressures over 20,000 psi (STD.)							
AM - AND 10050-4 (¼ tubing connection)							
RW - SAE 7/16 & 20 Straight thread							
Process Connection Location							
L - Lower					L		
B - Back							
D - Side (3 o'clock)							
E - Side connection (9 o'clock)							
T - Top connection							
Options (If choosing an option(s) must include a "X") (See Table 1 on page 3 for more options)						–X__	
GV - Silicone case fill							
GX - Halocarbon® case fill							
LL - ***PLUS!***™ Performance						LL	
ND - PLUS! Performance, silicone free (glycerin and silicone filled gauges)							
NZ - ***PLUS!***™ Performance, silicone free dry gauges							
X1P - IP65 dry case (case cannot by liquid filled)							
NH - SS tag wired to case							
PD - Acrylic window (STD. with liquid filled or hermetically sealed cases)							
SG - Safety Glass							
C4 - Traceable calibration certificate							
6B - Cleaned for oxygen service							
5G - Attach one accessory to gauge. Applicable to PL02 pressure limiting valve, V01,V02,V03 valves, 1098, 1100, 1198, 2198 siphons, 7001, 7004 needle valves, 1115 capillary, 1106 pulsation dampner, 1112, PD02 pressure snubbers, MDV swivel adapter, 2265 electric warning contact							
Range (coding examples only, see range table on page 3 for all standard ranges)							
Single Scales							
15# - 15 psi							15#
1BR - 1 bar							
1KSC - 1 kg/cm^2							
100KP - 100 kPa							
Dual Scales							
15#/BR - 15 psi inner scale, 1 bar outer scale							
1BR/# - 1 bar inner scale, 15 psi outer scale							

When selecting a diaphragm seal or isolation ring, refer to the Min/Max Guide for compatibility with this gauge or scan the QR code to the right.

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ASHCROFT®
Trust the shield.®

1279 Duragauge® Pressure Gauge

TABLE 1

CODE	OPTION
AB	Gauges calibrated to compensate for absolute pressure
DA	Dial marking (text marking on the dial)
EP	Maximum pointer (adjustable, N/A with liquid filled or hermetically sealed cases)
HY	Hydrostatic/pneumatic testing (system pressurized to 150% of rated system pressure for 5 minutes. Overload stop STD.)
NG	Non-glare glass (N/A with liquid fill or hermetically sealed cases)
OS	Overload stop
SH	Red set hand, stationary
SG	Safety glass
TS	Throttle screw (STD. with liquid filled, hermetically sealed or ***PLUS!***™ Performance)
VS	Underload stop
56	Flush mounting ring
D3	DuraVis™ retroreflective dial
TM	2″ Pipe mounting bracket
1P	IP 65 Rating (dry gauge only; lower connect only)

STANDARD PRESSURE RANGES

	psi	bar	kPa	mPa	KG (kg/cm²)
Vacuum	30IMV	N1BR	N100KP	N1MP	N1KSC
	–	N1/0.6BR	N100/60KP	0.1/0.06MP	N1/0.6KSC
Compound	V/15#	–	–	–	–
	–	N1/1.5BR	N100/150KP	N0.1/0.15MP	N1/1.5KSC
	V/30#	–	–	–	–
	–	N1/3BR	N100/300KP	N0.1/0.3MP	N1/3KSC
	V/60#	–	–	–	–
	–	N1/5BR	N100/500KP	N0.1/0.5MP	N1/5KSC
	V/100#	–	–	–	–
	–	N1/9BR	N100/900KP	N0.1/0.9MP	N1/9KSC
Positive Pressure	15#	1BR	100KP	0.1MP	1KSC
	20#	–	–	–	–
	–	1.6BR	160KP	0.16MP	1.6KSC
	30#	–	–	–	–
	–	2.5BR	250KP	0.25MP	2.5KSC
	60#	4BR	400KP	0.4MP	4KSC
	–	6BR	600KP	0.6MP	6KSC
	100#	–	–	–	–
	120#	–	–	–	–
	–	10BR	1000KP	1MP	10KSC
	160#	–	–	–	–
	200#	–	–	–	–
	–	16BR	1600KP	1.6MP	16KSC
	300#	–	–	–	–
	–	25BR	2500KP	2.5MP	25KG
	400#	–	–	–	–
	500#	–	–	–	–
	600#	40BR	4000KP	4MP	40KSC
	800#	–	–	–	–
	–	60BR	6000KP	6MP	60KSC
	1000#	–	–	–	–
	1500#	100BR	10000KP	10MP	100KG
	2000#	–	–	–	–
	–	160BR	16000KP	16MP	160KSC
	3000#	–	–	–	–
	–	250BR	25000KP	25MP	250KSC
	4000#	–	–	–	–
	5000#	–	–	–	–
	6000#	400BR	40000KP	40MP	400KSC
	8000#	–	–	–	–
	–	600BR	60000KP	60MP	600KSC
	10000#	–	–	–	–
	15000#	1000BR	100000KP	100MP	1000KSC
	20000#	-	-	-	-
	-	1600BR	-	160MP	1600KSC
	30000#	-	-	-	-

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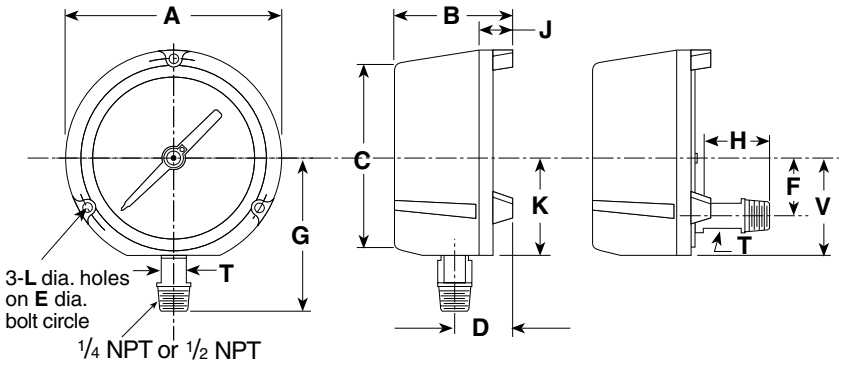
1279 Duragauge® Pressure Gauge

DIMENSIONS in [ ] are millimeters

For reference only, consult Ashcroft for specific dimensional drawings

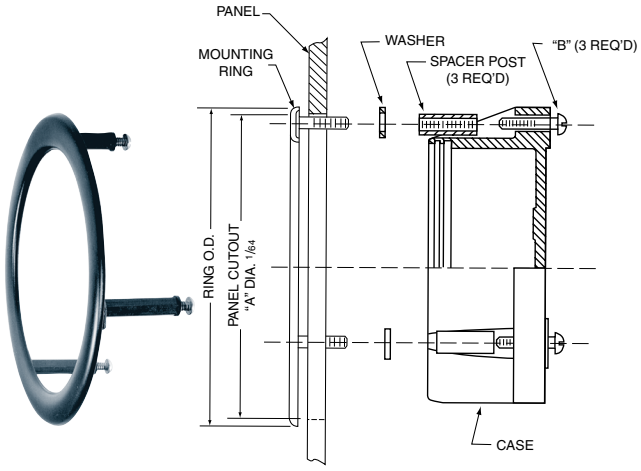
Dial Size Inches	A	B	C	D	E	F	G	H	J	K	L	T	V	Weight oz/kg
4½	5.81 [147.6]	3.36 [85.3]	5.07 [128.7]	1.60 [40.6]	5.375 [137]	1.62 [41.2]	3.92 [99.6]	0.73 [18.4]	0.94 [23.9]	2.62 [66.7]	0.218 [5.5]	0.62 [15.7]	2.62 [66.7]	2.5 (Dry) 3.5 (L.F.)



1278M Series Flush Mounting Ring

1278M Series Flush Mounting Ring. Used to flush mount gauge case 1279(*)S. Black finish (STD.); Polished SS finish (OPT.)

Gauge Size Inches	Ring O.D.	"A" DIA.	"B" Size of 3 Screws	"C" Size of Washers
4½	6 [152]	5.625 [148]	#10-24 x 1⅝	7/16 x 17/64 x 5/8



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ASHCROFT®

PRESSURE GAUGE INSTALLATION, OPERATION AND MAINTENANCE

I&M008-10098-5/02 (250-1353-L) Rev. 12/15

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1.0 SELECTION & APPLICATION

Users should become familiar with ASME B40.100 (Gauges – Pressure Indicating Dial Type – Elastic Element) before specifying pressure measuring gauges. That document – containing valuable information regarding gauge construction, accuracy, safety, selection and testing – may be ordered from:

ASME International
Three Park Avenue
New York, N.Y. 10016-5990
800-843-2763 (US/Canada)
001-800-843-2763 (Mexico)
973-882-1170 outside North America
email: infocentral@asme.org
www.asme.org

WARNING: To prevent misapplication, pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. The information contained in this manual is offered as a guide in making the proper selection of a pressure gauge. Additional information is available from Ashcroft Inc.

The following is a highlight of some of the more important considerations:

1.1 Range – The range of the instrument should be approximately twice the maximum operating pressure. Too low a range may result in (a) low fatigue life of the elastic element due to high operating stress and (b) susceptibility to overpressure set due to pressure transients that exceed the normal operating pressure. Too high a range may yield insufficient resolution for the application.

1.2 Temperature – Refer to Section 2 of this manual for important information concerning temperature related limitations of pressure gauges, both dry and liquid filled.

1.3 Media – The material of the process sensing element must be compatible with the process media. Use of a diaphragm seal with the gauge is recommended for process media that (a) is corrosive to the process sensing element; (b) contain heavy particulates (slurries) or (c) are very viscous including those that harden at room temperature.

1.4 Oxidizing media – Gauges for direct use on oxidizing media should be specially cleaned. Gauges for oxygen service should be ordered to variation X6B and will carry the ASME required dial marking "USE NO OIL" in red letters. Gauges for direct use on other oxidizing media may be ordered to variation X6W. They will be cleaned but carry no dial marking. *PLUS!*™ Performance gauges or Halocarbon filled gauge or diaphragm fill is required for use with oxidizing media; order variation XCF.

1.5 Pulsation/Vibration – Pressure pulsation can be dampened by several mechanisms; the patented *PLUS! Performance* gauge will handle the vast majority of applications. One exception to this is high frequency pulsation which is difficult to detect. The only indication may be an upscale zero shift due to movement wear. These applications should be addressed with a liquid filled gauge, or in extreme cases, a remotely mounted liquid filled gauge connected with a length of capillary line. The small diameter of the capillary provides excellent dampening, but can be plugged. The Ashcroft 1106 pulsation dampener and 1112 snubber are auxiliary devices which dampen pulsation with less tendency to plug.

1.6 Gauge fills. – Once it has been determined that a liquid filled gauge is in order, the next step is selecting the type of fill. **Glycerin** satisfies most applications. While being the least expensive fill, its usable temperature range is 20/180°F. **Silicone** filled gauges have a broader service range: –40/250°F. Oxidizing media require the use of **Halocarbon,** with a service range of –40/250°F. Pointer motion will be slowed at the low end of the low end of these temperature ranges.

1.7 Mounting – Users should predetermine how the gauge will be mounted in service: stem (pipe), wall (surface) or panel (flush). Ashcroft wall or panel mounting kits should be ordered with the gauge. See Section 3.

2.0 TEMPERATURE

2.1 Ambient Temperature – To ensure long life and accuracy, pressure gauges should preferably be used at an ambient temperature between –20 and +150°F (–30 to +65°C). At very low temperatures, standard gauges may exhibit slow pointer response. Above 150°F, the accuracy will be affected by approximately 1.5% per 100°F. Other than discoloration of the dial and hardening of the gasketing and degradation of accuracy, non-liquid filled Type 1279 (phenolic case) and 1379 (aluminum case) Duragauge® gauge, with standard glass windows, can withstand continuous operating temperatures up to 250°F. Unigauge models 2½˝ and 3½˝ 1009 and 1008S liquid filled gauges can withstand 200°F but glycerin fill and the acrylic window of Duragauge® gauges will tend to yellow. Silicone fill will have much less tendency to yellow. Low pressure, liquid filled Types 1008 and 1009 gauges may have some downscale errors caused by liquid fill expansion. This can be alleviated by venting the gauge at the top plug (pullout the blue plug insert). To do this the gauge must be installed in the vertical position.

Although the gauge may be destroyed and calibration lost, gauges can withstand short times at the following temperatures: gauges with all welded pressure boundary joints, 750°F (400°C); gauges with silver brazed joints, 450°F (232°C) and gauges with soft soldered joints, 250°F (121°C). For expected long term service below –20°F (–30°C) Duragauge® and 4½˝ 1009 gauges should be hermetically sealed and specially lubricated; add "H" to the product code for hermetic sealing. Add variation XVY for special lubricant. Standard Duralife® gauges may be used to –50°F (–45°C) without modification.

2.2 Accuracy – Heat and cold affect accuracy of indication. A general rule of thumb for **dry gauges** is 0.5% of full scale change for every 40°F change from 75°F. Double that allowance for gauges with hermetically sealed or liquid filled cases, except for Duragauge® gauges where no extra allowance is required due to the elastomeric, compensating back. Above 250°F there may exist very significant errors in indication.

2.3 Steam service – In order to prevent live steam from entering the Bourdon tube, a siphon filled with water should be installed between the gauge and the process line. Siphons can be supplied with ratings up to 4,000 psi. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal should be used to isolate the gauge from the process steam. Siphons should also be used whenever condensing, hot vapors (not just steam) are present. Super heated steam should have enough piping or capillary line ahead of the siphon to maintain liquid water in the siphon loop.

2.4 Hot or very cold media – A five foot capillary line assembly will bring most hot or cold process media within the recommended gauge ambient temperature range. For media above

750°F (400°C) the customers should use their own small diameter piping to avoid possible corrosion of the stainless steel. The five foot capillary will protect the gauges used on the common cryogenic (less than –300°F (200°C) gases, liquid argon, nitrogen, and oxygen.) The capillary and gauge must be cleaned for oxygen service. The media must not be corrosive to stainless steel, and must not plug the small bore of the capillary.

2.5 Diaphragm seals – A diaphragm seal should be used to protect gauges from corrosive media, or media that will plug the instrument. Diaphragm seals are offered in a wide variety of designs and corrosion resistant materials to accommodate almost any application and most connections. Visit www.ashcroft.com for details.

2.6 Autoclaving – Sanitary gauges with clamp type connections are frequently steam sterilized in an autoclave. Gauges equipped with polysulfone windows will withstand more autoclave cycles than those equipped with polycarbonate windows. Gauges equipped with plain glass or laminated safety glass **should not be autoclaved.** Gauge cases should be vented to atmosphere (removing the rubber fill/safety plug if necessary) **before** autoclaving to prevent the plastic window from cracking or excessively distorting. If the gauge is liquid filled, the fill should be drained from the case and the front ring loosened before autoclaving.

3.0 INSTALLATION

3.1 Location – Whenever possible, gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

3.2 Gauge reuse – ASME B40.100 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

3.3 Tightening of gauge – Torque should never be applied to the gauge case. Instead, an open end or adjustable wrench should always be used on the wrench flats of the gauge socket to tighten the gauge into the fitting or pipe. NPT threads require the use of a suitable thread sealant, such as pipe dope or teflon tape, and must be tightened very securely to ensure a leak tight seal.

CAUTION: Torque applied to a diaphragm seal or its attached gauge, that tends to loosen one relative to the other, can cause loss of fill and subsequent inaccurate readings. Always apply torque **only** to the wrench flats on the lower seal housing when installing filled, diaphragm seal assemblies or removing same from process lines.

3.4 Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

3.5 Surface mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

3.6 Flush mounting – Also known as panel mounting. The applicable panel mounting cutout dimensions can be found at www.ashcroft.com

4.0 OPERATION

4.1 Frequency of inspection – This is quite subjective and depends upon the severity of the service and how critical the accuracy of the indicated pressure is. For example, a monthly inspection frequency may be in order for critical, severe service applications. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

4.2 In-service inspection – If the accuracy of the gauge cannot be checked in place, the user can at least look for (a) erratic or random pointer motion; (b) readings that are suspect – especially indications of pressure when the user believes the true pressure is 0 psig. Any gauge which is obviously not working or indicating erroneously, should be immediately valved-off or removed from service to avoid a possible pressure boundary failure.

4.3 When to check accuracy – Any suspicious behavior of the gauge pointer warrants that a full accuracy check be performed. Even if the gauge is not showing any symptoms of abnormal performance, the user may want to establish a frequency of bench type inspection.

4.4 When to recalibrate – This depends on the criticality of the application. If the accuracy of a 3-2-3% commercial type gauge is only 0.5% beyond specification, the user must decide whether it's worth the time and expense to bring the gauge back into specification. Conversely if the accuracy of a 0.25% test gauge is found to be 0.1% out of specification then the gauge should be recalibrated.

4.5 Other considerations – These include (a) bent or unattached pointers due to extreme pressure pulsation; (b) broken windows which should be replaced to keep dirt out of the internals; (c) leakage of gauge fill; (d) case damage – dents and/or cracks; (e) any signs of service media leakage through the gauge including its connection; (f) discoloration of gauge fill that impedes readability.

4.6 Spare parts – As a general rule it is recommended that the user maintain in inventory one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service.

5.0 GAUGE REPLACEMENT

It is recommended that the user stock one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service. With regard to gauges having a service history, consideration should be given to discarding rather than repairing them. Gauges in this category include the following:

a. Gauges that exhibit a span shift greater than 10%. It is possible the Bourdon tube has suffered thinning of its walls by corrosion.

b. Gauges that exhibit a zero shift greater than 25%. It is likely the Bourdon tube has seen significant overpressure leaving residual stresses that may be detrimental to the application.

c. Gauges which have accumulated over 1,000,000 pressure cycles with significant pointer excursion.

d. Gauges showing any signs of corrosion and/or leakage of the pressure system.

e. Gauges which have been exposed to high temperature or exhibit signs of having been exposed to high temperature – specifically 250°F or greater for soft soldered systems; 450°F or greater for brazed systems; and 750°F or greater for welded systems.

f. Gauges showing significant friction error and/or wear of the movement and linkage.

g. Gauges having damaged sockets, especially damaged threads.

h. Liquid filled gauges showing loss of case fill.

NOTE: ASME B40.100 does not recommend moving gauges from one application to another. This policy is prudent in that it encourages the user to procure a new gauge, properly tailored by specification, to each application that arises.

6.0 ACCURACY: PROCEDURES/DEFINITIONS

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and downscale, before and after lightly rapping the gauge to remove friction. **A pressure standard with accuracy at least four times greater than the accuracy of the gauge being tested is recommended.**

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leaktight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – ASME B40.100 recommends that **known** pressure (based on the reading from the pressure standard used) be applied to the gauge under test. Readings including any error from the nominal input pressure, are then taken from the gauge under test. The practice of aligning the pointer of the gauge under test with a dial graduation and then reading the error from the master gauge ("reverse reading") can result in inconsistent and misleading data and should NOT be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap. "*Rap*" means lightly tapping the gauge **before** reading to remove friction as described in ASME B40.100.

Referring to Figure 1, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is

FIG. 1

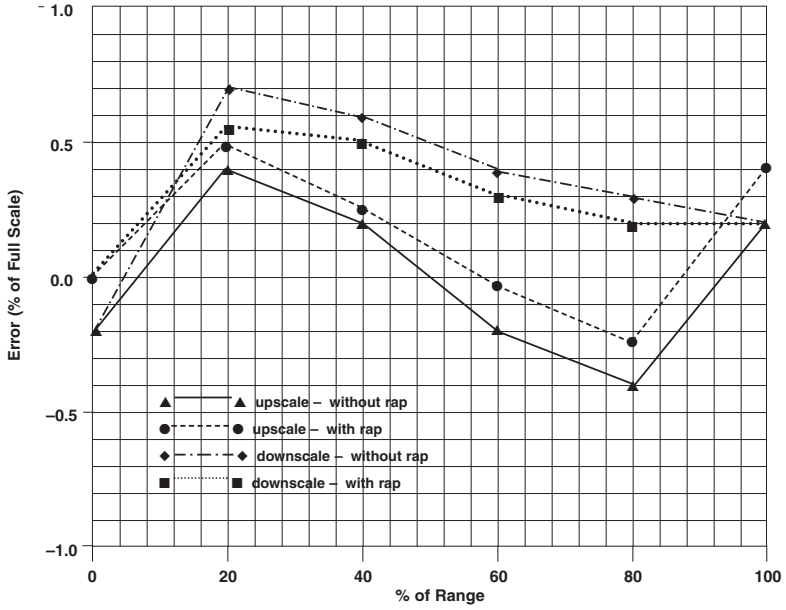
TYPICAL CALIBRATION CHART

INDICATED VALUE (PSI)

True Value – PSI	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.4	0	–.4	0
40	+.8	+1.0	+1.4	+1.1
80	+.4	+.5	+1.2	+1.0
120	–.4	–1.0	+.8	+.6
160	–.8	–.5	+.6	+.4
200	+.4	+.8	+.4	+.4

ERROR (% OF FULL SCALE)

True Value – % of Range	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.20	0	–.20	0
20	+.40	+.50	+.70	+.55
40	+.20	+.25	+.60	+.50
60	–.20	–.05	+.40	+.30
80	–.40	–.25	+.30	+.20
100	+.20	+.40	+.20	+.20



dropped or overpressured and the Bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer. Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 (Typical Calibration Chart) is not linear. The Ashcroft Duragauge® pressure gauge is equipped with a rotary movement feature which permits the user to minimize this class of error. Other Ashcroft gauge designs (e.g., 1009 Duralife®) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some Bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves. This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly tapping the gauge case at a check point. Possible causes of friction are burrs or foreign material in the movement gearing, "bound" linkages between the movement and the bourdon tube, or an improperly tensioned hairspring. If correcting these potential causes of friction does not eliminate excessive friction error, the movement should be replaced.

6.1 Calibration – Rotary Movement Gauges and Type 1259 Gauges – Inspect gauge for accuracy. Many times gauges are simply "off zero" and a simple pointer adjustment using the micrometer pointer is adequate. If inspection shows the gauge warrants recalibration to correct span and/or linearity errors, proceed as follows:

a. Remove ring, window and, if solid front case, the rear closure assembly.

b. Pressurize the gauge **once** to full scale and back to zero.

c. Refer to Figure 2 (Ashcroft System Assembly w/Rotary Gear Movement) for a view of a typical Ashcroft rotary system assembly with component parts identified. Refer to Figure 2A for link configuration of Type 1259 gauge.

FIG. 2 ASHCROFT SYSTEM ASSEMBLY W/ROTARY GEAR MOVEMENT

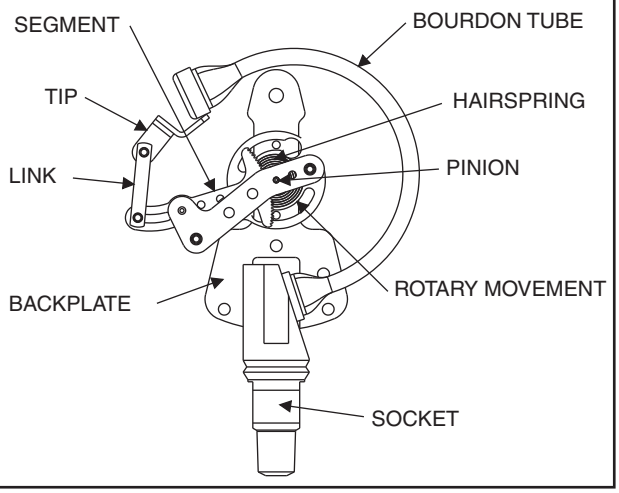
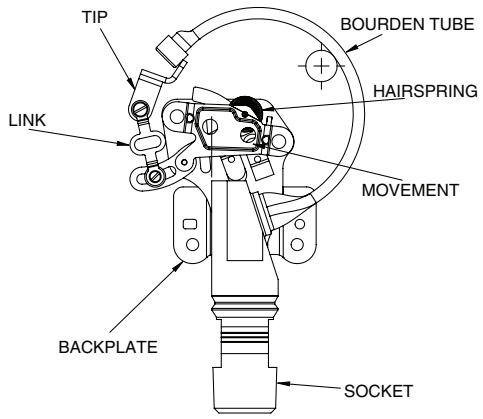


FIG. 2A ASHCROFT TYPE 1259 SYSTEM ASSEMBLY



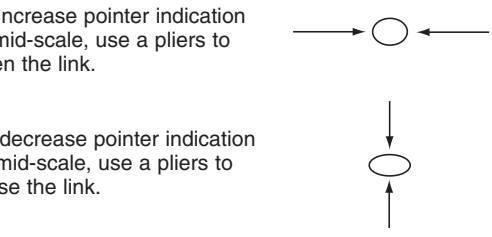
d. Adjust the micrometer pointer so that it rests at the true zero position. For open front gauges the pointer and dial must also be disassembled and the pointer should then be lightly pressed onto the pinion at the 9:00 o'clock position.

e. Apply full scale pressure and note the magnitude of the span error. With open front gauges, ideal span (270 degrees) will exist when at full scale pressure the pointer rests exactly at the 6:00 o'clock position.

f. If the span has shifted significantly (span error greater than 10%), the gauge should be replaced because there may be some partial corrosion inside the Bourdon tube which could lead to ultimate failure. If the span error exceeds 0.25%, loosen the lower link screw and move the lower end of the link toward the movement to increase span or away to decrease span. An adjustment of 0.004 inch will change the span by approximately 1%. This is a repetitive procedure which often requires more than one adjustment of the link position and the subsequent rechecking of the errors at zero and full scale pressure.

g. Apply midscale pressure and note error in reading. Even though the gauge is accurate at zero and full scale, it may be inaccurate at the midpoint. This is called linearity error. For corrections to linearity with the Type 1259 gauges refer to Figure 2B. For rotary movement gauges, note the following: if the error is positive, the movement should be rotated counter clockwise. Rotating the movement one degree will change this error by approximately 0.25%. Rotating the movement often affects span and it should be subsequently rechecked and readjusted if necessary according to step 6.1e and 6.1f.

FIG. 2B LINEARITY ADJUSTMENT & LINK CONFIGURATION FOR ASHCROFT TYPE 1259



h. While recalibrating the gauge, the friction error – difference in readings taken with and without rap – should be

noted. This error should not exceed the basic accuracy of the gauge. If the friction error is excessive, the movement should be replaced. One possible cause of excessive friction is improper adjustment of the hairspring. The hairspring torque,or tension, must be adequate without being excessive. The hairspring should also be level, unwind evenly (no turns rubbing) and it should never tangle.

NOTES:

1 For operation of test gauge external zero reset, refer to page 17.

2 For test gauge calibration procedure, refer to Figure 2 on page 18.

7.0 DIAPHRAGM SEALS

7.1 General – A diaphragm seal (isolator) is a device which is attached to the inlet connection of a pressure instrument to isolate its measuring element from the process media. The space between the diaphragm and the instrument's pressure sensing element is solidly filled with a suitable liquid. Displacement of the liquid fill in the pressure element, through movement of the diaphragm, transmits process pressure changes directly to a gauge, switch or any other pressure instrument. When diaphragm seals are used with pressure gauges, an additional 0.5% tolerance must be added to the gauge accuracy because of the diaphragm spring rate.

Used in a variety of process applications where corrosives, slurries or viscous fluids may be encountered, the diaphragm seal affords protection to the instrument where:

- The process fluid being measured would normally clog the pressure element.
- Pressure element materials capable of withstanding corrosive effects of certain fluids are not available.
- The process fluid might freeze due to changes in ambient temperature and damage the element.

7.2 Installation – Refer to bulletin OH-1 for information regarding (a) seal configurations; (b) filling fluids; (c) temperature range of filling fluids; (d) diaphragm material pressure and temperature limits; (e) bottom housing material pressure and temperature limits; (f) pressure rating of seal assembly; (g) accuracy/temperature errors of seal assembly; (h) diaphragm seal displacement. The volumetric displacement of the diaphragm must at least equal the volumetric displacement of the measuring element in the pressure instrument to which the seal is to be attached.

It is imperative that the pressure instrument/diaphragm seal assembly be **properly** filled prior to being placed in service. Ashcroft diaphragm seal assemblies should only be filled by a seal assembler certified by Ashcroft Inc. Refer to section 3.3 for a cautionary note about not applying torque on either the instrument or seal relative to the other.

7.3 Operation – All Ashcroft® diaphragm seals, with the exception of Type 310 mini-seals, are continuous duty. Should the pressure instrument fail, or be removed accidentally or deliberately, the diaphragm will seat against a matching surface preventing damage to the diaphragm or leakage of the process fluid.

7.4 Maintenance – Clamp type diaphragm seals – Types 100, 200 and 300 – allow for replacement of the diaphragm or diaphragm capsule, if that ever becomes necessary. The Type 200 top housing must also be replaced with the diaphragm. With all three types the clamping arrangement allows field disassembly to permit cleaning of the seal interior.

7.5 Failures – Diaphragm failures are generally caused by either corrosion, high temperatures or fill leakage. Process media build-up on the process side of the diaphragm can also require seal cleaning or replacement. Consult Customer Service, Stratford CT for advice on seal failures and/or replacement.

WARNING: All seal components should be selected considering process and ambient operating conditions to prevent misapplication. Improper application could result in failure, possible personal injury, property damage or death.

8.0 DAMPENING DEVICES

8.1 General – Some type of dampening device should be used whenever the pressure gauge may be exposed to repetitive pressure fluctuations that are fairly rapid, high in magnitude and especially when transitory pressure spikes exceeding the gauge range are present (as with starting and stopping action of valves and pumps). A restricted orifice of some kind is employed through which pressure fluctuations must pass before they reach the Bourdon tube. The dampener reduces the magnitude of the pressure pulse thus extending the life of the Bourdon tube and movement. This reduction of the pressure pulsation as "seen" by the pressure gauge is generally evidenced by a reduction in the pointer travel. If the orifice is very small the pointer may indicate the average service pressure, with little or no indication of the time varying component of the process pressure.

Commonly encountered media (e.g. – water and hydraulic oil) often carry impurities which can plug the orifice over time thus rendering the gauge inoperative until the dampener is cleaned or replaced.

Highly viscous media and media that tend to periodically harden (e.g., asphalt) require a diaphragm seal be fitted to the gauge. The seal contains an internal orifice which dampens the pressure fluctuation within the fill fluid.

8.2 Throttle Screws & Plugs – These accessories provide dampening for the least cost. They have the advantage of fitting completely within the gauge socket and come in three types: (a) a screwed-in type which permits easy removal for cleaning or replacement; (b) a pressed in, non-threaded design and (c) a pressed in, threaded design which provides a highly restrictive, helical flow path. Not all styles are available on all gauge types.

8.3 Ashcroft Pulsation Dampener – Type 1106 Ashcroft pulsation dampener is a moving pin type in which the restricted orifice is the clearance between the pin and any one of five preselected hole diameters. Unlike a simple throttle screw/plug, this device has a self-cleaning action in that the pin moves up and down under the influence of pressure fluctuations.

8.4 Ashcroft Pressure Snubber – The heart of the Type 1112 pressure snubber is a thick porous metal filter disc. The disc is available in four standard porosity grades.

8.5 Ashcroft Needle Valves – Type 7001 thru 7004 steel needle valves provide varying degrees of dampening. These devices, in the event of plugging, can easily be opened to allow the pressure fluid to clear away the obstruction.

8.6 Chemiquip® Pressure Limiting Valves – Model PLV-255, PLV-2550, PLV-5460, PLV-5500 and PLV-6430, available with and without built-in snubbers, automatically "shut off" at adjustable preset values of pressure to protect the gauge from damage to overpressure. They are especially useful on hydraulic systems wherein hydraulic transients

(spikes) are common.

9.0 TEST EQUIPMENT & TOOL KITS

See our website www.ashcroft.com for more details

9.1 Pressure Instrument Testing Equipment

Type 1305D Deadweight Tester

Type 1327D Pressure Gauge Comparator

Type 1327CM “Precision” Gauge Comparator

9.2 Tools & Tool Kits For Recalibration of 4½˝ and Larger Gauges

Type 2505 universal carrying case for 1082 test gauge

Type 266A132-01 span wrench for 1082 test gauge

Type 1281 socket O-Ring kit for 1279/1379 lower connect

Type 1285 4½˝ ring wrench for 1279/1379 lower & back connect

Type 1286 6˝ ring wrench for 1379 lower & back connect

Type 3220 pointer puller (all gauges except 1009 Duralife®)

Type 3530 pinion back-up tool for 1009 Duralife®

Type 3220 Handjack set

Type 1105 Tool Kit

9.3 Kits to Convert a Dry Gauge to a Liquid Filled or Weather Proof Case Gauge

Type 1280 conversion kit for 4½˝ lower connect 1279/1379

Type 1283 conversion kit for 4½˝ back connect 1279/1379

Type 1284 conversion kit for 6˝ lower & back connect

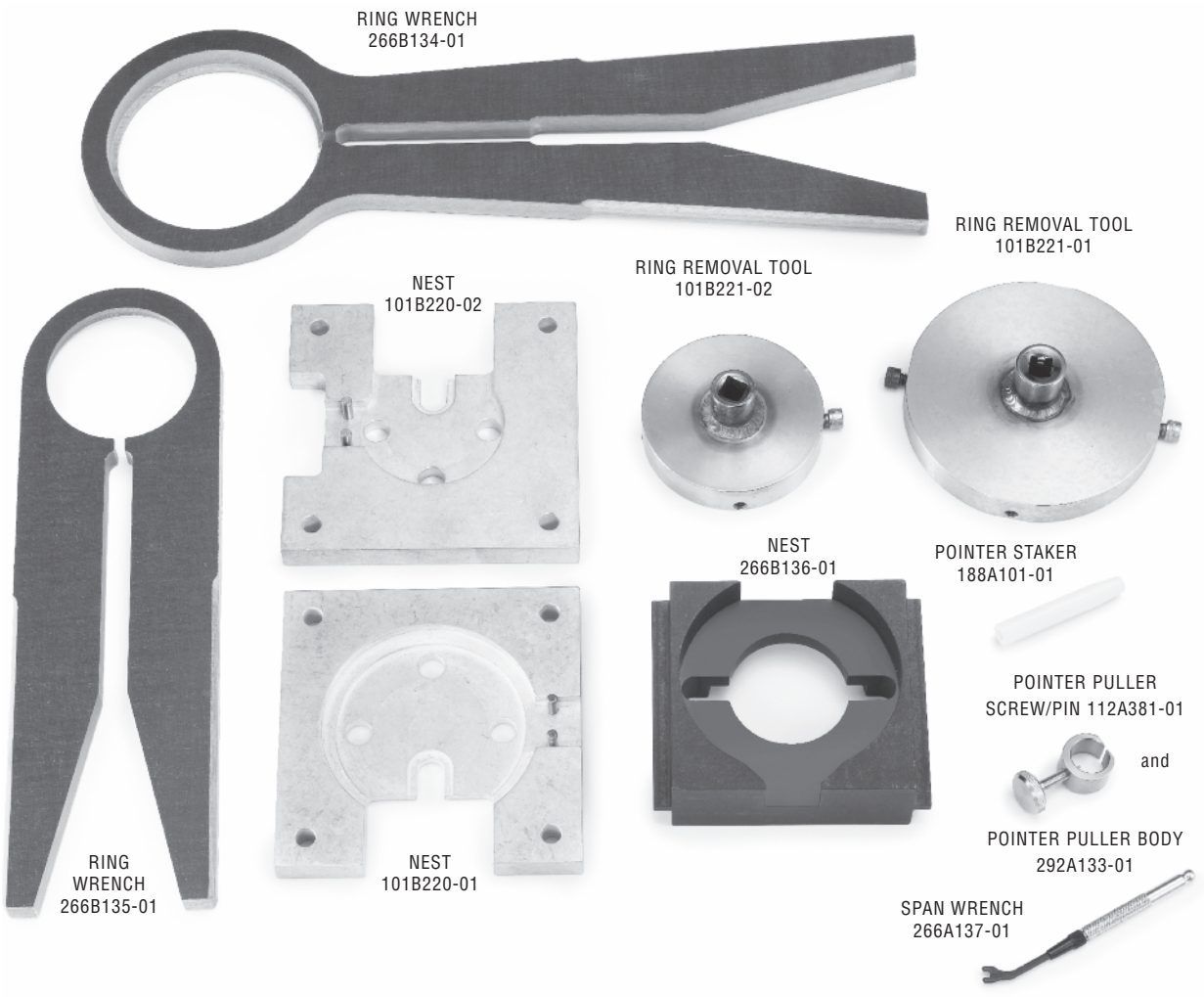
TYPE 1105
TOOL KIT

TYPE 3220
HAND JACK SET

9.4 2½ & 3½ 1009 Duralife® Gauge Tools

Description	Part No.
Pointer Puller Screw/Pin[2][3][4]	112A381-01
Pointer Puller Body[2][3][4]	292A133-01
Pointer Staker[2][4]	188A101-01
Span Wrench[2][5] (to adjust span)	266A137-01
Ring Wrench 3½″[1][5] (for ring removal) (35 1009)	266B134-01
Ring Wrench 2½″[1][5] (for ring removal) (25 1009)	266B135-01
Nest 2½″ & 3½″[1][5] (to hold gauge for ring removal) (25/35 1009)	266B136-01
Ring Removal Tool[6] (25 1009)	101B221-02
Ring Removal Tool[6] (35 1009)	101B221-01
Nest 2½″[6] (to hold gauge for ring removal) (25 1009)	101B220-02
Nest 3½″[6] (to hold gauge for ring removal) (35 1009)	101B220-01
Type 1230 throttle plug insertion (¼ NPT) for 1009 Duralife®)	1230
Type 1231 throttle plug insertion (½ NPT) for 1009 Duralife® (body only)	1231
Tool to open orifice on push-in throttle plug	101A206-01

(1) Formerly 1206T Tool Kit.
(2) Formerly some parts in 1205T Tool Kit.
(3) Both parts must be purchased together.
(4) Previous and current design.
(5) Previous design only.
(6) Current design only.



ASHCROFT® Type 1188 Bellows Gauge Calibration Procedure

CALIBRATION & TROUBLE CORRECTION DIAGRAM

RANGE SPAN ADJUSTMENT

- **RANGE TOO SHORT** — Adjust slide "S" inward
- **RANGE TOO LONG** — Adjust slide "S" outward

POINTER JUMPING

- **STICKY PARTS** — Clean all bearings and gear teeth
- **LOOSE HAIRSPRING** — Remove backlash by disengaging pinion & rotate to tighten
- **COUNTER BALANCE RUBBING** — Bend if necessary to clear socket in travel

NOTE: After adjusting range span, set both movement stops. Set the underload stop so that the pointer will stop at zero. Set the overload stop so that the pointer will pass the maximum range approximately 5˝.

After adjusting span re-zero pointer by removing from pinion and re-assembling at the proper dial mark.

SLUGGISH MOVEMENT

TIGHT HAIRSPRING — Loosen by disengaging pinion & rotate

NON LINEAR

- **NON LINEAR FIRST 3RD.** → **ADJ. ANGLE OF PULL BY INCREASING ANGLE "A"**
- **NON LINEAR LAST 3RD.** → **ADJ. ANGLE OF PULL BY DECREASING ANGLE "A"**

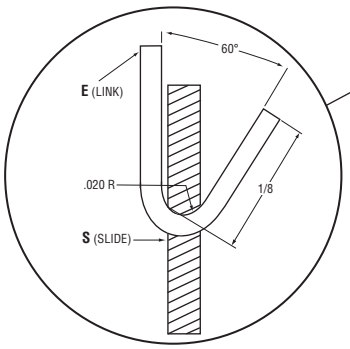
NOTE: To increase or decrease angle "A," bend tip inward or outward as required. Doing this may run the movement segment off the pinion. This can be corrected by cutting off one end off the link "E" decreasing its length, or makin a new length from .032 dia. phos. bronze wire.

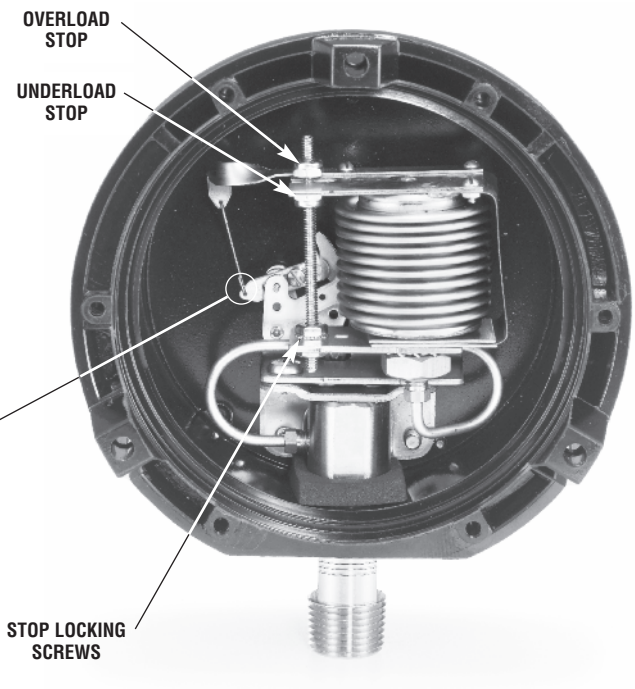
Caution: When reproducing link end, follow figure 44 very closely. this will prevent too much play, or, binding in operation.

REF: Replacing System Bellows

After assembling bellows to the gauge socket securely, subject system to 30 psi for five minutes, allowing bellows to travel approximately 1/8˝ against the overload stop. After this, heat treat system for 15 hours at 250°F, this procedure is necssary to prevent gauge drift.

SLIDE AND LINK (angle "A")
Enlarged view of slide and link





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ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Vacuum Range

1. Remove ring, window and gasket pointer.

2. Using a pencil, refer to dial and mark the 0 and 25˝ Hg positions on the case flange.

3. Remove dial.

4. Apply 25˝ Hg vac.

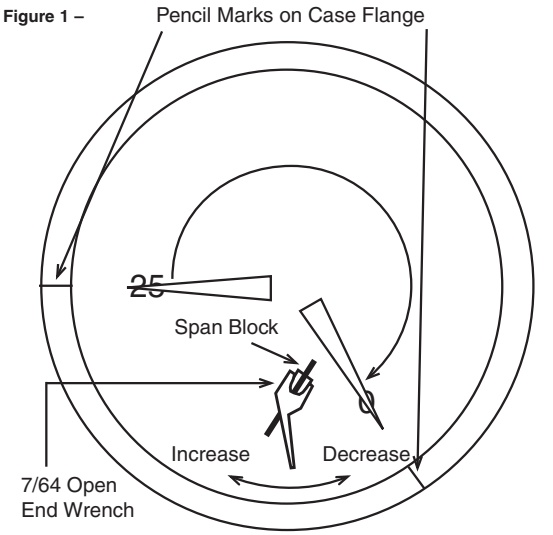
5. Lightly press pointer onto pinion carefully aligning it with the 25˝ Hg vac. mark on the flange.

6. Release vacuum fully.

7. Note agreement of pointer to zero mark on flange.

8. If span is high or low, turn span block as shown in Figure 1.

Figure 1 –



9. Repeat steps 4 through 8 until span is correct.

10. Remove pointer.

11. With 25˝ Hg vac applied, reassemble dial, dial screws (finger tight) and point.

12. Apply 15˝ Hg vac. and note accuracy of indication. If required, slide dial left or right to reduce error to 1% maximum.

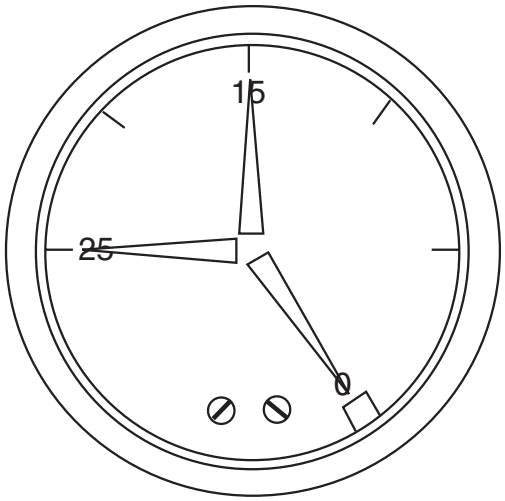
13. Firmly tighten dial screws.

14. Firmly tap pointer onto pinion.

15. recheck accuracy at 15 and 25˝ Hg vac. (Figure 2).

16. Reassemble window, gasket and ring.

Figure 2 –



Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

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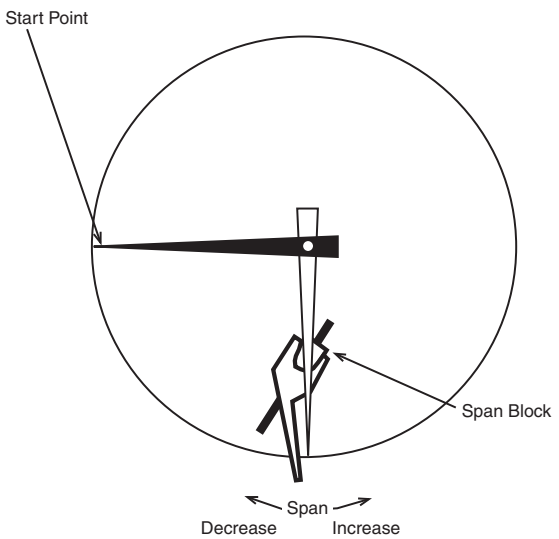
Step 1. With the dial off, install pointer at 9 o'clock "lightly," Figure 3.

Figure 3 –

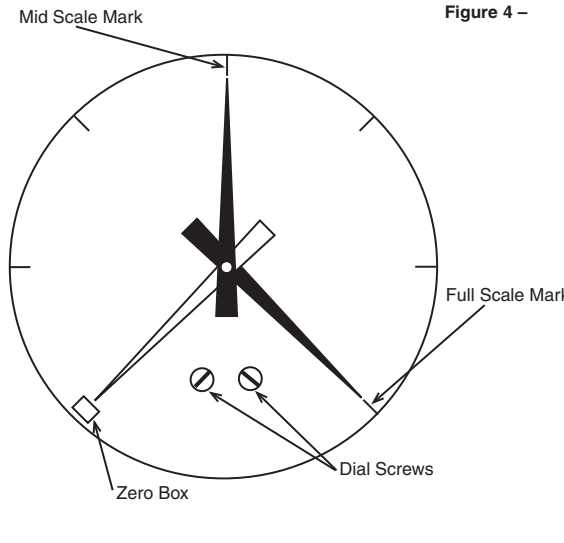


Step 2. Go to full scale pressure…rotate span block with tool until pointer rests at 6 o'clock.

Step 3. Go to zero pressure (9 o'clock)…if pointer has not moved away from start point, go to Step 4. If pointer has moved, repeat Step 1 until span is correct.

Step 4. Install dial with screws snug.

Figure 4 –



Step 5. Install pointer centered in zero box, Figure 4.

Step 6. Go to full scale pressure…check that pointer is within 1% of full scale mark. If not, remove pointer and dial and return to step 1, Figure 4.

Step 7. Go to mid-scale pressure…rotate dial until mid-scale mark is aligned with pointer, Figure 4.

Step 8. Tighten dials screws and stake on pointer.

Step 9. Check zero and full scale. Reassemble window, gasket and ring.

Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
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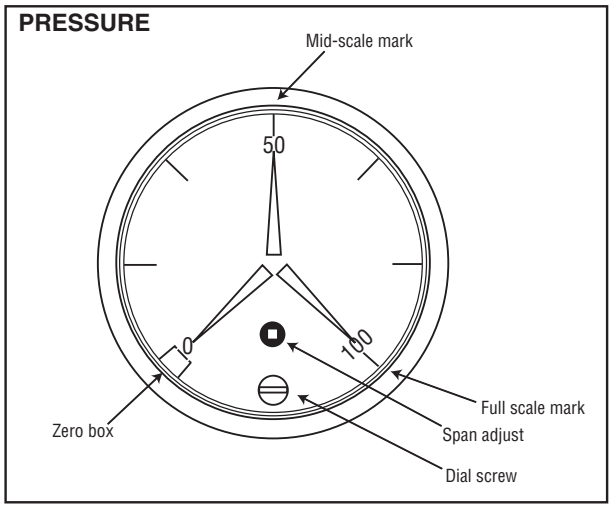
ASHCROFT® Current Type 1009 Duralife® Calibration Procedure – Pressure and Vacuum Range

Calibration – 1009 Duralife® Gauge –
Inspect gauge for accuracy. At times gauges are simply "off zero" and opening the ventable plug at the top of the gauge will relieve internal gauge pressure and correct the offset. If this is not adequate and inspection shows that the gauge warrants recalibration to correct zero, span and/or linearity errors, proceed as follows:

Remove ring, window, and gasket using Ashcroft Ring Removal Tools P/N 101B220-02 and 101B221-02 for 2½" gauges and 101B220-01 and 101B221-01 for 3½" gauges.



Positive Pressure Ranges –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply full scale pressure. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise increases span, counterclockwise decrease span.

3. Fully exhaust pressure and check that pointer still is still in the zero box. If not, repeat step 1 and 2

4. Once 0 and full scale are within tolerance, pressurize gauge to mid-scale.

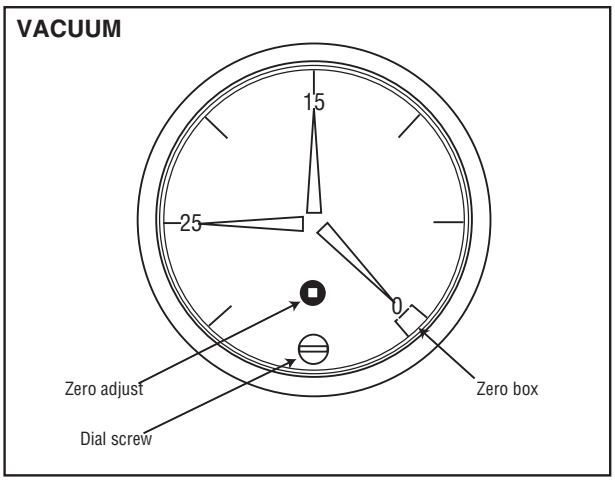
5. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 5, recheck the gauge at zero and full scale, adjust accordingly until zero, mid and full scale points are in tolerance.

Vacuum Range –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply 25 inches Hg vacuum. If the error exceeds 1% adjust pointer with a slotted screwdriver until gauge is within tolerance.



3. Vent to 0 pressure and check pointer position in the zero box. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise rotation moves pointer clockwise, counterclockwise rotation moves the pointer counterclockwise.

4. Repeat step 1 and 2 until 0 and 25 inches of Hg are within gauge tolerance.

5. Apply 15 inches Hg vacuum. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 4, recheck the gauge at zero and 25 inches of Hg vacuum, adjust accordingly until zero, 15 and 25 inches Hg are in tolerance.

7. Continue below.

Re-assemble window and ring to gauge:

a. If plastic window is used, push window back into front of gauge, ensure the o-ring does not roll out of window groove (lubricate if necessary). Align the tabs of the window with the tabs of the case front. Once window is in place, install ring and tighten with tools referenced above and shown on page 10.

b If safety glass is used, reinstall window, gasket, and ring. Ensure that the gasket is seated properly under all four tabs of the ring and does not wrinkle when ring is tightened.

Note: Tighten ring: Apply 120-200inlb of torque. Rotate ring clockwise to tighten. Warning: over tightening of safety glass may induce cracking.

Notes: See page 10 for any tools required to calibrate.

For models produced after September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

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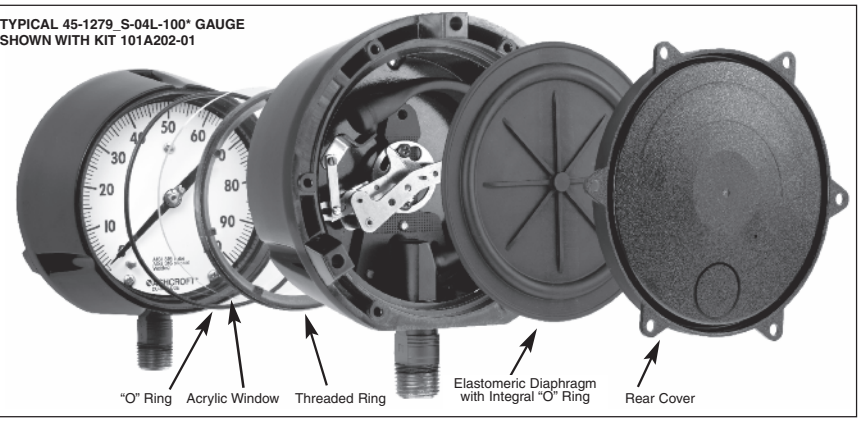
TYPE 1279 & 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

ASHCROFT®

TYPICAL 45-1279_S-04L-100* GAUGE SHOWN WITH KIT 101A202-01



	1279		1379		
	4½˝ LOWER	4½˝ BACK	4½˝ LOWER	4½˝ BACK	6˝ LOWER & BACK
KIT PART NO.	101A202-01	101A203-01	1280	1283	1284
	QUANTITY INCLUDED				
ACRYLIC WINDOW	1	1	1	1	1
FRONT O-RING	1	1	1	1	1
DIAPHRAGM(1)	1	1	1	1	2(1-LC:1-BC)
REAR COVER	1	1	1	1	2(1-LC:1-BC)
COVER SCREWS	4	4	-	-	-
THROTTLE SCREWS	2	2	2	2	2
GARTER SPRING	–	1	1	1	1
FILL IDENTIFICATION	1	1	1	1	1
THREADED RING	–	–	1	1	1
TOP FILL PLUG	–	–	1	1	–

1. When Halocarbon fill is a requirement, rear case diaphragm bladder material is Viton instead of the standard Buna diaphragm bladder. Consult factory for part number.

TEMPERATURE LIMITS[1]				60 psi and Under Down Scale Zero Shift Required
	Ambient	Process	Storage	
Dry (IP66)	–20/200°F (–29/93°C)	–20/250°F(1) (–29/121°C)	–40/250°F (–40/121°C)	NONE
LF (glycerin)	20/150°F (7/66°C)	20/200°F (7/93°C)	0/150°F (–18/66°C)	NONE
(silicone)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi
(halocarbon)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150°F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250°F (121°C). Liquid-filled gauges can withstand 200°F (93°C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68°F will be affected by approximately .4% per 25°F. Gauges with welded joints will withstand 750°F (450°F (232°C) with silver brazed joints) for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250°F (121°C), a diaphragm seal or capillary or siphon is recommended.
(1) Available for temperature below –20°F, see Production Information page ASH-PI-21B for details

1. Unscrew front threaded ring (turn CCW). Remove and discard glass window. For range spans 60 psi and under, shift pointer down scale by the amount shown in the table. With either the glass or plastic window, replace the O-ring with one furnished in the kit.
2. Remove protective paper from acrylic plastic window taking care not to scratch window. Assemble window in gauge.
3. Moisten face of threaded ring with silicone oil or silicone grease where ring bears up against window. Replace front threaded ring and tighten firmly hand tight. See instructions on reverse side for applying proper torque to ring to establish desired squeeze on O-ring seal. **(Fig. 4).**
It is important to hold gauge **rigidly,** otherwise ring lugs may be damaged during removal or assembly process.
4. From rear of gauge, remove and discard these parts: rear cover and cover gaskets from case.
Note: Disregard Step Nos. 5a and 5b if converting to hermetically sealed version.
When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.
5. Filling Procedures:
a. Manual Filling Procedure: Place gauge face down on bench and **tip gauge** by blocking up front with a ⅜ inch block at the 12 o'clock dial position. Tipping of the gauge is necessary so fluid will flow into front cavity of the case. Pour in fill liquid to within about 1⁄16 inch of rear seal lip. When bubbles stop rising, front cavity is filled. Remove ⅜ inch block and pour in liquid until level is about 1⁄16 inch below rear sealing lip.
Note: An alternative method of filling is to fill the front dial cavity, adding the front window, etc., as in Step No. 3. Then fill the rear of the gauge. This method eliminates the need to tip the gauge.
b. Vacuum Pump Fill Procedure: (This procedure is recommended when filling a large number of gauges.) Place gauge face down and insert a ⅛ inch diameter tube, connected to a vacuum pump, through the 12 o'clock position hole in the rear, solid front portion of the case **(see Fig. 5).** Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1⁄16 inch BELOW the O-ring channel lip.
Pre-measuring fill amount is not necessary with above methods. For reference, amount of fill is approximately 400 ml. or 14 fluid oz. (4½˝ GA.) and 455 ml. or 16 fluid oz. (6˝ GA.).
c. Note: The liquid fill level should be ⅜˝ (±⅛) as measured from the inside of the ring at the 12:00 o'clock position.
6. On lower connection gauges, assemble rear seal diaphragm to case.
For back connection gauges see instructions on reverse side. **(Fig. 2/4).**
7. For 1279:
Assemble rear cover and six self tapping screws in a criss-cross pattern and torque to 12 in lbs. (±2 in lbs.)
For 1379:
- Thread rear ring and torque to 200 in lbs
- Install stainless steel back cover using two screws. Torque screws to 14 in lbs. (±2 in lbs.)

8. Assemble throttle screw to threaded hole in socket.
Note: If system is monel (socket wrench flat stamped "PHS" or "PH") use monel throttle screw.
9. Check appropriate box on fill identification label, and peel off label back, and attach fill label to gauge case.
10. If gauge is to be repackaged:
a. Include enclosed instruction sheet inside carton.
b. Change type number on carton label to:
(1) Hermetically Sealed – 1279(*)SH.
(2) Liquid Filled – 1279(*)SL.
*Bourdon Tube System Code

Glycerin or silicone should not be used in applications involving Oxygen, Chlorine, Nitric Acid, Hydrogen Peroxide or other strong oxidizing agents, because of danger of spontaneous chemical reaction, ignition or explosion. Halocarbon should be specified. Products with this fill can be ordered from factory.

The use of fluids other than those listed in the table above (for example, Hydrocarbon-based oils) may result in leakage caused by a reaction between the fluid and the elastomeric seals. Consult the factory before filling with any other fluid.

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TYPE 1279 & 1379 SOLID FRONT DURAGAUGE®
PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

ASHCROFT®

INSTRUCTIONS FOR USING CONE TOOL AND RING WRENCH

Garter Spring & Diaphragm Assembly (Back Connection Gauge Only)

A. Place cone tool over socket shank as shown.

B. Moisten lip of socket and outer O-ring surface with silicone oil or grease.

C. Place diaphragm with rib side facing upward over cone into case grove.
Diaphragm O-ring must be completely in socket-shank grove.

D. Place garter spring over cone as shown and slide onto diaphragm in socket grove

E. Assemble rear cover with screws per step 7.

Front Ring Assembly (All Gauges)

A. Assemble ring to case by hand to start.

B. Place ring on wrench as shown

C. Use ½˝ drive extension and torque ring to 200 in. lb

Alternate Method

A. Tighten ring snugly by hand

B. Mark case and ring.

C. Turn ring another 100 to 120 degrees (slightly less than ½ turn) using the ring wrench and ½˝ drive socket wrench or place the blunt end of a wooden or plastic dowel against a ring lug and tap with a hammer.

BACK CONNECTION ASSEMBLED GAUGE

Fig. 2

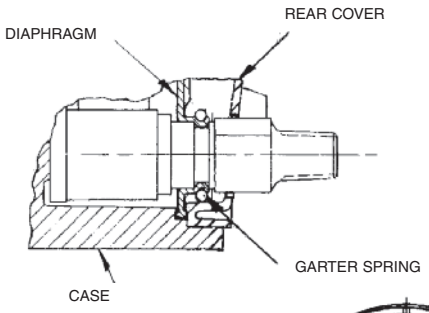


Fig. 3

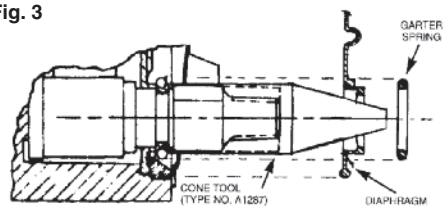
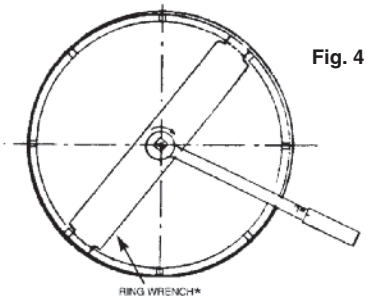


Fig. 4



INSTRUCTIONS FOR LIQUID FILLING ASHCROFT® TYPE 1279 AND 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGES USING A VACUUM PUMP

A. Insert a length of ⅛ ˝ diameter tubing through the 12 o'clock position hole in the rear, solid front portion of the case, as shown.

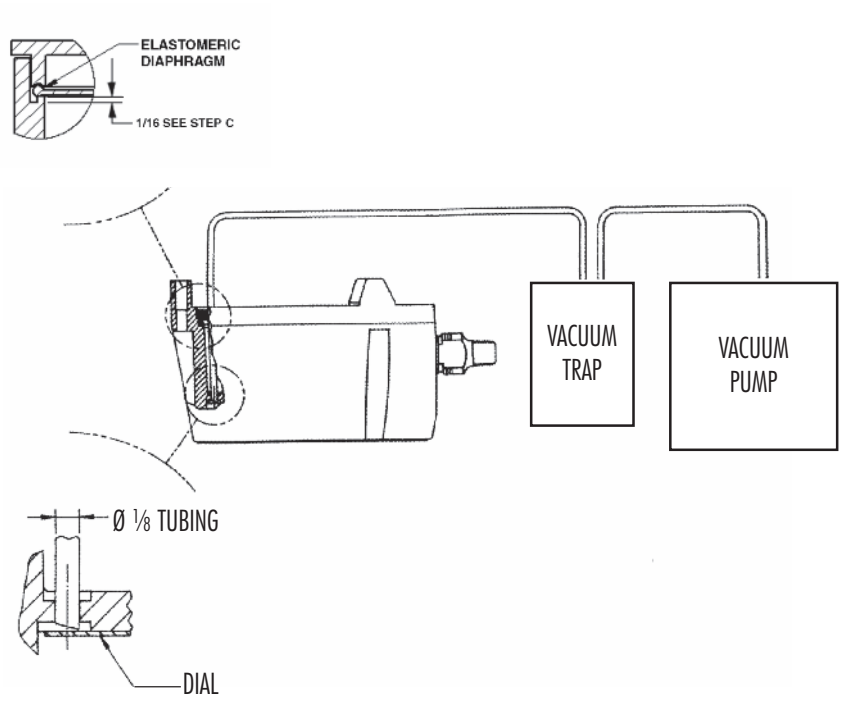
B. Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid.*

C. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16 ˝ below the o-ring channel lip, as shown.

D. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

*To prevent breakage, reduce vacuum to 15 in. Hg for plain glass and safety glass.

Fig. 5



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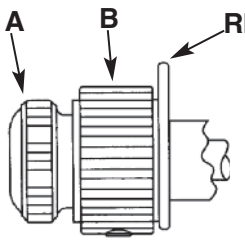
INSTRUCTIONS FOR USE OF EXTERNAL EASY ZERO™ ADJUST FEATURE*

Fig. 1



1. LOOSEN RING-LOCKING SCREW **A**.
2. OBTAIN REQUIRED ADJUSTMENT BY ROTATING KNOB **B** CLOCKWISE OR COUNTER-CLOCKWISE.
3. TIGHTEN SCREW **A** DOWN ON KNOB **B**.

*Applicable only for test gauge with hinged ring design.

ADDITIONAL CALIBRATION INSTRUCTIONS

1) "Standards shall have nominal errors no greater than ¼ of these permitted for the gauge being tested." *(Ref: ASME B40=100-1998)*
2) The instrument used as the calibration standard should have a maximum range no greater than 2x that of the gauge being tested. (i.e. Do not use a 400psi standard to test a 15psi gauge.)
3) "Known pressure shall be applied at each test point on increasing pressure (or vacuum) from one end to the other end of the scale. At each test point the gauge shall be . . .
lightly tapped, and then read . . ."
(*Ref: ASME B40.1 ¶ 6.2.4.1*)
4) To read gauge indication, move eye over red pointer tip at OD of printed dial until red reflection in mirror band is no longer visible, and then read the pointer position in reference to the dial.

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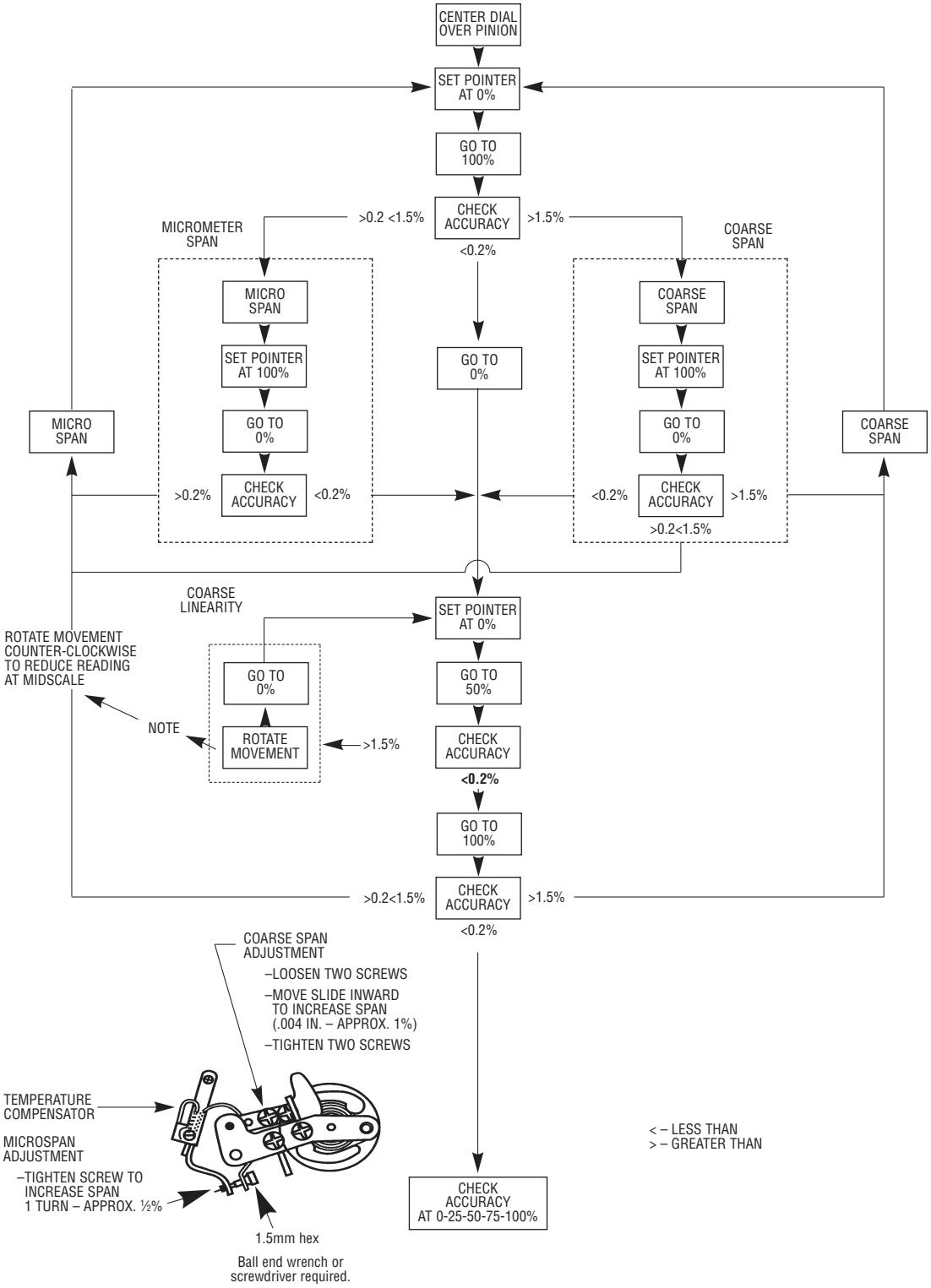
Fig. 2

THIS TEST GAUGE IS PROVIDED WITH A MICROSPAN™ ADJUSTMENT TO SIMPLIFY CALIBRATION. THE FLOW CHART BELOW OUTLINES THE RECOMMENDED CALIBRATION PROCEDURE



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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C40PIT1201	3051 In-Line Pressure Transmitter	Rosemount	3051TG2A2B21AM4B4	Section 40 91 00	09-I-006, 4091-304A
002							
003							
004							
005							
006							
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Product Data Sheet
00813-0100-4001, Rev WF
February 2025

Rosemount™ 3051 Pressure Transmitter

The Rosemount 3051 Pressure Transmitter allows more control over your plant. You will:

- reduce product variation and complexity
- reduce total cost of ownership by leveraging one device across a number of pressure, level, and flow applications
- access information to diagnose, correct, and even prevent issues

With unparalleled reliability and experience, the 3051 assists global competitiveness by being the industry standard enabling higher levels of efficiency and safety.

Contents

Setting the standard for pressure measurement..... 2
Rosemount 3051C Coplanar Pressure Transmitter ordering information..... 6
Rosemount 3051T In-Line Transmitter ordering information..... 18
Rosemount 3051CF Flow Meter selection guide..... 28
Rosemount 3051L Level Transmitter ordering information..... 62
Specifications..... 73
Rosemount 3051 product certifications..... 91
Dimensional drawings 92
Options..... 106

Setting the standard for pressure measurement

Proven best-in-class performance, reliability, and safety

- More than ten million installed
- Reference accuracy 0.04 percent of span
- Installed total performance of 0.14 percent of span
- 10-year stability of 0.2 percent of URL
- SIL 2/3 certified (IEC 61508)

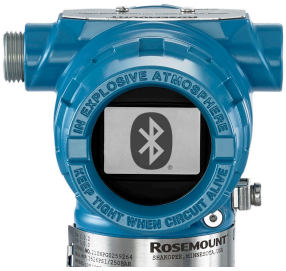
Maximize installation and application flexibility with the Coplanar™ platform

- Improve reliability and performance with integrated DP Flow meters, DP Level solutions, and integral manifolds.
- Easy installation with all solutions fully assembled, leak-tested, and calibrated.
- Meet your application needs with a broad offering.

Advanced functionality

Bluetooth® technology

- Increase productivity, reliability, and personnel safety. No hot work permit needed. No climbing tanks or building scaffolding.
- Quickly configure, service, and troubleshoot with access to all devices near the technician at speeds up to 10 times faster than traditional HART® connections.



Diagnostics

- The Loop Integrity diagnostic continuously monitors the electrical loop to detect issues that affect the communication signal and will alert you to corrosion, water in the housing, or an unstable power supply.
- The Plugged Impulse Line diagnostic continuously monitors for plugged impulse lines and alerts you to abnormal conditions so you can take proactive measures before it affects the quality of the process.
- Diagnostic events are tracked in the built-in diagnostic log which allows you to see the device status at all times.
- These capabilities are safety certified for your most critical applications.

Enhanced software

- Application specific configuration allows you to transform your pressure transmitter into a flow meter with a totalizer or a level transmitter with volume calculations.
- Process alerts can be configured for any dynamic variable. They can be given a custom name, assigned target thresholds, and can notify via HART alert or analog output alarm.

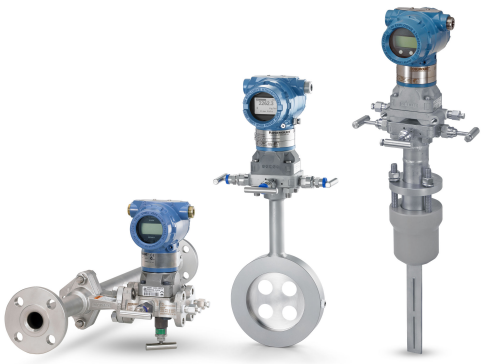
Quick service buttons

- Straightforward menus and built-in configuration buttons allow you to quickly commission the device.
- Configure in hazardous-area locations without removing the transmitter cover using external buttons.

Industry leading capabilities extended to IEC 62591 (*Wireless*HART®)

- Cost effectively implement wireless on the industry's most proven platform.
- Optimize safety with the industry's only intrinsically safe power module.
- Eliminate wiring design and construction complexities to lower costs by 40 to 60 percent.
- Quickly deploy new pressure, level, and flow measurements in 70 percent less time.

Innovative integrated DP flow meters

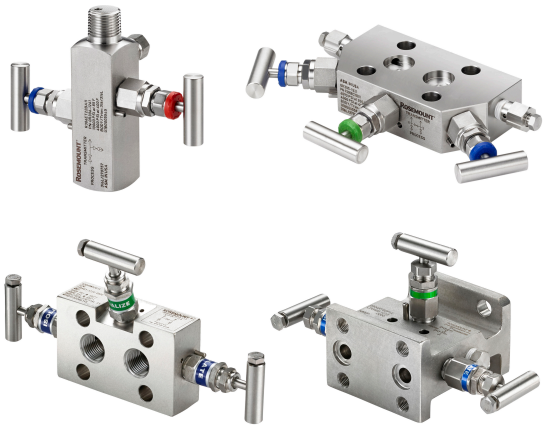


- Fully assembled and leak tested for out-of-the-box installation.
- Easy commissioning with factory configuration of flow rate and totalized flow.
- Reduce straight pipe requirements, lower permanent pressure loss, and achieve accurate measurement in small line sizes.
- Up to 1.65 percent volumetric flow accuracy at 8:1 turndown.

Proven, reliable, and innovative DP Level technologies

- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount, or capillary connections and materials.
- Configuration wizard guides you through complex level applications and enables volume measurement.
- Quantify and optimize total system performance with QZ option.
- Operate at higher temperature and in vacuum applications.
- Optimize level measurement with cost efficient Rosemount Tuned-System™ assemblies.

Instrument manifolds – high quality, convenient, and easy



- Designed and engineered for optimal performance with Rosemount transmitters.
- Save installation time and money with factory assembly.
- Offers a variety of styles, materials, and configurations.

Access information when you need it with asset tags

Newly shipped devices include a unique QR code asset tag that enables you to access serialized information directly from the device. With this capability, you can:

- Access device drawings, diagrams, technical documentation, and troubleshooting information in your MyEmerson account.
- Improve mean time to repair and maintain efficiency.
- Ensure confidence that you have located the correct device.
- Eliminate the time-consuming process of locating and transcribing nameplates to view asset information.

Rosemount 3051T In-Line Transmitter ordering information

Rosemount 3051T In-Line Pressure Transmitters are the industry standard for gage and absolute pressure measurement. The in-line, compact design allows the transmitter to be connected directly to a process for quick, easy and cost effective installation.

- Loop Integrity and Plugged Impulse Line Diagnostics detect issues that might compromise the integrity of the output signal (code DA1).
- Bluetooth® Connectivity enables efficient, reliable, and safe configuration and maintenance (code BLE).
- Back-lit Graphical Display with Local Language Capability (code M6).
- Safety certification and proof testing (code QT and T9).

CONFIGURE > VIEW PRODUCT >

Online product configurator

Many products are configurable online using our product configurator.

Select the **Configure** button or visit Emerson.com/global to start. With this tool's built-in logic and continuous validation, you can configure your products more quickly and accurately.

Specifications and options

The purchaser of the equipment must specify and select the product materials, options, and components.

Model codes

Model codes contain the details related to each product. Exact model codes will vary; an example of a typical model code is shown in Figure 2.

Figure 2: Model Code Example

3051TG3A2B21A (1) **WR5M6BLEDA1** (2)

1. Required model components (choices available on most)
2. Additional options (variety of features and functions that may be added to products)

Optimizing lead time

The starred offerings (★) represent the most common options and should be selected for the fastest delivery. The non-starred offerings are subject to additional delivery lead time.

Required model components

Model

Code	Description	
3051T	In-Line Pressure Transmitter	★

Pressure type

Code	Description	
G	Gage	★
A(1)	Absolute	★

(1) *Wireless output (code X) available in absolute measurement type (code A) with only range 1–5, with 14-NPT process connection (code 2B) and housing (code P).*

Pressure range

Code	Gage (Rosemount 3051TG)(1)	Absolute (Rosemount 3051TA)	
0	–5 to 5 psi (-344.74 to 344.74 mbar)	N/A	★
1	–14.7 to 30 psi (-1.01 to 2.06 bar)	0 to 30 psia (0 to 2.06 bar)	★
2	–14.7 to 150 psi (-1.01 to 10.34 bar)	0 to 150 psia (0 to 10.34 bar)	★
3	–14.7 to 800 psi (-1.01 to 55.15 bar)	0 to 800 psia (0 to 55.15 bar)	★
4	–14.7 to 4000 psi (-1.01 to 275.79 bar)	0 to 4000 psia (0 to 275.79 bar)	★
5	–14.7 to 10000 psi (-1.01 to 689.47 bar)	0 to 10000 psia (0 to 689.47 bar)	★
6(2)	–14.7 to 20000 psi (–1.01 to 1378.95 bar)	0 to 20000 psia (0 to 1378.95 bar)	

(1) *Rosemount 3051TG lower range limit assumes atmospheric pressure of 14.7 psig.*
(2) *Not available with PROFIBUS PA or Low Power 1–5 Vdc transmitter output (option code W or M), inert sensor fill fluid (option code 2), NSW drinking water approval (option code DW), or assemble to manifolds (option code S5).*

Transmitter output

Code	Description	
A	4–20 mA with digital signal based on HART® Protocol	★
F	FOUNDATION™ Fieldbus Protocol	★
W(1)	PROFIBUS® PA Protocol	★
X(2)	Wireless (requires wireless options and engineered polymer housing)	★
M(3)	Low-power, 1–5 Vdc with digital signal based on HART Protocol	

(1) *For local addressing and configuration, M4 (LOI) is required. Not available with product certification codes E4, EM, EP, I6, IM, KD, KL, KM, KP, KS, and N3.*
(2) *This option is only available with intrinsically safe approvals.*

(3) *Only available with C6, E2, E5, I5, K5, KB, EM, IM, KM, EP, and E8 product certifications.*

Process connection style

Code	Description	
2B	½-14 NPT female (range 0-5 only)	★
2C[1]	G½ A EN837-1 male (range 0-4 only)	★
2F[2]	Coned and threaded, compatible with autoclave Type F-250-C (range 5-6 only)	
61[3][4]	Non-threaded instrument flange (range 1-4 only)	

(1) *Not available with S1, S5, or WSM. Wireless output (code X) not available with absolute pressure type or C-276 diaphragm material.*
(2) *Not available with wireless (output code X) for range 5.*
(3) *Not available with wireless (output code X).*
(4) *Only available with 316L stainless steel isolating diaphragm.*

Isolating diaphragm

Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.

Code	Isolating diaphragm	Process connection wetted parts material	
2	316L stainless steel	316L stainless steel	★
3	Alloy C-276	Alloy C-276	★
7	Gold-plated 316 stainless steel	316L stainless steel	
8	Gold-plated alloy C-276	C-276	

Sensor fill fluid

Code	Description	
1	Silicone	★
2[1]	Inert	

(1) *Not available with wireless (output code X).*

Housing material

Code	Housing material	Conduit entry size	
A	Aluminum	½-14 NPT	★
B	Aluminum	M20 x 1.5	★
E	Aluminum, ultra low copper	½-14 NPT	
F	Aluminum, ultra low copper	M20 x 1.5	
J	Stainless steel	½-14 NPT	★
K	Stainless steel	M20 x 1.5	
P[1]	Engineered polymer	No conduit entries	★
D[2]	Aluminum	G½	
M[2]	Stainless steel	G½	

(1) *Only available with wireless (output code X). Only available with gauge pressure ranges 1-4.*

(2) *Transmitter conduit entry will be ½ NPT, and a ½ NPT to G½ thread adapter will be provided. Only available with product certifications options I1, I2, I3, I7, IA, IB, IM, KA, N1, N3, N7. Product certifications options E4 and IG are available with aluminum only (option D).*

Wireless options

Requires wireless output (code X) and engineered polymer housing (code P).

Wireless transmit rate, operating frequency, and protocol

Code	Description	
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART®	★

Antenna and SmartPower™

Code	Description	
WP5	Internal antenna, compatible with Green Power Module (I.S. Power Module sold separately).	★

Additional options

Local wireless device access

Code	Description	
BLE(1)	Bluetooth® configuration and maintenance	★

(1) *Requires the Graphical LCD Display (code M6).*

Extended product warranty

Code	Description	
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★

Plantweb™ control functionality

Code	Description	
A01	FOUNDATION™ Fieldbus control function block suite	★

Plantweb™ diagnostic functionality

Code	Description	
DA0(1)	Loop Integrity Diagnostic	★
DA1(2)	Loop Integrity and Plugged Impulse Line Diagnostics	★
D01	FOUNDATION™ Fieldbus Diagnostics Suite	★

(1) *Only available with 4-20 mA HART® protocol (code A).*
(2) *Only available with 4-20 mA HART (code A) and Low Power (code M) output codes. With Low Power output code, only the Plugged Impulse Line Diagnostic is included.*

Integral assembly

“Assemble-to” items are specified separately and require a completed model number.

Code	Description	
S5	Assemble to Rosemount 306 Integral Manifold	★

Diaphragm seal assemblies

“Assemble-to” items are specified separately and require a completed model number.

Code	Description	
S1	Assemble to one Rosemount seal	★

Mounting bracket

Panel mounting bolts are not supplied.

Code	Description	
B4	Bracket for 2-in. pipe or panel mounting, all stainless steel	★
BE	316SST B4 bracket with 316SST bolts	

Product certifications

Code	Description	
E1	ATEX Flameproof	★
I1[1]	ATEX Intrinsic Safety	★
IA	ATEX FISCO Intrinsic Safety; for FOUNDATION™ Fieldbus or PROFIBUS® PA Protocol only	★
N1	ATEX Type n Certification	★
K8	ATEX Flameproof, Intrinsic Safety, Type n, Dust (combination of E8, I1 and N1)	★
E4[2]	Japan Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
I5[3]	USA Intrinsically Safe, Nonincendive	★
K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
I6	Canada Intrinsic Safety	★
C6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
K6	Canada Explosion-proof, Intrinsically Safe, and Division 2 (combination of E6 and I6)	★
E7	IECEx Flameproof	★
I7	IECEx Intrinsic Safety	★
N7	IECEx Type n Certification	★
K7	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, and Type n (combination of I7, N7, and E7)	★
IG	IECEx FISCO Intrinsically Safe; for FOUNDATION Fieldbus or PROFIBUS PA Protocols only	★
E2	Brazil Flameproof	★
I2	Brazil Intrinsic Safety	★
IB	Brazil FISCO intrinsically safe; for FOUNDATION Fieldbus or PROFIBUS PA Protocols only	★

K2	Brazil Flameproof, Intrinsic Safety	★
E3	China Flameproof	★
I3	China Intrinsic Safety	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	★
KM	Technical Regulations Customs Union (EAC) Flameproof and Intrinsic Safety	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2 (combination of K5 and C6)	★
KD	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe (combination of K5, C6, I1, and E8)	★
KL(4)	USA, Canada, IECEx, ATEX Intrinsic Safety Combination	★
KS	USA, Canada, IECEx, ATEX Explosion-proof, Intrinsically Safe, Dust, Non-Incendive, Type-N, Div. 2	★
EP	Republic of Korea Flameproof	★
IP	Republic of Korea Intrinsic Safety	★
KP	Republic of Korea Flameproof, Intrinsic Safety	★

(1) *Dust approval not applicable to wireless (out\put code X). For wireless approvals, see the Certifications chaper of the Rosemount 3051 Wireless Pressure Transmitters Reference Manual.*
(2) *Only available with 4-20 mA HART®(output code A), FOUNDATION™ Fieldbus (output code F), or PROFIBUS® PA (output code W). Only available with aluminum housing and G½ conduit entry size (housing material code D).*
(3) *Nonincendive certification not provided with wireless (output code X).*
(4) *Only available with wireless (output code X).*

Drinking water approval

Not available with alloy C-276 isolator (code 3), assemble-to manifolds (code S5), assemble-to seals (code S1), and surface finish certification (code Q16).

Code	Description	
DW	NSF drinking water approval	★

Shipboard approvals

Not available with wireless output (code X).

Code	Description	
SBS	American Bureau of Shipping	★
SBV(1)	Bureau Veritas (BV)	★
SDN	Det Norske Veritas	★
SLL(1)	Lloyds Register (LR)	★

(1) *Only available with product certifications E7, E8, I1, I7, IA, K7, K8, KD, N1, and N7.*

SST tagging

Code	Description	
Y2	316 SST nameplate, top tag, wire-on tag, and fasteners	

Custody transfer

The custody transfer option is only available with HART 4–20 mA output (code A).

Code	Description	
C5	Measurement Canada Accuracy Approval (limited availability depending on transmitter type and range; contact an Emerson representative).	★

Calibration certification

Code	Description	
Q4	Calibration certificate	★
QP	Calibration certificate and tamper evident seal	★

Material traceability certification

Code	Description	
Q8	Material traceability certification per EN 10204 3.1.B	★

Positive material identification (PMI)

Code	Description	
Q76	PMI verification and certificate	★

Quality certification for safety

The quality certification for safety is only available with HART® 4–20 mA output (code A).

Code	Description	
QT	Safety certified to IEC 61508 with certificate of FMEDA	★

Enhanced safety

Only available with HART® 4-20 mA output (Code A).

Code	Description	
T9	Enhanced SIS proof testing and logging	★

Configuration buttons

Code	Description	
D1(1)	Quick service buttons	★
D4(2)	Analog zero and span	★
DZ(3)	Digital zero trim	★

(1) *Only available with Graphical LCD Display (code M6)*
(2) *Only available with HART 4–20 mA output (code A).*
(3) *Only available with HART 4–20 mA output (output code A) and wireless output (output code X).*

Display and interface options

Code	Description	
M6(1)	Graphical LCD display	★
M5	LCD display	★

Code	Description	
M4[2]	LCD display with LOI	★

(1) *Only available with 4-20 mA HART® output (code A).*
(2) *Only available with 4-20 mA HART output (code A), Low Power (code M), and PROFIBUS-PA (code W).*

Wireless sensor module

Code	Description	
WSM	Wireless stainless steel sensor module	★

Transient protection

The transient protection option is not available with wireless (output code X). The T1 option is not needed with FISCO Product Certifications; transient protection is included in the FISCO product certification codes IA, IB, and IE.

Code	Description	
T1	Transient protection terminal block	★

Conduit plug

The conduit plug option is not available with wireless output (code X).

Code	Description	
DO	316 SST conduit plug	★

Software configuration

Code	Description	
C1	Custom software configuration. (For wired, see the Rosemount 3051 Configuration Data Sheet. For wireless, see the Rosemount 3051 Wireless Configuration Data Sheet.)	★

Alarm levels

The alarm levels option is only available with HART 4–20 mA output (code A).

Code	Description	
C4	Analog output levels compliant with NAMUR recommendation NE 43, alarm high	★
CN	Analog output levels compliant with NAMUR recommendation NE 43, alarm low	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1)	★
CT	Rosemount standard low alarm	★

Pressure testing

Code	Description	
P1[1]	Hydrostatic testing with certificate	★

(1) *Not available with pressure range 0.*

Cleaning process area

Not valid with alternate process connection (code S5).

Code	Description
P2	Cleaning for special service
P3	Cleaning for < 1 ppm chlorine/fluoride

Ground screw

The ground screw option is not available with wireless output (code X). The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

Code	Description	
V5	External ground screw assembly	★

Surface finish

Code	Description	
Q16	Surface finish certification for sanitary remote seals	★

Toolkit total system performance reports

Code	Description	
QZ	Remote seal system performance calculation report	★

Conduit electrical connector

The conduit electrical connector option is not available with wireless output (code X).

Code	Description	
GB	ATEX Cable gland and plug, M20 x 1.5, polyamide, black	
GE	M12, 4-pin, male connector (eurofast®)	★
GM	A size mini, 4-pin, male connector (minifast®)	★

NACE certificate

Note that NACE®-compliant wetted materials are required. Materials of construction must comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult the latest standard for details. All selected materials must also conform to NACE MR0103 for sour refining environments.

Code	Description	
Q15	Certificate of Compliance to NACE MR0175/ISO 15156 for wetted materials	★
Q25	Certificate of Compliance to NACE MR0103 for wetted materials	★

Enhanced software

Enhanced software enables application specific configuration, expanded process alerts, and logging capabilities.

Code	Description	
RK	Enhanced software	★

Cold temperature

This option is only available for pressure ranges 1–5 with 4-20 mA HART® and FOUNDATION Fieldbus Protocol, and silicone sensor fill fluid. BR5 and BR6 are not available with Non-threaded instrument flange (code 61) or the assemble to one Rosemount seal (option S1).

Code	Description	
BR5[1]	–58 °F (–50 °C) cold temperature operation	★
BR6[2]	–76 °F (–60 °C) cold temperature operation	★

(1) *If Product Certification Options are required, the BR5 option is only available with approval codes C6, E2, E5, E6, E7, EM, EP, I2, I5, I6, I7, IM, IP, K2, K5, K7, KB, KM, and KP.*

(2) *If Product Certification Options are required, the BR6 option is only available with approval codes E2, E7, EM, I2, I6, I7, IM, IP, K2, K7, and KM.*

Specifications

Performance specifications

Conformance to specifications (±3σ [Sigma])

Technology leadership, advanced manufacturing techniques, and statistical process control ensure specification conformance to at least ±3σ.

Reference accuracy

Stated reference accuracy equations include terminal based linearity, hysteresis, and repeatability. For wireless, FOUNDATION™ Fieldbus, and PROFIBUS® PA devices, use calibrated range in place of span.

Models	Rosemount 3051 and *Wireless*HART®
Rosemount 3051C[1]	
Range 5	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0{,}015 + 0{,}005\left(\frac{URL}{Span}\right)\right]$% of Span
Ranges 2–4	± 0.04% of span For spans less than 10:1[2], accuracy = $\pm\left[0{,}015 + 0{,}005\left(\frac{URL}{Span}\right)\right]$% of Span
Range 1	± 0.10% of span For spans less than 15:1, accuracy = $\pm\left[0{,}025 + 0{,}005\left(\frac{URL}{Span}\right)\right]$% of Span
Range 0 (CD)	± 0.10% of span For spans less than 2:1, accuracy = ± 0.05% of URL
Rosemount 3051CA	
Ranges 1–4	± 0.04% of span[3] For spans less 10:1, accuracy = $\pm\left[0{,}0075\left(\frac{URL}{Span}\right)\right]$% of Span
Rosemount 3051T[1]	
Range 0	± 0.04% of span[3] For spans less 5:1 to 20:1, accuracy = $\pm\left[0{,}05 + 0{,}01\left(\frac{URL}{Span}\right)\right]$% of span

Ranges 1–4	± 0.04% of span[3] For spans less than 10:1, accuracy = $\pm\left[0{,}0075\left(\frac{URL}{Span}\right)\right]$% of Span
Range 5–6	± 0.075% of span
Rosemount 3051L	
Ranges 2-4	± 0.075% of span For spans less than 10:1, accuracy = $\pm\left[0{,}025 + 0{,}005\left(\frac{URL}{Span}\right)\right]$% of Span

(1) *For Rosemount 3051C and 3051T with seal assemble to code S1, use 3051L specification.*
(2) *For output code F, for span less than 5:1.*
(3) *For output code M, ±0.065 percent span.*

Flow Performance - Flow Reference Accuracy

Note
Accuracy over range of use is always application dependent. Range 1 flow meters may experience an additional uncertainty up to 0.9 percent. Consult your Emerson representative for exact specifications.

Rosemount 3051CFA Annubar™ Flow Meter		
Ranges 2–3		±1.80% of flow rate at 8:1 flow turndown
Rosemount 3051CFC_A Compact Annubar Flow Meter – Rosemount Annubar Option A		
Ranges 2–3	Standard	±2.10% of flow rate at 8:1 flow turndown
	Calibrated	±1.80% of Flow Rate at 8:1 flow turndown
Rosemount 3051CFC_C Compact Orifice Flow Meter – Conditioning Option C		
Ranges 2–3	β = 0.4	±1.75% of flow rate at 8:1 flow turndown
	β = 0.50, 0.65	±1.95% of flow rate at 8:1 flow turndown
Rosemount 3051CFC_P Compact Orifice Flow Meter – Orifice Type Option P[1]		
Ranges 2–3	β= 0.4	±2.00% of flow rate at 8:1 flow turndown
	β= 0.65	±2.00% of flow rate at 8:1 flow turndown
Rosemount 3051CFP Integral Orifice Flow Meter		
Ranges 2–3	β<0.1	±3.00% of flow rate at 8:1 flow turndown
	0.1< β<0.2	±1.95% of flow rate at 8:1 flow turndown
	0.2< β<0.6	±1.75% of flow rate at 8:1 flow turndown
	0.6< β<0.8	±2.15% of flow rate at 8:1 flow turndown

(1) *Applicable to 2- to 12-in. line sizes. For smaller line sizes, see the Rosemount DP Flow Meters and Primary Elements Product Data Sheet.*

Total performance

Total performance is based on combined errors of reference accuracy, ambient temperature effect, and static pressure effect at normal operating conditions (70 percent of span typical reading, 740 psi (51.02 bar) line pressure).

For ±50 °F (28 °C) temperature changes; 0–100 percent relative humidity, from 1:1 to 5:1 rangedown

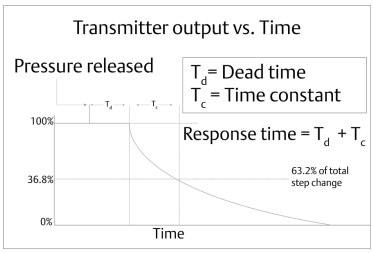
Models	Total performance[1]
Rosemount 3051C Ranges 2–5	± 0.14% of span
Rosemount 3051L Ranges 2–4	Use Instrument Toolkit or the QZ option to quantify the total performance of a remote seal assembly under operating conditions.

(1) *For output code W, F, and M, total performance is ±0.15 percent of span.*

Long term stability

Models	Long term stability
Rosemount 3051C	
Ranges 2–5	±0.2% of URL for 10 years, ±50 °F (28 °C) temperature changes, and up to 1000 psi (68.95 bar) line pressure.
Rosemount 3051 CD, 3051CG Low/Draft Range Ranges 0-1, 3051TG Range 0	±0.2% of URL for 1 year
Rosemount 3051CA Low Range	
Range 1	±0.2% of URL for 10 years, ±50 °F (28 °C) temperature changes, and up to 1000 psi (68.95 bar) line pressure.
Rosemount 3051T	
Ranges 1–4	±0.2% of URL for 10 years, ±50 °F (28 °C) temperature changes, and up to 1000 psi (68.95 bar) line pressure.
Rosemount 3051L	
Ranges 2–3	±0.1% of URL for 1 year
Ranges 4–5	±0.2% of URL for 1 year

Dynamic performance

	4 - 20 mA HART®(1)	FOUNDATION™ Fieldbus and PROFIBUS® PA Protocols(2)	Typical HART transmitter response time
Total Response Time ($T_d + T_c$)(3):			
Rosemount 3051C			
Ranges 2-5(4)	85 ms	152 ms	
Range 1	255 ms	307 ms	
Range 0	700 ms	N/A	
Rosemount 3051T	100 ms	152 ms	
Rosemount 3051L	See Instrument Toolkit.	See Instrument Toolkit.	
Dead time (Td)	45 ms (nominal)	97 ms	
Update rate(5)	22 times per second	22 times per second	

(1) *Dead time and update rate apply to all models and ranges; analog output only.*
(2) *Transducer block response time, Analog Input block execution time not included.*
(3) *Nominal total response time at 75 °F (24 °C) reference conditions.*
(4) *With option codes M6, RK, T9, DA1, response time is 85 ms. All other options response time is 100 ms.*
(5) *Does not apply to wireless output (code X). See Wireless (output code X) for wireless update rate.*

Line pressure effect per 1000 psi (68.95 bar)

For line pressures above 2000 psi (137.90 bar) and Ranges 4–5, see the following documents:

- For HART®, see Rosemount 3051 Pressure Transmitter with 4-20 mA HART Protocol Manual
- For *Wireless*HART, see Rosemount 3051 Wireless Pressure Transmitters Reference Manual
- For FOUNDATION™ Fieldbus, see the Rosemount 3051 Pressure Transmitter with FOUNDATION™ Fieldbus Protocol Reference Manual.
- For FOUNDATION™ Fieldbus, see the Rosemount 3051 Pressure Transmitter with FOUNDATION™ Fieldbus Protocol Reference Manual.
- For PROFIBUS® PA, see the Rosemount 3051 Pressure Transmitter with PROFIBUS PA Protocol Reference Manual.

Table 1: Rosemount 3051CD and 3051CF Line Pressure Effect

Range	Line pressure effect
Zero error	
Ranges 2–3	±0.05% of URL/1000 psi (68.95 bar) for line pressures from 0 to 2000 psi (0 to 137.90 bar)
Range 1	±0.25% of URL/1000 psi (68.95 bar) for line pressures from 0 to 2000 psi (0 to 137.90 bar)
Range 0	±0.125% of URL/100 psi (6.89 bar) for line pressures from 0 to 750 psi (0 to 51.71 bar)
Span error	
Ranges 2–3	±0.1% of reading/1000 psi (68.95 bar)
Range 1	±0.4% of reading/1000 psi (68.95 bar)
Range 0	±0.15% of reading/100 psi (6.895 bar)

Ambient temperature effect per 50 °F (28 °C)

Models	Ambient temperature effect
Rosemount 3051C	
Range 0	±(0.25% URL + 0.05% span) from 1:1 to 30:1
Range 1	±(0.1% URL + 0.25% span) from 1:1 to 30:1 ±(0.14% URL + 0.15% span) from 30:1 to 50:1
Ranges 2–5	±(0.0125% URL + 0.0625% span) from 1:1 to 5:1 ±(0.025% URL + 0.125% span) from 5:1 to 150:1
Rosemount 3051CA	
Ranges 1–4	±(0.025% URL + 0.125% span) from 1:1 to 30:1 ±(0.035% URL + 0.125% span) from 30:1 to 150:1
Rosemount 3051T	
Range 0	±(0.15% URL + 0.075% span) from 1:1 to 20:1
Range 1	±(0.025% URL + 0.125% span) from 1:1 to 10:1 ±(0.05% URL + 0.125% span) from 10:1 to 100:1
Range 2–4	±(0.025% URL + 0.125% span) from 1:1 to 30:1 ±(0.035% URL + 0.125% span) from 30:1 to 150:1
Range 5–6	±(0.1% URL + 0.15% span) from 1:1 to 5:1
Rosemount 3051L	**See Instrument Toolkit™ software.**

Mounting position effects

Models	Mounting position effects
Rosemount 3051C	Zero shifts up to ±1.25 in H_2O (3.11 mbar), which can be calibrated out. No span effect.
Rosemount 3051CA, 3051T	Zero shifts up to ±2.5 in H_2O (6.22 mbar), which can be calibrated out. No span effect.
Rosemount 3051L	With liquid level diaphragm in vertical plane, zero shift of up to ±1 in H_2O (2.49 mbar). With diaphragm in horizontal plane, zero shift of up to ±5 in H_2O (12.43 mbar) plus extension length on extended units. All zero shifts can be calibrated out. No span effect.

Vibration effect

Less than ±0.1 percent of URL when tested per the requirements of IEC60770-1: 1999 field or pipeline with high vibration level (10–60 Hz 0.21 mm displacement peak amplitude/60–2000 Hz 3g).

Power supply effect

Less than ±0.005 percent of calibrated span per volt change.

Electromagnetic compatibility

Meets all industrial environment requirements of EN61326 and NAMUR NE-21. Maximum deviation <1% span during EMC disturbance.

Note
NAMUR NE-21 does not apply to Low-Power (transmitter output option code M) or Wireless (transmitter output code X).

Transient protection (option code T1)

Tested in accordance with IEEE C62.41.2-2002, location category B

- 6 kV crest (0.5 µs - 100 kHz)
- 3 kA crest (8 x 20 µs)
- 6 kV crest (1.2 x 50 µs)

Functional specifications

Range and sensor limits

Table 2: Rosemount 3051CD, 3051CG, 3051CF, and 3051L Range and Sensor Limits

Range[1]	Minimum span	Range and sensor limits				
	Rosemount 3051CD, 3051CG, 3051CF, 3051L[2]	Upper (URL)	Lower (LRL)			
			Rosemount 3051CD Differential, 3051CF Flow Meters	Rosemount 3051CG Gage[3]	Rosemount 3051L Differential	Rosemount 3051L Gage[3]
0	0.10 inH_2O (0.24 mbar)	3.00 inH_2O (7.45 mbar)	–3.00 inH_2O (–7.45 mbar)	N/A	N/A	N/A
1	0.50 inH_2O (1.24 mbar)	25.00 inH_2O (62.16 mbar)	–25.00 inH_2O (–62.16 mbar)	–25.00 inH_2O (–62.16 mbar)	N/A	N/A
2	1.67 inH_2O (4.15 mbar)	250.00 inH_2O (621.60 mbar)	–250.00 inH_2O (–621.60 mbar)	–250.00 inH_2O (–621.60 mbar)	–250.00 inH_2O (–621.60 mbar)	–250.00 inH_2O (–621.60 mbar)
3	6.67 inH_2O (16.58 mbar)	1000.00 inH_2O (2.48 bar)	–1000.00 inH_2O (–2.48 bar)	0.50 psia (34.47 mbar)	–1000.00 inH_2O (–2.48 bar)	0.50 psia (34.47 mbar)
4	2.00 psi (137.89 mbar)	300.00 psi (20.68 bar)	–300.00 psi (–20.68 bar)	0.50 psia (34.47 mbar)	–300.00 psi (–20.68 bar)	0.50 psia (34.47 mbar)
5	13.33 psi (919.01 mbar)	2000.00 psi (137.89 bar)	– 2000.00 psi (–137.89 bar)	0.50 psia (34.47 mbar)	N/A	N/A

(1) *inH_2O referenced at 68 °F (20 °C). Range 0 only available with Rosemount 3051CD. Range 1 only available with 3051CD, 3051CG, or 3051CF.*

(2) *For outputs options W and M, minimum span are: range 2 - 2.50 inH_2O (6.21 mbar), range 3 - 10.00 inH_2O (24.86 mbar), range 4 - 3.00 psi (0.21 bar), range 5 - 20.00 psi (1.38 bar).*

(3) *Assumes atmospheric pressure of 14.7 psig.*

Table 3: Rosemount 3051CA and 3051T Range and Sensor Limits

Range	Rosemount 3051CA			Rosemount 3051T			
	Minimum span[1]	Upper (URL)	Lower (LRL)	Minimum span[1]	Upper (URL)	Lower (LRL) (absolute)	Lower[2] (LRL) (gage)
0	N/A	N/A	N/A	0.25 psi (17.24 mbar)	5 psi (344.74 mbar)	N/A	–5 psi (–344.74 mbar)
1	0.30 psi (20.68 mbar)	30 psia (2.06 bar)	0 psia (0 bar)	0.30 psi (20.68 mbar)	30.00 psi (2.06 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)
2	1.00 psi (68.94 mbar)	150 psia (10.34 bar)	0 psia (0 bar)	1.00 psi (68.94 mbar)	150.00 psi (10.34 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)
3	5.33 psi (367.49 mbar)	800 psia (55.15 bar)	0 psia (0 bar)	5.33 psi (367.49 mbar)	800.00 psi (55.15 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)
4	26.67 psi (1.83 bar)	4000 psia (275.79 bar)	0 psia (0 bar)	26.67 psi (1.83 bar)	4000.00 psi (275.79 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)

Table 3: Rosemount 3051CA and 3051T Range and Sensor Limits *(continued)*

Range	Rosemount 3051CA			Rosemount 3051T			
	Minimum span[1]	Upper (URL)	Lower (LRL)	Minimum span[1]	Upper (URL)	Lower (LRL) (absolute)	Lower[2] (LRL) (gage)
5	N/A	N/A	N/A	2000 psi (137.89 bar)	10000.00 psi (689.47 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)
6	N/A	N/A	N/A	4000 psi (275.79 bar)	20000.00 psi (1378.95 bar)	0 psia (0 bar)	–14.70 psig (–1.01 bar)

(1) *For output options W and M, minimum span are: range 2 – 1.50 psi (0.10 bar), range 3 – 8.00 psi (0.55 bar), range 4 – 40.00 psi (2.75 bar).*
(2) *Assumes atmospheric pressure of 14.7 psig.*

Service

Liquid, gas, and vapor applications.

4–20 mA HART® (output code A)

Power supply

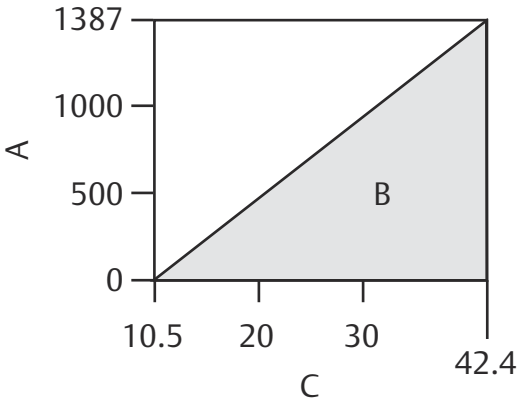
External power supply required. Standard transmitter (4–20 mA) operates on 10.5–42.4 Vdc with no load.

Load limitations

Maximum loop resistance is determined by the voltage level of the external power supply described by:

Max. loop resistance = 43.5 (power supply voltage - 10.5)

Communication requires a minimum loop resistance of 250 ohms.



A. Load (Ωs)
B. Operating region
C. Voltage (Vdc)

Note
For CSA approval, power supply must not exceed 42.4 V.

Indication

Optional 2-line LCD/LOI Display

Optional 3-line Graphical Display with Backlight and Local Language

- Languages include:
  - English

— Chinese
— French
— German
— Italian
— Portuguese
— Russian
— Spanish

Optional configuration buttons

Configuration buttons need to be specified:

- Quick service buttons (option D1) allow for straightforward commissioning using a simple menu without needing to remove the housing cover. The quick service button option allows users to zero, rerange their device, perform a loop test, view configuration, and flip the graphical LCD display screen in the field.
- Digital Zero trim (option code DZ) changes digital value of the transmitter and is used for performing a sensor zero trim.
- Analog Zero and Span (option code D4) changes analog value and can be used to rerange the transmitter with an applied pressure.

Output

Two-wire 4–20 mA, user selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to HART Protocol.

Bluetooth® Connectivity

Typical Range: At least 50 ft. (15 m) line of sight. Maximum communication range will vary depending on orientation, obstacles (person, metal, wall, etc.), or electromagnetic environment.

FOUNDATION™ Fieldbus (output code F)

Power supply

External power supply required; transmitters operate on 9.0 to 32.0 Vdc transmitter terminal voltage. FISCO transmitters operate on 9.0 to 17.5 Vdc.

Current draw

17.5 mA for all configurations (including display option)

Indication

Optional two-line LCD display

FOUNDATION Fieldbus block execution times

Block	Execution time
Resource	N/A
Sensor and SPM transducer	N/A
LCD display	N/A
Analog input 1, 2	20 milliseconds
PID	25 milliseconds
Input selector	20 milliseconds
Arithmetic	20 milliseconds
Signal characterizer	20 milliseconds

Block	Execution time
Integrator	20 milliseconds
Output splitter	20 milliseconds
Control selector	20 milliseconds

FOUNDATION Fieldbus parameters

Links:	out
	25 max.
Virtual communications relationship (VCR):	20 max.

FOUNDATION Fieldbus function blocks (option A01)

Resource block The resource block contains diagnostic, hardware, and electronics information. There are no linkable inputs or outputs to the resource block.

Sensor transducer block The sensor transducer block contains sensor information and the ability to calibrate the pressure sensor or recall factory calibration.

LCD transducer block The LCD display transducer block is used to configure the LCD display meter.

Analog input block The Analog Input (AI) function block processes the measurements from the sensor and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The AI block is widely used for scaling functionality.

Input selector block The Input Selector (ISEL) function block can be used to select the first good, hot backup, maximum, minimum, or average of as many as eight input values and place it at the output. The block supports signal status propagation.

Integrator block The Integrator (INT) function block integrates one or two variables over time. The block compares the integrated or accumulated value to pre-trip and trip limits and generates discrete output signals when the limits are reached. The INT function block is used as a totalizer. This block will accept up to two inputs, has six options how to totalize the inputs, and two trip outputs.

Arithmetic block The Arithmetic (ARTH) function block provides the ability to configure a range extension function for a primary input. It can also be used to compute nine different arithmetic functions including flow with partial density compensation, electronic remote seals, hydrostatic tank gaging, ratio control, and others.

Signal characterizer block The Signal Characterizer (SGCR) function block characterizes or approximates any function that defines an input/output relationship. The function is defined by configuring as many as 20 X,Y coordinates. The block interpolates an output value for a given input value using the curve defined by the configured coordinates. Two separate analog input signals can be processed simultaneously to give two corresponding separate output values using the same defined curve.

PID block The PID function block combines all of the necessary logic to perform proportional/integral/derivative PID control. The block supports mode control, signal scaling and limiting, feed forward control, override tracking, alarm limit detection, and signal status propagation.

Control selector block The control selector function block selects one of two or three inputs to be the output. The inputs are normally connected to the outputs of PID or other function blocks. One of the inputs would be considered normal and the other two overrides.

Output splitter block The output splitter function block provides the capability to drive two control outputs from a single input. It takes the output of one PID or other control block to control two valves or other actuators.

Backup Link Active Scheduler (LAS)

The transmitter can function as an LAS if the current link master device fails or is removed from the segment.

FOUNDATION Fieldbus Diagnostics Suite (option code D01)

The Rosemount 3051C FOUNDATION Fieldbus Diagnostics Suite features SPM technology to detect changes in the process, process equipment, or installation conditions (such as plugged impulse lines) of the transmitter. This is done by modeling the process noise signature (using the statistical values of mean and standard deviation) under normal conditions and then comparing the baseline values to current values over time. If a significant change in the current values is detected, the transmitter can generate an alert.

PROFIBUS® PA (output code W)

Profile version

3.02

Power supply

External power supply required; transmitters operate on 9.0 to 32.0 Vdc transmitter terminal voltage. FISCO transmitters operate on 9.0 to 17.5 Vdc.

Current draw

17.5 mA for all configurations (including LCD display option)

Output update rate

Four times per second

Standard function block

Analog input (AI block)	The AI function block processes the measurements and makes them available to the host device. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The AI block is widely used for scaling functionality.

Note
The channel, Set XD_Scale, Set L_Type, and sometimes Set Out_Scale are typically configured by instrument personnel. Other AI block parameters, block links, and schedule are typically configured by the control systems configuration engineer.

Indication

Optional two-line LCD display

LOI

The LOI uses a two-button menu with external configuration buttons.

Wireless (output code X)

Output

IEC 62591 (*Wireless*HART®), 2.4 GHz DSSS

Wireless radio (internal antenna, WP5 option)

- Frequency: 2.400 – 2.485 GHz
- Channels: 15
- Modulation: IEEE 802.15.4 compliant DSSS
- Transmission: Maximum of 10 dBm EIRP

Local display

The optional three-line, seven-digit LCD display can display user-selectable information, such as primary variable in engineering units, scaled variable, percent of range, sensor module temperature, and electronics temperature. The display updates based on the wireless update rate.

Digital zero trim

Digital zero trim (option DZ) is an offset adjustment to compensate for mounting position effects, up to 5 percent of URL.

Update rate

User selectable 1 second to 60 minute.

Wireless sensor module for in-line transmitters

The Rosemount 3051 Wireless Transmitter requires the engineered polymer housing to be selected. The standard sensor module will come with aluminum material. If SST is required, you must select the option WSM.

Power module

Field replaceable, keyed connection eliminates the risk of incorrect installation, Intrinsically Safe Lithium-thionyl chloride Power Module with PBT/PC enclosure. Ten-year life at one minute update rate(7).

Note
Continuous exposure to ambient temperature limits of -40 °F or 185 °F (–40 °C or 85 °C) may reduce specified life by less than 20 percent.

Low power output

1–5 Vdc HART® low power (output code M)

Output

The default three-wire 1–5 Vdc is a user-selectable output. Also user selectable for linear or square root output configuration. Digital process variable superimposed on voltage signal, available to any host conforming to the HART Protocol. Low-power transmitter operates on 6–12 Vdc with no load.

Power consumption

3.0 mA, 18–36 mW

Minimum load impedance

100 kΩ (V_{out} wiring)

Indication

Optional five-digit LCD display

Overpressure limits

Rosemount 3051CD/CG/CF

- Range 0: 750 psi (51.71 bar)
- Range 1: 2000 psig (137.90 bar)
- Ranges 2–5: 3626 psig (250.00 bar), 4500 psig (310.26 bar) for option code P9

Rosemount 3051CA

- Range 1: 750 psia (51.71 bar)

(7) Reference conditions are 70 °F (21 °C), and routing data for three additional network devices.

- Range 2: 1500 psia (103.42 bar)
- Range 3: 1600 psia (110.32 bar)
- Range 4: 6000 psia (413.69 bar)

Rosemount 3051TG/TA

- Range 0: 60 psi (4.14 bar)
- Range 1: 750 psi (51.71 bar)
- Range 2: 1500 psi (103.42 bar)
- Range 3: 1600 psi (110.32 bar)
- Range 4: 6000 psi (413.69 bar)
- Range 5: 15000 psi (1034.21 bar)
- Range 6: 24000 psi (1654.74 bar)

For Rosemount 3051L or level flange option codes FA, FB, FC, FD, FP, and FQ, limit is 0 psia to the flange rating or sensor rating, whichever is lower.

Table 4: Rosemount 3051L and Level Flange Rating Limits

Standard	Type	CS rating	SST rating
ANSI/ASME	Class 150	285 psig	275 psig
ANSI/ASME	Class 300	740 psig	720 psig
ANSI/ASME	Class 600	1480 psig	1440 psig
At 100 °F (38 °C), the rating decreases with increasing temperature, per ANSI/ASME B16.5.			
DIN	PN 10–40	40 bar	40 bar
DIN	PN 10/16	16 bar	16 bar
DIN	PN 25/40	40 bar	40 bar
At 248 °F (120 °C), the rating decreases with increasing temperature, per DIN 2401.			

Static pressure limit

Rosemount 3051CD only

Operates within specifications between static line pressures of 0.5 psia and 3626 psig (4500 psig (310.26 bar) for option code P9).

Range 0: 0.5 psia and 750 psig (0.03 bar and 51.71 bar)

Range 1: 0.5 psia and 2000 psig (0.03 bar and 137.90 bar)

Burst pressure limits

Rosemount 3051C, 3051CF coplanar or traditional transmitter flange

10081 psig (695,06 bar)

Rosemount 3051T in-line

- Ranges 0–4: 11016 psi (759.53 bar)
- Range 5: 26016 psig (1793.74 bar)
- Range 6: 46092 psi (3177.93 bar)

Failure mode alarm

HART® 4–20 mA (output option code A)

If self-diagnostics detect a sensor or microprocessor failure, the analog signal is driven either high or low to alert the user. High or low failure mode is user-selectable with a jumper/switch on the transmitter. The values to which the transmitter drives its output in failure mode depend on whether it is configured to standard, NAMUR-compliant, or custom levels. The values for each are as follows:

Table 5: Failure mode alarm

	High alarm	Low alarm
Default	≥ 21.75[1] mA	≤ 3.75 mA
NAMUR compliant [2]	≥ 22.5 mA	≤ 3.6 mA
Custom levels [3]	20.2 – 23.0 mA	3.6 – 3.8 mA

(1) *High Alarm default is ≥22.5 mA for some options (codes M6, DA1, T9, RK).*
(2) *See option codes C4 or CN.*
(3) *Low alarm must be 0.1 mA less than low saturation and high alarm must be 0.1 mA greater than high saturation.*

Output code M

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 0.94 V or above 5.4 V to alert the user. High or low alarm signal is user-selectable by internal jumper.

Output code F, W, and X

If self-diagnostics detect a gross transmitter failure, that information gets passed as an alert and a status along with the process variable.

Temperature limits

Ambient

- –40 to 185 °F (–40 to 85 °C)
- With display[1][2][3]: –40 to 176 °F (–40 to 80 °C)
- With option code BR5: –58 to 185 °F (–50 to 85 °C)
- With option code BR6: –76 to 185 °F (–60 to 85 °C)

(1) *LCD display may not be readable and LCD display updates will be slower at temperatures below –22 °F (–30 °C).*
(2) *Wireless LCD display may not be readable and LCD display updates will be slower at temperature below –4 °F (–20 °C).*
(3) *Graphical LCD display updates will be slower at temperatures below 32 °F (0 °C). Graphical LCD display may not be readable below -22 °F (-30 °C).*

Storage

Note
If storage temperature is above 185 °F (85 °C), perform a sensor trim prior to installation.

- –76 to 230 °F (–60 to 110 °C)
- With display: –76 to 185 °F (–60 to 85 °C)
- With wireless output: –40 °F to 185 °F (–40 °C to 85 °C)

Process

At atmospheric pressures and above. See Table 6.

Table 6: Process Connection Temperature Limits

Rosemount 3051CD, 3051CG, 3051CF, 3051CA	
Silicone fill sensor[1]	N/A

Table 6: Process Connection Temperature Limits *(continued)*

With coplanar flange	–40 to 250 °F (–40 to 121 °C)[2]
With traditional flange	–40 to 300 °F (–40 to 149 °C)[2][3]
With level flange	–40 to 300 °F (–40 to 149 °C)[2]
With Rosemount 305 Integral Manifold	–40 to 300 °F (–40 to 149 °C)[2]
Inert fill sensor[1][4]	–40 to 185 °F (–40 to 85 °C) [5][6]
With Option Code BR6, coplanar flange	–76 to 250 °F (–60 to 121 °C)[2]
With Option Code BR6, traditional flange	–75 to 300 °F (–60 to 149 °C)[2]
Rosemount 3051T (process fill fluid)	
Silicone fill sensor[1]	–40 to 250 °F (–40 to 121 °C)[2]
With Option Code BR6	–76 to 250 °F (–60 to 121 °C)[2]
Inert fill sensor[1]	–22 to 250 °F (–30 to 121 °C)[2]
Rosemount 3051L low-side temperature limits	
Silicone fill sensor[1]	–40 to 250 °F (–40 to 121 °C)[2]
Inert fill sensor[1]	–40 to 185 °F (–40 to 85 °C)[5]
Rosemount 3051L high-side temperature limits (process fill fluid)	
SYLTHERM XLT	–157 to 293 °F (–105 to 145 °C)
Silicone 704	32 to 401 °F (0 to 205 °C)
Silicone 200	–49 to 401 °F (–45 to 205 °C)
Inert	–49 to 320 °F (–45 to 160 °C)
Glycerin and water	5 to 203 °F (–15 to 95 °C)
Neobee M-20	5 to 401 °F (–15 to 205 °C)
Propylene glycol and water	5 to 203 °F (–15 to 95 °C)

(1) *Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio.*
(2) *220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.*
(3) *Rosemount 3051CD0 process temperature limits are –40 to 212 °F (–40 to 100 °C).*
(4) *Inert fill with traditional flange on Range 0: limits are 32 to 185 °F (0 to 85 °C).*
(5) *160 °F (71 °C) limit in vacuum service.*
(6) *Not available for Rosemount 3051CA.*

Humidity limits

0–100 percent relative humidity

Turn-on time

Performance within specifications less than 2.0 seconds (20.0 seconds for PROFIBUS® PA and FOUNDATION™ Fieldbus Protocols) after power is applied to the transmitter.

Note
Does not apply to wireless option code X.

Volumetric displacement

Less than 0.005-in^3 (0.08 cm^3)

Damping

4–20 mA HART®

Analog output response to a step input change is user-enterable from 0.0 to 60 seconds for one time constant. This software damping is in addition to sensor module response time.

FOUNDATION™ Fieldbus

- Transducer block: User configurable
- AI Block: User configurable

PROFIBUS® PA

AI Block only: User configurable

Physical specifications

Material selection

Emerson provides a variety of Rosemount products with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product materials, options, and components for the particular application. Emerson is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product options, configuration, or materials of construction selected.

Electrical connections

½–14 NPT, G½, and M20 x 1.5 conduit. The polymer housing (code P) has no conduit entries. HART® interface connections fixed to terminal block for output code A and to 701P Power Module for output code X.

Process connections

Rosemount 3051C

- ¼–18 NPT on 2⅛-in. centers
- ½–14 NPT on 2-, 2⅛-, or 2¼-in. centers

Rosemount 3051L

- High pressure side: 2-, 3-, or 4-in., ASME B 16.5 (ANSI) Class 150, 300 or 600 flange; 50, 80, or 100 mm, PN 40 or 10/16 flange
- Low pressure side: ¼–18 NPT on flange ½–14 NPT on adapter

Rosemount 3051T

- ½–14 NPT female
- G½ A DIN 16288 male (range 1–4 only)
- Autoclave type F-250-C (pressure relieved 9/16–18 gland thread; ¼ OD high pressure tube 60° cone; available for range 5–6 transmitters only).

Rosemount 3051CF

- For Rosemount 3051CFA, see Rosemount DP Flow Meters and Primary Elements Product Data Sheet in the Rosemount 485 Annubar section .

- For Rosemount 3051CFC, see Rosemount DP Flow Meters and Primary Elements Product Data Sheet in the Rosemount 405 Compact Orifice Plate section.
- For Rosemount 3051CFP, see Rosemount DP Flow Meters and Primary Elements Product Data Sheet in the Rosemount 1195 Integral Orifice section.

Transmitter process-wetted parts

Drain/vent valves

316 SST, alloy C-276, or alloy 400 material (alloy 400 not available with Rosemount 3051L).

Transmitter flanges and adapters

- Plated CS
- SST: CF-8M (Cast 316 SST) per ASTM A743
- Cast C-276: CW-12MW per ASTM A494
- Cast Alloy 400: M-30C per ASTM A494

Wetted O-rings

Glass-filled PTFE or graphite-filled PTFE

Process isolating diaphragms

Isolating diaphragm material	3051CD, 3051CG	3051T	3051CA
316L SST (UNS S31603)	•	•	•
Alloy C-276 (UNS N10276)	•	•	•
Alloy 400 (UNS N04400)	•	N/A	•
Tantalum (UNS R05440)	•	N/A	N/A
Gold-plated alloy 400	•	N/A	•
Gold-plated 316L SST	•	•	•

Rosemount 3051L process wetted parts

Flanged process connection (transmitter high side)

Process diaphragms, including process gasket surface	316L SST, Alloy C-276, or Tantalum
Extension	CF-3M (Cast version of 316L SST, material per ASTM-A743), or Alloy C-276. Fits schedule 40 and 80 pipe.
Mounting flange	Zinc-cobalt plated CS or SST

Reference process connection (transmitter low side)

Isolating diaphragms	316L SST or Alloy C-276
Reference flange and adapter	CF-8M (cast version of 316 SST, material per ASTM-A743)

Non-wetted parts

Electronics housing

Low-copper aluminum or CF-8M (cast version of 316 SST)

Enclosure type 4X, IP65, IP66, IP68

Housing material code P: PBT/PC with NEMA 4X and IP66/67/68

Coplanar sensor housing module

SST: CF-3M (Cast 316L SST)

Bolts

- Plated CS per ASTM A449, Type 1
- Austenitic 316 SST per ASTM F593
- ASTM A193, Grade B7M alloy steel
- Alloy K-500

Sensor module fill fluid

- Coplanar: silicone or inert halocarbon
  In-line: silicone or inert halocarbon

Process fill fluid (Rosemount 3051L only)

Syltherm XLT, Silicone 704, Silicone 200, inert, glycerin and water, Neobee M-20, or propylene glycol and water

Paint

Polyurethane

Cover O-rings

- Buna-N
- Silicone (for wireless option code X)

Power module

Field replaceable, keyed connection eliminates the risk of incorrect installation, Intrinsically Safe lithium-thionyl chloride power module with PBT enclosure.

Shipping weights

Note
Transmitter weights include the sensor module and housing only (aluminum for Rosemount 3051 and polymer for wireless).

Table 7: Transmitter Weights without Options

Rosemount transmitter	Rosemount 3051 in lb. (kg)	Wireless in lb. (kg)
3051C	6.0 (2.7)	3.9 (1.8)
3051T	3.0 (1.4)	1.9 (0.86)
3051L	Table 8	Table 8

Table 8: Rosemount 3051L Weights without Options

Flange	Flush lb (kg)	2-in. ext. lb (kg)	4-in. ext. lb (kg)	6-in. ext. lb (kg)
2-in., Class 150	12.5 (5.7)	N/A	N/A	N/A
3-in., Class 150	17.5 (7.9)	19.5 (8.8)	20.5 (9.3)	21.5 (9.7)
4-in., Class 150	23.5 (10.7)	26.5 (12.0)	28.5 (12.9)	30.5 (13.8)
2-in., Class 300	17.5 (7.9)	N/A	N/A	N/A
3-in., Class 300	22.5 (10.2)	24.5 (11.1)	25.5 (11.6)	26.5 (12.0)
4-in., Class 300	32.5 (14.7)	35.5 (16.1)	37.5 (17.0)	39.5 (17.9)
2-in., Class 600	15.3 (6.9)	N/A	N/A	N/A

Table 8: Rosemount 3051L Weights without Options *(continued)*

Flange	Flush lb (kg)	2-in. ext. lb (kg)	4-in. ext. lb (kg)	6-in. ext. lb (kg)
3-in., Class 600	25.2 (11.4)	27.2 (12.3)	28.2 (12.8)	29.2 (13.2)
DN 50/ PN 40	13.8 (6.2)	N/A	N/A	N/A
DN 80/ PN 40	19.5 (8.8)	21.5 (9.7)	22.5 (10.2)	23.5 (10.6)
DN 100/ PN 10/16	17.8 (8.1)	19.8 (9.0)	20.8 (9.5)	21.8 (9.9)
DN 100/ PN 40	23.2 (10.5)	25.2 (11.5)	26.2 (11.9)	27.2 (12.3)

Table 9: Transmitter Option Weights

Code	Option	Additional lb. (kg)
J, K, L, M	SST housing (T)	3.9 (1.8)
J, K, L, M	SST housing (C, L, H, P)	3.1 (1.4)
M4/M5/M6	Display for wired transmitter	0.5 (0.2)
M5	LCD display for wireless output	0.1 (0.04)
B4, BE	SST mounting bracket for coplanar flange	1.0 (0.5)
B1, B2, B3	Mounting bracket for traditional flange	2.3 (1.0)
B7, B8, B9	Mounting bracket for traditional flange	2.3 (1.0)
BA, BC	SST bracket for traditional flange	2.3 (1.0)
H2	Traditional flange	2.4 (1.1)
H3	Traditional flange	2.7 (1.2)
H4	Traditional flange	2.6 (1.2)
H7	Traditional flange	2.5 (1.1)
FC	Level flange — 3 in., 150	10.8 (4.9)
FD	Level flange — 3 in., 300	14.3 (6.5)
FA	Level flange — 2 in., 150	10.7 (4.8)
FB	Level flange — 2 in., 300	14.0 (6.3)
FP	DIN level flange, SST, DN 50, PN 40	8.3 (3.8)
FQ	DIN level flange, SST, DN 80, PN 40	13.7 (6.2)
WSM	SST sensor module	1.0 (0.45)
N/A	Power module (701PGNKF)	0.4 (0.18)

Rosemount 3051 product certifications

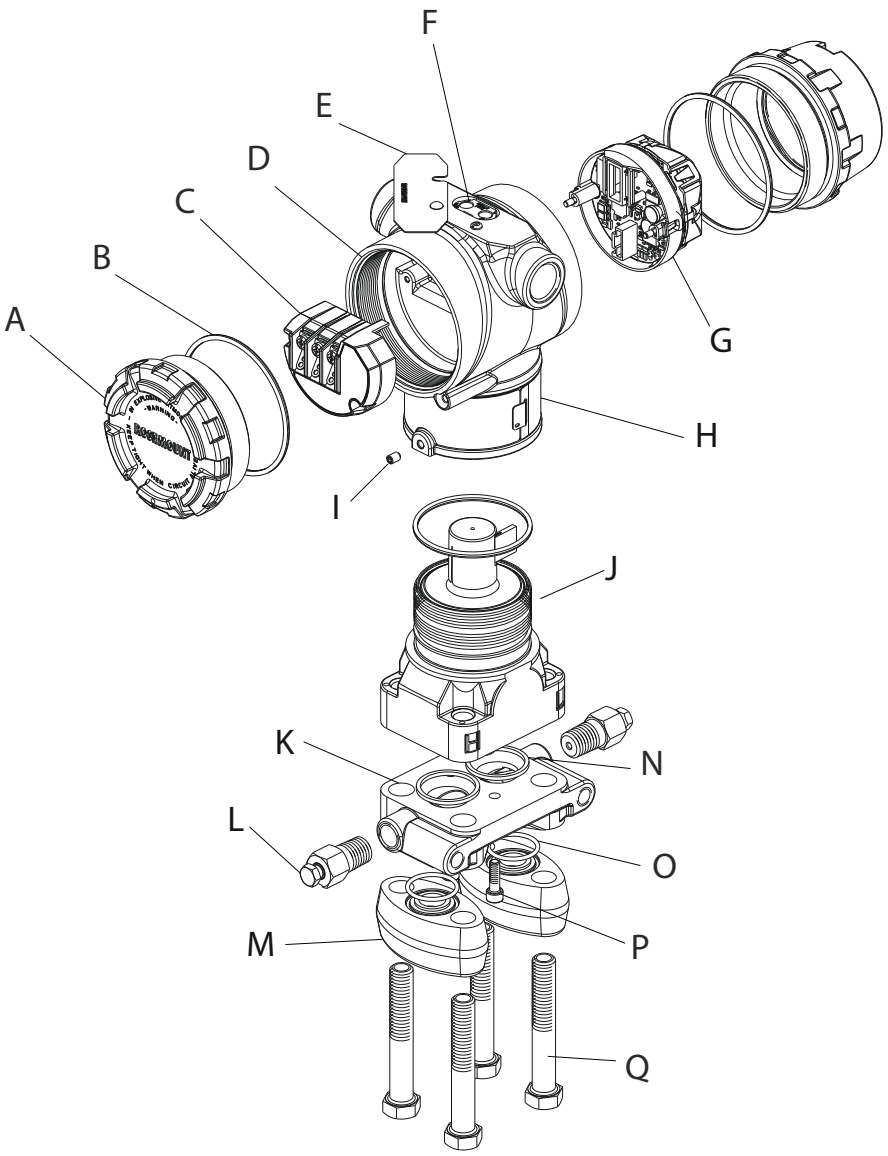
See the Rosemount 3051 Quick Start Guides for detailed information on the existing approvals and certifications.

Product approval information	Links
Rosemount 3051 Pressure Transmitter and 3051CF Series Flow Meter with 4-20 mA HART® Protocol	Link
Rosemount 3051 Pressure Transmitter and 3051CF Series Flow Meter with FOUNDATION™ Fieldbus Protocol	Link
Rosemount 3051 Pressure Transmitter and 3051CF Series Flow Meter with Profibus-PA Protocol	Link
Rosemount 3051 Pressure Transmitter and 3051CF Series Flow Meter with 1-5 VDC Low Power	Link
Rosemount 3051 Pressure Transmitter and Rosemount 3051CF Series Flow Meter with *Wireless*HART® Protocol	Link

Dimensional drawings

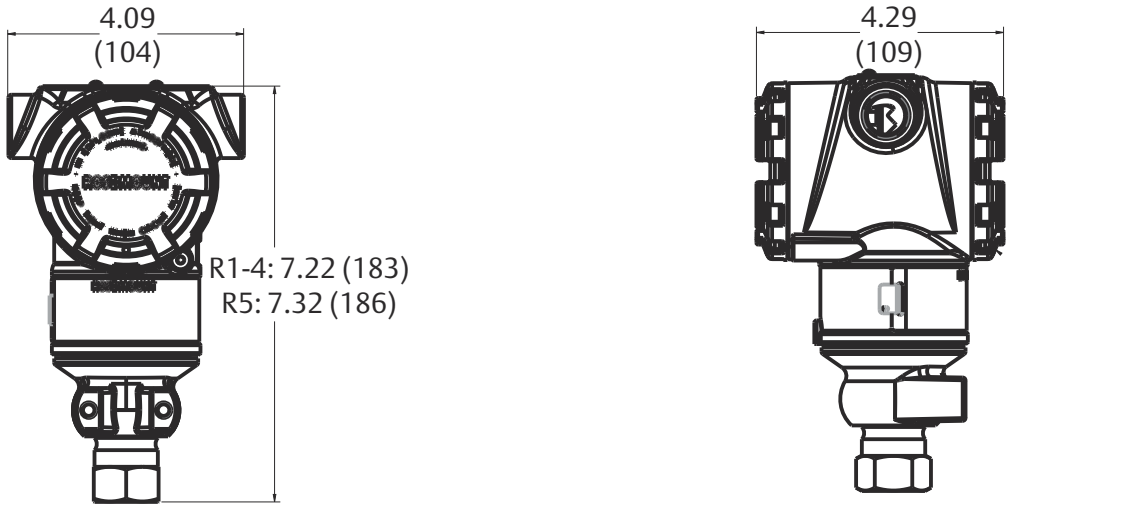
Note
This section contains dimensional drawings for output codes A, F and X. For output codes W and M, visit Emerson.com/en-us/support.

Figure 7: Rosemount 3051C Exploded View



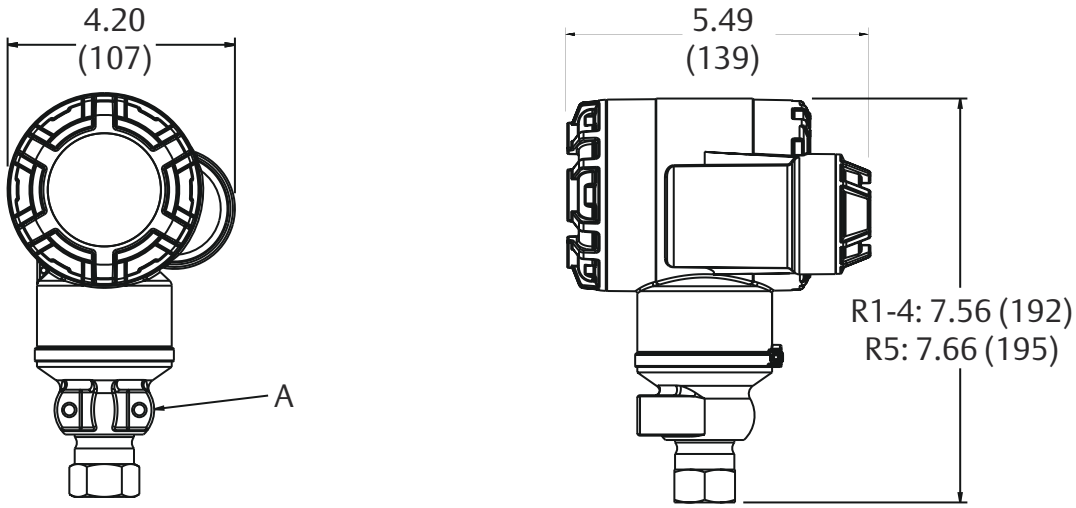
A. Cover
B. Cover O-ring
C. Terminal block
D. Electronics housing
E. Configuration buttons cover
F. Local configuration buttons
G. Electronics board
H. Name plate
I. Housing rotation set screw (180 degree maximum rotation without further disassembly)
J. Sensor module
K. Coplanar flange
L. Drain/vent valve
M. Flange adapters
N. Process O-ring
O. Flange adapter O-ring
P. Flange alignment screw (not pressure retaining)
Q. Flange bolts

Figure 15: Rosemount 3051T



Dimensions are in inches (millimeters).

Figure 16: Rosemount 3051T Wireless Housing

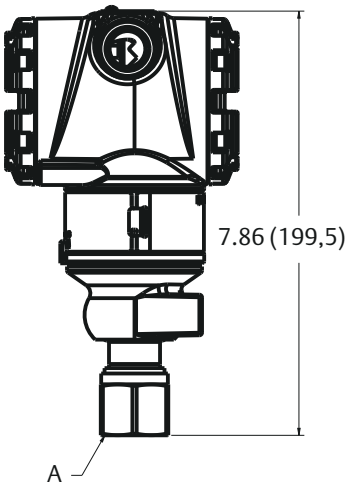


A. U-Bolt bracket

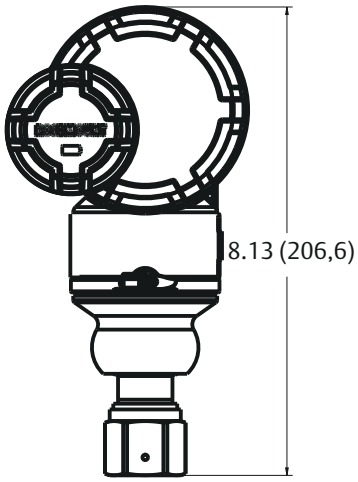
Dimensions are in inches (millimeters).

Figure 17: Rosemount 3051T In-Line Range 6

In-line



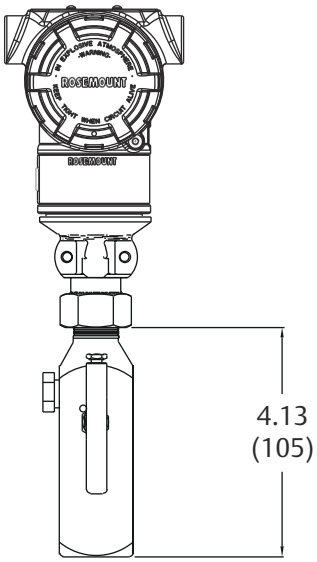
Wireless in-line

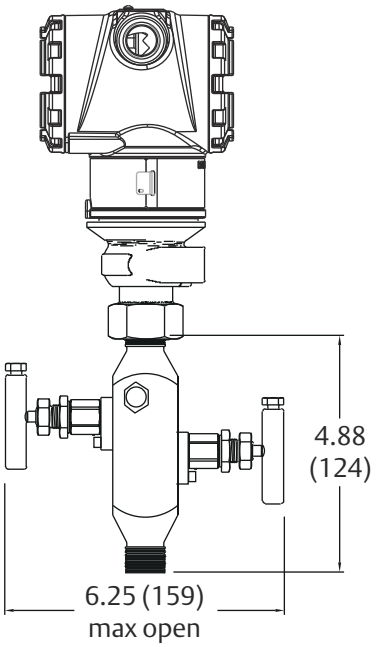


A. Autoclave type F-250-C

Dimensions are in inches (millimeters).

Figure 18: Rosemount 3051T with Rosemount 306 2-Valve Integral Manifold



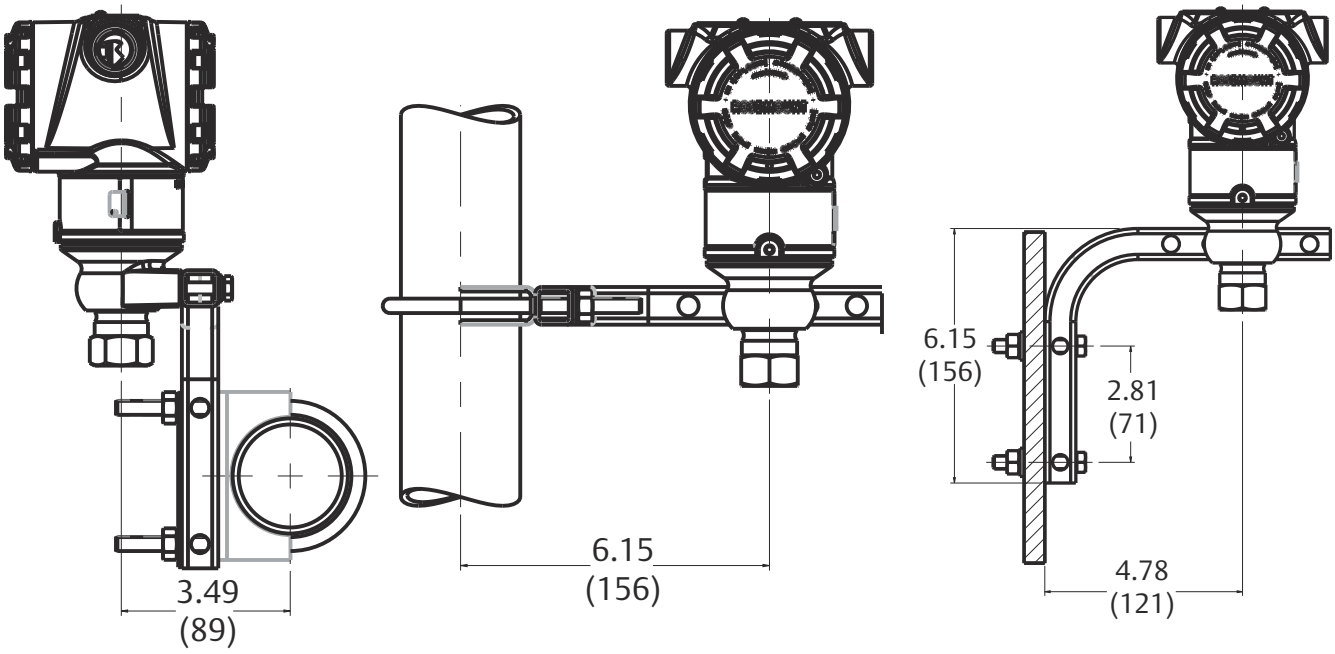


Dimensions are in inches (millimeters).

Figure 19: Rosemount 3051T Typical Mounting Configurations with Optional Mounting Bracket

Pipe mounting

Panel mounting



Dimensions are in inches (millimeters).

Options

Standard configuration

Unless otherwise specified, transmitter is shipped as follows:

Engineering units	Setting
Differential/Gage	inH_2O at 68 °F (Range 0, 1, 2, and 3)
Absolute/Rosemount 3051TA/3051TG	psi (all ranges)
4 mA(1)	0 (engineering units above)
20 mA(1)	Upper range limit
Output - Transfer function	Linear
External buttons	None
Flange type	Specified model code option
Flange material	Specified model code option
O-ring material	Specified model code option
Drain/vent	Specified model code option
Display	None
Alarm(1)	High
Software tag	(Blank)
Damping	0.4 seconds (2)

(1) *Not applicable to FOUNDATION Fieldbus, PROFIBUS PA, or wireless.*
(2) *For Fieldbus Protocols, default damping is one second.*

Display default settings

Unless otherwise specified, transmitter is shipped as follows when a display is ordered:

Table 12: Graphical LCD Display (Code M6)

Language	English
Backlight	On
Decimal digit precision	Automatic
GP/AP unit label	Disable
Decimal separator	Period
Bluetooth®(1)	Enable
Display parameters	Pressure

(1) *Bluetooth Configuration and Maintenance (Code BLE) only.*

Custom configuration

Note
Not applicable to WirelessHART®, Low-power,FOUNDATION Fieldbus or PROFIBUS PA Protocols.

If option code C1 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Transmitter information
- Output information
- Display parameters
- Graphical LCD display settings
- Process variable output assignments
- Security information
- Custom alarm and saturation signal levels
- Process Alerts
- Application Specific Configuration

Refer to the Rosemount 3051 Configuration Data Sheet for Rosemount 3051 HART® Protocol.

For Wireless, refer to the Rosemount 3051 Wireless Configuration Data Sheet.

Tagging (three options available)

- Standard SST hardware tag is stamped on the transmitter, 56 characters maximum.
- Tag may be wired to the transmitter upon request. Tag character height is 0.125 in. (3.18 mm), 56 characters maximum.
- Tag may be stored in transmitter memory, 32 characters maximum.

Commissioning tag

Note
Only applicable to FOUNDATION Fieldbus.

A temporary commissioning tag is attached to all transmitters. The tag indicates the device ID and allows an area for writing the location.

Optional Rosemount 304, 305, or 306 Integral Manifolds

Factory assembled to Rosemount 3051C and 3051T transmitters. Refer to the following Product Data Sheet for Rosemount 304, 305, and 306 for additional information.

Other seals

Refer to Rosemount DP Level Transmitters and Diaphragm Seal System Product Data Sheet for additional information.

Output information

Output range points must be the same unit of measure. Available units of measure include:

Pressure			
inH_2O (68 °F)	mbar	inH_2O (60 °F)(1)	ftH_2O (4 °C)(1)
inHg (0 °C)	g/cm^2	cmH_2O (4 °C)(1)	ftH_2O (60 °F)(1)
ftH_2O (68 °F)	kg/cm^2	mH_2O (4 °C)(1)	mHg (0 °C)(1)
mmH_2O (68 °F)	Pa	cmHg (0 °C)(1)	MPa(1)
mmHg (0 °C)	kPa	lb/ft^2	inH_2O (4 °C)(1)
psi	Torr	hPa(1)	mmH_2O (4 °C)(1)
bar	atm	$kg/m^{2(1)}$	psf (1)(2)

Flow			
User-defined			
Totalizer – Flow Units of Time			
Seconds	Minutes	Hours	Days
Level			
Feet (ft)	Meters (m)	Inches (in)	Centimeters (cm)
Millimeters (mm)			
Volume			
Gallons	Liters	Imperial Gallons	Cubic Meters
Barrels	Cubic Yards	Cubic Feet	Cubic Inches

(1) *Not available with Low Power (output code M) or PROFIBUS PA (output option code W).*
(2) *Not available with 4-20 mA HART (output code A).*

Display and interface options

M4 Digital display with LOI

- Available for 4–20 mA HART, Low Power, and PROFIBUS PA

M5 Digital display

- Two-line, five-digit LCD display for low power output
- Two-line, eight-digit LCD display for 4–20 mA HART, FOUNDATION Fieldbus, and PROFIBUS PA
- Three-line, seven-digit LCD display for Wireless
- Direct reading of digital data for higher accuracy
- Displays user-defined flow, level, volume, or pressure units
- Displays diagnostic messages for local troubleshooting
- 90-degree rotation capability for easy viewing

M6 Graphical LCD display

- Available for 4–20 mA HART
- Three-line, fourteen character graphical LCD display
- Backlit
- Available in English, Chinese, French, German, Italian, Portuguese, Russian, and Spanish
- Bluetooth®, square root, and NAMUR compliant maintenance icons
- 90-degree physical rotation and 180-degree software rotation capability for easy viewing
- User adjustable decimal precision and decimal separator
- Gage or absolute unit labels

Configuration buttons

Rosemount 3051 will ship with no buttons unless option D1 (quick service buttons), D4 (analog zero and span), DZ (digital zero), or M4 (LOI) for local configuration buttons are specified.

The Rosemount 3051 Wireless Transmitter is available with a Digital zero button installed with or without the LCD digital display.

Transient protection (option code T1)

Tested in accordance with IEEE C62.41.2-2002, location category B

- 6 kV crest (0.5 µs–100 kHz)
- 3 kA crest (8 x 20 µs)
- 6 kV crest (1.2 x 50 µs)

External ground screw assembly

The external ground screw assembly can be ordered by specifying option code V5. The transient protection terminal block (option code T1) and some product certifications include the ground screw assembly in the transmitter, hence it is not necessary to order the V5 code when ordering these options. Table 13 identifies which product certification options include the external ground screw assembly and which do not.

Table 13: External ground screw assembly

Option code	External ground screw assembly included?
C6, E5, E6, I2, I3, I4, I5, I6, I7, IM, IP, K5, K6, KB, KL	No. Order option V5 or T1.
E2, E3, E4, E7, E8, EM, EP, I1, IA, IB, IE, IG, IN, K2, K6, K7, K8, KC, KD, KM, KP, KS, N1, N3, N7, ND, NK	Yes

Bolts for flanges and adapters

- Options permit bolts for flanges and adapters to be obtained in various materials
- Standard material is plated CS per ASTM A449, Type 1
- L4 austenitic 316 SST bolts
- L5 ASTM A 193, Grade B7M bolts
- L6 alloy k-500 bolts

Conduit plug

DO option replaces the standard CS plug with 316 SST plug.

Rosemount 3051C Coplanar Flange and 3051T bracket option

B4 Bracket for 2-inch pipe or panel mounting

- For use with the standard coplanar flange configuration
- Bracket for mounting of transmitter on 2-inch pipe or panel
- SST construction with SST bolts

Rosemount 3051C Traditional Flange bracket options

B1 Bracket for 2-inch pipe mounting

- For use with the traditional flange option
- Bracket for mounting on 2-in. pipe
- CS construction with CS bolts
- Coated with polyurethane paint

B2 Bracket for panel mounting

- For use with the traditional flange option
- Bracket for mounting transmitter on wall or panel
- CS construction with CS bolts
- Coated with polyurethane paint

B3 Flat Bracket for 2-in. pipe mounting

- For use with the traditional flange option

- Bracket for vertical mounting of transmitter on 2-in. pipe
- CS construction with CS bolts
- Coated with polyurethane paint

B7 B1 Bracket with SST bolts

- Same bracket as the B1 option with Series 300 SST bolts

B8 B2 Bracket with SST bolts

- Same bracket as the B2 option with Series 300 SST bolts

B9 B3 Bracket with SST bolts

- Same bracket as the B3 option with Series 300 SST bolts

BA SST B1 bracket with SST bolts

- B1 bracket in SST with Series 300 SST bolts

BC SST B3 Bracket with SST bolts

- B3 bracket in SST with Series 300 SST bolts

BE 316SST B4 Bracket with 316SST bolts

- B4 bracket in 316SST with 316SST bolts

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Rosemount™ 3051 Pressure Transmitter and 3051CF Series Flow Meter

with 4-20 mA HART®

ROSEMOUNT™

EMERSON

Safety messages

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

Before connecting a communication device in an explosive atmosphere, ensure that the instruments are installed in accordance with intrinsically safe or non-incendive field wiring practices.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

⚠ WARNING

Process leaks

Process leaks may cause harm or result in death.

To avoid process leaks, only use the O-ring designed to seal with the corresponding flange adapter.

⚠ WARNING

Electrical shock

Electrical shock can result in death or serious injury.

Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental in protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

⚠ WARNING

Refer to the *Product certifications* section of this Quick Start Guide documentation when using the RFID tag (option code Y3) for required installation conditions.

NOTICE

Unless otherwise marked, the conduit/cable entries in the housing enclosure use a ½–14 NPT form. Only use plugs, adapters, glands, or conduit with a compatible thread form when closing these entries.

Entries marked M20 are M20 × 1.5 thread form. On devices with multiple conduit entries, all entries will have the same thread form.

When installing in a hazardous location, use only appropriately listed or Ex-certified plugs, glands, or adapters in cable/conduit entries.

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1 About this guide

This guide provides basic installation guidelines for Rosemount 3051 Transmitters.

Refer to Rosemount 3051 Pressure Transmitter Manual for instructions about:

- configuration
- diagnostics
- maintenance
- service
- troubleshooting
- explosion-proof
- flameproof
- intrinsically safe installations

This guide and the referenced manual are also available on Emerson.com/global.

2 Mounting the transmitter

⚠ WARNING

Process connection temperatures above 185 °F (85 °C) require a limited ambient temperature, reduced by a 1:1.5 ratio.

Consider process connection and ambient temperatures when installing the transmitter with hazardous location certifications. See Table 2-1.

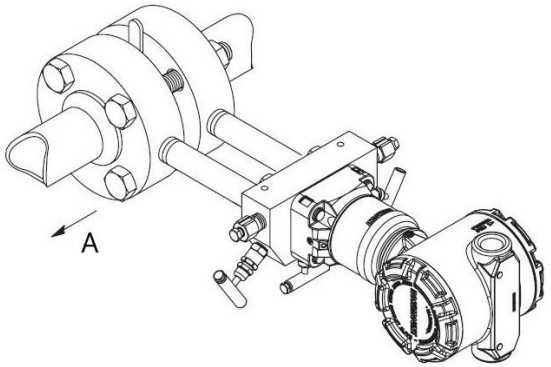
Table 2-1: Intrinsically Safe/Increased Safety

Process connection temperature	Maximum ambient temperature
-76 °F to +185 °F (-60 °C to +85 °C)	158 °F (70 °C)
185 °F to 250 °F (85 °C to 121 °C)	158 °F to 60 °F (70 °C to 16 °C)(1)

(1) Maximum ambient temperature is reduced by 1.5 degree for 1 degree temperature rise in the process connection temperature beyond 185 °F (85 °C).

2.1 Mount the transmitter in a liquid flow application

Figure 2-1: Mounting the transmitter



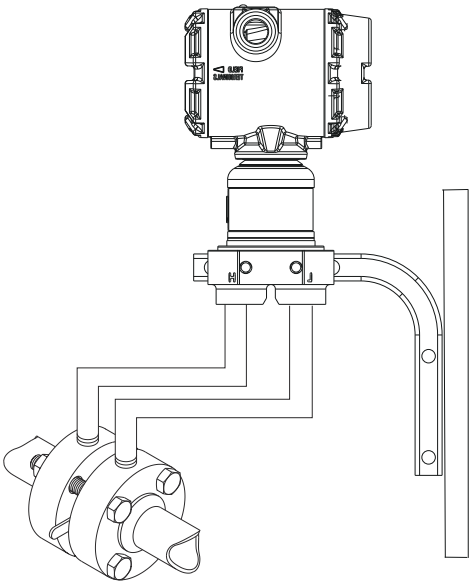
A. Flow

Procedure

1. Place taps to the side of the line.
2. Mount the transmitter beside or below the taps.

3. Mount the transmitter so that the drain/vent valves are oriented upward.

2.2 Mount the transmitter in a gas flow application



NOTICE

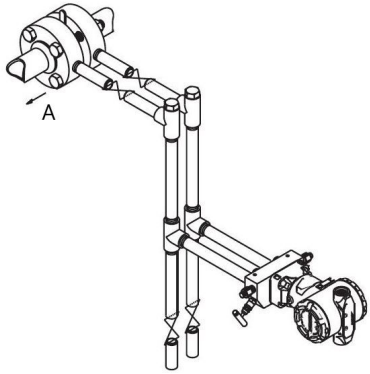
A bracket is required to support the transmitter and the ¼-inch tubing going into the transmitter.

Procedure

1. Place taps in the top or side of the line.
2. Mount the transmitter beside or above the taps.

2.3 Steam flow applications

Figure 2-2: Steam Flow Application



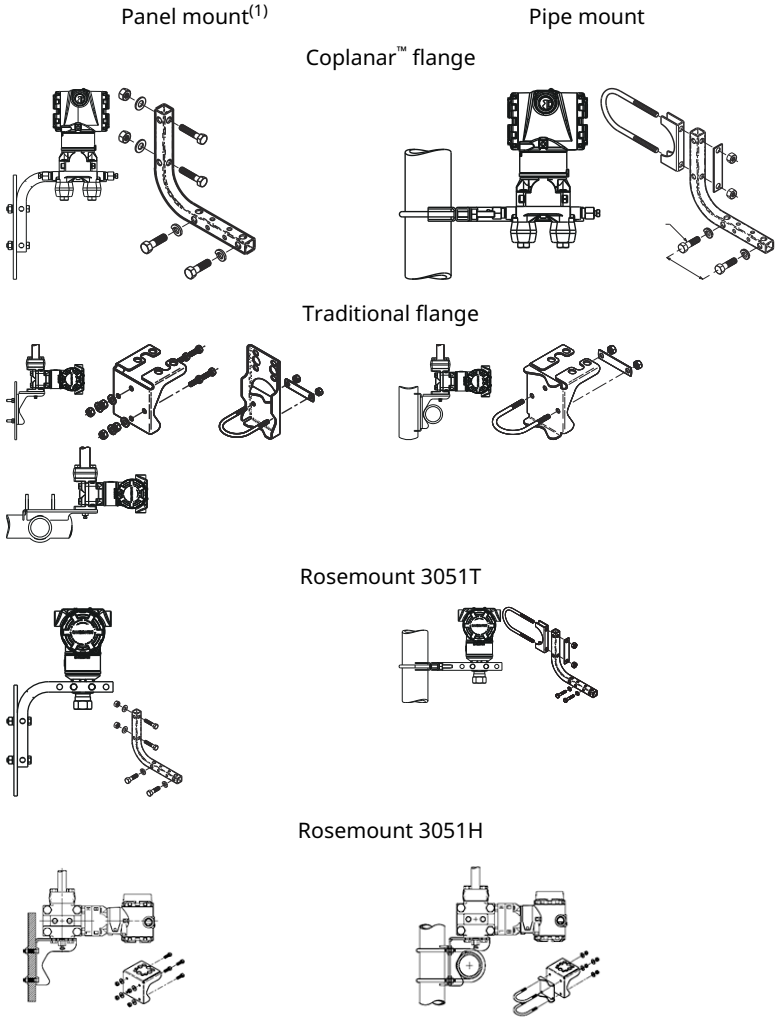
A. Flow

Procedure

1. Place taps to the side of the line.
2. Mount beside or below the taps.
3. Fill impulse lines with water.

2.4 Panel and pipe mount

Figure 2-3: Panel and Pipe Mounting



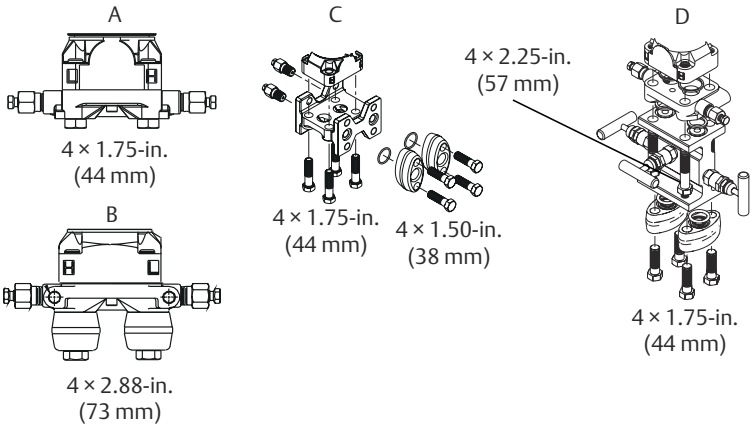
(1) 5/16 x 1½ panel bolts are customer-supplied.

2.5 Bolting considerations

If the transmitter installation requires assembly of the process flanges, manifolds, or flange adapters, use the following assembly guidelines to ensure a tight seal for optimal performance characteristics of the transmitters.

Use only bolts supplied with the transmitter or sold by Emerson as spare parts. Figure 2-4 illustrates common transmitter assemblies with the bolt length required for proper transmitter assembly.

Figure 2-4: Common Transmitter Assemblies



A. Transmitter with Coplanar™ flange
B. Transmitter with Coplanar flange and optional flange adapters
C. Transmitter with traditional flange and optional flange adapters
D. Transmitter with Coplanar flange and optional manifold and flange adapters

Bolts are typically carbon steel or stainless steel. Confirm the material by viewing the markings on the head of the bolt and referencing Table 2-2. If bolt material is not shown in Table 2-2, contact your local Emerson representative for more information.

2.5.1 Install bolts

NOTICE

Carbon steel bolts do not require lubrication, and the stainless steel bolts are coated with a lubricant to ease installation. Do not apply any additional lubricant when installing either type of bolt.

Procedure

1. Finger-tighten the bolts.
2. Torque the bolts to the initial torque value using a crossing pattern.

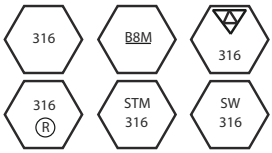
   Note
   See Table 2-2 for torque values.

3. Torque the bolts to the final torque value using the same crossing pattern.

   Note
   See Table 2-2 for torque values.

4. Verify the flange bolts are protruding through the isolator plate before applying pressure.

Table 2-2: Torque Values for the Flange and Flange Adapter Bolts

Bolt material	Head markings	Initial torque	Final torque
Carbon Steel (CS)		300 in-lb.	650 in-lb.
Stainless Steel (SST)		150 in-lb.	300 in-lb.

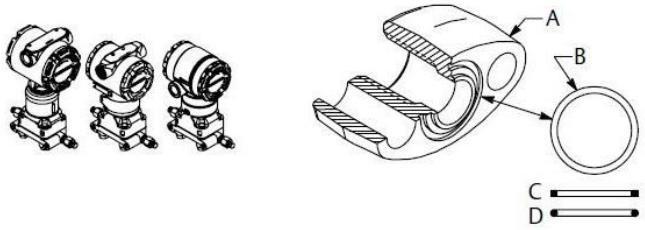
2.6 O-rings with flange adapters

⚠ WARNING

Failure to install proper flange adapter O-rings may cause process leaks, which can result in death or serious injury.

The two flange adapters are distinguished by unique O-ring grooves. Only use the O-ring that is designed for its specific flange adapter, as shown in Figure 2-5.

Figure 2-5: O-ring Location: Rosemount 3051S/3051/2051



A. Flange adapter
B. O-ring
C. PTFE-based profile (square)
D. Elastomer profile (round)

Note
Whenever the flanges or adapters are removed, visually inspect the O-rings. Replace them if there are any signs of damage, such as nicks or cuts. If you replace the O-rings, re-torque the flange bolts and alignment screws after installation to compensate for seating of the PTFE O-ring.

2.7 Environmental seal for housing

For NEMA® 4X, IP66, and IP68 requirements, use thread-sealing PTFE tape or paste on male threads of conduit to provide a water and dust tight seal. Consult factory if other ingress protection ratings are required.

For M20 threads, install conduit plugs to full thread engagement or until mechanical resistance is met.

2.8 In-line gauge transmitter orientation

The low side pressure port (atmospheric reference) on the in-line gauge transmitter is located in the neck of the transmitter, behind the housing.

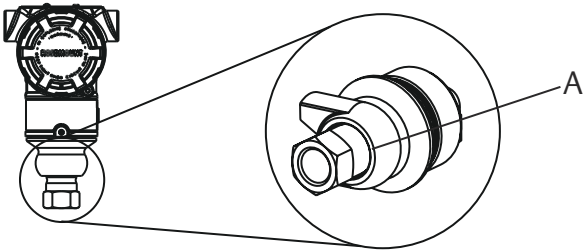
The vent path is 360° around the transmitter between the housing and sensor. (See Figure 2-6.)

To allow fluids to drain away, keep the vent path free of any obstruction, including but not limited to:

- paint
- dust

- lubrication

Figure 2-6: In-line Gauge Low Side Pressure Port



A. Pressure port location

3 Rotate housing

To improve field access to wiring or to better view the optional display:

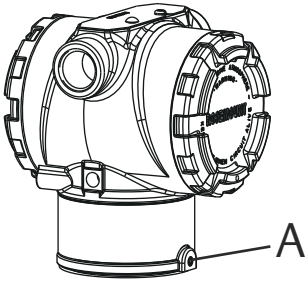
Procedure

1. Loosen the housing rotation set screw using a 5/64-in. hex wrench.
2. Turn the housing left or right up to a maximum of 180° from its original position.(1)
3. Re-tighten the housing rotation set screw to a maximum of 7 in-lb. when desired location is reached.

NOTICE

Over-rotating will damage the transmitter.

Figure 3-1: Housing Rotation



A. Housing rotation set screw (5/64 in.)

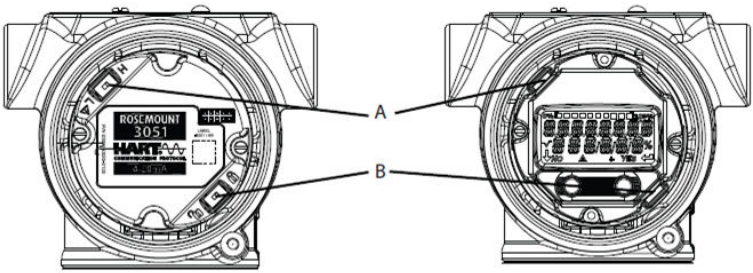
(1) Rosemount 3051C original position aligns with H side; Rosemount 3051T original position is the opposite side of the bracket holes.

4 Set the switches

Set **Alarm** and **Security** switch configuration before installation, as shown in Figure 4-1.

Figure 4-1: Electronics Board

Without LCD display With LCD display



*A. **Alarm** switch*
*B. **Security** switch*

- The **Alarm** switch sets the analog output alarm to **high** or **low**.
- Default **Alarm** is **high**.
- The **Security** switch allows ( ) or prevents ( ) any configuration of the transmitter.
- Default **Security** is **off** ( ).

To change the switch configuration:

Procedure

1. If the transmitter is installed, secure the loop, and remove power.
2. Remove the housing cover opposite the field terminal side.

⚠ WARNING

Do not remove the instrument cover in explosive atmospheres when the circuit is live.

3. Slide the **Security** and **Alarm** switches into the preferred position using a small screwdriver.

4. Reattach the transmitter cover.

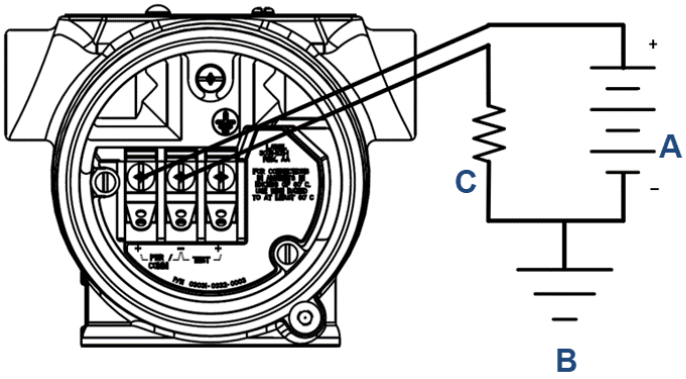
⚠ WARNING

The cover must be fully engaged to comply with explosion-proof requirements.

5 Connect the wiring and power up

Figure 5-1 shows wiring connections necessary to power a Rosemount 3051 Transmitter and enable communications with a communication device.

Figure 5-1: Transmitter Wiring Diagrams



A. Power supply
B. Ground
C. Resistor

Table 5-1: Power Supply and Resistance Needs by Communicator Type

Communicator	Power supply	Resistor
AMS Device Manager	≥ 16.6 Vdc	≥ 250 Ω
AMS Trex (HART®)	≥ 16.6 Vdc	≥ 250 Ω
AMS Trex (HART + pwr)	None	None
AMS Device Configurator Bluetooth® App	≥ 10.5 Vdc	None
Quick Service buttons	≥ 10.5 Vdc	None
Local operator interface (LOI)	≥ 10.5 Vdc	None

Resistance and power requirements vary based on the interface type used to communicate with the device. See Table 5-1 for specific loop power and resistance needs.

To wire the transmitter:

Procedure

1. Remove the housing cover on the field terminals side.
2. Connect the positive lead to the "+" terminal (PWR/COMM) and the negative lead to the "–" terminal.
3. Ensure full contact with terminal block screw and washer. When using a direct wiring method, wrap wire clockwise to ensure it is in place when tightening the terminal block screw.

NOTICE

Emerson does not recommend using a pin or a ferrule wire, as the connection may be more susceptible to loosening over time or under vibration.

4. Ensure proper grounding.

NOTICE

It is important that the instrument cable shield:

Be trimmed close and insulated from touching the transmitter housing.

Be connected to the next shield if cable is routed through a junction box.

Be connected to a good earth ground at the power supply end.

Do not connect the powered signal wiring to the test terminals. Power could damage the test diode in the test connection. Use shielded twisted pair cable for best results. Use 24 AWG or larger wire and do not exceed 5,000 ft. (1500 m).

5. Plug and seal unused conduit connections.
6. If applicable, install wiring with a drip loop. Arrange the drip loop so the bottom is lower than the conduit connections and the transmitter housing.
7. Replace the housing cover.

NOTICE

Installation of the transient protection terminal block does not provide transient protection unless the transmitter enclosure is properly grounded.

5.1 Run ground signal wiring

⚠ WARNING

Do not run signal wiring in conduit or open trays with power wiring or near heavy electrical equipment.

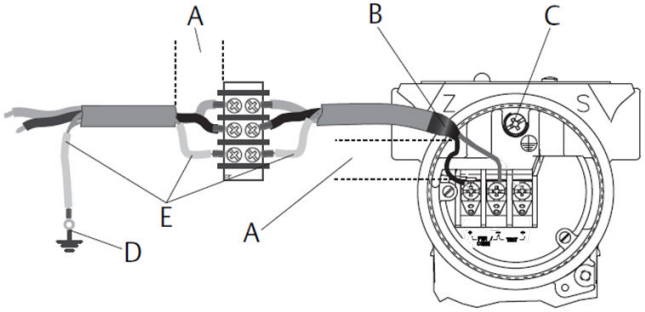
Grounding terminations are provided on the outside of the electronics housing and inside the terminal compartment. Use these terminations when transient protect terminal blocks are installed or to fulfill local regulations. See Step 2 for more information on how the cable shield should be grounded.

Procedure

1. Remove the field terminals housing cover.

2. Connect the wiring pair and ground as indicated in Figure 5-2.
   Ensure the wiring is:
   - Trimmed close and insulated from touching the transmitter housing.
   - Continuously connected to the termination point.
   - Connected to a good earth ground at the power supply end.

Figure 5-2: Wiring



A. Minimize distance
B. Trim shield and insulate
C. Ground for transient protection
D. Shield connected to power supply ground
E. Insulate shield

3. Replace the housing cover.

NOTICE

Emerson recommends tightening the cover until there is no gap between the cover and the housing.

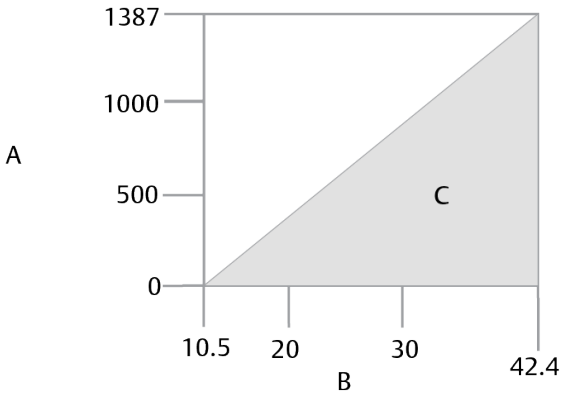
4. Plug and seal unused conduit connections.

5.2 Power supply for a 4-20 mA HART® communication device

The transmitter operates on 10.5 to 42.4 Vdc at the terminal. The DC power supply must provide power with less than two percent ripple. Loops with a 250 Ω resistance require a minimum of 16.6 V.

Note
The transmitter must have a minimum of 250 Ω to communicate with a communication device. If you are using a single power supply to power more than one transmitter, ensure the power supply used and the circuitry common to the transmitters do not have more than 20 Ω of impedance at 1200 Hz.

Figure 5-3: Load Limitation



Maximum loop resistance = 43.5 x (power supply voltage - 10.5)

A. Load (Ω)
B. Voltage (Vdc)
C. Operating region

The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, intrinsically safe (IS) barriers, and related pieces. If you use IS barriers, then include the resistance and voltage drop.

6 Verify configuration parameters

Emerson recommends verifying various configuration parameters prior to installing the transmitter into the process:

- **Alarm** and **saturation** levels
- **Damping**
- **Process variables**
- **Range values**
- **Tag**
- **Transfer function**
- **Units**

See Figure 6-1 for a full menu tree.

NOTICE

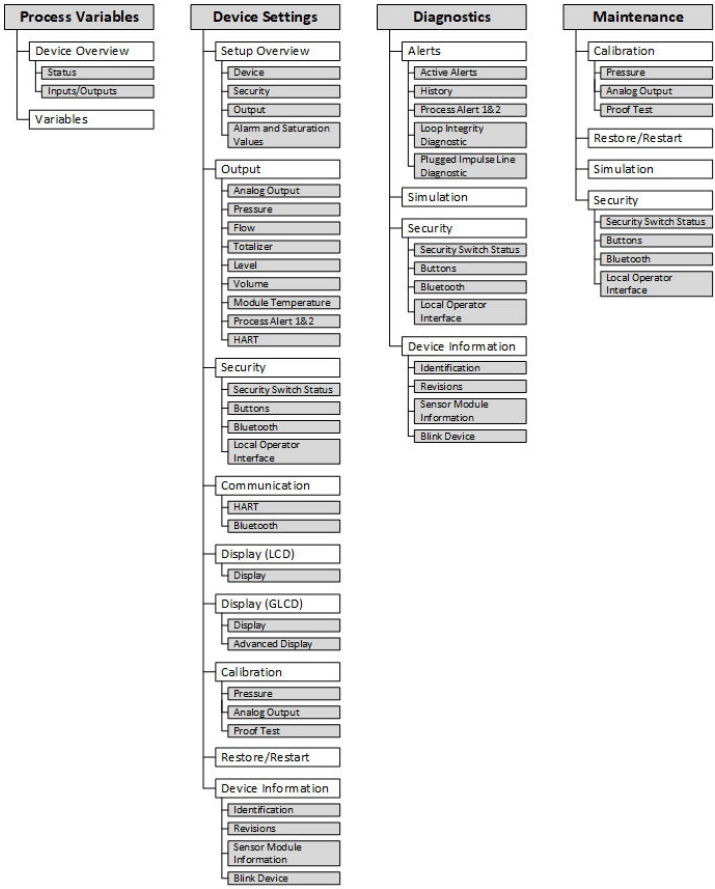
Emerson recommends installing the latest device driver (DD) to ensure full functionality. Download the latest DD at Software & Drivers.

Procedure

1. Set alarm and saturation values: **Device Settings** → **Setup Overview** → **Alarm and Saturation Values**.
2. Set damping: **Device Settings** → **Setup Overview** → **Output**.
3. Set process variables:
   - Primary variable: **Device Settings** → **Setup Overview** → **Output**
   - Secondary/tertiary/quaternary variables: **Device Settings** → **Communication** → **HART** → **Variable Mapping**
4. Set range values: **Device Settings** → **Setup Overview** → **Output**.
5. Set tag: **Device Settings** → **Setup Overview** → **Device**.
6. Set transfer function: **Device Settings** → **Setup Overview** → **Output**.
7. Set units:
   - Pressure units: **Device Settings** → **Setup Overview** → **Output**

- Other units: **Device Settings → Output → Pressure/Flow/ Totalizer/Level/Volume/Module Temperature → Setup**

Figure 6-1: DD Menu Tree



6.1 Wireless configuration via Bluetooth® technology

6.1.1 Download AMS Device Configurator

Procedure

Download and install the AMS Device Configurator app from your preferred app store.

Note
If this is your first time opening AMS Device Configurator, then you may be asked to allow the application to access media on your device and to access your device's location. If prompted, select **Allow**.

Figure 6-2: Emerson Application Icon

Related information

Bluetooth® Connectivity for Field Instrumentation

6.1.2 Configure via Bluetooth® wireless technology

Bluetooth wireless technology enables faster commissioning and improved ease of use.

Procedure

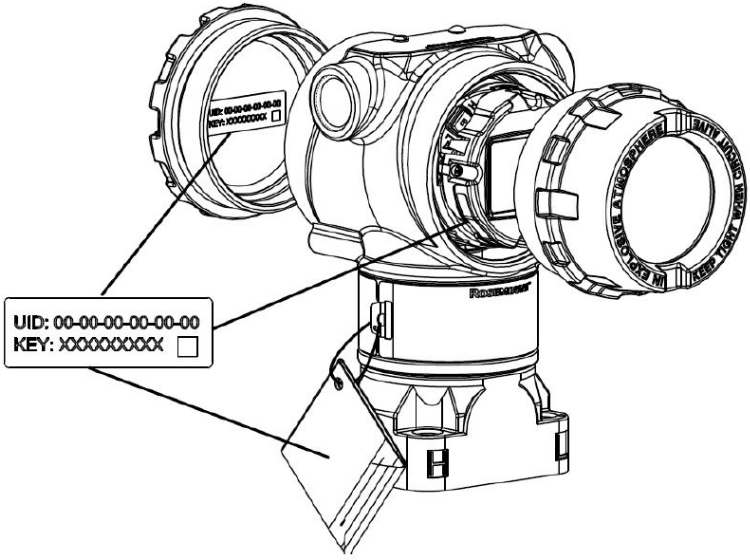
1. Launch AMS Device Configurator.
   See AMS Device Configurator for Emerson Field Devices.
2. Select the device you want to connect to.
3. On first connection, enter the key for this device.
4. At the top left, click the menu icon to navigate the desired device menu.
5. Verify and configure according to the parameters using the procedure shown in Verify configuration

Bluetooth® UID and key

You can find the Unique Identifier (UID) and key on the disposable paper tag attached to:

- device
- terminal block cover
- display unit

Figure 6-3: Bluetooth Security Information



7 Trimming the transmitter

Note
Emerson ships transmitters fully calibrated per request or by the factory default of full scale (span = upper range limit).

7.1 Zero trim

A zero trim is a single-point adjustment used for compensating mounting position effects.

When performing a zero trim, ensure the equalizing valve is open and all wet legs are filled to the correct level.

There are two methods to compensate for mounting effects:

- Zero trim
- Using the transmitter zero adjustment buttons

The zero trim will affect the 4–20 mA value, the HART® Primary Variable (PV), and the display value.

7.1.1 Zero trim using communication device

Procedure

1. Equalize or vent the transmitter and connect communication device.
2. Navigate to **Maintenance** → **Calibration** → **Pressure** → **Calibration** → **Zero Sensor Trim**.
3. Follow the commands to perform a zero trim.

7.1.2 Zero trim using Quick Service buttons

Procedure

1. Locate the external buttons under the top nameplate as shown in Figure 7-1.
2. Press either button to activate the menu.
3. Follow the on-screen prompt by pressing the other button.
4. Once on the ***Quick Service Button*** main menu, use the **Scroll** and **Enter** buttons to navigate to the ***Zero*** menu.

7.1.3 Zero trim using the transmitter zero adjustment buttons

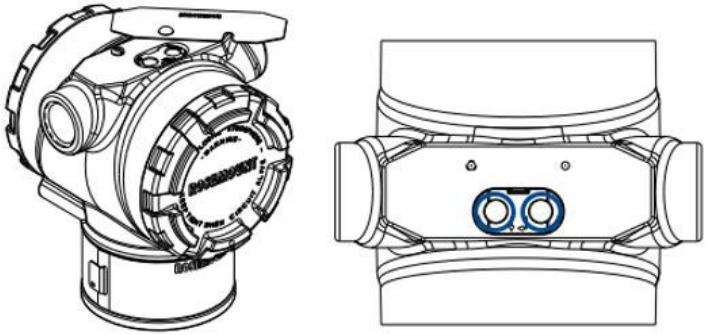
You can use the transmitter zero adjustment buttons to set the Lower Range Value (LRV) to the pressure applied to the transmitter.

This adjustment will affect the 4–20 mA value only.

Procedure

1. Loosen the certifications label screw and slide the label to expose the zero adjustment buttons.
2. Set the 4 mA point by pressing the **Zero** button for two seconds. Verify the output is `4 mA`.
   The optional LCD display will show `ZERO PASS`.

Figure 7-1: Zero Adjustment or Quick Service Buttons



8 Safety Instrumented Systems (SIS)

For safety certified installations, refer to the Rosemount 3051 Pressure Transmitter Manual for installation procedure and system requirements.

9 Product certifications

9.1 European directive information

A copy of the EU Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EU Declaration of Conformity can be found at Emerson.com/global.

9.2 Federal Communication Commission (FCC) notice

This device complies with Part 15 of the Federal Communication Commission Rules.

Operation is subject to the following conditions: This device may not cause harmful interference; this device must accept any interference received, including interference that may cause undesired operation. This device must be installed to ensure a minimum antenna separation distance of 7.9 in. (20 cm) from all persons. Changes or modification to the equipment not expressly approved by Emerson could void the user's authority to operate the equipment.

9.3 Innovation, Science, and Economic Development (ISED) notice

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science, and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions: This device may not cause interference. This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conformé à la norme RSS-247 Industrie Canada exempt de licence. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences pouvant causer un mauvais fonctionnement du dispositif.

9.4 NCC notice

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使 用者均不 得擅自變更頻率、加大功率或變更原設計之特性及功能。低功率射 頻器 材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應 立即停用，並改善至無干擾時方得繼續使用。前述合法通信，指依電信 管理 法規定作業之無線電通信。低功率射頻器材須忍受合法通信或工 業、科學及 醫療用電波輻

9.5 Ordinary location certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a Nationally Recognized Test Laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

9.5.1 Functional specifications

Pollution degree	4
Altitude	16,404.2 ft. (5000 m) maximum
Humidity	All models: 0 to 100 percent relative humidity
Supply voltage (VMAX)	4-20 mA (HART®): 42.4 Vdc FOUNDATION™ Fieldbus, PROFIBUS™ PA: 32 Vdc Low power (HART): 28 Vdc

9.6 North America

9.6.1 E5 USA Explosion-proof (XP) and Dust-Ignitionproof (DIP)

Certificate	FM16US0121 Range 1-5 (HART® only)
Standards	FM 3600: 2018, FM 3615: 2018, FM 3616: 2011, FM 3810: 2005, ANSI/NEMA® 250: 2008
Markings	XP: CL I, DIV 1, GP B, C, D, T5; DIP: CL II, DIV 1, GP E, F, G; CL III; T5 (-50 °C ≤ T_a ≤ +85 °C) Type 4X
Certificate	1053834 Ranges 1-6
Standards	FM 3600: 2022, FM 3610: 2021, FM 3615: 2022, FM 3616: 2022, ANSI/UL 61010-1-2019 Third Edition, ANSI-ISA-12.27.01–2022, ANSI/UL 50E (First Edition)
Markings	XP: CL I, DIV 1, GP B, C, D T5; Seal not required DIP: CL II, DIV 1, GP E, F, G; CL III T5; (-50 °C ≤ T_a≤ +[85 °C) Type 4X, IP 68

Optional: single seal

Specific Conditions for Use:

1. The Rosemount 3051 transmitter housing may contain aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact and friction.
2. Equipment evaluated for atmospheric pressure range between 80 kPa (0.8 bar) to 110 kPa (1.1 bar).
3. Process temperature limits shall be in accordance with 03031-1053.
4. Flameproof joints are not intended for repair.

9.6.2 I5 USA Intrinsic Safety (IS) and Nonincendive (NI)

Certificate FM16US0120X

Ranges 1-5 (HART® only)

Standards FM 3600: 2011, FM 3610: 2010, FM 3611: 2004, FM 3810: 2005, ANSI/NEMA 250: 2008

Markings IS: CL I, DIV 1, GP A, B, C, D T4

CL II, DIV 1, GP E, F, G; CL III

NI: CL 1, DIV 2, GP A, B, C, D; T4

HART: (–50 °C ≤ T_a ≤ +70 °C)

FOUNDATION™ Fieldbus/PROFIBUS®-PA: (-50 °C ≤ T_a ≤ +60 °C)

Install per 03031-1019.

Type 4X

Special Conditions for Safe Use (X):

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.
2. The Rosemount 3051 Transmitter with the transient terminal block (option code T1) will not pass the 500 Vrms dielectric strength test, and this must be taken into account during installation.

Certificate 1053834

Ranges 1-6

Standards FM 3600: 2022, FM 3610: 2018, FM 3611: 2021, ANSI/UL 61010-1-2019 Third Edition, ANSI/UL 60079-0: 2017, ANSI/UL 60079-11: 2013, ANSI-ISA-12.27.01–2022, ANSI/UL 50E (First Edition)

Markings IS: CL I GP ABCD T4

IS: CL II GP EFG; CL III T4

CL I ZN 0 AEx ia IIC T4 Ga

NI: CL I DIV 2 GP ABCD T4

-76 °F (-60 °C) ≤ T_a ≤ 158 °F (70 °F)

Optional: single seal

Type 4X IP 68

INSTALL PER 03031-1024

Specific Conditions for Use

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.
2. The Rosemount 3051 Transmitter with the transient terminal block (option code T1) will not pass the 500 Vrms dielectric strength test, and this must be taken into account during installation.
3. Equipment evaluated for atmospheric pressure range between 80 kPa (0.8 bar) to 110 kPa (1.1 bar).
4. Maximum process temperature limits shall be in accordance with 03031-1053.

9.6.3 IE USA FISCO

Certificate FM16US0120X

Ranges 1-5

Standards FM 3600: 2011, FM 3610: 2010, FM 3611: 2004, FM 3810: 2005, ANSI/NEMA® 250: 2008

Markings IS: CL I, DIV 1, GP A, B, C, D T4;

CL II, DIV 1, GP E, F, G; CL III

-50 °C ≤ T_a ≤ +60 °C

FISCO

Install per 03031-1019

Type 4X

Special Conditions for Safe Use (X):

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.

Certificate 1053834

Standards FM 3600: 2022, FM 3610: 2018, FM 3611: 2021, ANSI/UL 61010-1-2019 Third Edition, ANSI/UL 60079-0: 2017, ANSI/UL 60079-11: 2013, ANSI-ISA-12.27.01–2022, ANSI/UL 50E (First Edition)

Markings IS: CL I GP ABCD T4

CL I ZN 0 AEx ia IIC T4 Ga

-60 °C ≤ T_a ≤ +70 °C

FISCO

Optional: single seal

Type 4X, IP 68

Install per 03031-1024.

Specific Conditions for Use

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.
2. Equipment evaluated for atmospheric pressure range between 80 kPa (0.8 bar) to 110 kPa (1.1 bar).
3. Process temperature limits shall be in accordance with 03031-1053.

9.6.4 C6 Canada Explosion-proof, Dust-Ignitionproof, Intrinsic Safety, and Nonincendive

Certificate 1053834

Standards CAN/CSA C22.2 No. 61010-1-12, CAN/CSA C22.2 No. 94.2-20, CSA C22.2 No. 25-17, CAN/CSA C22.2 No. 30:20, CAN/CSA C22.2 No. 213-17 +UPD1 (2018)+UPD2 (2019)+UPD3 (2021), CAN/CSA C22.2 No. 60079-0:19, CAN/CSA C22.2 No. 60079-1:16, CAN/CSA-60079-11:14, ANSI-ISA-12.27.01–2021

Markings XP: CL I, DIV 1, GP B, C, D T5

Ex db IIC T5 Gb

Seal not required
(–50 °C ≤ T_a ≤ +85 °C);
DIP: CL II, DIV 1, GP E, F, G; CL III T5;
T5: –50 °C ≤ T_a ≤ +85 °C
IS: CL I DIV 2 GP ABCD T4
T4: -60 °C ≤ Ta ≤ +70 °C;
Install per 03031-1024 (IS/NI only)
Single seal - temp limits 03031-1053
Type 4X, IP68

Specific Conditions for Use:

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.
2. Equipment evaluated for atmospheric pressure range between 80 kPa (0.8 bar) to 110 kPa (1.1 bar).
3. The Rosemount 3051 Transmitter with the transient terminal block (option code T1) will not pass the 500 Vrms dielectric strength test, and this must be taken into account during installation.
4. Flameproof joints are not intended for repair.

9.6.5 E6 Canada Explosion-proof, Dust-Ignitionproof, and Division 2

Certificate 1053834

Standards CAN/CSA C22.2 No. 61010-1-12, CAN/CSA C22.2 No. 94.2-20, CSA C22.2 No. 25-17, CAN/CSA C22.2 No. 30:20, CAN/CSA C22.2 No. 213-17 +UPD1 (2018) +UPD2 (2019) +UPD3 (2021), CAN/CSA C22.2 No. 60079-0:19, CAN/CSA C22.2 No. 60079-1:16, ANSI-ISA-12.27.01–2021

Markings XP: CL I, DIV 1, GP B, C, D T5
Ex db IIC T5 Gb
Seal not required
DIP: CL II, DIV 1, GP E, F, G; CL III T5;
T5: –50 °C ≤ T_a ≤ +85 °C
NI: CL I DIV 2 GP ABCD T4
T4: -60 °C ≤ Ta ≤ +70 °C;
Single seal - temp limits per 03031-1053

Type 4X, IP68

Specific Conditions for Use:

1. The Rosemount 3051 Transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.
2. Equipment evaluated for atmospheric pressure range between 80 kPa (0.8 bar) to 110 kPa (1.1 bar).
3. Flameproof joints are not intended for repair.

9.7 Europe

9.7.1 E8 ATEX Flameproof and Dust

ATEX Certificate KEMA00ATEX2013X (Ex db); Baseefa11ATEX0275X (Ex ta)

Standards Used EN IEC 60079-0: 2018, EN 60079-1: 2014, EN 60079-26: 2015, EN 60079-31: 2014

Markings ⟨Ex⟩ II ½ G Ex db IIC T6...T4 Ga/Gb T6

T6: –60 °C ≤ T_a ≤ +70 °C

T4/T5: –60 °C ≤ T_a ≤ +80 °C;

⟨Ex⟩ II 1 D Ex ta IIIC T_{500}105 °C Da

-20 °C ≤ T_a ≤ +85 °C

Table 9-1: Process Temperature

Temperature class	Process connection temperature	Ambient temperature
T6	–60 °C to +70 °C	–60 °C to +70 °C
T5	–60 °C to +80 °C	–60 °C to +80 °C
T4	–60 °C to +120 °C	–60 °C to +80 °C

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm less than 1 mm thick that forms a boundary between Category 1G (process connection) and Category 2G (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. During installation, maintenance, and use, the environmental conditions to which the diaphragm will be subjected shall

be taken into account. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.

2. Flameproof joints are not intended to be repaired.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.
4. Some variants of the equipment have reduced markings on the nameplate. Refer to the Certificate for full equipment marking.
5. Variants with a paint finish must not be installed in a dust-laden airflow.

9.7.2 I1 ATEX Intrinsic Safety and Dust

Certificate BAS97ATEX1089X; Baseefa11ATEX0275X

Standards EN IEC 60079-0: 2018, EN60079-11: 2012, EN60079-31: 2014

Markings IS: ⟨Ex⟩ II 1 G Ex ia IIC T4 Ga
HART®: -60 °C ≤ T_a ≤ +70 °C
Fieldbus/PROFIBUS®: -60 °C ≤ T_a ≤ +60 °C
Dust: ⟨Ex⟩ II 1 D Ex ta IIIC T_{500} 105 °C Da
-20 °C ≤ T_a ≤ +85 °C

Table 9-2: Input Parameters

	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1.0 W	1.3 W
Capacitance C_i	8 nF	0 µF
Inductance L_i	0 mH	0 mH

Specific Conditions of Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by clause 6.3.12 of EN60079-11: 2012. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if located in Zone 0.
3. Some variants of the equipment have reduced markings on the nameplate. Refer to the Certificate for full equipment marking.
4. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.

9.7.3 IA ATEX FISCO

Certificate	BAS97ATEX1089X
Standards	EN IEC 60079-0: 2018, EN60079-11: 2012
Markings	Ⓔx II 1 G Ex ia IIC T4 Ga –60 °C ≤ T_a ≤ +60 °C

Table 9-3: Input parameters

	Fieldbus/PROFIBUS®
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	≤ 5 nF
Inductance L_i	≤ 10 µH

Specific Conditions for Safe Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by clause 6.3.12 of EN60079-11: 2012. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in Zone 0.

3. Some variants of the equipment have reduced markings on the nameplate. Refer to the Certificate for full equipment marking.

9.7.4 N1 ATEX Type n and Dust

Certificate BAS00ATEX3105X; Baseefa11ATEX0275X

Standards EN IEC 60079-0: 2018, EN60079-15: 2010, EN60079-31: 2014

Markings Ⓔx II 3 G Ex nA IIC T5 Gc
–40 °C ≤ T_a ≤ +70 °C;
Ⓔx II 1 D Ex ta IIIC T_{500} 105 °C Da
–20 °C ≤ T_a ≤ +85 °C

Specific Conditions for Safe Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by EN 60079-15: 2010. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if located in Zone 0.
3. Variants with a paint finish must not be installed in a dust-laden airflow.
4. Some variants of the equipment have reduced markings on the nameplate. Refer to the Certificate for full equipment marking.

9.8 International

9.8.1 E7 IECEx Flameproof and Dust

Certificate IECEx KEM 09.0034X; IECEx BAS 10.0034X

Standards IEC 60079-0: 2017, IEC 60079-1: 2014-06, IEC 60079-26: 2014-10, IEC 60079-31: 2013

Markings Ex db IIC T6...T4 Ga/Gb
T6: -60 °C ≤ T_a ≤ +70 °C;
T4/T5: -60 °C ≤ T_a ≤ +80 °C;
Ex ta IIIC T_{500}105 °C Da
-20 °C ≤ T_a ≤ +85 °C

Table 9-4: Process Temperature

Temperature class	Process connection temperature
T6	-60 °C to +70 °C
T5	-60 °C to +80 °C
T4	-60 °C to +80 °C

Specific Conditions of Use:

1. This device contains a thin wall diaphragm less than 1 mm thick that forms a boundary between EPL Ga (process connection) and EPL Gb (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. During installation, maintenance, and use, the environmental conditions to which the diaphragm will be subjected shall be taken into account. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Flameproof joints are not intended to be repaired.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.
4. Some variants of the equipment have reduced markings on the nameplate. Refer to the Certificate for full equipment marking.

9.8.2 I7 IECEx Intrinsic Safety

Certificate IECEx BAS 09.0076X

Standards IEC 60079-0: 2017, IEC60079-11: 2011

Markings Ex ia IIC T4 Ga
HART®: -60 °C ≤ T_a ≤ +70 °C
Fieldbus/PROFIBUS®: -60 °C ≤ T_a ≤ +60 °C

Table 9-5: Input Parameters

	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA

Table 9-5: Input Parameters *(continued)*

	HART	Fieldbus/PROFIBUS
Power P_i	1.0 W	1.3 W
Capacitance C_i	8 nF	0 µF
Inductance L_i	0 mH	0 mH

Specific Conditions of Use:

1. If the apparatus is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test required by clause 6.3.12 of IEC 60079-11. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if located in Zone 0.

IECEx Mining (Special A0259)

Certificate IECEx TSA 14.0001X

Standards IEC 60079-0: 2011, IEC 60079-11: 2011

Markings Ex ia I Ma (-60 °C ≤ T_a ≤ +70 °C)

Table 9-6: Input Parameters

	HART	Fieldbus/ PROFIBUS	FISCO
Voltage U_i	30 V	30 V	17.5 V
Current I_i	200 mA	300 mA	380 mA
Power P_i	0.9 W	1.3 W	5.32 W
Capacitance C_i	0.012 µF	0 µF	< 5 nF
Inductance L_i	0 mH	0 mH	< 10 µH

Specific Conditions of Use:

1. If the apparatus is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test required by IEC60079-11. This must be taken into account when installing the apparatus.
2. It is a condition of safe use that the above input parameters shall be taken into account during installation.

3. It is a condition of manufacture that only the apparatus fitted with housing, covers, and sensor module housing made out of stainless steel are used in Group 1 applications.

9.8.3 IG IECEx FISCO

Certificate IECEx BAS 09.0076X

Standards IEC 60079-0: 2017, IEC60079-11: 2011

Markings Ex ia IIC T4 Ga
-60 °C ≤ T_a ≤ +60 °C

Table 9-7: Input Parameters

	Fieldbus/PROFIBUS®
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	≤ 5 nF
Inductance L_i	≤ 10 µH

Specific Conditions for Safe Use:

1. If the apparatus is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test required by clause 6.3.12 of IEC 60079-11. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if located in Zone 0.

9.8.4 N7 IECEx Type n

Certificate IECEx BAS 09.0077X

Standards IEC60079-0: 2017, IEC60079-15: 2010

Markings Ex nA IIC T5 Gc (-40 °C ≤ T_a ≤ +70 °C)

Specific Condition for Safe Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by clause 6.5.1 of IEC 60079-15. This must be taken into account when installing the apparatus.

9.9 Brazil

9.9.1 E2 Brazil Flameproof

Certificate UL-BR 13.0643X
UL-BR 13.0643X (BRMC)
UL-BR 22.3782X (RSK)
UL-BR 22.3783X (SMMC)

Standards ABNT NBR IEC 60079-0: 2013; ABNT NBR IEC 60079-1: 2016; ABNT NBR IEC 60079-26: 2016

Markings Ex db IIC T6...T4 Ga/Gb
T6: -60 °C ≤ T_a ≤ +70 °C
T4/T5: -60 °C ≤ T_a ≤ +80 °C

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm with less than 1 mm thickness that forms a boundary between zone 0 (process connection) and zone 1 (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. Installation, maintenance, and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Flameproof joints are not intended to be repaired.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.

9.9.2 I2 Brazil Intrinsic Safety

Certificate UL-BR 13.0584X
UL-BR 13.0584X (BRMC)
UL-BR 22.3843X (SMMC)
UL-BR 22.3844X (RSK)

Standards ABNT NBR IEC60079-0: 2013, ABNT NBR IEC60079-11: 2013

Markings HART®: Ex ia IIC T5/T4 Ga, T5 (-60 °C ≤ T_a ≤ +40 °C), T4 (-60 °C ≤ T_a ≤ +70 °C)

Fieldbus/PROFIBUS®: Ex ia IIC T4 Ga (-60 °C ≤ T_a ≤ +60 °C)

Table 9-8: Input Parameters

	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1.0 W	1.3 W
Capacitance C_i	8 nF	0 µF
Inductance L_i	0 mH	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test required by ABNT NBR IRC 60079-11. This must be taken into account when installing the equipment.
2. The enclosure may be made of aluminum alloy and given protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if equipment requires EPL Ga.

9.9.3 IB Brazil FISCO

Certificate UL-BR 13.0584X
UL-BR 13.0584X (BRMC)
UL-BR 22.3843X (SMMC)
UL-BR 22.3844X (RSK)

Standards ABNT NBR IEC60079-0: 2013, ABNT NBR IEC60079-11: 2013

Markings Ex ia IIC T4 Ga (-60 °C ≤ T_a ≤ +60 °C)

Table 9-9: Input Parameters

	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	≤ 5 nF
Inductance L_i	≤ 10 µH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test required by ABNT NBR IRC 60079-11. This must be taken into account when installing the equipment.
2. The enclosure may be made of aluminum alloy and given protective polyurethane paint finish; however, care must be taken to protect it from impact or abrasion if equipment requires EPL Ga.

9.10 China

9.10.1 E3 China Flameproof

Certificate GYJ24.1006X [Transmitters]; GYJ20.1486X [Flow meters]

Standards GB/T 3836.1-2021, GB/T 3836.2-2021, GB/T 3836.20-2021, GB/T 3836.31-2021

Markings 3051 Series: Ex db IIC T6···T4 Ga/Gb, Ex ta IIIC T200 105 °C Da (-20 °C ≤ Ta ≤ +85 °C)

3051CF Series: Ex d IIC T6~T4 Ga/Gb

9.10.2 I3 China Intrinsic Safety

Certificate GYJ23.1139X; GYJ20.1488X [Flow meters]

Standards GB/T 3836.1-2021, GB/T 3836.4-2021, GB/T 3836.31-2021

Markings 3051 Series: Ex ia IIC T4 Ga, Ex ta IIIC T_{500} 105 °C Da

3051CF Series: Ex ia IIC T4 Ga, Ex ta IIIC T_{500} 105 °C Da

9.10.3 N3 China Type n

Certificate GYJ25.1047X

Standards GB/T 3836.1-2021, GB/T 3836.3-2021

Markings Ex ec IIC T5 Gc

9.11 Japan

9.11.1 E4 Japan Flameproof

Certificate CML20JPN1098X

Markings Ex db IIC T6...T4 Ga/Gb, T6 (-60 °C ≤ Ta ≤ +70 °C), T5/T4 (-60 °C ≤ Ta ≤ +80 °C)

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm less than 1 mm thick that forms a boundary between EPL Ga (process connection) and EPL Gb (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. During installation, maintenance, and use, the environmental conditions to which the diaphragm will be subjected shall be taken into account. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Flameproof joints are not intended to be repaired.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.

9.12 Republic of Korea

9.12.1 EP Republic of Korea Flameproof

Certificate 11-KB4BO-0188X [Manufacturing Singapore]
19-KA4BO-0979X [Manufacturing USA]

Markings Ex db IIC T6...T4 Ga/Gb

9.12.2 IP Republic of Korea Intrinsic Safety

Certificate 10-KB4BO-0138X [HART™ - Manufacturing Singapore]
13-KB4BO-0206X [Fieldbus - Manufacturing Singapore]
18-KA4BO-0354X [HART - Manufacturing USA]
18-KA4BO-0355X [Fieldbus - Manufacturing USA]

Markings Ex ia IIC T4

9.13 Combinations

K2 Combination of E2 and I2

K5 Combination of E5 and I5

K6 Combination of C6, E8, and I1

K7 Combination of E7, I7, and N7

K8 Combination of E8, I1, and N1

KB Combination of E5, I5, and C6

KD Combination of E8, I1, E5, I5, and C6

KM Combination of EM and IM

KP Combination of EP and IP

9.14 Additional certifications

9.14.1 SBS American Bureau of Shipping (ABS) Type Approval

Certificate 18-HS1814795-PDA

Intended use Marine and offshore applications – Measurement of either gauge or absolute pressure for liquid, gas, and vapor.

9.14.2 SBV Bureau Veritas (BV) Type Approval

Certificate 23155

Requirements Bureau Veritas rules for the classification of steel ships

Application Class notations: AUT-UMS, AUT-CCS, AUT-PORT, and AUT-IMS; Pressure transmitter type 3051 cannot be installed on diesel engines.

9.14.3 SDN Det Norske Veritas (DNV) Type Approval

Certificate TAA000004F

Intended Use DNV GL rules for classification - ships and off-shore units

Application

Table 9-10: Location Classes

Temperature	D
Humidity	B
Vibration	A
Electromagnetic Compatibility (EMC)	B
Enclosure	D

9.14.4 SLL Lloyds Register (LR) Type Approval

Certificate LR21173788TA

Application Environmental categories ENV1, ENV2, ENV3, and ENV5

9.14.5 C5 Custody Transfer - Measurement Canada Accuracy Approval

Certificate AG-0226; AG-0454; AG-0477

9.15 EU Declaration of Conformity

EMERSON.

EU DECLARATION OF CONFORMITY

CE
RMD 1017-AK

This declaration of conformity is issued under the sole responsibility of

Rosemount Inc.
6021 Innovation Blvd
Shakopee, MN 55379
USA

that the following products,

Rosemount™ 3051 Pressure Transmitters

comply with the provisions of the European Union Directives, including the latest amendments, valid at the time this declaration was signed.

March 31, 2025 | Mark Lee | Vice President, Quality | Boulder, CO, USA
(signature & date of issue) (name) (function) (place of issue)

Authorized Representative in Europe:
Emerson S.R.L., company No. J12/88/2006
Emerson 4 street, Parcul Industrial
Tetarom II, Cluj-Napoca 400638, Romania

Regulatory Compliance Shared Services Department
Email: europeproductcompliance@emerson.com Phone: +40 374 132 035

PED Notified Body:

DNV Business Assurance Italia S.r.l. [Notified Body Number: 0496]
Via Energy Park, 14, N-20871
Vimercate (MB), Italy

ATEX Notified Bodies for EU Type Examination Certificates:

DEKRA [Notified Body Number: 0344]
Meander 1051 P.O. Box 5185
6825 MJ Arnhem 6802 ED Arnhem
Netherlands Netherlands

SGS Fimko Oy [Notified Body Number: 0598]
Takomotie 8
FI-00380 Helsinki,
Finland

ATEX Notified Body for Quality Assurance:

SGS Fimko Oy [Notified Body Number: 0598]
Takomotie 8
FI-00380 Helsinki
Finland

EMERSON.

EU DECLARATION OF CONFORMITY

CE
RMD 1017-AK

EMC Directive (2014/30/EU)

Harmonized Standards:
EN 61326-1:2013
EN 61326-2-3:2013

Radio Equipment Direction (RED) (2014/53/EU)

Harmonized Standards:
EN 300 328 V2.2.2

Other Standards:
EN 301 489-1 V2.2.0
EN 301 489-17 V3.2.4: 2020
EN 61010-1: 2010
EN 62311: 2020

PED Directive (2014/68/EU)

Rosemount 3051CA4; 3051CD2, 3, 4, 5; 3051HD2, 3, 4, 5; *(also with P9 option)*

QS Certificate of Assessment - Certificate No. 12698-2018-CE-USA-ACCREDIA

Module H Conformity Assessment

Other Standards Used: ANSI/ISA61010-1:2004

All other Rosemount 3051 Pressure Transmitters
Sound Engineering Practice

Transmitter Attachments: Diaphragm Seal, Process Flange, or Manifold
Sound Engineering Practice

Rosemount 3051CFx DP Flowmeters
See DSI 1000 Declaration of Conformity

RoHS Directive (2011/65/EU)

Model 3051 Pressure Transmitters
Harmonized standard: EN IEC 63000:2018

Does not apply to the following options:
Wireless output code X

ATEX Directive (2014/34/EU)

BAS97ATEX1089X - Intrinsic Safety

Equipment Group II Category 1 G
Ex ia IIC T5/T4 Ga
Harmonized Standards Used:
EN IEC 60079-0: 2018, EN 60079-11: 2012

BAS00ATEX3105X - Type n

Equipment Group II Category 3 G
Ex nA IIC T5 Gc
Harmonized Standards Used:
EN IEC 60079-0: 2018, EN 60079-15: 2010

Baseefa11ATEX0275X - Dust

Equipment Group II Category 1 D
Ex ta IIIC T_{500} 105 °C Da
Harmonized Standards Used:
EN IEC 60079-0: 2018, EN 60079-31: 2014

KEMA00ATEX2013X - Flameproof

Equipment Group II Category 1/2 G
Ex db IIC T6…T4 Ga/Gb
Harmonized Standards Used:
EN IEC 60079-0: 2018, EN 60079-1: 2014, EN 60079-26: 2015

9.16 China RoHS

含有China RoHS管控物质超过最大浓度限值的部件型号列表 3051
List of 3051 Parts with China RoHS Concentration above MCVs

部件名称 Part Name	有害物质 / Hazardous Substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴联苯醚 Polybrominated diphenyl ethers (PBDE)
电子组件 Electronics Assembly	X	O	O	O	O	O
壳体组件 Housing Assembly	O	O	O	O	O	O
传感器组件 Sensor Assembly	X	O	O	O	O	O

本表格系依据SJT11364的规定而制作.
This table is proposed in accordance with the provision of SJT11364.

O: 意为该部件的所有均质材料中该有害物质的含量均低于GB/T 26572所规定的限量要求.
O: Indicate that said hazardous substance in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: 意为在该部件所使用的所有均质材料里，至少有一类均质材料中该有害物质的含量高于GB/T 26572所规定的限量要求.
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.

部件名称 Part Name	组装备件说明 Spare Parts Descriptions for Assemblies
电子组件 Electronics Assembly	电子线路板组件 Electronic Board Assemblies 端子块组件 Terminal Block Assemblies 升级套件 Upgrade Kits 液晶显示屏或本地操作界面 LCD or LOI Display
壳体组件 Housing Assembly	电子外壳 Electrical Housing
传感器组件 Sensor Assembly	传感器模块 Sensor Module

9.17 Y3 ATEX/IECEx RFID tag approvals

Certificate IECEx EPS 15.0042X, EPS 15 ATEX 1 1011 X

Markings II 2G Ex ia IIC T6/T4 Gb, II 2D Ex ia IIC T80/T130C Db

Conditions of certification

Maximum operating temperature: –58 °F (–50 °C) to +158 °F (+70 °C)

The RFID tags shall never be exposed to high electromagnetic field strengths according to IEC 60079-14.

Electrostatic charges shall be avoided. The tags shall never be used next to strong charge generating processes.

⚠ WARNING

Additional warnings

The plastic enclosure may present a potential electrostatic ignition hazard.

RFID tag has limitations in ambient temperature and zone installation areas (Zones 1 & 21) as compared to the gauge.

Quick Start Guide
00825-0100-4007, Rev. HM
June 2025

For more information: **Emerson.com/global**

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ROSEMOUNT™

EMERSON™

Manual
00809-0100-4007, Rev BG
July 2024

Rosemount™ 3051 Pressure Transmitter

with 4-20 mA HART® Protocol

ROSEMOUNT™

EMERSON™

Safety messages

⚠ WARNING

Read this manual before working with the product. For personal and system safety and for optimum product performance, ensure you thoroughly understand the contents before installing, using, or maintaining this product.

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

Installation of device in an explosive environment must be in accordance with appropriate local, national, and international standards, codes, and practices. Review the *Product Certifications* section of the Rosemount 3051 Pressure Transmitter and 3051CF Series Flow Meter Quick Start Guide for any restrictions associated with a safe installation.

Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments are installed in accordance with intrinsically safe or non-incendive field wiring practices.

⚠ WARNING

Process leaks

Process leaks may cause harm or result in death.

Install and tighten process connectors before applying pressure.

Do not attempt to loosen or remove flange bolts while the transmitter is in service.

⚠ WARNING

Electrical shock

Electrical shock can result in death or serious injury.

Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

⚠ WARNING

Replacement equipment

Replacement equipment or spare parts not approved by Emerson for use as spare parts could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.

Use only bolts supplied or sold by Emerson as spare parts.

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental in protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

NOTICE

Improper assembly
Improper assembly of manifolds to traditional flange can damage sensor module.

For safe assembly of manifold to traditional flange, bolts must break back plane of flange web (also called bolt hole) but must not contact sensor module housing.

Severe changes in the electrical loop may inhibit HART® communication or the ability to reach alarm values. Therefore, Emerson absolutely cannot warrant or guarantee that the correct `Failure` alarm level (`High` or `Low`) can be read by the host system at the time of annunciation.

NOTICE

Nuclear applications
The products described in this document are not designed for nuclear-qualified applications. Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Emerson Sales Representative.

NOTICE

Transmitter hardware adjustments
Set all transmitter hardware adjustments during commissioning to avoid exposing the transmitter electronics to the plant environment after installation.

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1 Introduction

1.1 Models covered

The following Rosemount 3051 Transmitters are covered by this manual:

- Rosemount 3051C Coplanar™ Pressure Transmitter
  - Measures differential and gauge pressure up to 2000 psi (137.9 bar).
  - Measures absolute pressure up to 4000 psia (275.8 bar).
- Rosemount 3051T In-Line Pressure Transmitter
  - Measures absolute pressure up to 20000 psi (1378.95 bar).
- Rosemount 3051L Liquid Level Transmitter
  - Measures level and specific gravity up to 300 psi (20.7 bar).
- Rosemount 3051CF Series Flow Meter
  - Measures flow in line sizes from ½ in. (15 mm) to 96 in. (2400 mm).

Note
For transmitter with FOUNDATION™ Fieldbus, see the Rosemount 3051 Pressure Transmitter with FOUNDATION™ Fieldbus Protocol Manual.

For transmitter with PROFIBUS® PA, see the Rosemount 3051 Pressure Transmitter with PROFIBUS™ PA Protocol Manual.

1.2 Product recycling/disposal

Consider recycling equipment. Dispose of packaging in accordance with local and national legislation/regulations.

2 Configuration

2.1 Overview

This section contains information on commissioning and tasks that must be performed on the bench prior to installation, as well as tasks performed after installation.

This section also provides instructions on configuring using any communication device, including:

- Communication device, such as AMS Trex
- HART® host, such as AMS Device Manager
- AMS Device Configurator Bluetooth® app
- Physical buttons, such as the **Quick Service** buttons or local operator interface (LOI)

2.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Refer to Safety messages.

2.3 System readiness

If using HART®-based control or asset management systems, confirm the HART capability of such systems prior to commissioning and installation. Not all systems can communicate with HART Revision 7 devices.

2.3.1 Confirming correct device descriptor

- Verify that the latest device descriptor (DD/DTM™) is loaded on your systems to ensure proper communications.
- Download the latest DD at Sofware & Drivers or FieldCommGroup.org
- In the ***Browse by Member*** drop-down menu, select the Rosemount business unit of Emerson.
- Select the desired product.
- Use the device revision numbers to find the correct DD.

Table 2-1: Rosemount 3051 device revisions and files

Release date	Device identification			Device descriptor identification		Review instructions	Review functionality
	NAMUR software revision(1)	HART® hardware revision(1)	HART software revision(2)	HART universal revision	Device revision(3)	Manual document number	Change description
March 2023	2.0.xx	2.0.xx	01	7	11	00809-0100-4007	(4)
April 2012	1.0xx	1.0xx	01	7	10	00809-0100-4007	(5)
January 1998	N/A	N/A	178	5	3	00809-0100-4001	N/A

(1) The NAMUR revision is located on the hardware tag of the device. Differences in level 3 changes, signified above by `xx`, represent minor product changes as defined per NE53. Compatibility and functionality are preserved, and you can use the products interchangeably.

(2) You can read the HART software revision with a HART-capable configuration tool. The value shown is the minimum revision that could correspond to NAMUR revisions.

(3) Device descriptor file names use device and DD Revision, such as `10_01`. The HART protocol is designed to enable legacy device descriptor revisions to continue to communicate with new HART devices. To access new functionality, you must download the new device descriptor. Emerson recommends downloading new device descriptor files to ensure full functionality.

(4) Valid for Manual revision BD or later. Changes include:

- *Bluetooth® connectivity*
- *Application-specific configuration*
- *Plugged impulse line diagnostics*
- *Enhanced safety*
- ***Quick Service** buttons*
- *Graphical display*

(5) Valid up to Manual Revision BC. Changes include:

- *HART Revision 5 and 7 selectable, power diagnostics*
- *Safety certified local operator interface (LOI)*
- *Process alerts*
- *Scaled variable*
- *Configurable alarms*
- *Expanded engineering units*

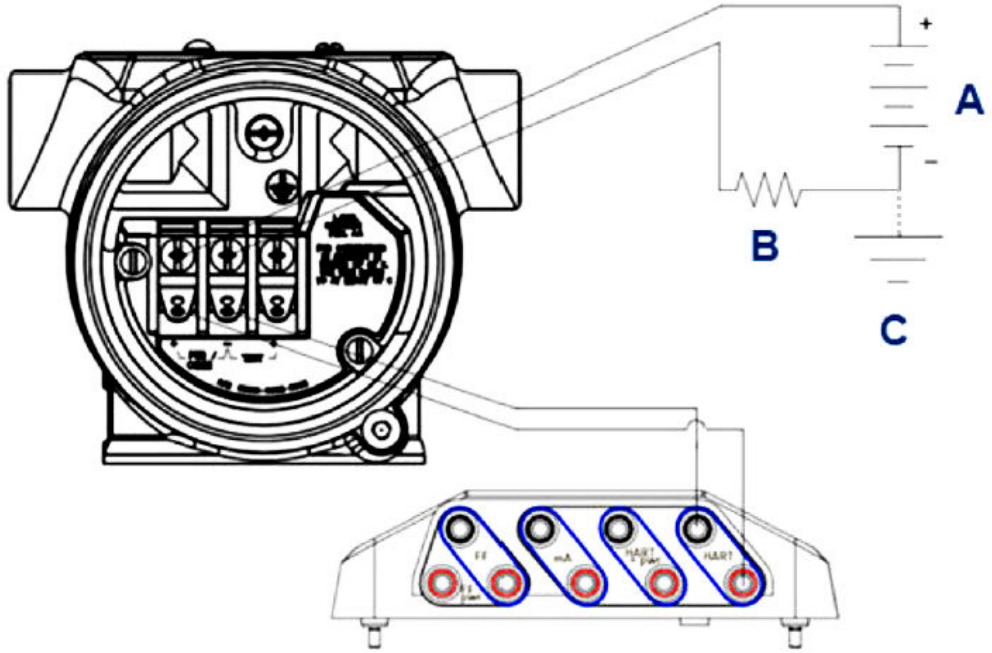
2.4 Configuration tools

You can set up the transmitter before or after mounting it by wiring it to a power supply and a configuration device as shown in Figure 2-1, but if you're using the AMS Trex, Bluetooth app, **Quick Service** buttons, or a local operator interface (LOI), you don't need a resistor.

You can configure the transmitter either before or after installation. To ensure that all transmitter components are in working order prior to installation, configure the transmitter on the bench using the applicable communication device and power supply.

See Figure 2-1 for more information on how to wire the power supply and attach leads from a configuration device.

Figure 2-1: Power supply and communicator wiring



A. Power supply
B. Resistor
C. Ground

Note
You do not need the resistor if you are connected in one of the following ways:

- AMS Trex (HART® **+ power**)
- AMS Device Configurator Bluetooth® app
- **Quick Service** buttons
- Local operator interface (LOI)

Table 2-2: Power supply and resistance by communicator type

Communicator	Power supply	Resistor
AMS Device Manager	≥ 16.6 Vdc	≥ 250Ω
AMS Trex (HART)	≥ 16.6 Vdc	≥ 250Ω
AMS Trex (**HART + pwr**)	None	None
AMS Device Configurator Bluetooth®app	≥ 10.5 Vdc	None
Quick Service buttons	≥ 10.5 Vdc	None
LOI	≥ 10.5 Vdc	None

2.4.1 Configuring with a communication device

For more detailed information about AMS Trex, see AMS Trex Device Communicator.

It is critical that the latest device descriptors (DDs) are loaded onto the communication device to ensure full functionality.

Related information

System readiness
Device Driver (DD) menu trees

2.4.2 Configuring using AMS Device Manager

For more detailed information about AMS Device Manager, see the AMS Device Manager product page.

It is critical that the latest device descriptors (DDs) are loaded onto the AMS Device Manager to ensure full functionality.

Related information

System readiness

2.4.3 Configuring using the AMS Device Configurator Bluetooth® app

For more detailed information about the AMS Device Configurator Bluetooth app, see Configure via Bluetooth® wireless technology.

Related information

Device Driver (DD) menu trees

2.4.4 Configuring using the **Quick Service** buttons

You can use the **Quick Service** buttons for the following configuration and maintenance tasks:

- **View Configuration**
- **Zero**
- **Rerange/Span**
- **Loop Test**

- **Flip Screen**

Figure 2-2: Quick Service buttons location

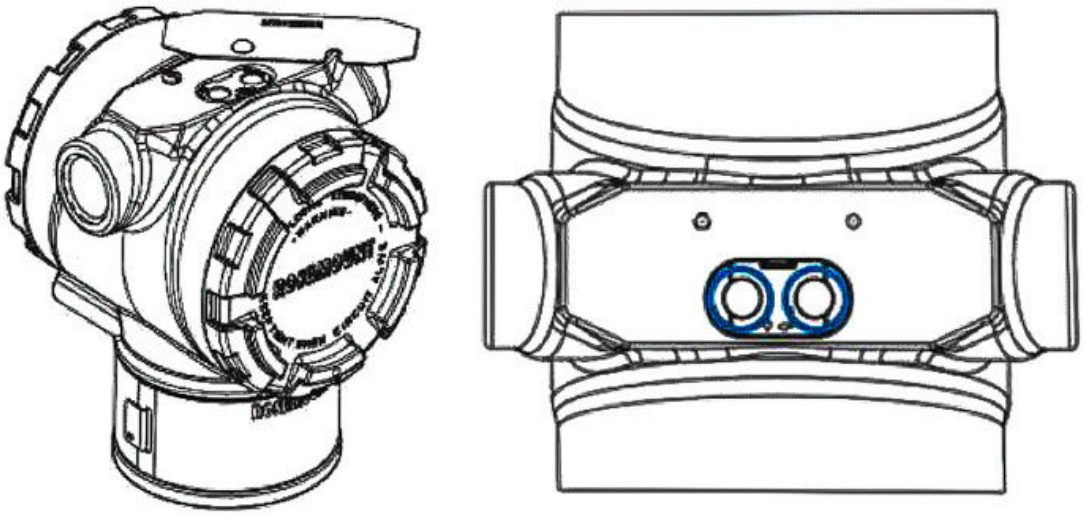


Table 2-3: Quick Service buttons operation

Symbol	Meaning
↓	1. Scroll. 2. Click the Left button. 3. Continue to the next option.
↵	1. Enter. 2. Click the Right button. 3. Go to the next step or sub menu.

NOTICE

Scroll and **Enter** buttons are fixed on the left and right of the display respectively, regardless of the display orientation. For 90, 80, and 270 degree rotations, check the symbol on the plastic insert near the button for proper operation.

Related information

Quick Service buttons

2.4.5 Configure with the local operator interface (LOI)

When using the LOI for configuration, several features require multiple screens for a successful configuration.

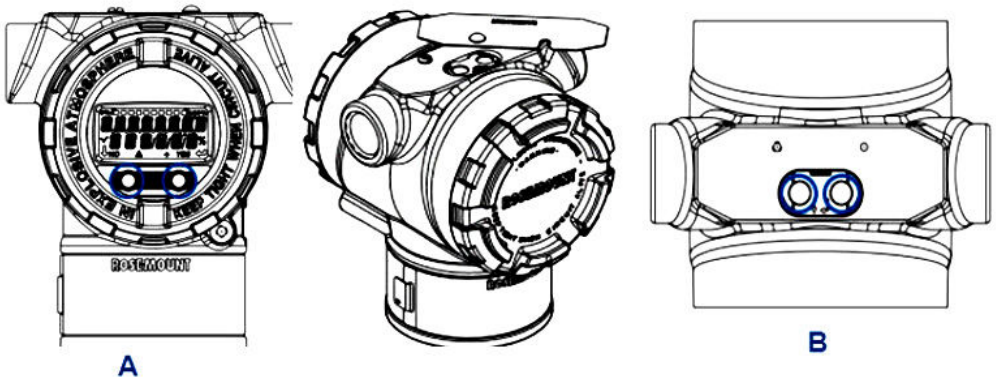
Data entered is saved on a screen-by-screen basis; the LOI indicates this by flashing `SAVED` on the LCD display each time.

Procedure

To activate the LOI, push either configuration button.

Configuration buttons are located on the LCD display[1] or underneath the top tag of the transmitter. See Figure 2-3 for configuration button locations and Table 2-4 for configuration button functionality.

Figure 2-3: Configuration buttons locations



A. Internal configuration buttons
B. External configuration buttons

Table 2-4: Configuration button operation

Symbol	Meaning
↓	Scroll (on the bottom left of the display). Click the Left button. Continue to the next option.
↵	Enter (on the bottom right of the display). Click the right button. Go to the next step or sub menu.
◂ ■ ▸	Progress bar (along the top of the display). Shows how far into the menu you are. The last two options are **Back to Menu** and **Exit Menu**. If you continue to press the scroll button after **Exit Menu**, the menu repeats from the beginning.

(1) Remove the housing cover to access the LCD display.

2.5 How to configure

Each unique application of the 3051 may require different steps to commission and configure the transmitter. This section provides an overview of the procedures to perform common configuration tasks on your transmitter.

2.5.1 Setting the loop to Manual

Whenever sending or requesting data that would disrupt the loop or change the output of the transmitter, set the process application loop to Manual control.

The configuration device will prompt you to set the loop to Manual when necessary. The prompt is only a reminder; acknowledging this prompt does not set the loop to Manual. You must set the loop to Manual control as a separate operation.

2.5.2 Verifying configuration parameters

Emerson recommends verifying the following configuration parameters prior to installation into the process:

- Alarm and Saturation Values
- Damping
- Process Variables
- Range Values
- Tag
- Transfer Function
- Units

Verify configuration parameters with a communication device

Procedure

1. Go to **Device Settings** → **Setup Overview** → **Alarm and Saturation Values** to set alarm and saturation levels.
2. Go to **Device Settings** → **Setup Overview** → **Output** to set damping.
3. Set the process variables:
   a) To set the primary variable, go to **Device Settings** → **Output** → **Analog Output** → **PV Setup**.
   b) To set up the other process variables, go to **Device Settings** → **Communication** → **HART** → **Variable Mapping**.
4. To set range values, go to **Device Settings** → **Output** → **Analog Output** → **PV Setup**.
5. To set a tag, go to **Device Settings** → **Setup Overview** → **Device**.
6. To set transfer function, go to **Device Settings** → **Output** → **Analog Output** → **PV Setup**.
7. Set units:
   a) To set pressure units, go to **Device Settings** → **Output** → **Pressure** → **Setup**.
   b) To set other units, go to **Device Settings** → **Output** → **Pressure/Flow/Totalizer/Level/Volume/Module Temperature** → **Setup**.

Verify configuration parameters with the Quick Service buttons

To access the ***View Configuration*** screen, locate the external **Quick Service** buttons and use them to wake the menu, follow on-screen prompts, and navigate using the **Scroll** and **Enter** buttons.

Procedure

1. Locate the external **Quick Service** buttons.
   See Figure 2-2.
2. Press either button to wake the menu.
3. Press the other button, following the on-screen prompts.
4. Use the **Scroll** and **Enter** buttons to get to the ***View Configuration*** screen.

Verify configuration parameters with the Local Operator Interface (LOI)

Procedure

1. Press either configuration button to activate the LOI.
2. Select **View Config**.

2.5.3 Setting Pressure Unit

The Pressure Unit command sets the unit of measure for the reported pressure.

The procedure is the same for other variables:

- Flow
- Totalizer
- Level
- Volume
- Module Temperature

Select your desired variable and then follow the procedure the procedure below using the desired variable in place of Pressure.

Set Pressure units with a communication device

Procedure

Go to **Device Settings** → **Output** → **Pressure** → **Setup**.

Set Pressure units with the local operator interface (LOI)

Procedure

1. Click either button to activate the LOI.
2. Select **Units**.

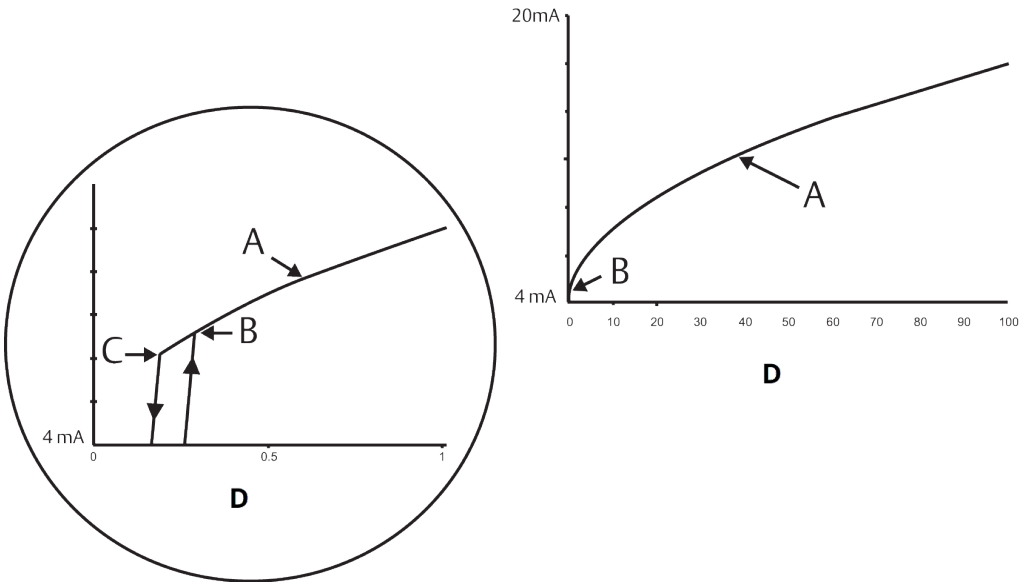
2.5.4 Setting transmitter output (transfer function)

The transmitter has two output settings: Linear and Square Root.

As shown in Figure 2-4, activating the Square Root option makes analog output proportional to flow and includes a fixed Low Flow Cut-off at four percent and a Low Flow Cut-in of five percent of the square root analog output range.

Emerson recommends using application-specific configuration to configure differential pressure (DP) flow applications. Refer to Application specific configuration for setup instructions. When flow rate is assigned to the primary variable, the transfer function will be set to Linear in the communication device and cannot be changed to Square Root. The flow rate variable is automatically set to a Square Root relationship with respect to pressure.

Figure 2-4: 4-20 mA HART® Square Root output transition point



A. Square root curve
B. 5 percent transition point
C. 4 percent transition point
D. Percent pressure input

Set transmitter output using a communication device

Procedure

Go to **Device Settings** → **Output** → **Analog Output** → **PV Setup** → **Transfer Function**.

Set transmitter output using the local operator interface (LOI)

Activate the LOI by clicking any button on the transmitter and then navigate to **Extended Menu** → **Transfer Funct** to proceed with the operation.

Procedure

1. Click either button on the transmitter to activate the LOI.
2. Go to **Extended Menu** → **Transfer Funct**.

2.5.5 Rerange the transmitter

The range values command sets each of the lower and upper range analog values (4 and 20 mA points) to a pressure. The lower range represents 0 percent of range, and the upper range point represents 100 percent of range.

In practice, you can change the transmitter range values as often as necessary to reflect changing process requirements. For a complete listing of range and sensor limits, refer to the *Specifications* section of the Rosemount 3051 Product Data Sheet.

Select from one of the methods below to rerange the transmitter. Each method is unique; examine all options closely before deciding which method works best for your process.

- Rerange by manually setting range points.
- Rerange with a pressure input source.

Rerange the transmitter with a communication device

Procedure

1. Go to **Device Settings** → **Output** → **Analog Output** → **PV Setup**.
2. Do one of the following:
   - Enter range points.
   - Select **Range by Applying Pressure** and follow the prompts.

Rerange the transmitter with the Quick Service buttons

To rerange the transmitter, locate the external buttons, wake the menu with either button, follow on-screen prompts with the other, and use the **Scroll** and **Enter** buttons to make your selection.

Procedure

1. Locate the external buttons.
   See Figure 2-2.
2. Press either button to wake the menu.
3. Press the other button, following the on-screen prompts.
4. Use the **Scroll** and **Enter** buttons to select Rerange.

Rerange the transmitter with the Local Operator Interface (LOI)

Procedure

1. Click either button to activate the LOI.
2. Select **Rerange**.
3. Do one of the following:
   - Select **Enter Values** to manually enter range points.
   - Select **Apply Values** and follow the prompts to use a pressure input source.

Rerange with the Zero and Span buttons

Procedure

1. Locate the external **Zero** and **Span** buttons.
2. Apply transmitter pressure.

3. Rerange the transmitter.
   - To change the zero (4 mA point) while maintaining the span, press and hold the **Zero** button for at least two seconds; then release.
   - To change the span (20 mA) point while maintaining the zero point, press and hold the **Span** button for at least two seconds and then release.

2.5.6 Damping

The **Damping** command changes the response time of the transmitter; higher values can smooth variations in output readings caused by rapid input changes.

Determine the appropriate **Damping** setting based on the necessary response time, signal stability, and other requirements of the loop dynamics within your system. The **Damping** command uses floating point configuration, allowing you to input any damping value within 0 - 60 seconds.

`Damping` using a communication device

Procedure

Go to **Device Settings** → **Output** → **[pick the output you want to set damping for (such as Pressure or Level)]** → **Setup** → **Damping**.

`Damping` using the local operator interface (LOI)

To adjust the Damping settings, activate the LOI by clicking either button and navigate through the ***Extended Menu*** to the Damping option.

Procedure

1. Click either button to activate the LOI.
2. Go to **Extended Menu** → **Damping**.

2.5.7 Configuring the display

Configuring the LCD display

Customize the LCD display to suit application requirements. The LCD display will alternate between the selected items.

- Pressure
- Module Temperature
- Percent of Range
- Analog Output
- Level
- Volume
- Flow Rate
- Totalized Flow

Configure LCD display using a communication device

Procedure

Go to **Device Settings** → **Display** → **Display** → **Display Parameters**.

Configure LCD display using the local operator interface (LOI)

Activate the LOI by clicking either button and then select **Display** to proceed with the setup.

Procedure

1. Click either button to activate the LOI.
2. Select **Display**.

Configuring the graphical LCD display

The graphical LCD display gives you more options to choose from when customizing the display. The display will alternate between the selected items.

- Pressure
- Module Temperature
- Percent of Range
- Analog Output
- Level
- Volume
- Flow Rate
- Totalized Flow
- HART Long Tag
- Alarm Switch State
- Security Status

Advanced display settings

You can configure additional settings for the graphical LCD display from the ***Advanced display settings*** tab.

- Select from eight different languages:
  - English
  - Chinese
  - French
  - German
  - Italian
  - Portuguese
  - Russian
  - Spanish
- Define the type of decimal separator used: comma or period.
- For gauge and absolute transmitters, you can enable a Gauge Pressure (GP) or Absolute Pressure (AP) unit label. For example, if units are psi and the GP/AP unit label is enabled, then the units will display as `psi-g` or `psi-a` on the graphical display.

- Turn the back light on or off.
- Adjust the number of decimal places on the display up one or down one from the default.

You can use software to rotate the graphical LCD display 180 degrees if the transmitter is mounted upside down. You can also rotate the display manually in 90 degree increments to meet installations requiring a 90 degree or 270 degree rotation.

Configure the graphical LCD display using a communication device

Procedure

Go to **Device Settings** → **Display** → **Display** → **Display Parameters**.

2.6 Application specific configuration

2.6.1 Configuring for flow rate

With the flow rate configuration, you can create a relationship between the pressure units and user-defined flow units. By defining a pressure at a specific flow rate, the transmitter will perform a square root extraction to convert the pressure reading to a linear flow rate output.

Flow rate configuration includes the following parameters:

- Flow Units: User-specified units for flow rate
- Entered Flow Rate: User-specified flow rate
- Pressure at Flow Rate(2): User-specified pressure at the entered flow rate.

Configure for flow rate with a communication device

Procedure

Go to **Device Settings** → **Output** → **Flow** → **Setup** → **Configure Flow**.

Configuring Low Flow Cut-off

Emerson highly recommends using the Low Flow Cut-off function to have a stable output and avoid problems due to process noise at a low flow or no flow condition.

There are two key definitions to aid in understanding Low Flow Cut-off:

Pressure cut-off value	The pressure at which the field device will stop measuring the flow rate. If the measured pressure is less than the cut-off value, the device will calculate the flow rate to be zero.
Pressure cut-in value	The pressure at which the field device will begin measuring the flow rate. If the measured pressure is more than the cut-in value, the device will begin measuring flow rate.

Configure Low Flow Cutoff with a communication device

Procedure

Go to **Device Settings** → **Output** → **Flow** → **Setup** → **Low Flow Cutoff**

Configuring for flow rate example

Use a differential pressure transmitter in conjunction with an orifice plate in a water flow application where the full-scale flow rate is 20,000 US gallons per hour with a differential pressure of 100 inH_2O at 68 °F. The pressure cut-off and pressure cut-in values for the Low Flow Cutoff will be set to 0.5 inH_2O at 68 °F.

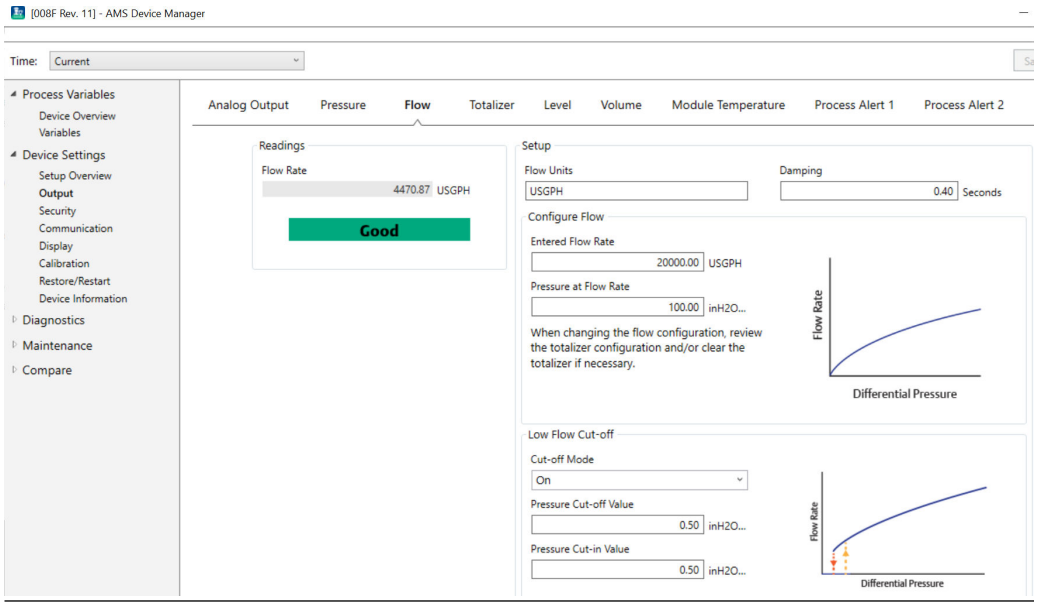
Based on this information, the configuration would be:

(2) You can use the DP Flow Sizing and Selection Tool to help you establish the relationship between pressure and flow.

Table 2-5: Entered values for flow rate configuration example

Parameter	Value
Flow Rate Units	USGPH
Entered Flow Rate	20,000 USGPH
Pressure at Flow Rate	100 inH_2O at 68 °F
Low Flow Cutoff	Cut-off mode: `On`
Pressure Cutoff Value	0.5 inH_2O at 68 °F
Pressure Cut-in Value	0.5 inH_2O at 68 °F

Figure 2-5: AMS configuration screen for flow rate example



2.6.2 Configuring for totalized flow

The flow totalizer will track the amount of flow that has passed your measurement point over time. The totalized flow output tracks the configured flow rate and will require the following inputs:

Totalizer Unit Unit of measure associated with the mass or volume component of the flow rate. Six characters maximum.

Flow Unit of Time Unit of measure associated with the time component of the flow rate.

Example

For a flow rate of USGPH, the Totalizer Unit would be USGAL, and the Flow Unit of Time would be Hours.

The flow unit is displayed on the communication device for convenience when you configure totalized flow on a communication device.

Direction

The totalizer can be configured to support the following flow orientations:

Forward Flow	Only tracks flow in the forward direction (positive differential pressure).
Reverse Flow	Only tracks flow in the reverse direction (negative differential pressure).
Gross Flow	Gross Flow = Forward Flow + Reverse Flow
Net Flow	Net Flow = Forward Flow - Reverse Flow

Max Value

The maximum value that the totalizer can measure is displayed.

Unit Conversion Factor

Used to define a totalizer specific unit of measure.

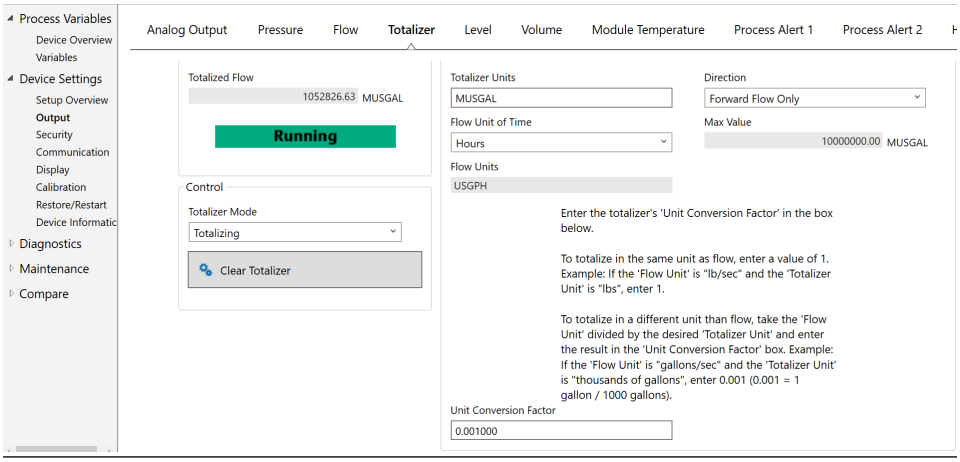
Example If the unit you input is USGPH, and your desired totalizer value is thousands of USGAL, MUSGAL, a conversion factor of 0.001 would convert USGAL to MUSGAL. If your desired totalizer value is USGAL, use a Unit Conversion Factor of `1`.

Configure for Totalized Flow using a communication device

Procedure

1. Go to **Device Settings** → **Output** → **Totalizer** → **Setup**.

Figure 2-6: AMS configuration screen for flow *Totalizer* example



2. Once the totalizer is configured and you are ready to begin totalizing, do the following:
   a) Go to **Device Settings** → **Output** → **Totalizer** → **Control**.
   b) Set the **Totalizer Mode** value to Stopped.
   c) Run the **Clear Totalizer** method.
   d) Set the **Totalizer Mode** value to Totalizing.

Note
If either the hardware **Security** switch or the software **Security** setting is On, it is not possible to clear the totalizer.

2.6.3 Configuring for level

With level configuration, you can convert your pressure transmitter to output in level units by creating a relationship between the measured pressure units and the desired level units.

To define this relationship directly, enter the maximum pressure at the maximum level and the minimum pressure at the minimum level.

To simplify configuration and to capture the unique applications that are associated with level measurement, Emerson recommends using the built-in level configurator to quickly and easily configure the transmitter to measure level.

Level configuration parameters

The level configurator calculates the relationship between pressure and level using the following parameters:

Level Units	User-selectable units for level measurement
Tank Configuration	Vented or pressurized tank
Technology	Selection is dependent on tank configuration. • Capillary Remote Seal(s) • Direct Mount • Impulse Piping (wet or dry leg)
Maximum Level	Maximum level that can be measured
Minimum Level	Minimum level that can be measured
Process Fluid Specific Gravity	Specific gravity of the process fluid

If applicable:

Pressure Tap Configuration	Vertical distance between high side process connection and transmitter
Fill Fluid	Fill fluid used with remote seal capillary system
Wet Leg	Height of low pressure wet leg
Wet Leg Specific Gravity	Specific gravity of the wet leg

Configure for level

Procedure

Go to **Device Settings** → **Output** → **Level** → **Level Configurator**

Adjust level reading

After configuring level, you can use adjust level reading to change the transmitter level reading to match a desired level. This adjustment can be used to eliminate the effects of various installation variables, such as ambient temperature effects or distance measurement errors.

Procedure

Go to **Device Settings** → **Output** → **Level** → **Calibration** → **Adjust Level Reading**.

Configure for level example

Use a differential pressure Rosemount 3051C with two remote seals on a pressurized tank installation where it will measure level.

The tank has a direct mount seal transmitter on the high side and a low side remote seal with capillary connection with Silicone 200 fill fluid. The process fluid is water with a specific gravity of 1. The transmitter is mounted on the lower tap, which is defined as zero level, and the low-side seal is mounted 10 feet above. The **Level Configurator** method walks you through the configuration to establish the pressure at both minimum and maximum level.

Figure 2-7: *Level Configurator unit information* screen

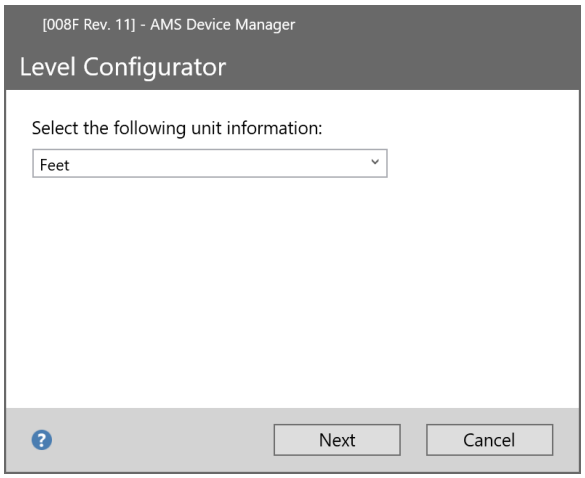


Figure 2-8: *Level Configurator tank configuration* screen

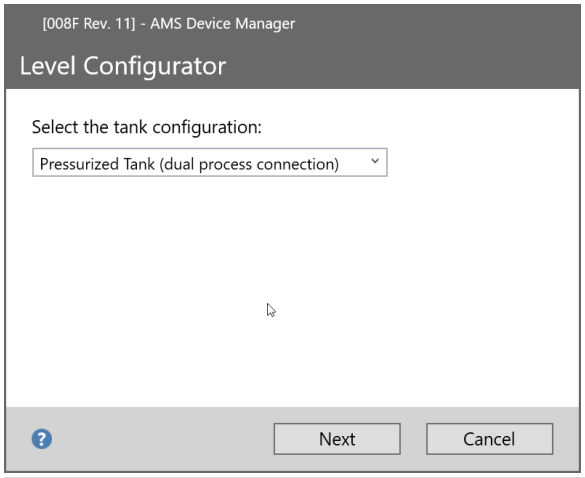


Figure 2-9: *Level Configurator technology* screen

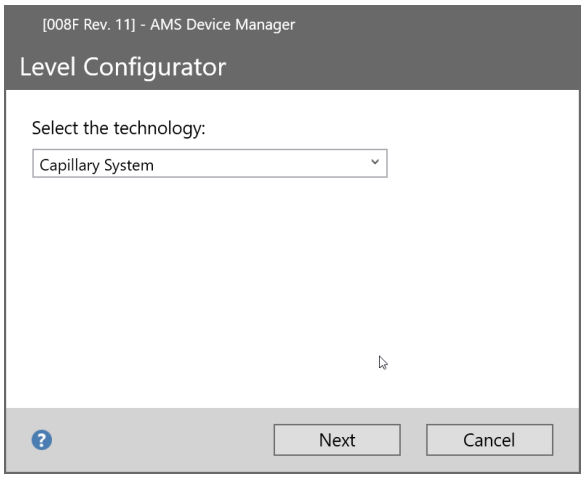
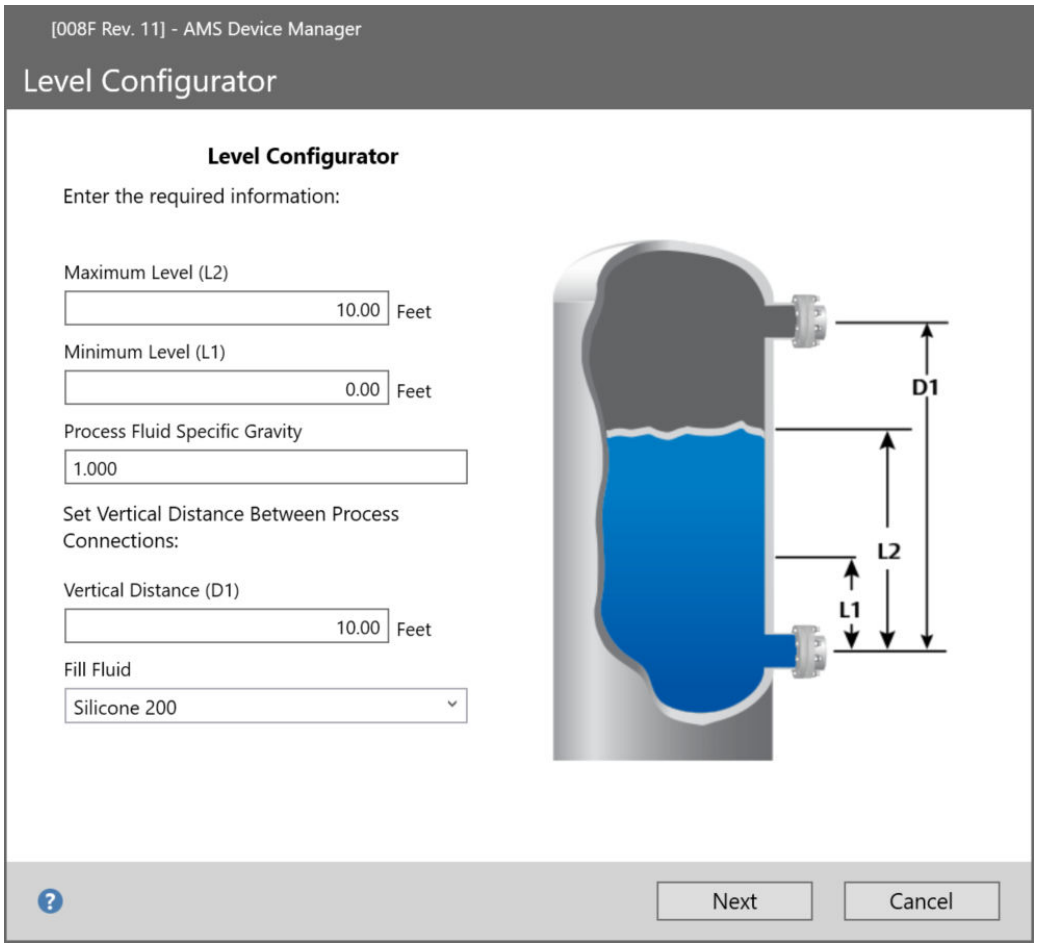
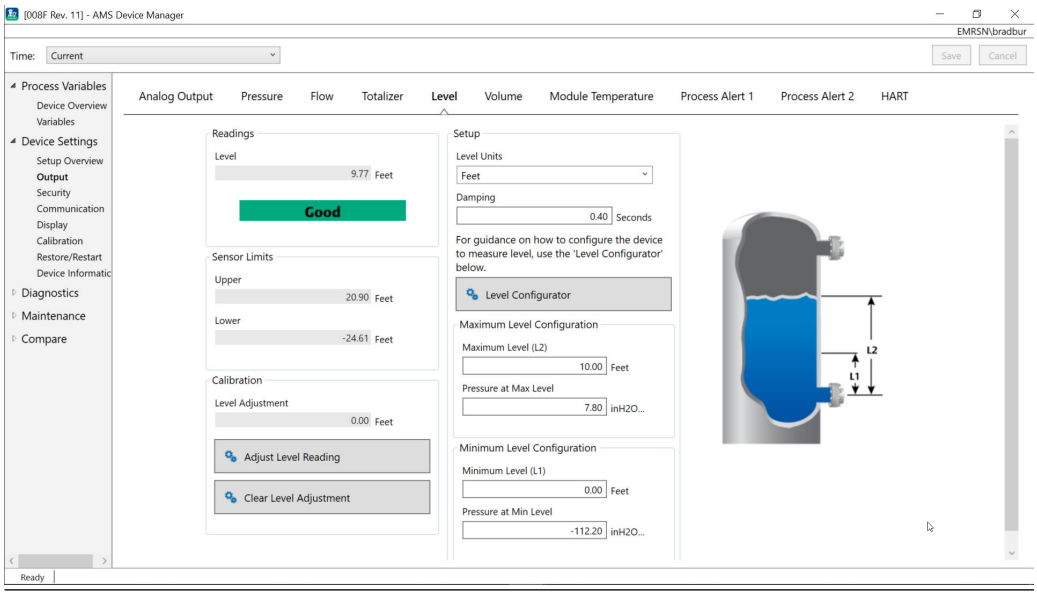


Figure 2-10: *Level Configurator Water Return* screen



After you complete the Level Configurator method, you can view the ***Level Output*** screen to confirm that the values are set as expected.

Figure 2-11: *Level* Output screen



You can use the **Adjust Level Reading** method to adjust the level reading by up to (20.90 - (-24.61))* 0.03 = 1.37 feet. In this example, you could adjust the level up to 11.14 feet maximum or down to 8.4 feet minimum from its current value of 9.77 feet. To adjust further, you would need to manually update the ***Minimum Level Configuration*** and/or ***Maximum Level Configuration*** to correct the output to the desired value.

2.6.4 Configuring for volume

Use the Configure Tank method to configure your pressure transmitter to output in volume units.

This method allows you to select from one of five standard tank geometries or to configure the device with a strapping table to create a relationship between level and volume.

Volume configuration parameters

You can configure volume to use any one of five standard tank geometries to calculate volume as a function of level.

Standard tank geometries assume that zero level is at the geometric bottom of the tank to accurately calculate the volume of the entire tank. If your zero level point is above the geometric bottom of the tank, you can correct your volume reading in one of the following ways:

- Adjust the level reading on the ***Level Configuration*** window.
- Use a strapping table to configure the level and volume relationship.

The **Configure Tank** method creates a relationship between level and volume using the following parameters:

Tank type User-selectable tank geometry
- **Sphere**
- **Vertical bullet**

- **Horizontal bullet**
- **Vertical cylinder**
- **Horizontal cylinder**
- **Custom**

Volume units	User-selectable units for volume measurement
Level units	User-selectable units for level measurement. Level unit selection changes in this method will update the level output.
Tank length (L)	Length of the tank, not required for a sphere or custom tank type
Tank radius (R)	Radius of the tank, not required for custom tank type

Parameters for custom tank type

Number of strapping points	Number of user-entered points to relate level to volume. 2 minimum and 50 maximum.
Level and volume	For each strapping point, enter a level and volume.

Note
Values for **Level** and **Volume** must be greater than zero. Entries for each strapping point must have increasing values for both **Level** and **Volume** and must not exceed maximum level.

Levels below the **Level** entry on **Strapping Point 1** will output the volume on **Strapping Point 1**. Levels above the highest level on the strapping table will output the highest volume entered. In either case, the **Volume** reading will show a **Degraded** status to alert you of the problem.

Configure for volume using a communication device

Procedure

Go to **Device Settings** → **Output** → **Volume** → **Setup** → **Configure Tank**.

2.7 Detailed transmitter setup

2.7.1 Configuring alarm and saturation values

In normal operation, the transmitter drives the output in response to pressure from the lower and upper saturation points. If the pressure goes outside of the sensor limits, or if the output would be beyond the saturation points, the output will be limited to the associated saturation point.

The Rosemount 3051 Transmitter automatically and continuously performs self-diagnostic routines. If the self-diagnostic routines detect a failure, the transmitter drives the output to configured alarm and value based on the position of the alarm switch. See Move Alarm switch.

Table 2-6: Rosemount 3051 alarm and saturation values

Level	4-20 mA saturation	4-20 mA alarm
Low	3.9 mA	≤ 3.75 mA
High	20.8 mA	≥ 21.75 mA

Table 2-7: NAMUR-compliant alarm and saturation values

Level	4-20 mA saturation	4-20 mA alarm
Low	3.8 mA	≤ 3.6 mA
High	20.5 mA	≥ 22.5 mA

Table 2-8: Custom alarm and saturation values

Level	4-20 mA saturation	4-20 mA alarm
Low	3.7 - 3.9 mA	3.6 - 3.8 mA
High	20.1 - 22.9 mA	20.2 - 23.0 mA

- Low alarm level must be at least 0.1 mA less than the low saturation level.
- High alarm level must be at least 0.1 mA higher than the high saturation level.

Configure alarm and saturation values with a communication device

Procedure

Go to **Device Settings** → **Setup Overview** → **Alarm and Saturation Values** → **Configure Alarm and Saturation Values**.

Configure alarm and saturation values with the Local Operator Interface (LOI)

Procedure

1. Click either button to activate the LOI.
2. Go to **Extended Menu** → **Alarm Sat Values**.

2.7.2 Configuring process alerts

There are two process alerts that you can configure to use with any dynamic process variable.

Dynamic process variables:

- **Pressure**
- **Flow Rate**
- **Totalizer**
- **Level**
- **Volume**
- **Module Temperature**

The process alerts are independent of each other. You can use these alerts to receive notifications via HART® Status Alert or via **Analog Output alarm**. Process alerts can be triggered with any dynamic variable, regardless of the HART variable assignments. This means that an **Analog Output Alarm** can be triggered by any of the dynamic process variables listed above, even if they are not assigned to be the HART primary variable.

Process alert configuration parameters

Use the **Configure Process Alert** method to configure each process alert. You can configure the following parameters.

Notification Mode

Sets the method of notification or disables the process alert.

- **Disable Alert**
- **HART Status Alert**
- **Analog Output Alarm**

Monitored Device Variable

The dynamic variable that the process alert tracks.

- **Pressure**
- **Flow Rate**
- **Totalizer**
- **Level**
- **Volume**
- **Module Temperature**

Activation Trigger

Activates the process alert when the dynamic variable is one of the following:

- **Above High Side**
- **Below Low Side**
- **Inside Window**
- **Outside Window**

High Alert Value

When the **Monitored Device Variable** crosses this high threshold, the process alert will take the configured action. (Not used for **Below Low Side** activation trigger).

Low Alert Value

When the **Monitored Device Variable** value crosses this low threshold, the process alert will take the configured action. (Not used for **Above High Side** activation trigger).

Sporadic Alert Reduction

Two different approaches to prevent repeated activation or deactivation of the process alert when the dynamic process variable is fluctuating near one of the alert thresholds.

Deadband	A user-defined range, entered in the same units as the **Monitored Device Variable**, beyond the **Alert Value** trigger when a process alert will not be enunciated.
Time Delay	A user-defined amount of time (30 seconds maximum) after alert detection when the process alert will not be enunciated.
Alert Name	The name that will be shown for the alert on the device display.

NOTICE

The **High Alert Value** must be higher than the **Low Alert Value**. Both alert values must be within the range limits of the dynamic process variable.

Configure process alerts with a communication device

Procedure

Go to **Device Settings** → **Output** → **Process Alert (1 or 2)** → **Alert Settings** → **Configure Process Alert (1 or 2)**.

2.7.3 Re-mapping device variables

Use the re-mapping function to configure the transmitter primary, secondary, tertiary, and quaternary variables (PV, SV, TV, and QV).

You can use the Local Operator Interface (LOI) to select the primary variable. However, you must use a Field Communicator, AMS Device Manager, or the AMS Device Configurator Bluetooth® app to set the SV, TV, and QV.

Note
The variable assigned as the primary variable drives the 4-20 mA output. Possible primary variables include:

- **Pressure**
- **Level**
- **Volume**
- **Flow**
- **Totalizer**

Re-map device variables using a communication device

Procedure

1. Select the primary variable by going to **Device Settings** → **Output** → **Analog Output** → **PV Setup** → **Primary Variable**.
2. Map the secondary variable, tertiary variable, and quaternary variable by going to **Device Settings** → **Communication** → **HART** → **Variable Mapping**.

Re-map the primary variable with the Local Operator Interface (LOI)

Procedure

1. Click either button to activate the LOI.
2. Go to **Extended Menu** → **Assign PV**.

2.8 Configure via Bluetooth® wireless technology

Procedure

1. Launch AMS Device Configurator.

See AMS Device Configurator for Emerson Field Devices.

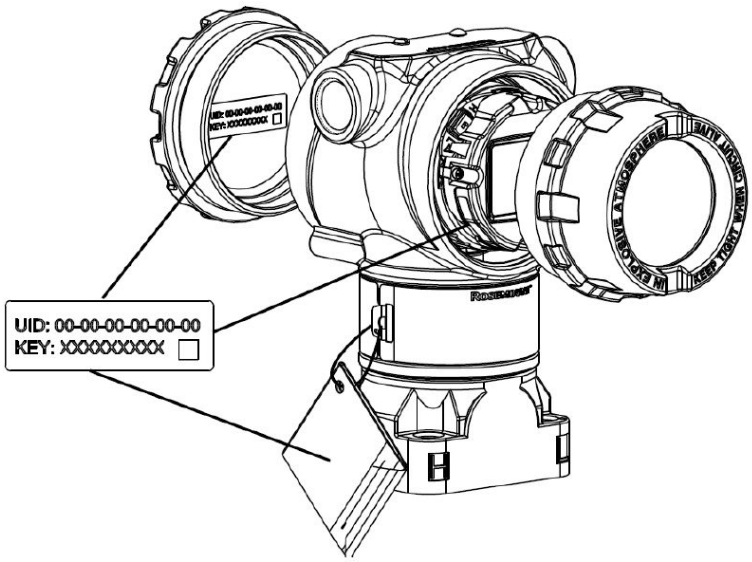
2. Select the device where you want to connect.
3. On first connection, enter the key for selected device.
4. At the top left, select the menu icon to navigate the desired device menu.

2.8.1 Bluetooth® UID and key

You can find the Unique Identifier (UID) and key on the disposable paper tag attached to:

- The device
- The terminal block cover
- The display unit

Figure 2-12: Bluetooth security information



2.9 Configuring transmitter diagnostics

The diagnostics and service functions in this section are primarily for use after field installation.

2.9.1 Configuring the loop integrity diagnostic

You can use the loop integrity diagnostic to detect issues that may jeopardize the integrity of the electrical loop.

Some examples are:

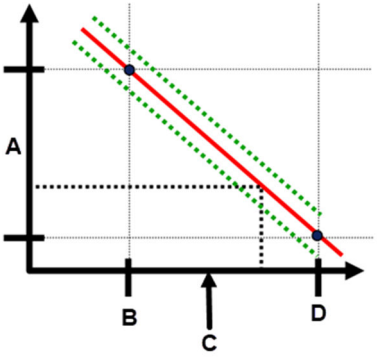
- Water entering the wiring compartment and making contact with the terminals
- An unstable power supply nearing end of life
- Heavy corrosion on the terminals

The technology is based on the premise that once a transmitter is installed and powered up, the electrical loop has a baseline characteristic that reflects the proper installation.

If the transmitter terminal voltage deviates from the baseline and outside the user configured threshold, the transmitter can generate a HART® alert or analog alarm.

To use the diagnostic, you must first create a baseline characteristic for the electrical loop after installing the transmitter. The loop is automatically characterized with the push of a button. This creates a linear relationship for expected terminal voltage values along the operating region from 4-20 mA. See Figure 2-13.

Figure 2-13: Baseline operating region



A. Terminal voltage
B. 4 mA
C. Output current
D. 20 mA

Overview

Emerson ships the transmitter with **Loop Integrity** off as default and without any loop characterization performed. Once the transmitter is installed and powered up, you must perform a loop characterization for the Loop Integrity diagnostic to function.

When you initiate a loop characterization, the transmitter will check to see if the loop has sufficient power for proper operation. Then the transmitter will drive the analog output to both 4 and 20 mA to establish a baseline and determine the maximum allowable terminal voltage deviation. Once this is complete, you enter a sensitivity threshold called **Terminal Voltage Deviation Limit**, and a check is in place to ensure this threshold value is valid.

Once you have characterized the loop and set the Terminal Voltage Deviation Limit, the Loop Integrity diagnostic actively monitors the electrical loop for deviations from the baseline. If the terminal voltage has changed relative to the expected baseline value, exceeding the configured Terminal Voltage Deviation Limit, the transmitter can generate an alert or alarm.

NOTICE

The loop integrity diagnostic in the Rosemount 3051 Pressure Transmitter with Advanced HART® Diagnostics monitors and detects changes in the terminal voltage from expected values to detect common failures. It is not possible to predict and detect all types of electrical failures on the 4-20 mA output. Therefore, Emerson cannot absolutely warrant or guarantee that the loop integrity diagnostic will accurately detect failures under all circumstances.

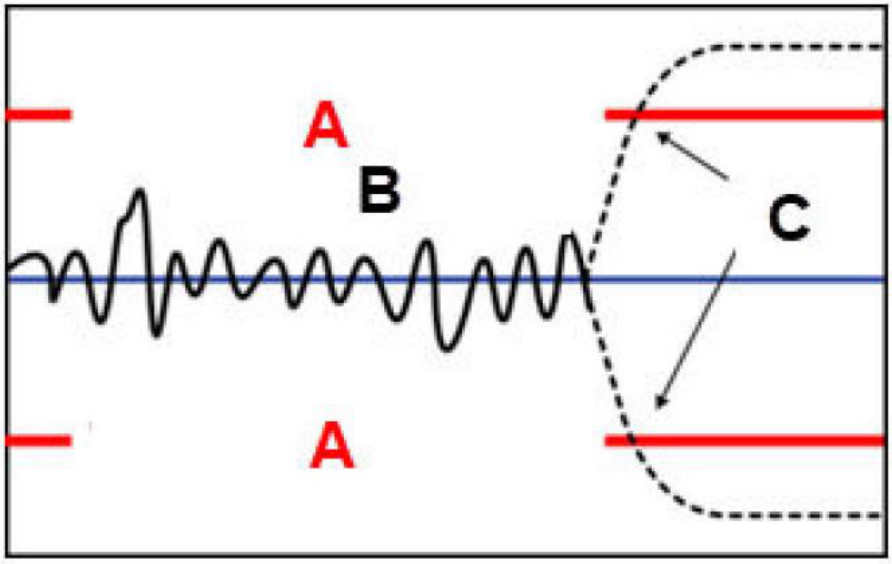
Terminal voltage

This field shows the current terminal voltage value in volts. the terminal voltage is a dynamic value and is directly related to the mA output value.

Terminal voltage deviation limit

Set the terminal voltage deviation limit large enough that expected voltage changes do not cause false failures.

Figure 2-14: Voltage deviation limit



A. Voltage deviation limit
B. Terminal voltage
C. Alert

NOTICE

Changes in electrical loop

Severe changes in the electrical loop may inhibit HART® communication or the ability to reach alarm values. Therefore, Emerson cannot absolutely warrant or guarantee that the correct Failure alarm level (High or Low) can be read by the host system at the time of annunciation.

Resistance

This value is the calculated resistance of the electrical loop (in Ωs) measured during the characterize loop procedure. Changes in the resistance may occur due to changes in the physical condition of the loop installation. You can compare baseline and previous baselines to see how much resistance has changed over time.

Power supply

This value is the calculated power supply voltage of the electrical loop (in volts) measured during the characterize loop procedure. Changes in this value may occur due to degraded

performance of the power supply. You can compare baseline and previous baselines to see how much the power supply has changed over time.

Characterize loop

You must initiate loop characterization after installing the transmitter for the first time or after intentionally altering electrical loop characteristics.

Examples include:

- Modifying power supply level or loop resistance of the system
- Changing the terminal block on the transmitter
- Adding the Wireless THUM™ Adapter to the transmitter

Note
Emerson does not recommend the loop integrity diagnostic for transmitters operating in multidrop mode.

Loop integrity action

When the voltage deviation exceeds the set limit, you can configure three possible actions:

- **Disable Diagnostic**
- **HART Status Alert**
- **Analog Output Alarm**

The alert or alarm setting is unlatched. If the voltage deviation returns to within the allowed voltage deviation limit due to changes in the loop characteristics, the alert will be cleared from active alerts but will still appear in the diagnostic log.

Configure loop integrity diagnostic using a communication device

Procedure

Go to **Diagnostics** → **Alerts** → **Loop Integrity Diagnostic** → **Settings** → **Configure Loop Integrity**.

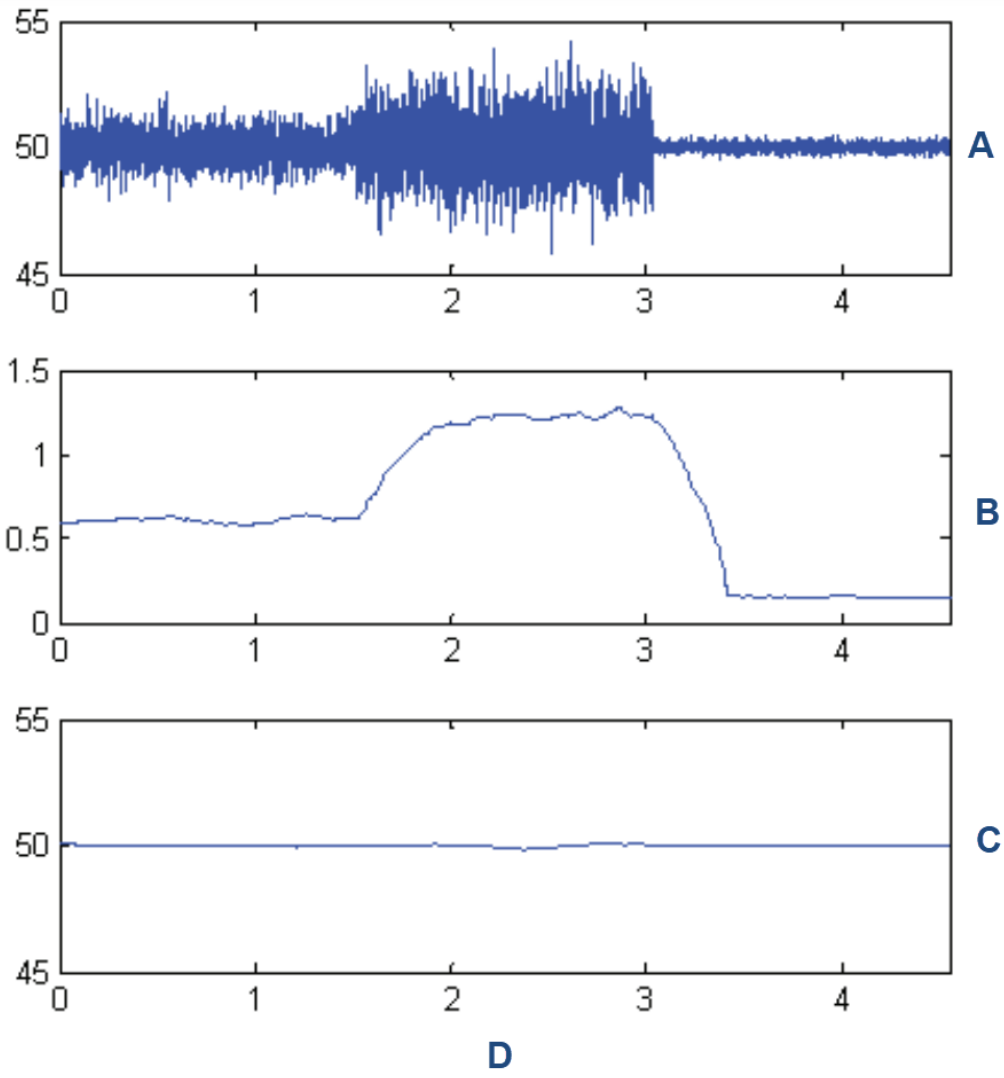
2.9.2 Configuring plugged impulse line diagnostic

The plugged impulse line diagnostics provides a means to detect plugged impulse lines early.

The technology is based on the premise that all dynamic processes have a unique noise or variation signature when operating normally. Changes in these signatures may signal that a significant change will occur or has occurred in the process. The sensing of the unique signature uses software in the electronics to compute statistical parameters that characterize and quantify the noise or variation. These statistical parameters are the mean, standard deviation, and coefficient of variation (ratio of standard deviation to mean) of the input pressure.

The transmitter has a filtering capability to separate slow changes in the process due to set point changes from the process noise or variation of interest.

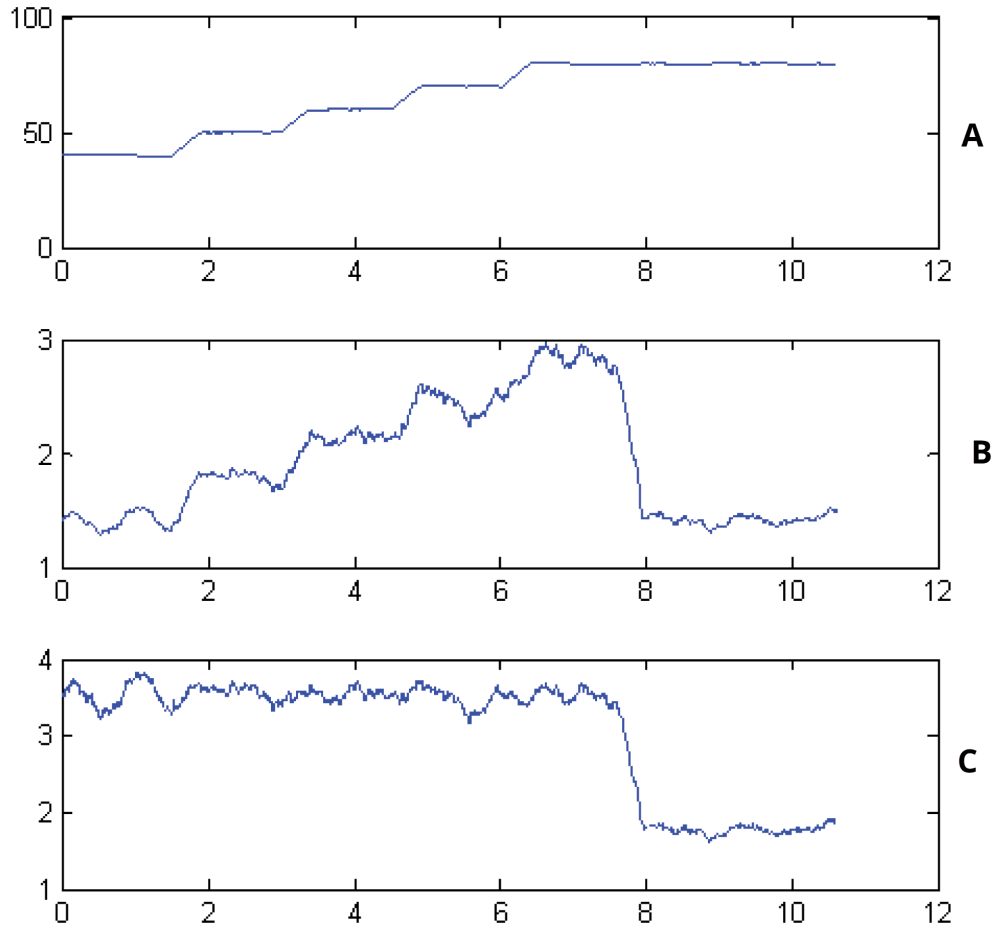
Figure 2-15: Changes in process noise or variability and effect on statistical parameters



A. Process noise
B. Standard deviation
C. Mean
D. Time (minutes)

Note
Standard deviation increases or decreases with changing noise level.

Figure 2-16: Coefficient of variation (CV) is the ratio of standard deviation to mean



CV is stable if mean is proportional to standard deviation.

A. Mean
B. Standard deviation
C. Coefficient of variation

Typical applications for the plugged line impulse diagnostic include detecting abnormal process connection conditions, such as:

- Plugged impulse lines
- Process leaks
- Coated or plugged Rosemount Annubar

Configure plugged impulse line diagnostic with a communication device.

To configure the plugged line impulse diagnostic, follow a simple method in the transmitter software.

Procedure

1. Go to **Diagnostics** → **Alerts** → **Plugged Impulse Line Diagnostic** → **Settings** → **Configure Plugged Impulse Line Diagnostic**.
2. Select a notification mode:
   - **HART alert**
   - **Analog Output Alarm**
3. Select if the transmitter is installed in a flow application or not.
   The software chooses to use the standard deviation or coefficient of variation based on the application. Then the software determines if the transmitter is installed in an active running process, and it will ensure that there is enough noise to configure the diagnostic.
4. Once the diagnostic is configured, you can adjust the level of sensitivity to meet application specific conditions.

   You can set the sensitivity at:
   - **Low**
   - **Medium**
   - **High**

2.10 Performing transmitter tests

2.10.1 Verifying alarm level

If the transmitter electronics board, sensor module, or display is repaired or replaced, verify the transmitter alarm level before returning the transmitter to service. This is useful in testing the reaction of the control system to a transmitter in an alarm state, thus ensuring that the control system recognizes the alarm when activated.

To verify the transmitter alarm values, perform a loop test and set the transmitter output to the alarm value (see Table 2-6 through Table 2-8).

2.10.2 Performing an analog loop test

The **analog loop test** command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. Emerson recommends testing the 4-20 mA (1-5 Vdc) points in addition to alarm levels when installing, repairing, or replacing a transmitter.

The host system may provide a current measurement for the 4–20 mA (1-5 Vdc) HART® output. If it does not, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block or shunting transmitter power through the meter at some point in the loop.

Perform an analog loop test using a communication device

Procedure

Go to **Diagnostics** → **Simulation** → **Loop Test**.

Perform an analog loop test using Quick Service buttons

Procedure

1. Locate the external buttons under the top nameplate as shown in Figure 2-2.
2. Press either button to wake the menu.
3. Follow the on-screen prompt by pressing the other button.
   The ***Quick Service Button Main Menu*** opens.
4. Use the **Scroll** and **Enter** buttons to navigate to the ***Loop Test Menu***.

Perform an analog loop test using the Local Operator Interface (LOI)

Procedure

1. Click either button to activate the LOI.
2. Select **Loop Test**.

2.10.3 Simulating device variables

You can temporarily set the following variables to user-defined fixed values for testing purposes.

- **Pressure**
- **Module temperature**

Once the simulated variable method is exited, the transmitter automatically returns the process variable to a live measurement.

Simulate a device variable with a communication device

Procedure

Go to **Diagnostics** → **Simulation** → **Simulate Device Variable**.

2.10.4 Simulating primary variable

You can temporarily set the primary variable to user-defined fixed values for testing purposes. Simulating the primary variable drives the digital reading and the analog output to match the user-defined value.

You can set the primary variable to any of the following output variables:

- **Pressure**
- **Level**
- **Volume**
- **Flow rate**
- **Totalized flow**

Simulate primary variable with a communication device

Procedure

Go to **Diagnostics** → **Simulation** → **Simulate PV**.

2.11 Configuring Burst mode

Burst mode is compatible with the analog signal. Because the HART® protocol features simultaneous digital and analog data transmission, the analog value can drive other equipment in the loop while the control system is receiving digital information.

Burst mode applies only to the transmission of dynamic data and does not affect the way other transmitter data is accessed. However, when activated, **Burst** mode can slow down communication of non-dynamic data to the host by 50 percent.

The transmitter accesses information other than dynamic transmitter data through the normal poll/response method of HART® Communication. A communication device or the control system may request any of the information that is normally available while the transmitter is in **Burst** mode. Between each message sent by the transmitter, a short pause allows the communication device to initiate a request.

Message content options:

Cmd 1	**Read Primary Variable**
Cmd 2	**Read Percent Range/Current**
Cmd 3	**Read Dynamic Variables/Current**
Cmd 9	**Read Device Variables with Status**
Cmd 33	**Read Device Variables**
Cmd 48	**Read Additional Device Status**

Trigger mode options:

- **Continuous**
- **Rising**
- **Falling**
- **Windowed**
- **On change**

NOTICE

Consult host system manufacturer for **Burst** mode requirements.

2.11.1 Configure **Burst** mode using a communication device

Procedure

Go to **Device Settings** → **Output (or Communication)** → **HART** → **Burst Mode Configuration**.

2.12 Establishing multidrop communication

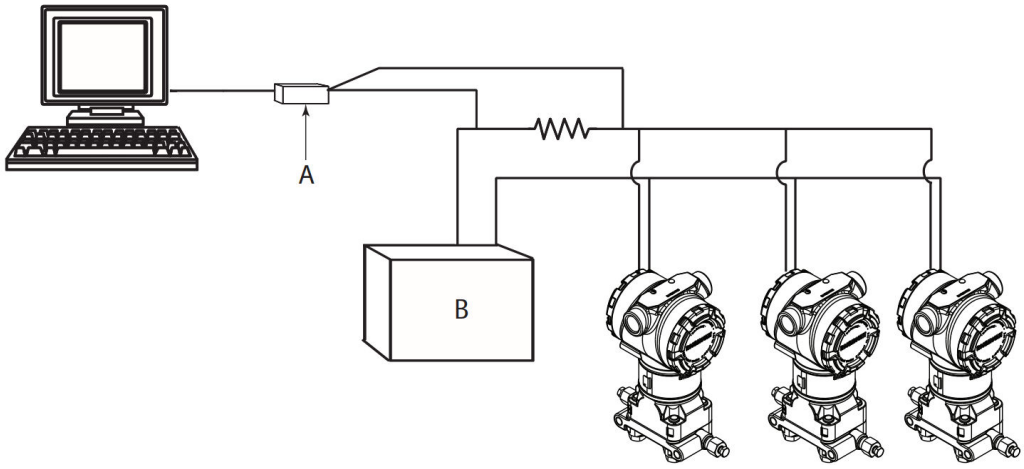
Multidrop communication refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated.

To install multidrop communication, you must consider the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. You can communicate with transmitters with HART modems and a host implementing HART protocol. Each transmitter is identified by a unique address and responds to the commands defined in the HART protocol. Communication devices, the AMS Device Manager, and the AMS Device Configurator Bluetooth® app can test, configure, and format a multidropped transmitter the same way they do for a transmitter in a standard point-to-point installation.

Figure 2-17 shows a typical multidrop network. This figure is not intended as an installation diagram.

Note
A multidrop transmitter has a fixed analog output of 4 mA for all but one device. Only one device is allowed to have an active analog signal.

Figure 2-17: Typical multidrop network



A. HART® modem
B. Power supply

Emerson sets the Rosemount 3051 to address zero (**0**) at the factory, which allows operation in the standard point-to-point manner with a 4-20 mA output signal. To activate multidrop communication, you must change the transmitter address to a number from 1 to 63. This change deactivates the 4-20 mA analog output, sending it to 4 mA. It also disables the failure mode alarm signal, which is controlled by the upscale/downscale switch position. HART messages communicate failure signals in multidropped transmitters.

2.12.1 Changing a transmitter address

To activate multidrop communication, assign the transmitter poll address to a number from 1 to 63.

Each transmitter in a multidropped loop must have a unique poll address.

Change a transmitter address using a communication device

Procedure

Go to **Device Settings** → **Output (or Communication)** → **HART** → **Communication Settings** → **Change Polling Address**.

2.12.2 Communicating with a multidropped transmitter

To communicate with a multidropped transmitter, set up the communication device or AMS Device Manager for polling.

Communicate with a multidropped transmitter using a communication device

To set up a communication device for polling:

Procedure

1. Go to **Utility** → **Configure HART Application**.
2. Select **Polling Addresses**.
3. Enter `0-63`.

Communicate with a multidropped transmitter using AMS Device Manager

Procedure

1. Click the **HART** modem icon.
2. Select **Scan All Devices**.

3 Hardware installation

3.1 Overview

The information in this section covers installation considerations for the Rosemount 3051 with HART® protocol. Emerson ships a Quick Start Guide with every transmitter to describe recommended pipe-fitting and wiring procedures for each initial installation.

Dimensional drawings for each Rosemount 3051 variation and mounting configuration are included in Mounting brackets.

Related information

Disassembling the transmitter
Reassemble the transmitter

3.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of personnel performing the operation.

Refer to Safety messages.

3.3 Considerations

3.3.1 Installation considerations

Measurement accuracy depends upon proper installation of the transmitter and impulse piping. Mount the transmitter close to the process and use a minimum of piping to achieve best accuracy. Keep in mind the need for easy access, personnel safety, practical field calibration, and a suitable transmitter environment. Install the transmitter to minimize vibration, shock, and temperature fluctuation.

3.3.2 Environmental considerations

The best practice is to mount the transmitter in an environment that has minimal ambient temperature change.

The transmitter electronics operating temperature limits are -40 to +185 °F (-40 to +85 °C). Refer to the Specifications section in the Rosemount 3051 Pressure Transmitter Product Data Sheet to view the sensing element operating limits. Mount the transmitter so it is not susceptible to vibration and mechanical shock and does not have external contact with corrosive materials.

3.3.3 Mechanical considerations

Steam service

For steam service or for applications with process temperatures greater than the limits of the transmitter, do not blow down impulse piping through the transmitter. Flush lines with the blocking valves closed and refill lines with water before resuming measurement.

Refer to #unique_115/unique_115_Connect_42_RFIXbq14512 for correct mounting orientation.

Side mounted

When the transmitter is mounted on its side, position the Coplanar™ flange to ensure proper venting or draining.

Mount the flange as shown in #unique_115/unique_115_Connect_42_RFIXbq14512, keeping drain/vent connections on the bottom for gas service and on the top for liquid service.

3.3.4 Draft range considerations

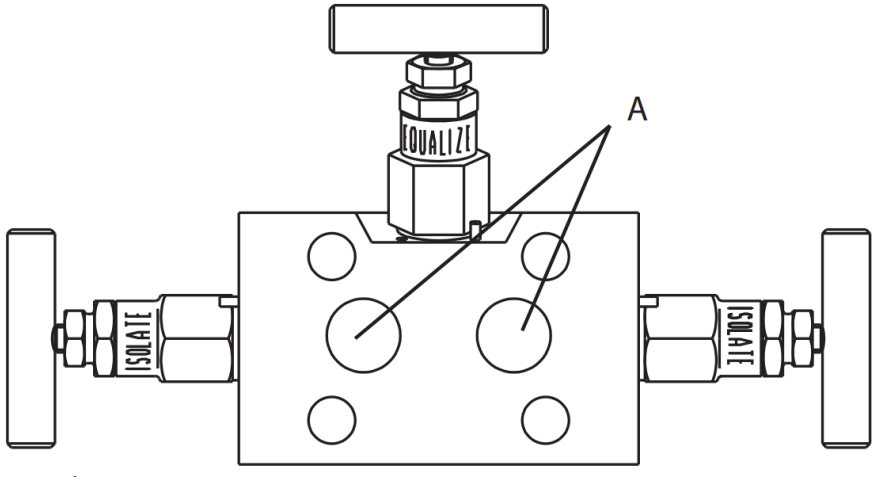
Installation

For the Rosemount 3051CD0 Draft Range Pressure Transmitter, Emerson recommends mounting the transmitter with the isolators parallel to the ground.

See Figure 3-1 for a draft range installation example on a Rosemount 304 manifold. Installing the transmitter in this way reduces oil head effect.

Tilting of the transmitter may cause a zero shift in the transmitter output, but you can eliminate this by performing a trim procedure.

Figure 3-1: Draft range installation example



A. Isolators

Reducing process noise

Rosemount 3051CD0 draft transmitters are sensitive to small pressure changes. Increasing the damping will decrease output noise, but will further reduce response time. In gauge applications, it is important to minimize pressure fluctuations to the low side isolator.

Output damping

At the factory, Emerson sets the output damping for the Rosemount 3051CD0 to **3.2**. If the transmitter output is still noisy, increase the damping time. If you need a faster response, decrease the damping time. See Damping for damping adjustment information.

Reference side filtering

In gauge applications, it is important to minimize fluctuations in atmospheric pressure to which the low side isolator is exposed.

One method of reducing fluctuations in atmospheric pressure is to attach a length of tubing to the reference side of the transmitter to act as a pressure buffer.

3.4 Installation procedures

3.4.1 Mounting the transmitter

For dimensional drawing information refer to the *Dimensional Drawings* section of the Rosemount 2051 Product Data Sheet.

Process flange orientation

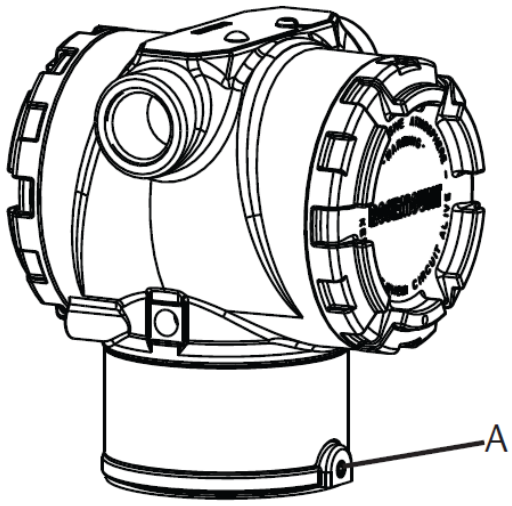
Mount the process flanges with sufficient clearance for process connections. For safety reasons, place the drain/vent valves so the process fluid is directed away from possible human contact when the vents are used. In addition, consider the need for a testing or calibration input.

Note
Most transmitters are calibrated in the horizontal position. If you mount the transmitter in any other position, the zero point will shift to the equivalent amount of liquid head pressure caused by the varied mounting position. To reset zero point, refer to Sensor trim overview.

Rotate housing

You can rotate the electronics housing up to 180 degrees in either direction to improve field access or to better view the optional LCD/Local Operator Interface (LOI) display.

Figure 3-2: Transmitter housing set screw



A. Housing rotation set screw (5/64 in.)

Procedure

1. Loosen the housing rotation set screw using a 5/64-in. hex wrench.

   Note
   Transmitter damage
   - Over-rotating can damage the transmitter.
   - Do not rotate the transmitter more than 180 degrees.

2. Turn the housing left or right up to 180 degrees from its original position.(3)
3. Re-tighten the housing rotation set screw.

Electronics housing clearance

Mount the transmitter so the terminal side is accessible.

To remove the cover, ensure there is clearance of 0.75 in. (19 mm). Use a conduit plug in the unused conduit opening. You need 3 in. (76 mm) of clearance to remove the cover if a meter is installed.

Environmental seal for housing

For NEMA® 4X, IP66, and IP68 requirements, use thread sealing PTFE tape or paste on male threads of conduit to provide a water and dust tight seal.

Always ensure a proper seal by installing the electronics housing cover(s) so that metal contacts metal. Use Rosemount O-rings.

Flange bolts

Emerson can ship the Rosemount 3051 with a coplanar flange or a traditional flange installed with four 1.75-in. flange bolts.

See Table 3-1 and Figure 3-3 for mounting bolts and bolting configurations for the coplanar and traditional flanges. Emerson supplies stainless steel bolts coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. Do not apply additional lubrication when installing either type of bolt. Bolts supplied by Emerson are identified by their head markings.

Bolt installation

⚠ WARNING

Spare parts

Replacement equipment or spare parts not approved by Emerson for use as spare parts could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.

Use only bolts supplied or sold by Emerson as spare parts.

Table 3-1: Bolt installation torque values

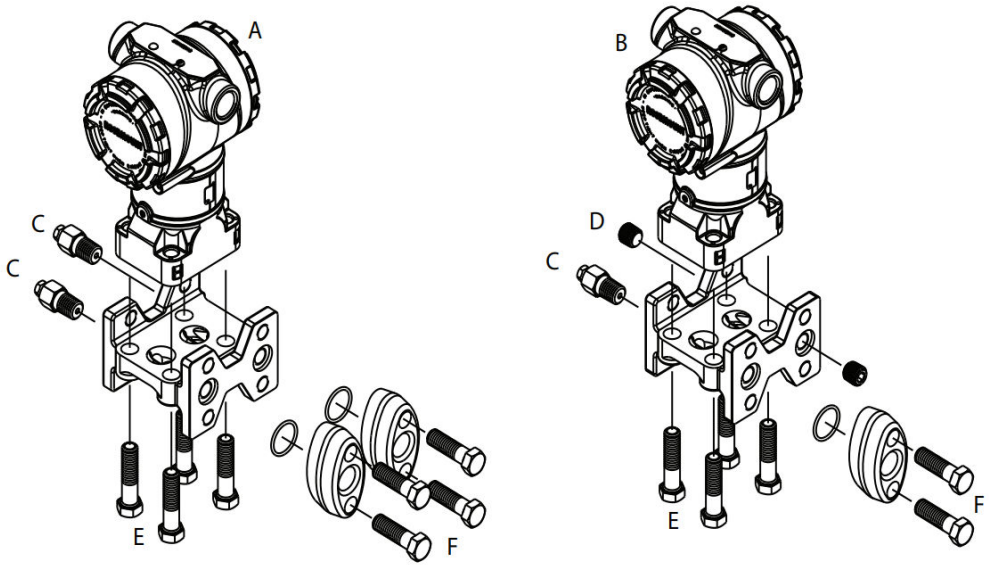
Bolt material	Initial torque value	Final torque value
CS-(ASTM-A445) standard	300 in-lb (34 N-m)	650 in-lb (73 N-m)

*(3) Rosemount 3051C original position aligns with **H** side; Rosemount 3051T original position is the opposite side of bracket holes.*

Table 3-1: Bolt installation torque values *(continued)*

Bolt material	Initial torque value	Final torque value
Austemitic 316 stainless steel (SST)—Option L4	150 in-lb (17 N-m)	300 in-lb (34 N-m)
ASTM A193 Grade B7M—Option L5	300 in-lb (34 N-m)	650 in-lb (73 N-m)

Figure 3-3: Traditional flange bolt configurations

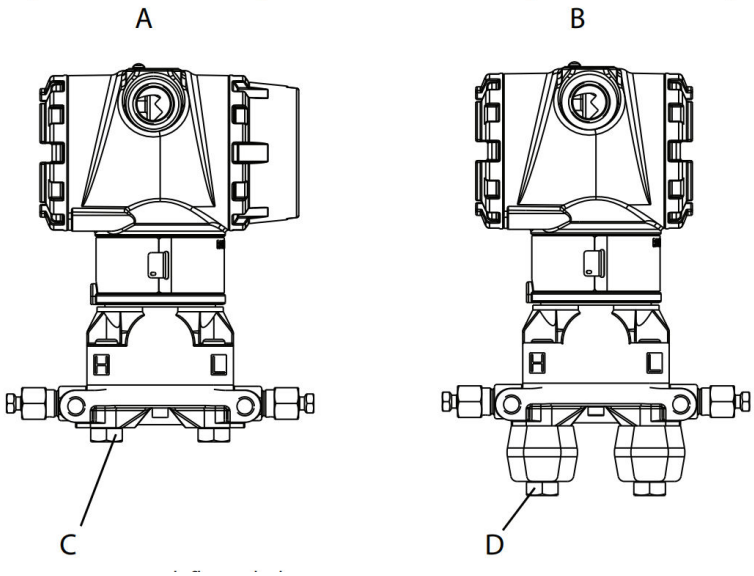


A. Differential transmitter
B. Gauge/absolute transmitter
C. Drain/vent
D. Vented fitting
E. 1.75 in. (44 mm) x 4
F. 1.50 in. (38 mm) x 4[(4)]

Dimensions are in inches (millimeters).

(4) For gauge and absolute transmitters: 150 (38) x 2

Figure 3-4: Mounting bolts and bolt configurations for coplanar flange



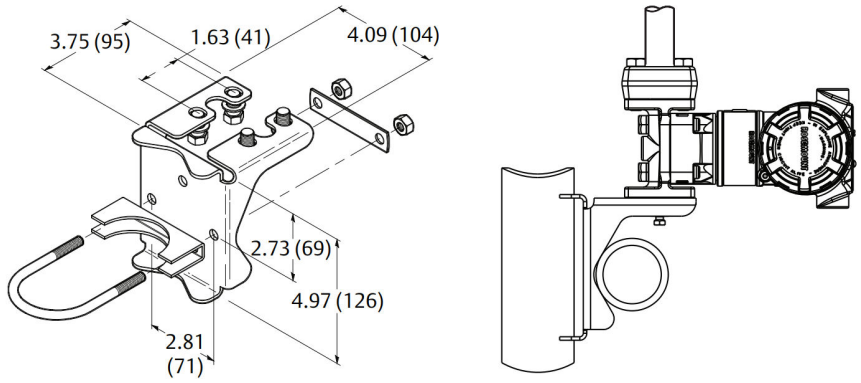
A. Transmitter with flange bolts
B. Transmitter with flange adapters and flange/adapter bolts
C. 1.75 (44) x 4
D. 2.88 (73) x 4

Note
Dimensions are in inches (millimeters).

Description	Quantity	Size
Differential pressure		
Flange bolts	4	1.75 in. (44 mm)
Flange/adapter bolts	4	2.88 in. (73 mm)
Gauge/absolute pressure (1)		
Flange bolts	4	1.75 in. (44 mm)
Flange/adapter bolts	2	2.88 in. (73 mm)

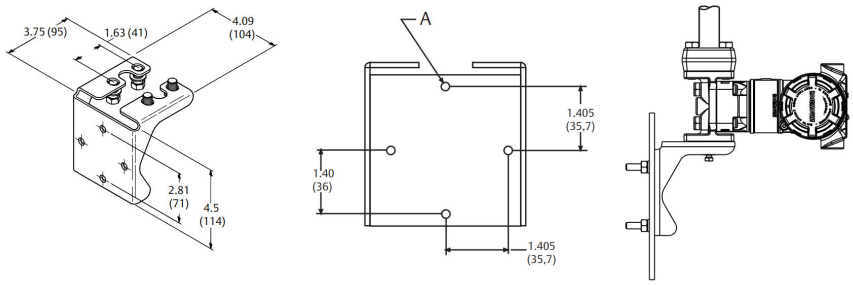
(1) Rosemount 3051T Transmitters are direct mount and do not require bolts for process connection.

Figure 3-5: Mounting bracket option codes B1, B7, and BA



Note
Dimensions are in inches (millimeters).

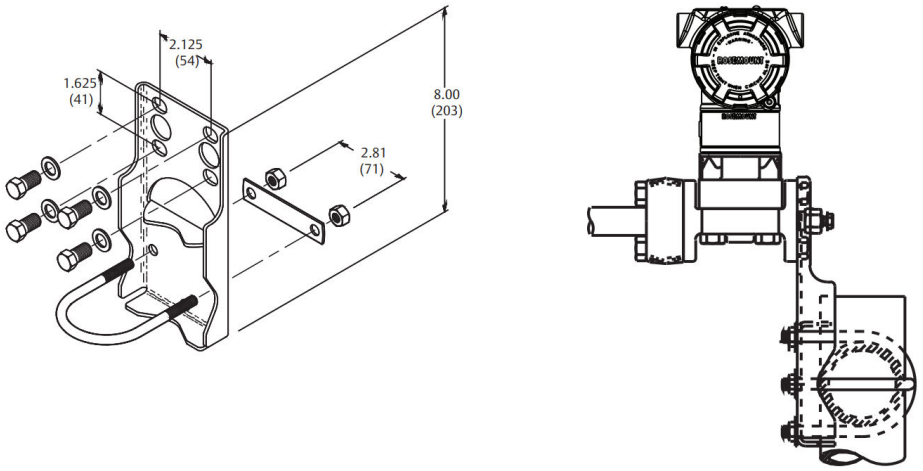
Figure 3-6: Panel mounting bracket option codes B2 and B8



A. Mounting holes 0.375 diameter (10)

Note
Dimensions are in inches (millimeters).

Figure 3-7: Flat mounting bracket option codes B3 and BC



Note
Dimensions are in inches (millimeters).

1. Finger-tighten the bolts.
2. Torque the bolts to the initial torque value using a crossing pattern (see Table 3-1 for torque values).
3. Torque the bolts to the final torque value using the same crossing pattern.

Mounting brackets

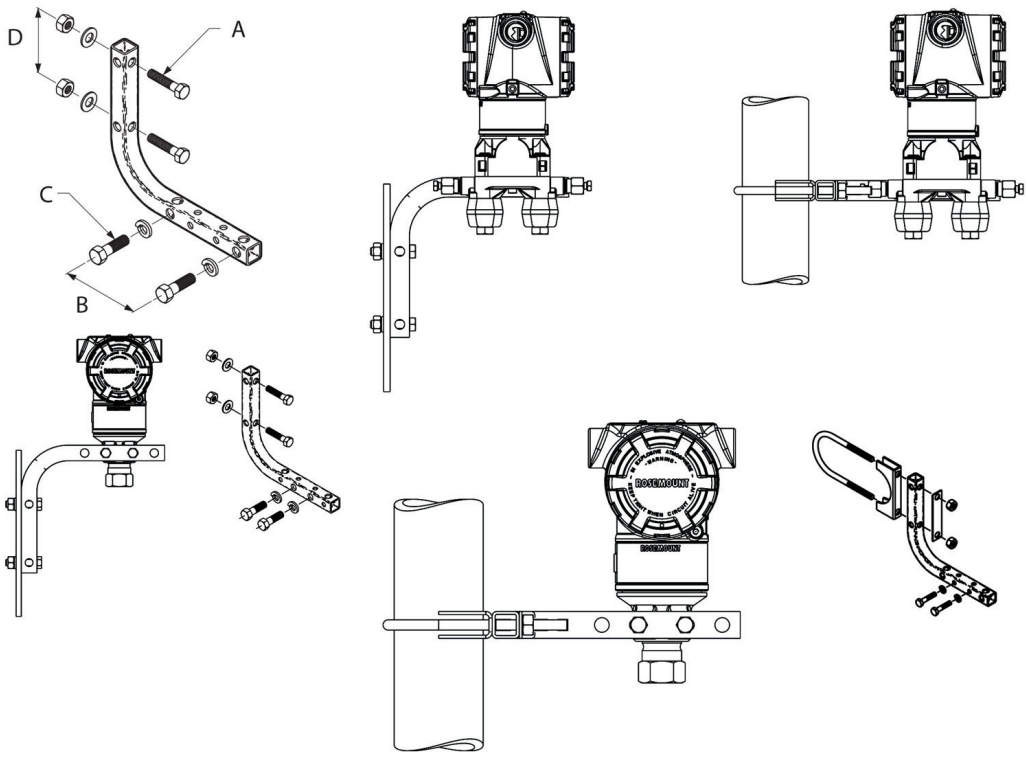
You can use an optional mounting bracket to panel mount or pipe mount the Rosemount 3051 Transmitter.

Refer to Table 3-2 for the complete offering and see Figure 3-7 and Figure 3-8 for dimensional and mounting configuration information.

Table 3-2: Mounting brackets

Option code	Process connections			Mounting			Materials			
	Co-planar	In-Line	Tradi-tional	Pipe mount	Panel mount	Flat panel mount	Carbon steel (CS) bracket	Stainless steel (SST) bracket	CS bolts	SST bolts
B4	X	X	N/A	X	X	X	N/A	X	N/A	X
B1	N/A	N/A	X	X	N/A	N/A	X	N/A	X	N/A
B2	N/A	N/A	X	N/A	X	N/A	X	N/A	X	N/A
B3	N/A	N/A	X	N/A	N/A	X	X	N/A	X	N/A
B7	N/A	N/A	X	X	N/A	N/A	X	N/A	N/A	X
B8	N/A	N/A	X	N/A	X	N/A	X	N/A	N/A	X
B9	N/A	N/A	X	N/A	N/A	X	X	N/A	N/A	X
BA	N/A	N/A	X	X	N/A	N/A	N/A	X	N/A	X
BC	N/A	N/A	X	N/A	N/A	X	N/A	X	N/A	X

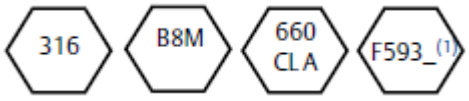
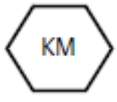
Figure 3-8: Mounting bracket option code B4



A. 5/16 x 1½-in. (38 mm) bolts for panel mounting (not supplied)
B. 3.4 in. (85 mm)
C. ⅜-in.-16 x 1¼-in. (32 mm) bolts for mounting to transmitter
D. 2.8 in. (71 mm)

Note
Dimensions are in inches (millimeters).

Table 3-3: Head markings

	Carbon steel (CS) head markings
	Stainless steel (SST) head markings (1)
	Alloy K-500 head marking

(1) The last digit in the FS93_ head marking may be any letter between A and M.

3.4.2 Impulse piping

Mounting requirements

Impulse piping configurations depend on specific measurement conditions. Refer to Figure 3-9 for examples of the following mounting configurations:

Liquid measurement

- Place taps to the side of the line to prevent sediment deposits on the transmitter's process isolators.
- Mount the transmitter beside or below the taps so gases can vent into the process line.
- Mount drain/vent valve upward to allow gases to vent.

Gas measurement

- Place taps in the top or side of the line.
- Mount the transmitter beside or above the taps so liquid will drain into the process line.

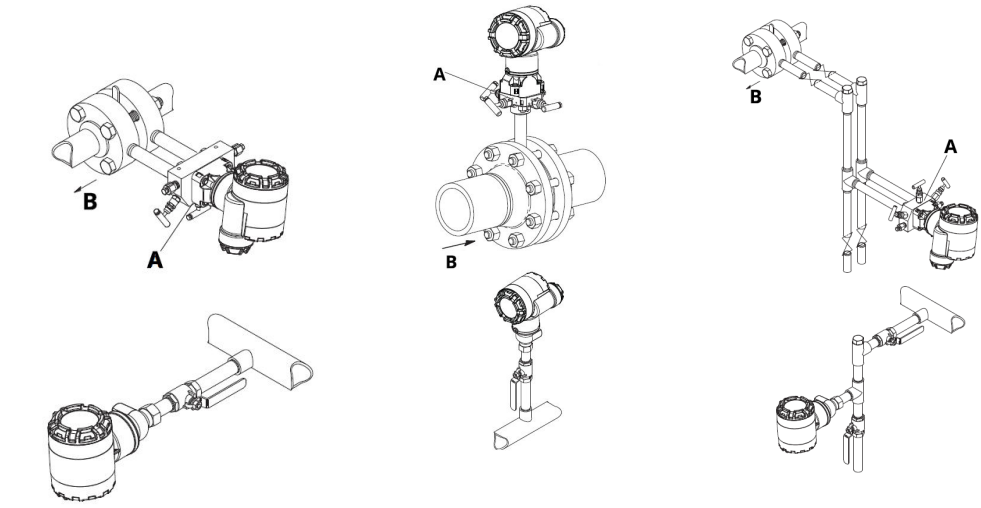
Steam measurement

- Place taps to the side of the line.
- Mount the transmitter below the taps to ensure that the impulse piping will stay filled with condensate.
- In steam service above 250 °F (121 °C), fill impulse lines with water to prevent steam from contacting the transmitter directly and to ensure accurate measurement start-up.

NOTICE

For steam or other elevated temperature services, it is important that temperatures at the process connection do not exceed the transmitter's process temperature limits.

Figure 3-9: Installation examples



A. Drain/vent valves
B. Flow

Best practices

The piping between the process and the transmitter must accurately transfer the pressure to obtain accurate measurements.

There are six possible sources of error:

- Pressure transfer
- Leaks
- Friction loss (particularly if purging is used)
- Trapped gas in a liquid line
- Liquid in a gas line
- Density variations between the legs

The best location for the transmitter in relation to the process pipe is dependent on the process. Use the following guidelines to determine transmitter location and placement of impulse piping:

- Keep impulse piping as short as possible.
- For liquid service, slope the impulse piping at least 1 in./ft. (8 cm/m) upward from the transmitter toward the process connection.
- For gas service, slope the piping at least 1 in./ft. (8 cm/m) downward from the transmitter toward the process connection.
- Avoid high points in liquid lines and low points in gas lines.
- Ensure impulse legs are the same temperature.

- Use impulse piping large enough to avoid friction effects and blockage.
- Vent all gas from liquid piping legs.
- When using a sealing fluid, fill both piping legs to the same level.
- When purging, make the purge connection close to the process taps and purge through equal lengths of the same size pipe. Avoid purging through the transmitter.
- Keep corrosive or hot (above 250 °F [121 °C]) process material out of direct contact with the sensor modules and flanges.
- Prevent sediment deposits in the impulse piping.
- Maintain equal leg of head pressure on both legs of the impulse piping.
- Avoid conditions that might allow process fluids to freeze within the process flange.

3.4.3 Process connections

Coplanar or traditional process connection

When properly installed, the flange bolts will protrude through the top of the sensor module housing.

Install flange adapters

Rosemount 3051DP and GP process connections on the transmitter flanges are ¼-18 NPT. Flange adapters are available with standard ½–14 NPT Class 2 connections. Use the flange adapters to disconnect from the process by removing the flange adapter bolts.

⚠ WARNING

Process leaks

Process leaks could result in death or serious injury.

Install and tighten all four flange bolts before applying pressure.
Do not attempt to loosen or remove flange bolts while the transmitter is in service.

Use plant-approved lubricant or sealant when making the process connections. Refer to the *Dimensional drawings* section of the Rosemount 3051 Product Data Sheet for the distance between pressure connections. You can vary the distance by ±¼-in. (6.4 mm) by rotating one or both of the flange adapters.

To install adapters to a Coplanar flange:

Procedure

1. Remove the flange bolts.

   Whenever you remove flanges or adapters, visually inspect the PTFE O-rings. If there are any signs of damage, such as nicks or cuts, replace the O-rings with O-rings designed for Rosemount transmitters. You may reuse undamaged O-rings. If you replace the O-rings, retorque the flange bolts after installation to compensate for cold flow.

   NOTICE

   If you remove the flange adapter, then replace PFTE O-rings.

2. Leaving the flange in place, move the adapters into position with the O-rings installed.
3. Clamp the adapters and the coplanar flange to the transmitter sensor module using the larger of the bolts supplied.
4. Tighten the bolts.

3.4.4 Inline process connection

Inline gauge transmitter orientation

NOTICE

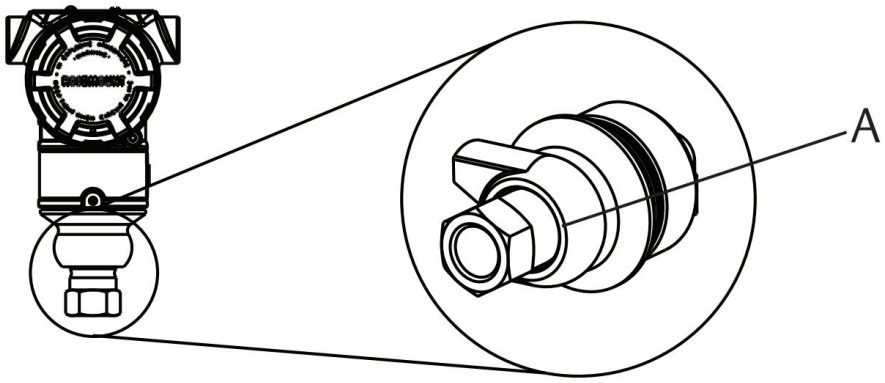
The transmitter may output erroneous pressure values.

Do not interfere or block the atmospheric reference port.

The low side pressure port on the inline gauge transmitter is located in the neck of the transmitter, behind the housing. The vent path is 360 degrees around the transmitter between the housing and sensor (see Figure 3-10).

Keep the vent path free of any obstruction, such as paint, dust, and lubrication, by mounting the transmitter so that the process can drain away.

Figure 3-10: Inline gauge low side pressure port



A. Low side pressure port (atmospheric reference)

NOTICE

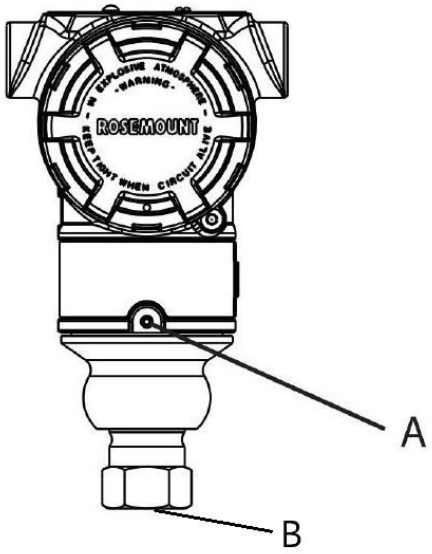
Electronics damage

Rotation between the sensor module and the process connection can damage the electronics.

Do not apply torque directly to the sensor module.

To avoid damage, apply torque only to the hex-shaped process connection. See Figure 3-11.

Figure 3-11: Inline gauge



A. Sensor module
B. Process connection

Install high pressure coned and threaded connection

The transmitter comes with an autoclave connection designed for pressure applications. To connect the transmitter to your process:

Procedure

1. Apply a process-compatible lubricant to the gland nut threads.
2. Slip the gland nut onto the tube; then thread the collar onto the tube end.

   The collar is reverse threaded.
3. Apply a small amount of process-compatible lubricant to the tube cone to help prevent galling and facilitate sealing. Insert the tubing into the connection and finger tighten the bolts.
4. Tighten the gland nut to a torque of 25 ft-lb.

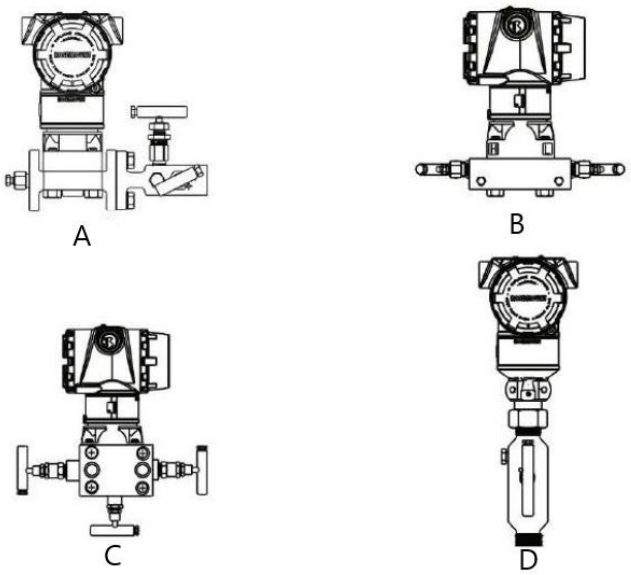
Note
A weep hole has been designed into the transmitter for safety and leak detection. If fluid begins to leak from the weep hole, isolate the process pressure, disconnect the transmitter, and reseal until the leak is resolved.

3.4.5 Rosemount 304, 305, and 306 Manifolds

The 305 Integral Manifold is available in two designs: Traditional and Coplanar.

You can mount the traditional 305 Integral Manifold to most primary elements with mounting adapters in the market today. The 306 Integral Manifold is used with 3051T In-Line Transmitters to provide block-and-bleed capabilities of up to 10,000 psi (690 bar).

Figure 3-12: Manifolds



A. Rosemount 3051C and 304 Conventional
B. Rosemount 3051C and 305 Integral Coplanar
C. Rosemount 3051C and 305 Integral Traditional
D. Rosemount 3051T and 306 In-Line

The Rosemount 304 Conventional Manifold combines a traditional flange and manifold that you can mount to most primary elements.

Install 304 Conventional Manifold

See Safety messages.

Procedure

1. Align the conventional manifold with the transmitter flange. Use the four manifold bolts for alignment.
2. Finger tighten the bolts; then tighten the bolts incrementally in a cross pattern to the final torque value.
   When fully tightened, the bolts extend through the top of the sensor module housing.
3. Leak-check assembly to maximum pressure range of transmitter.

Install 305 Integral Manifold

Procedure

1. Inspect the PTFE sensor module O-rings.

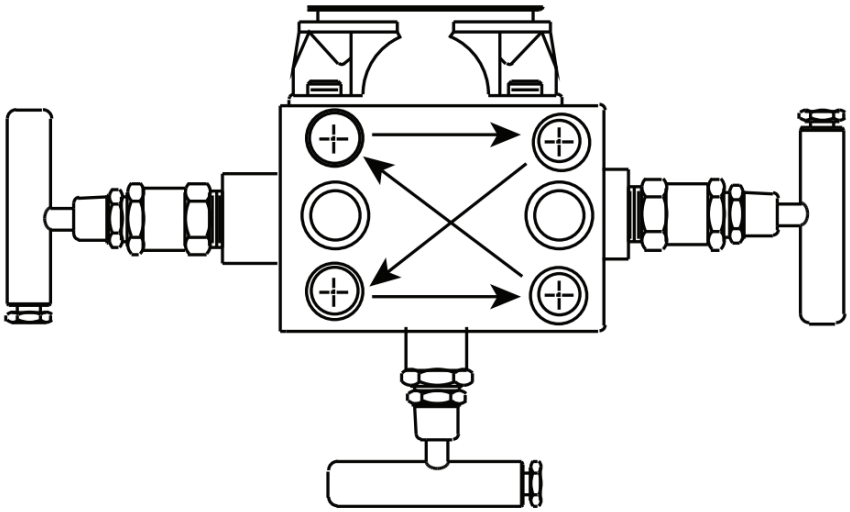
   You may reuse undamaged O-rings. If the O-rings are damaged (if they have nicks or cuts, for example), replace with O-rings designed for Rosemount transmitters.

NOTICE

If replacing the O-rings, take care not to scratch or deface the O-ring grooves or the surface of the isolating diaphragm while you remove the damaged O-rings.

2. Install the integral manifold on the sensor module. Use the four 2¼-inch (57 mm) manifold bolts for alignment. Finger-tighten the bolts; then tighten the bolts incrementally in a cross pattern as seen in Figure 3-13 to final torque value. When fully tightened, the bolts should extend through the top of the sensor module housing.

Figure 3-13: Bolt tightening pattern



3. If you have replaced the PTFE sensor module O-rings, re-tighten the flange bolts after installation to compensate for cold flow of the O-rings.

Install Rosemount 306 Integral Manifold

Only use the Rosemount 306 Manifold with a Rosemount 3051T In-Line Transmitter.

⚠ WARNING

Process leaks

Process leaks could result in death or serious injury.

Install and tighten process connectors before applying pressure.
Install and tighten all four flange bolts before applying pressure.
Do not attempt to loosen or remove flange bolts while the transmitter is in service.

Assemble the Rosemount 306 Manifold to the Rosemount 3051T In-Line Transmitter with a thread sealant.

Manifold operation

⚠ WARNING

Process leaks

Process leaks could result in death or serious injury.

Ensure manifolds are installed and operated correctly.

Always perform a zero trim on the transmitter/manifold assembly after installation to eliminate any shift due to mounting effects.

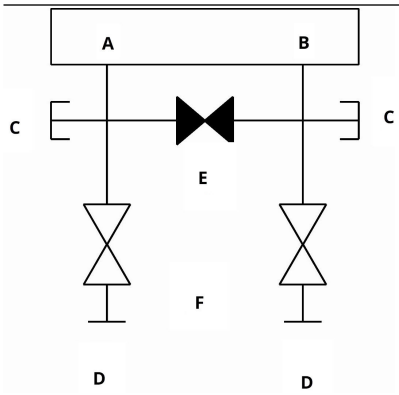
Related information

Sensor trim overview

Perform a zero trim on 3 and 5-valve manifolds

Perform zero trim at static line pressure.

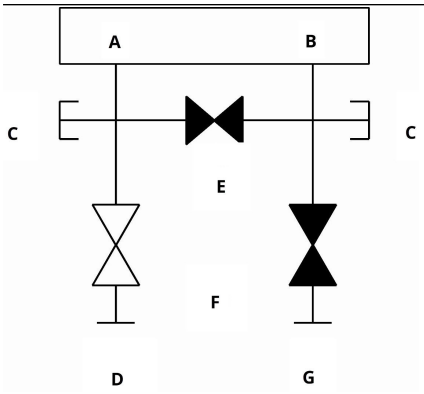
In normal operation, the two block valves between the process and instrument ports are open, and the equalizing valve is closed.



A. High
B. Low
C. Drain/vent valve
D. Isolate (open)
E. Equalize (closed)
F. Process

Procedure

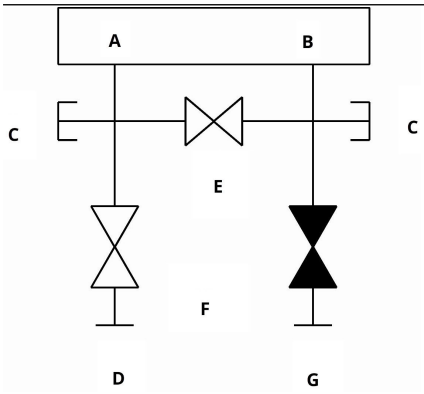
1. To zero the Rosemount 3051, close the block valve to the low pressure (downstream) side first.



A. High
B. Low
C. Drain/vent valve
D. Isolate (open)
E. Equalize (closed)
F. Process
G. Isolate (closed)

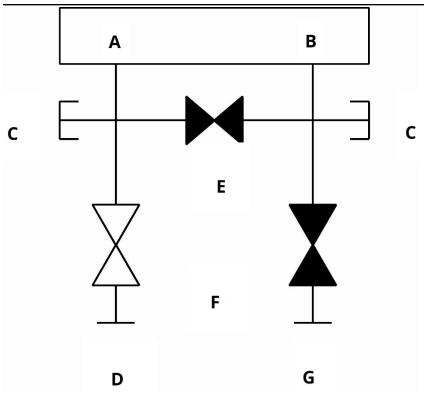
2. Open the equalize valve to equalize the pressure on both sides of the transmitter. Open the center (equalize) valve to equalize the pressure on both sides of the transmitter.

   The manifold valves are now in the proper configuration for zeroing the transmitter.



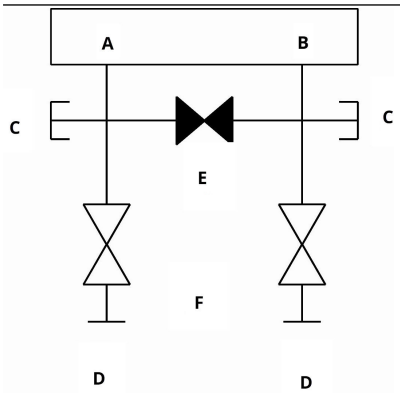
A. High
B. Low
C. Drain/vent valve
D. Isolate (open)
E. Equalize (open)
F. Process
G. Isolate (closed)

3. After zeroing the transmitter, close the equalize valve.



A. High
B. Low
C. Drain/vent valve
D. Isolate (open)
E. Equalize (closed)
F. Process
G. Isolate (closed)

4. Finally, to return the transmitter to service, open the low side isolate valve.Open the block valve on the low pressure side of the transmitter to return the transmitter to service.

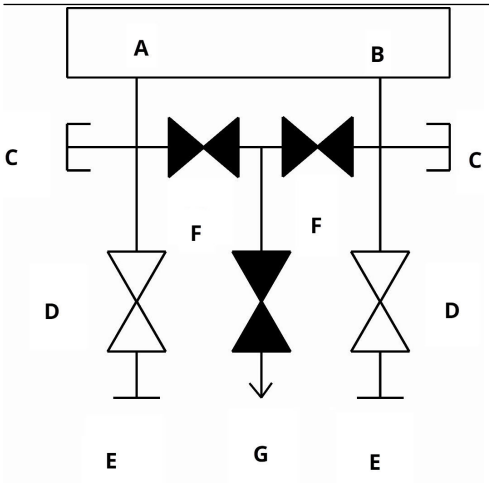


A. High
B. Low
C. Drain/vent valve
D. Isolate (open)
E. Equalize (closed)
F. Process

Zero a five-valve natural gas manifold

Perform zero trim at static line pressure.

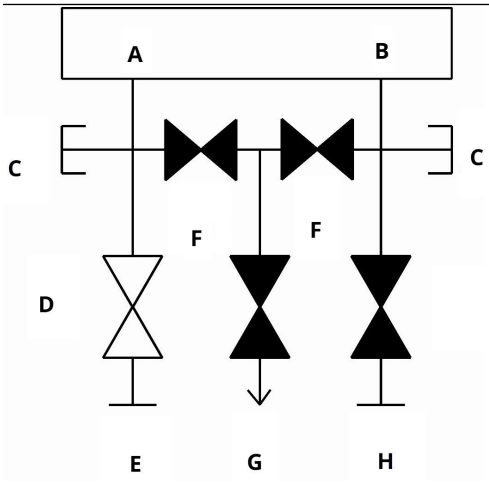
In normal operation, the two block valves between the process and instrument ports will be open, and the equalizing valves will be closed.



A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (closed)
G. Drain vent (closed)

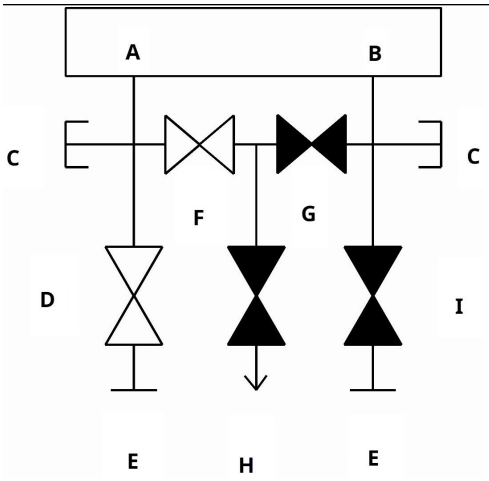
Procedure

1. To zero trim the transmitter, first close the isolate valve on the low pressure (downstream) side of the transmitter and the vent valve.Close the block valve on the low pressure (downstream) side of the transmitter.



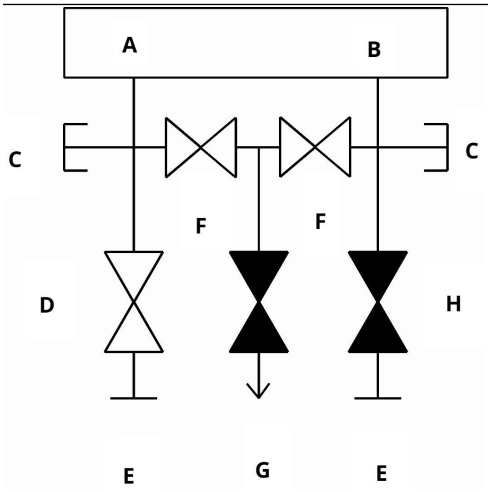
A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (closed)
G. Drain vent (closed)
H. Isolate (closed)

2. Open the equalize valve on the high pressure (upstream) side of the transmitter.



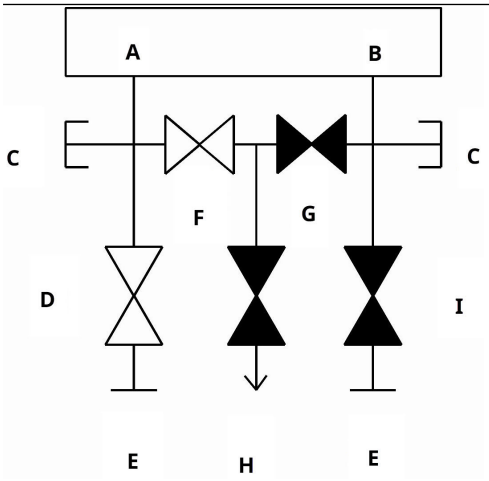
A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (open)
G. Equalize (closed)
H. Drain vent (closed)
I. Isolate (closed)

3. Open the equalize valve on the low pressure (downstream) side of the transmitter. The manifold is now in the proper configuration for zeroing the transmitter.



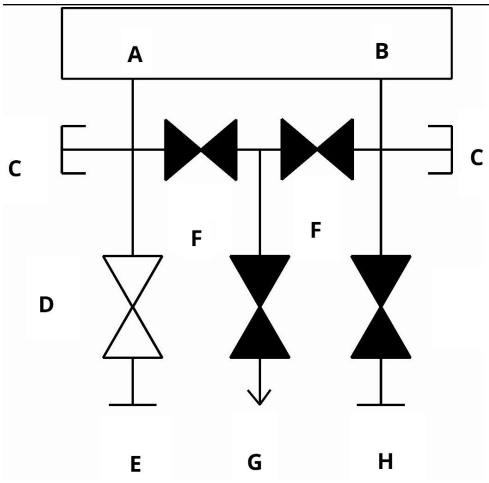
A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (open)
G. Drain vent (closed)
H. Isolate (closed)

4. After zeroing the transmitter, close the equalize valve on the low pressure (downstream) side of the transmitter.



A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (open)
G. Equalize (closed)
H. Drain vent (closed)
I. Isolate (closed)

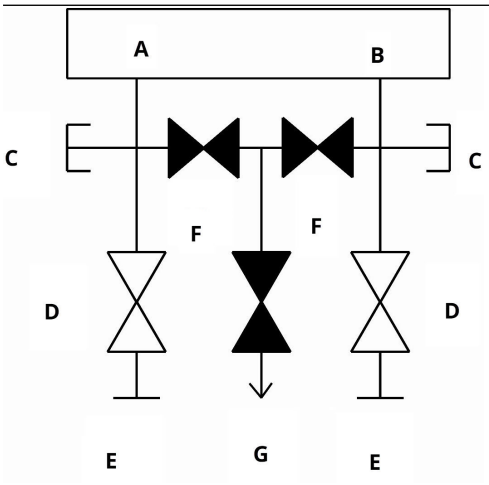
5. Close the equalize valve on the high pressure (upstream) side.



A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (closed)
G. Drain vent (closed)
H. Isolate (closed)

6. Finally, to return the transmitter to service, open the low side isolate valve and vent valve.To return the transmitter to service, open the low side isolation valve.

   The vent valve can remain open or closed during operation.



A. High
B. Low
C. Test (plugged)
D. Isolate (open)
E. Process
F. Equalize (closed)
G. Drain vent (closed)

4 Electrical installation

4.1 Overview

The information in this section covers installation considerations for the Rosemount 3051 Transmitter.

A Quick Start Guide is shipped with every transmitter to describe pipe-fitting, wiring procedures, and basic configuration for initial installation.

Related information

Disassembling the transmitter
Reassemble the transmitter

4.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations.

See Safety messages.

4.3 Install LCD display

Emerson ships transmitters ordered with the LCD display, graphical LCD display, or Local Operator Interface (LOI) options with the display installed.

To install the display on an existing Rosemount 3051 Transmitter:

Prerequisites

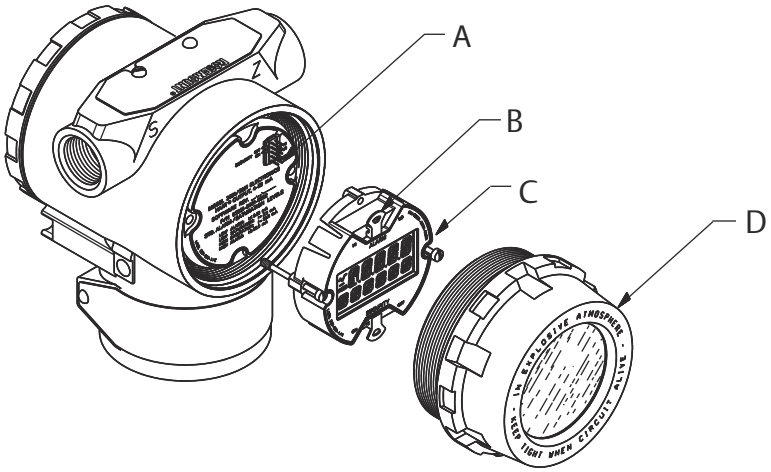
Small instrument screwdriver

Procedure

Carefully align the desired display connectors with the electronics board connector.

If the connectors don't align, the display and electronics board are not compatible.

Figure 4-1: LCD display assembly



A. Interconnecting pins
B. Jumpers (top and bottom)
C. Display
D. Extended cover

4.3.1 Rotate display

If you need to rotate the Local Operator Interface (LOI) or LCD display after it has been installed on the transmitter, complete the following steps.

Procedure

1. Secure the loop to **Manual** control and remove power to transmitter.

   ⚠ WARNING

   Explosions

   Explosions could result in death or serious injury.

   Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments are installed in accordance with intrinsically safe or non-incendive field wiring practices.

2. Remove transmitter housing cover.
3. Remove screws from the display and rotate it to the desired orientation.
   a) Insert 10-pin connector into the display board for the correct orientation. Carefully align pins for insertion into the output board.
4. Re-insert screws.
5. Reattach transmitter housing cover.
   Ensure that the cover is fully engaged to comply with explosion-proof requirements.
6. Re-attach power and return loop to automatic control.

Note
The graphical LCD display can be rotated with the software 180 degrees. You can access this feature with any configuration tool or the **Quick Service** buttons. For 90 degree and 270 degree orientation, the physical display rotation is still required.

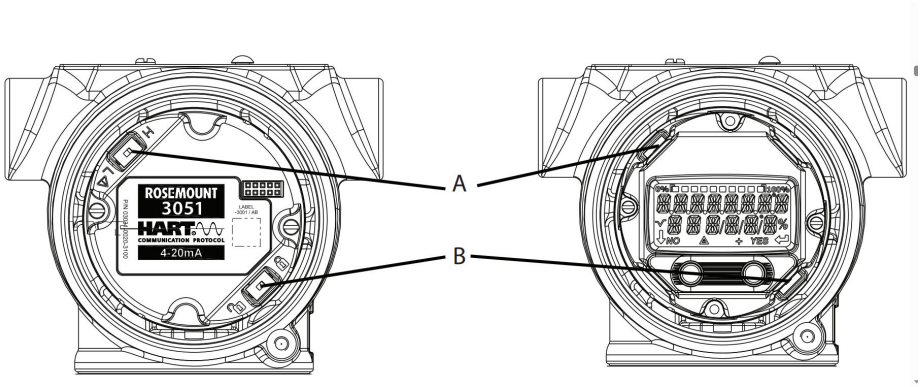
4.4 Configuring transmitter security

There are three ways to manage security with the Rosemount 3051 Transmitter.

- **Security** switch
- Software security
- Local Operator Interface (LOI) password

Figure 4-2: Electronics board

Without LOI/LCD display	With LOI/LCD display



A. ***Alarm***
B. ***Security***

4.4.1 Enable **Security** switch

You can enable the **Security** switch to prevent changes to the transmitter configuration data.

If you set the **Security** switch to Locked, the transmitter will reject any configuration requests sent via HART®, Bluetooth®, Local Operator Interface (LOI), or local configuration buttons, and it will not modify the configuration data. See Figure 4-2 for the location of the **Security** switch.

Procedure

1. If the transmitter is installed, secure the loop and remove power.

   ⚠ WARNING

   Explosions

   Explosions could result in death or serious injury.

   In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

2. Remove the housing cover opposite the field terminal side.

   ⚠ WARNING

   Do not remove the instrument cover in explosive atmospheres when the circuit is live.

3. Use a small screwdriver to slide the switch to the Lock position.
4. Reattach transmitter housing cover.

   Emerson recommends tightening the cover until there is no gap between the cover and housing to comply with explosion proof requirements.

4.4.2 Software security lock

The **software security lock** prevents changes to the transmitter configuration from all sources; it rejects all changes requested via HART®, Bluetooth®, Local Operator Interface (LOI), and local configuration buttons.

Use a communication device to enable or disable the **software security lock**.

4.4.3 Local Operator Interface (LOI) password

You can enter and enable an LOI password to prevent review and modification of device configuration via the LOI. This does not prevent configuration from HART or external keys (analog zero and span or digital zero trim).

The LOI password is a four-digit code that you can set. If the password is lost or forgotten, use the master password: `9307`.

You can configure and enable or disable the LOI password with HART Communication via a Field Communicator, AMS Device Manager, or the LOI.

4.5 Move Alarm switch

There is an **Alarm** switch on the electronics board.

For switch location, see Figure 4-2. Follow the steps below to move the **Alarm** switch:

Procedure

1. Set loop to **Manual** and remove power.

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

2. Remove transmitter housing cover.
3. Use a small screwdriver to slide switch to desired position.
4. Replace transmitter cover.

Note
The cover must be fully engaged to comply with explosion proof requirements.

4.6 Electrical considerations

⚠ WARNING

Ensure all electrical installation is in accordance with national and local code requirements.

Electrical shock

Electrical shock can result in death or serious injury.

Do not run signal wiring in conduit or open trays with power wiring or near heavy electrical equipment.

4.6.1 Conduit installation

NOTICE

Transmitter damage

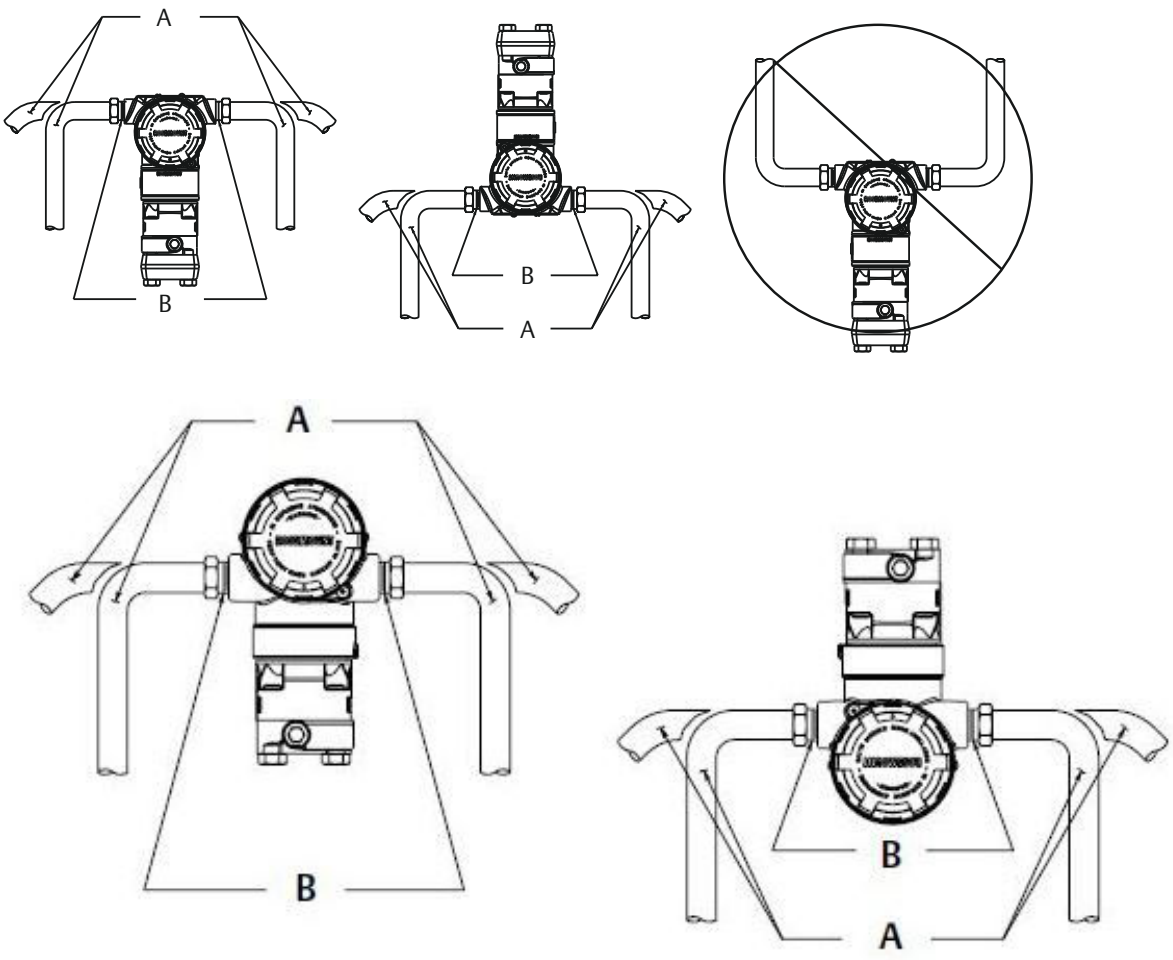
If all connections are not sealed, excess moisture accumulation can damage the transmitter.

Mount the transmitter with the electrical housing positioned downward for drainage.

To avoid moisture accumulation in the housing, install wiring with a drip loop and ensure the bottom of the drip loop is mounted lower than the conduit connections of the transmitter housing.

Figure 4-3 shows recommended conduit connections.

Figure 4-3: Conduit installation diagrams



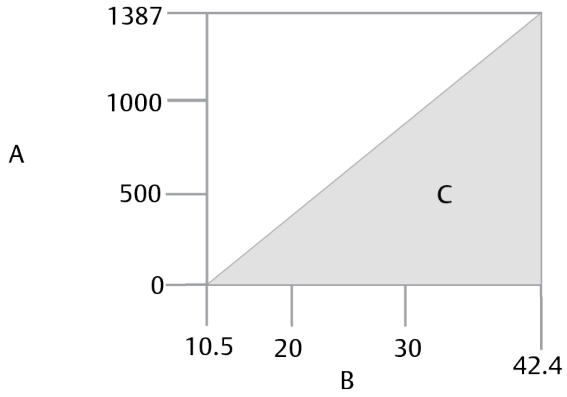
A. Possible conduit line positions
B. Sealing compound
C. Incorrect

4.6.2 Power supply for a 4-20 mA HART® communication device

The transmitter operates on 10.5 to 42.4 Vdc at the terminal. The DC power supply must provide power with less than two percent ripple. Loops with a 250 Ω resistance require a minimum of 16.6 V.

Note
The transmitter must have a minimum of 250 Ω to communicate with a communication device. If you are using a single power supply to power more than one transmitter, ensure the power supply used and the circuitry common to the transmitters do not have more than 20 Ω of impedance at 1200 Hz.

Figure 4-4: Load limitation



Maximum loop resistance = 43.5 x (power supply voltage - 10.5)

A. Load (Ω)
B. Voltage (Vdc)
C. Operating region

The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, Intrinsically Safe (IS) barriers, and related pieces. If you use IS barriers, then include the resistance and voltage drop.

4.6.3 1–5 Vdc low power HART® (output code M)

Low power transmitters operate on 9–28 Vdc.

The Dc power supply must provide power with less than 2 percent ripple. The V_{out} load must be 100 kΩ or greater.

4.6.4 Wire the transmitter

Improper wiring and non-compliance with correct procedure risk damage to testing and transmitting equipment, posing potential threats such as explosions: thus adherence to proper procedure and usage of specified wiring and correct installation are crucial to ensure safe and effective operation.

NOTICE

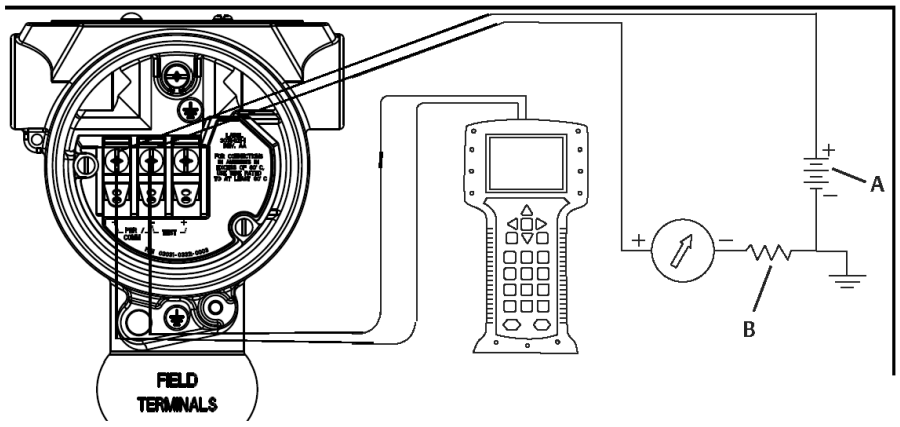
Equipment damage

Incorrect wiring can damage test circuit.

Do not connect the power signal wiring to the test terminals.

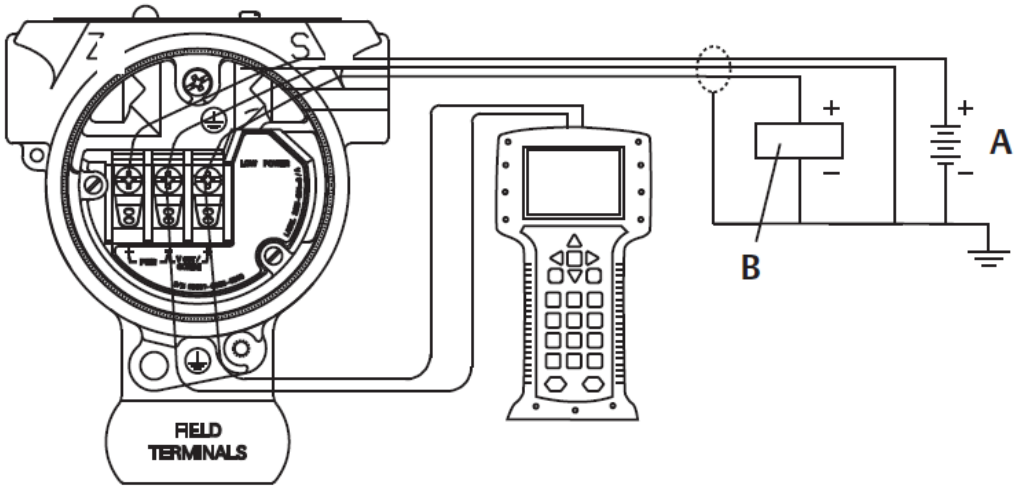
Note
Use shielded twisted pairs to yield best results. To ensure proper communication, use 24 AWG or larger wire and do not exceed 5,000 ft. (1,500 m).

Figure 4-5: Wiring the transmitter (4-20 mA HART®)



A. Vdc supply
B. $R_L \geq 250$ (necessary for HART communication only)

Figure 4-6: Wiring the transmitter (1-5 Vdc low power)



A. DC power supply
B. Voltmeter

Procedure

1. Remove the housing cover on terminal compartment side.

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

Note
Signal wiring supplies all power to the transmitter.

2. Connect leads.

Note
Equipment damage

Power could damage the test diode.

Do not connect the powered signal wiring to the test terminals.

To connect leads:

- For a 4-20 mA HART output, connect the positive lead to the terminal marked **pwr/comm+** and the negative lead to the terminal marked **pwr/comm-**.
- For a 1-5 Vdc HART output, connect the positive lead to the terminal marked **pwr+** and the negative lead to the terminal marked **pwr-**

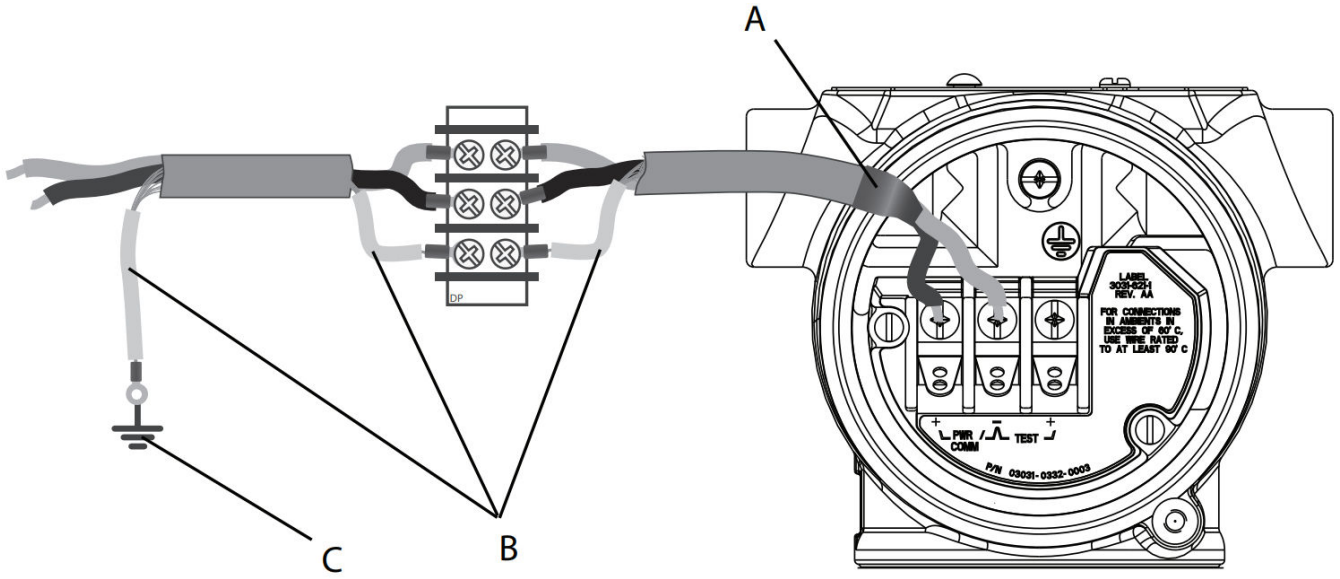
3. Plug and seal unused conduit connections on the transmitter housing to avoid moisture accumulation on the terminal side.

4.6.5 Ground signal cable shield

Trim and insulate the signal cable shield and unused shield drain wire to ensure that the signal cable shield and drain wire do not come in contact with the transmitter case.

Figure 4-7 summarizes signal cable shield grounding.

Figure 4-7: Wiring pair and ground



A. Insulate shield and shield drain wire.
B. Insulate exposed shield drain wire.
C. Terminate cable shield drain wire to earth ground.

See Grounding transmitter case for instructions on grounding the transmitter case.

Procedure

1. Remove the field terminals housing cover.
2. Connect the signal wire pair at the field terminals as indicated in Figure 4-7.

   Ensure the cable shield is:

   - Trimmed close and insulated from touching the transmitter housing.
   - Continuously connected to the termination point.
   - Connected to a good earth ground at the power supply end.
3. Reattach the field terminals housing cover.

   The cover must be fully engaged to comply with explosion-proof requirements.

   At terminations outside the transmitter housing, verify the cable shield drain wire is continuously connected.

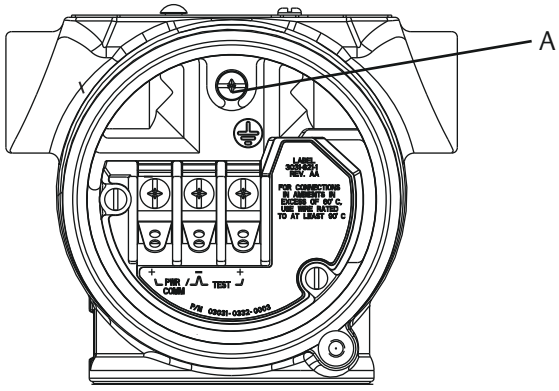
   Prior to the termination point, insulate any exposed shield drain wire as shown in Figure 4-7.
4. Properly terminate the signal cable shield drain wire to an earth ground at or near the power supply.

Grounding transmitter case

Always ground the transmitter case in accordance with national and local electrical codes. The most effective transmitter case grounding method is a direct connection to earth ground with minimal impedance. Methods for grounding the transmitter case include:

- Internal ground connection: The internal ground connection screw is inside the **FIELD TERMINALS** side of the electronics housing. This screw is identified by a ground symbol (⏚). The ground connection screw is standard on all Rosemount 3051 Transmitters. Refer to Figure 4-8.

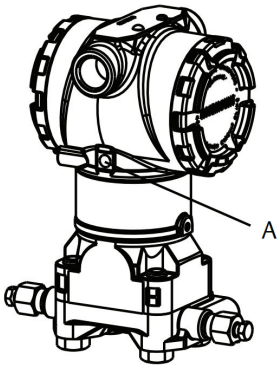
Figure 4-8: Internal ground connection



A. Internal ground location

- External ground connection: The external ground connection is located on the exterior of the transmitter housing. Refer to Figure 4-9. This connection is only available with option **V5** and **T1**.

Figure 4-9: External ground connection (option V5 or T1)



A. External ground location

NOTICE

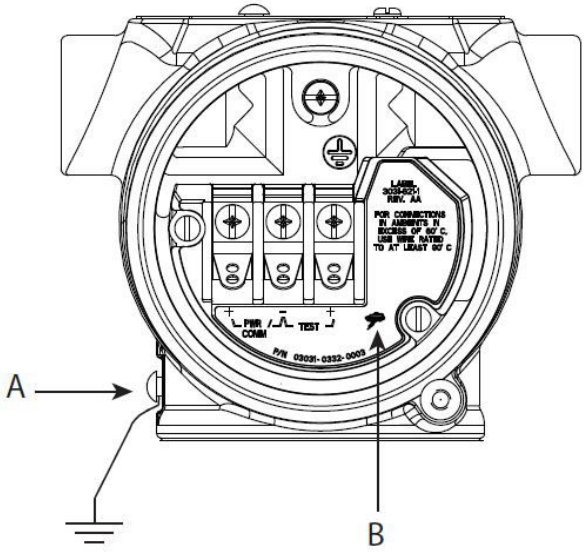
Grounding the transmitter case via threaded conduit connection may not provide sufficient ground continuity.

Grounding transient protection terminal block

The transmitter can withstand electrical transients of the energy level usually encountered in static discharges or induced switching treatments. However, high-energy transients, such as those induced in wiring from nearby lightning strikes, can damage the transmitter.

You can order the transient protection terminal block as an installed option (option code **T1**) or as a spare part to retrofit existing transmitters in the field. See the *Spare parts* section of the Rosemount 3051 Product Data Sheet for part numbers. The lightning bolt symbol shown in Figure 4-10 identifies the transient protection terminal block.

Figure 4-10: Transient protection terminal block



A. External ground connection location
B. Lightning bolt connection

NOTICE

The transient protection terminal block does not provide transient protection unless the transmitter case is properly grounded. Use the guidelines to ground the transmitter case. Refer to Figure 4-10.

5 Operation and maintenance

5.1 Overview

Note
Calibration
If any trim is done improperly or with inaccurate equipment, it may degrade the transmitter's performance.

Emerson calibrates absolute pressure transmitters (Rosemount 3051CA and 3051TA) at the factory. Trimming adjusts the position of the factory characterization curve.

Emerson provides instructions to perform configuration functions with the following:

- Field Communicator
- AMS Device Manager
- AMS Device Configurator Bluetooth® app
- **Quick Service** buttons
- Local Operator Interface (LOI)

5.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of personnel performing the operations.

See Safety messages.

Perform a `Restart with defaults` to set all function block information in the device to factory defaults. This includes the clearing of all function block links and schedule, as well as defaulting all resource and transducer block user data (SPM block algorithm configurations, LCD display transducer block parameter configuration, etc.).

5.3 Recommended calibration tasks

5.3.1 Calibrate in the field

Procedure

1. Perform sensor zero/lower trim to compensate for mounting pressure effects.
   Refer to Manifold operation for instructions on properly draining/venting valves.
2. Set/check basic configuration parameters:
   - **Damping value**
   - **Output type**
   - **Output units**
   - **Range points**

5.3.2 Calibrate on a bench

Procedure

1. Perform optional 4-20 mA output trim.
2. Perform a sensor trim.
   a) Zero/lower trim for using line pressure effect correction.
      Refer to Manifold operation for manifold drain/vent valve operation instructions.
   b) Perform the optional full scale trim.
      This sets the span of the device and requires accurate calibration equipment.
   c) Set/check basic configuration parameters.

NOTICE

To calibrate Rosemount 3051CA and 3051TA range 0 and range 5 devices, you need an accurate absolute pressure source.

5.4 Calibration overview

Note
Emerson fully calibrates the Rosemount 3051 Pressure Transmitter at the factory. Emerson provides a field calibration option to meet plant requirements or industry standards.

Note
Sensor calibration allows you to adjust the pressure (digital value) reported by the transmitter to be equal to a pressure standard. The sensor calibration can adjust the pressure offset to correct for mounting conditions or line pressure effects. Emerson recommends this correction. To calibrate the pressure range (pressure span or gain correction), you need accurate pressure standards (sources) to provide full calibration.

There are two parts to complete calibration of the transmitter: sensor calibration and analog output calibration.

Calibrate the sensor

To perform a sensor trim or a digital zero trim, see Trimming the pressure signal.

Calibrate the 4-20 mA output

- Performing digital-to-analog trim (4-20 mA output trim)

5.4.1 Determine necessary sensor trims

With bench calibrations, you can calibrate the instrument for its desired range of operation. Straightforward connections to a pressure source allow for a full calibration at the planned operating points. Exercise the transmitter over the desired pressure range to verify the analog output.

Trimming the pressure signal discusses how the trim operations change the calibration. It is possible to degrade the performance of the transmitter if a trim is done improperly or with inaccurate equipment. You can set the transmitter back to factory settings using the Recall Factory Trim command shown in Recall factory trim - sensor trim.

For transmitters that are field installed, the manifolds discussed in Rosemount 304, 305, and 306 Manifolds allow the differential transmitter to be zeroed using the zero trim function. Rosemount 305, 306, and 304 Manifolds discusses both three-valve and five-valve manifolds. This field calibration eliminates any pressure offsets caused by mounting effects (head effect of the oil fill) and static pressure effects of the process.

To determine the necessary trims:

Procedure

1. Apply pressure.
2. Check the pressure. If the pressure does not match the applied pressure, perform a sensor trim.

   See Trimming the pressure signal.
3. Check reported analog output against the live analog output. If they do not match, perform an analog output trim.

   See Performing digital-to-analog trim (4-20 mA output trim).

Trimming with configuration buttons

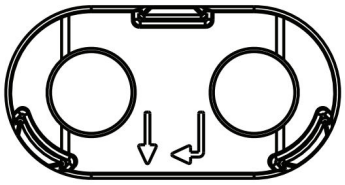
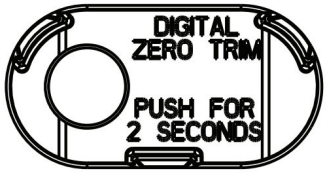
Local configuration buttons are external buttons located underneath the top tag of the transmitter that can be used to perform trims.

To access the buttons, loosen screw and rotate top tag until buttons are visible.

Configuration buttons	Can perform both digital sensor trim and the 4-20 mA output trim (analog output trim). Use the same procedure to trim with a communication device or AMS.
Digital zero trim	See Trimming the pressure signal for trim instructions.

Monitor all configuration changes by looking at a display or by measuring the loop output. Table 5-1 shows the physical differences between the two sets of buttons.

Table 5-1: Local configuration button options

Local operator interface (LOI) and **Quick Service** buttons- green retainer	**Digital Zero Trim** - gray retainer
	

5.4.2 Determine calibration frequency

Calibration frequency can vary greatly depending on the application, performance requirements, and process conditions. See How to Calculate Pressure Transmitter Calibration Intervals Technical Note.

To determine the calibration frequency that meets the needs of your application:

Procedure

1. Determine the performance required for your application.

2. Determine the operating conditions.
3. Calculate the Total Probable Error (TPE).
4. Calculate the stability per month.
5. Calculate the calibration frequency.

Sample calculation for Rosemount 3051 (0.04 percent accuracy and 10-year stability)

The following is an example of how to calculate calibration frequency:

Procedure

1. Determine the performance required for your application.

Required performance	0.20% of span

2. Determine the operating conditions.

Transmitter	Rosemount 3051CD, Range 2 (upper range value URL = 250 inH_2O [6.2 bar])
Calibrated span	150 inH_2O (3.7 bar)
Line pressure	500 psig (34.5 barg)

3. Calculate Total Probable Error (TPE).

   TPE = $\sqrt{(\text{ReferenceAccuracy})^2 + (\text{TemperatureEffect})^2 + (\text{StaticPressureEffect})^2}$ = 0.105% of span

   Where:

Reference Accuracy	±0.04% of span
Ambient Temperature Effect	$\left(\frac{(0{,}0125 \times \text{URL})}{\text{Span}} + 0{,}0625\right)$% per 50 °F = ±0,0833% of span
Span Static Pressure Effect	(5) 0,1% reading per 1000 psi (69 bar) = ±0,05% of span

4. Calculate the stability per month.

   $$\text{Stability} = \pm\left[\frac{0{,}2 \times \text{URL}}{\text{Span}}\right]\% \text{ of span for 10 years} = \pm 0{,}00278\% \text{ of span for 1 month}$$

5. Calculate calibration frequency.

   $$\text{Calibration frequency} = \frac{\text{Req. Performance - TPE}}{\text{Stability per month}} = \frac{0{,}2\% - 0{,}105\%}{0{,}00278\%} = 34 \text{ months}$$

(5) Zero static pressure effect removed by zero trimming at line pressure.

5.4.3 Compensating for span line pressure effects (Range 4 and 5)

Rosemount 3051 Range 4 and 5 Pressure Transmitters require a special calibration procedure when used in differential pressure applications. The purpose of this procedure is to optimize transmitter performance by reducing the effect of static line pressure in these applications.

The Rosemount Differential Pressure Transmitters (Ranges 1 through 3) do not require this procedure because optimization occurs at the sensor.The Rosemount 3051 Differential Pressure Transmitters (ranges 0 through 3) do not require this procedure because optimization occurs at the sensor.

The systematic span shift caused by the application of static line pressure is –0.95 percent of reading per 1000 psi (69 bar) for Range 4 transmitters and –1 percent of reading per 1000 psi (69 bar) for Range 5 transmitters.

Compensate for span line pressure effect (example)

A Range 4 differential pressure transmitter (Rosemount 3051CD4...) is used in an application with a static line pressure of 1200 psi (83 bar). The DP measurement span is from 500 inH_20 (1.2 bar) to 1500 inH_2O (3.7 bar).A Range 4 differential pressure HART® transmitter (Rosemount 3051 CD4...) is used in an application with a static line pressure of 1200 psi (83 bar). The transmitter output is ranged with 4 mA at 500 inH_2O (1.2 bar) and 20 mA at 1500 inH_2O (3.7 bar). To correct for systematic error caused by high static line pressure, first use the following formulas to determine the corrected values for the high trim value.

High trim value

HT = (URV – [S/100 ×P/1000 × LRV])

Where:

HT	Corrected high trim value
URV	Upper range value
S	Span shift per specification (as percent of reading)
P	Static line pressure in psi.

In this example:

URV	1500 inH_2O (3.7 bar)
S	-0.95%
P	1200 psi
LT	1500 inH_2O + (0.95%/100 x 1200 psi/100 psi x 1500 inH_2O)
LT	1517.1 inH_2O

Complete the upper sensor trim procedure as described in Trimming the pressure signal. In the example above, at Step 4, apply the nominal pressure value of 1500 inH_2O.In the preceding example, when calculating the stability per month, apply the nominal pressure value of 1500 inH_2O Lo. However, enter the calculated correct upper sensor trim value of 1517.1 inH_2O with a communication device.

NOTICE

The range values for the 4 and 20 mA points should be at the nominal URV and LRV. In the preceding example, the values are 1500 inH_2O and 500 inH_2O respectively. Confirm the values on the ***HOME*** screen of the Communication device. Modify, if needed, by following the steps in Rerange the transmitter.

5.5 Trimming the pressure signal

5.5.1 Sensor trim overview

A sensor trim corrects the pressure offset and pressure range to match a pressure standard.

The upper sensor trim corrects the pressure range, and the lower sensor trim (zero trim) corrects the pressure offset. An accurate pressure standard is required for full calibration. You can perform a zero trim if the process is vented or the high and low side pressure are equal (for differential pressure transmitters).

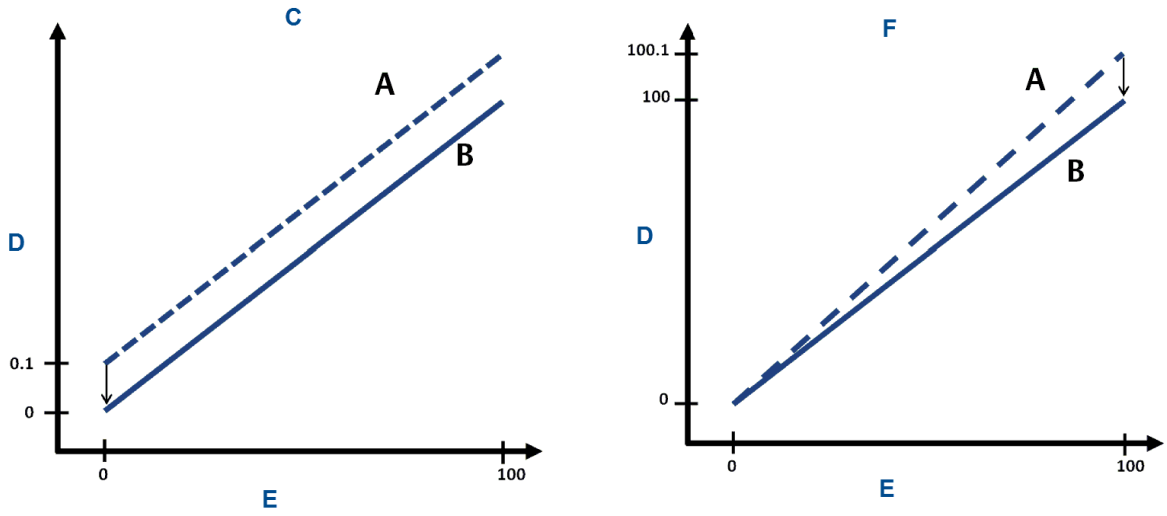
Zero trim is a single-point offset adjustment. It is useful for compensating for mounting position effects and is most effective when performed with the transmitter installed in its final mounting position. As this correction maintains the slope of the characterization curve, do not use it in place of a sensor trim over the full sensor range.

When performing a zero trim, ensure that the equalizing valve is open and all wet legs are filled to the correct levels. Apply line pressure to the transmitter during a zero trim to eliminate line pressure errors. Refer to Manifold operation.

Note
Do not perform a zero trim on Rosemount 3051T Absolute Pressure Transmitters. Zero trim is zero based, and absolute pressure transmitters reference absolute zero. To correct mounting position effects on a Rosemount 3051T Absolute Pressure Transmitter, perform a lower sensor trim within the sensor trim function. The lower sensor trim function provides an offset correction similar to the zero trim function, but it does not require zero-based input.

Upper and lower sensor trim is a two-point sensor calibration where two end-point pressures are applied and all output is linearized between them; this calibration also requires an accurate pressure source. Always adjust the low trim value first to establish the correct offset. Adjustment of the high trim value provides a slope correction to the characterization curve based on the low trim value. The trim values help optimize performance over a specific measurement range.

Figure 5-1: Sensor trim example



A. Before trim
B. After trim
C. Zero/lower sensor trim
D. Pressure reading
E. Pressure input
F. Upper sensor trim

5.5.2 Performing a sensor trim

When performing a sensor trim, you can trim both the upper and lower limits. If you need to perform both an upper and lower sensor trim, do the lower trim first.

Note
Use a pressure input source that is at least four times more accurate than the transmitter and allow the input pressure to stabilize for ten seconds before entering any values.

Perform a sensor trim with a communication device

To calibrate the sensor with a communication device using the **sensor trim** function, perform the following procedure.

Procedure

1. From the ***HOME*** screen, enter the Fast Key sequence.

Device Dashboard Fast Keys	3, 4, 1

2. Select Lower Sensor Trim.

   Note
   Select pressure points so that lower and upper values are equal to or outside the expected process operation range. To do this, see Rerange the transmitter.

3. Follow the commands provided by the communication device to complete the adjustment of the lower value.

4. Repeat the procedure for the upper value, replacing Lower Sensor Trim with Upper Sensor Trim in Step 2.

Perform a sensor trim using AMS Device Manager

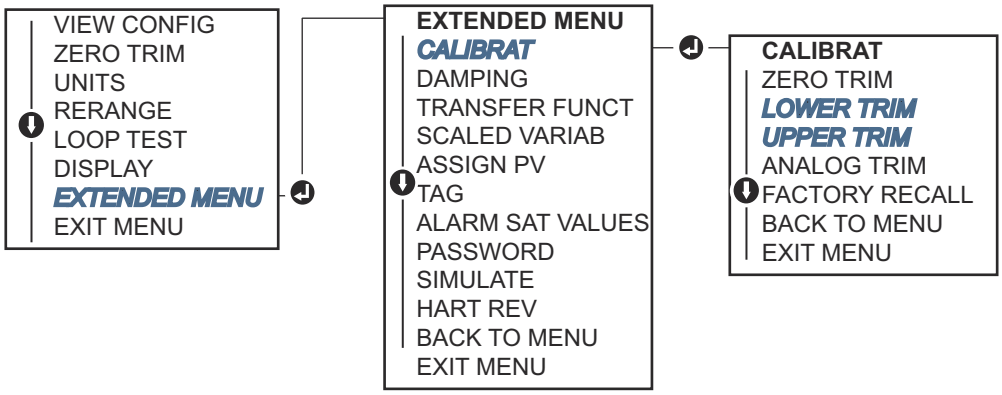
Procedure

1. Right-click the device and go to **Method** → **Calibrate** → **Sensor Trim** → **Lower Sensor Trim**.
2. Follow the screen prompts to perform a sensor trim using AMS Device Manager.
3. If desired, right-click the device again and go to **Method** → **Calibrate** → **Sensor Trim** → **Upper Sensor Trim**

Perform a sensor trim using LOI

Reference Figure 5-2 to perform an upper and lower sensor trim.

Figure 5-2: Sensor Trim with LOI



Go to **EXTENDED MENU** → **CALIBRAT** → **LOWER TRIM** to select the lower trim value. Go to **EXTENDED MENU** → **CALIBRAT** → **UPPER TRIM** to select the upper trim value.

Perform a digital zero trim (option DZ)

A digital zero trim (option DZ) provides the same function as a zero/lower sensor trim, but you can complete it in hazardous areas at any given time by simply pushing the **Zero trim** button when the transmitter is at zero pressure.

If the transmitter is not close enough to zero when you push the button, the command may fail due to excess correction. If desired, you can perform a digital zero trim by using external configuration buttons located underneath the top tag of the transmitter. See Table 5-1 for DZ button location.

Procedure

1. Loosen the top tag of the transmitter to expose buttons.
2. Press and hold the **Digital zero** button for at least two seconds; then release to perform a digital zero trim.

5.5.3 Recall factory trim - sensor trim

You can use the **Recall factory trim - Sensor trim** command to restore the "as-shipped" factory settings of the sensor trim.

This command can be useful for recovering from an inadvertant zero trim of an absolute pressure unit or inaccurate pressure source.

Recall factory trim with a communication device

Procedure

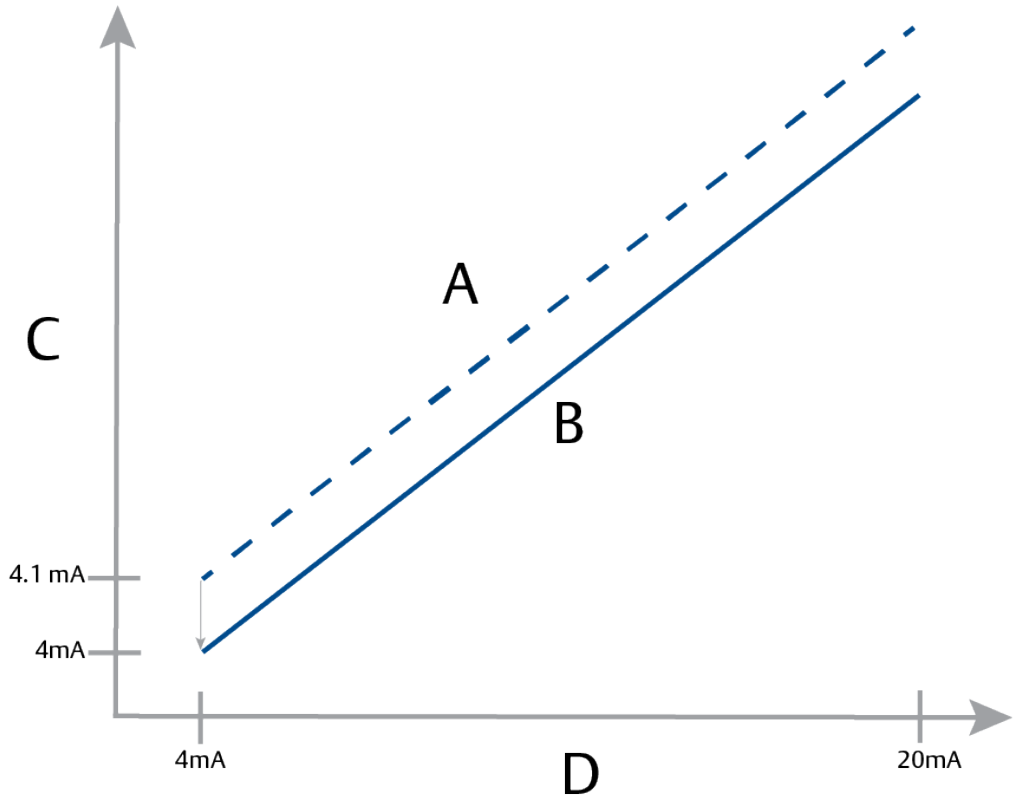
Go to **Device Settings** → **Calibration** → **Pressure** → **Factory Calibration** → **Restore Factory Calibration**.

5.6 Trimming the analog output

You can use the analog output trim command to adjust the transmitter's current output at the 4 and 20 mA points to match the plant standards. Perform this trim after the digital to analog conversion, so that it only affects the 4-20 mA analog signal.

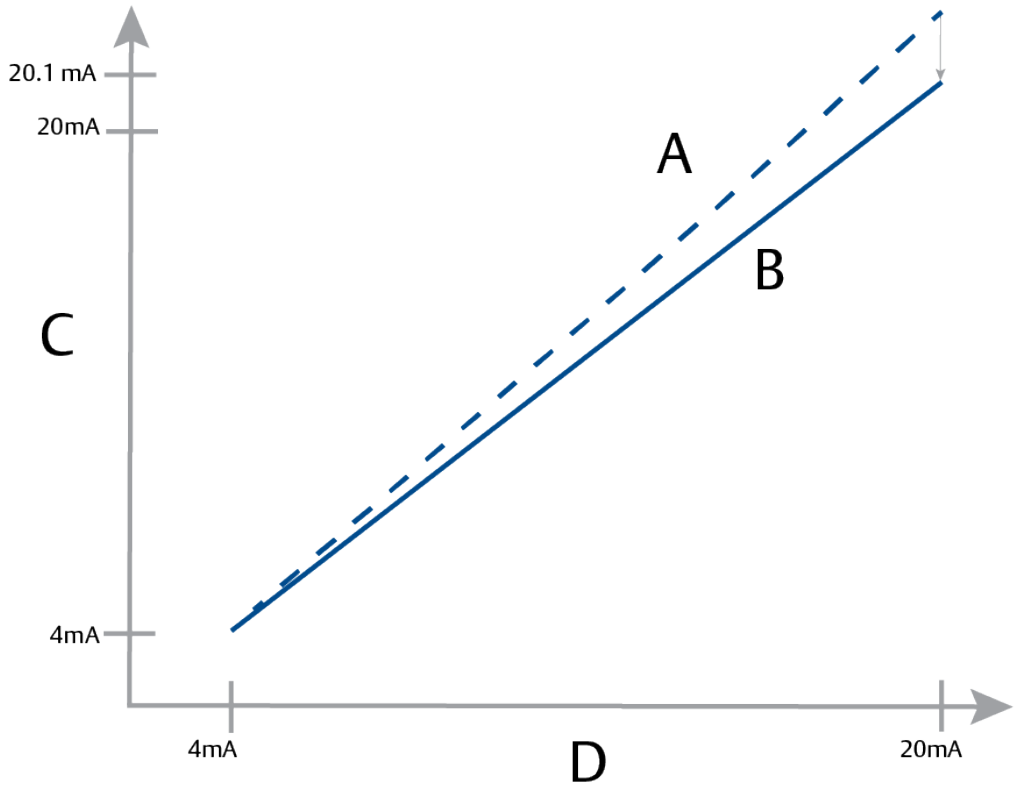
Figure 5-3 and Figure 5-4 graphically show the two ways the characterization curve is affected when an analog output trim is performed.

Figure 5-3: 4-20 mA output trim - zero/lower trim



A. Before trim
B. After trim
C. Meter reading
D. mA output

Figure 5-4: 4-20 mA output trim - upper trim



A. Before trim
B. After trim
C. Meter reading
D. mA output

5.6.1 Performing digital-to-analog trim (4-20 mA output trim)

NOTICE

If you add a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with additional loop resistance. Refer to Power supply for a 4-20 mA HART® communication device.

Perform a 4-20 mA output trim with a communication device

Procedure

Go to **Device Settings** → **Calibration** → **Analog Output** → **Calibration** → **Analog Calibration**.

5.6.2 Recalling factory trim - analog output

You can use the `Recall Factory Trim - Analog Output` command to restore the as-shipped factory settings to the analog output trim.

This command can be useful for recovering from an inadvertent trim, incorrect plant standard, or faulty meter.

Recall factory trim - analog output with a communication device

Procedure

Go to **Device Settings** → **Calibration** → **Analog Calibration** → **Factory Calibration** → **Restore Analog Calibration**.

6 Troubleshooting

6.1 Overview

This section provides summarized troubleshooting suggestions for the most common operating problems.

If you suspect malfunction despite the absence of any diagnostic messages on the Field Communicator display, consider using Diagnostic messages to identify any potential problem.

6.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of personnel performing the operations.

See Safety messages.

Perform a `Restart with defaults` to set all function block information in the device to factory defaults. This includes the clearing of all function block links and schedule, as well as defaulting all resource and transducer block user data (SPM block algorithm configurations, LCD display transducer block parameter configuration, etc.).

6.3 Troubleshooting for 4-20 mA output

6.3.1 Transmitter milliamp reading is zero

Recommended actions

1. Verify terminal voltage is 10.5 to 42.4 Vdc at signal terminals.
2. Check power wires for reversed polarity.
3. Check that power wires are connected to signal terminals.
4. Check for open diode across test terminal.

6.3.2 Transmitter not communicating with communication device

Recommended actions

1. Verify terminal voltage is 10.5 to 42.2 Vdc.
2. Check loop resistance.

   Note
   (Power supply voltage - terminal voltage)/loop current must be 250 Ω minimum.

3. Check that power wires are connected to signal terminals and not test terminals.
4. Verify clean Dc power to transmitter.

Note
Maximum AC noise is 0.2 volts peak to peak.

5. Verify the output is between 4 and 20 mA or saturation levels.
6. Use the communication device to poll for all addresses.

6.3.3 Transmitter milliamp reading is low or high

Recommended actions

1. Verify applied pressure.
2. Verify 4 and 20 mA range points.
3. Verify **output** is not in **alarm** condition.
4. Perform **analog trim**.
5. Check that power wires are connected to the correct signal terminals (positive to positive, negative to negative) and not the test terminal.

6.3.4 Transmitter will not respond to changes in applied pressure

Recommended actions

1. Check impulse piping or manifold for blockage.
2. Verify applied pressure is between 4 and 20 mA points.
3. Verify the **output** is not in **Alarm** condition.
4. Verify transmitter is not in **Loop Test** mode.
5. Verify transmitter is not in **Multidrop** mode.
6. Check test equipment.

6.3.5 **Digital pressure** variable reading is low or high

Recommended actions

1. Check impulse piping for blockage or low fill in wet leg.
2. Verify transmitter is calibrated properly.
3. Check test equipment (verify accuracy).
4. Verify pressure calculations for application.
5. Restore pressure calibration. Go to **Device Settings** → **Calibration** → **Pressure** → **Factory Calibration** → **Restore Pressure Calibration**.

6.3.6 **Digital pressure** variable reading is erratic

Recommended actions

1. Check application for faulty equipment in pressure line.
2. Verify transmitter is not reacting directly to equipment turning On/Off.
3. Verify damping is set properly for application.

6.3.7 Milliamps reading is erratic

Recommended actions

1. Verify power source to transmitter has adequate voltage and current.
2. Check for external electrical interference.
3. Verify transmitter is properly grounded.
4. Verify shield for twisted pair is only grounded at one end.

6.4 Diagnostic messages

The following sections contain possible messages that appear on either the display, a communication device, or an AMS system. Use them to diagnose status messages.

- `Failure`
- `Function Check`
- `Maintenance Required`
- `Out of Specification`

6.4.1 Diagnostic message: `Failure`

Electronics Board Failure

A failure has been detected in the electronics circuit board.

Graphical LCD display	`Electronics Board Failure`
LCD display	**FAIL BOARD**
Local Operator Interface (LOI)	**FAIL BOARD**

Recommended action

Replace the electronic circuit board.

Incompatible Sensor Module

The electronic circuit board has detected a sensor module that is incompatible with the system.

Graphical LCD display	`Incompatible Sensor Module`
LCD display	`XMTR MSMTCH`
Local Operator Interface (LOI)	`XMTR MSMTCH`

Recommended action

Replace the incompatible sensor module.

No Pressure Updates

There are no pressure updates from the sensor to the electronics.

Graphical LCD display	`Sensor Communication Failure`
LCD display	`NO P UPDATE`
Local Operator Interface (LOI)	`NO PRESS UPDATE`

Recommended actions

1. Ensure the sensor cable connection to the electronics is tight.
2. Replace the pressure sensor.

Sensor Module Failure

A failure has been detected in the sensor module.

Graphical LCD display	Sensor Module Failure
LCD display	`FAIL SENSOR`
Local Operator Interface (LOI)	**FAIL SENSOR**

Recommended action

Replace the sensor module.

No Temperature Updates

There are no temperature updates from the sensor to the electronics.

Graphical LCD display	`Sensor Communication Failure`
LCD display	`NO T UPDATE`
Local Operator Interface (LOI)	`NO TEMP UPDATE`

Recommended actions

1. Ensure the sensor cable connection to the electronics is tight.
2. Replace the pressure sensor.

6.4.2 Diagnostic message: `Function Check`

Primary or Device Variable Simulated

The primary or device variable is being simulated and does not represent the process measurement.

Graphical LCD display	`[Variable] Simulated`
LCD Display	(None)
Local operator interface (LOI)	(None)

Recommended action

Restart the device.

Loop Test Current Fixed

The analog output is fixed and does not represent the process measurement due to the device being set to loop test mode.

Graphical LCD display	`Loop Test Current Fixed`
LCD display	`ANLOG FIXED`
Local Operator Interface (LOI)	`ANLOG FIXED`

Recommended actions

1. Verify that the loop test is no longer required.
2. Disable Loop Test mode or restart the device.

6.4.3 Diagnostic message: `Maintenance Required`

Bluetooth® Electronics Error

Field device internal diagnostics detected a Bluetooth electronics error. This error will likely result in a reduced or no Bluetooth communication capability; however the field device will continue to function independently of this Bluetooth alert.

Graphical LCD display	`Bluetooth Electronics Error`
LCD display	N/A
Local operator interface (LOI)	N/A

Recommended actions

1. Remove the front housing cover (considering hazardous location requirements).
2. Replace the display (which contains the Bluetooth electronics).
3. Restart the device.

Bluetooth® Functionality Limited

Field device is unable to send device data over Bluetooth due to an internal error. The field device will continue to function independently of this Bluetooth alert.

Graphical LCD display	`Bluetooth Functionality Limited`
LCD display	N/A
Local operator interface (LOI)	N/A

Recommended actions

1. Remove the front housing cover (considering hazardous location requirements) and check that the display assembly is properly seated and connected to the electronic circuit board.

2. Replace the display (which contains the Bluetooth electronics).

Button Stuck

At least one button on the transmitter display or in the housing is stuck.

Graphical LCD display	`Button Stuck`
LCD display	`STUCK BUTTON`
Local operator interface (LOI)	`STUCK BUTTON`

Recommended actions

1. Check that the buttons on the housing are not depressed.
2. Remove the front housing cover (considering hazardous location requirements) and ensure that display buttons (if existing) are not depressed.
3. If the buttons will not be used, disable them.
4. Replace the display if it contains buttons.
5. Replace the electronic circuit board.

Display Communication Failure

The electronic circuit board has lost communication with the display. Note that the contents being displayed may not be correct.

Graphical LCD display	N/A
LCD display	N/A
Local operator interface (LOI)	N/A

Recommended actions

1. Remove the front housing cover (considering hazardous location requirements) and check that the display assembly is properly seated and connected to the electronic circuit board.
2. Replace the display.
3. Replace the electronic circuit board.

Loop Integrity Diagnostic

The `Loop Integrity Diagnostic` has detected a deviation of the terminal voltage outside of the configured limits. This may indicate degraded or loop integrity.

Graphical LCD display	`Loop Integrity Diagnostic`
LCD display	`POWER ADVISE`
Local Operator Interface (LOI)	`POWER ADVISE`

Recommended actions

1. Check the DC power supply to make sure the power is correct, stable, and has minimal ripple.

2. Check the loop wiring for degradation or improper grounding.
3. Remove the wiring compartment cover (considering hazardous location requirements) and check for water or terminal block corrosion.
4. Re-characterize the loop and adjust the deviation limit if necessary.

Plugged Impulse Line Diagnostic

The `Plugged Impulse Line Diagnostic` has detected a change in process noise levels, which could be attributed to a plugged impulse line, plugged flow element, or agitation loss.

Graphical LCD display	`Plugged Impulse Line Diagnostic`
LCD display	`Plug Line`
Local Operator Interface (LOI)	`Plugged Line`

Recommended actions

1. Verify the conditions of the process where the transmitter is installed.
2. Check the surrounding equipment and process for the following conditions:
   - Plugged impulse line
   - Plugged flow element
   - Agitation loss

Process Alert 1

The device has detected a change in the monitored variable that exceeds the configured thresholds for `Process Alert 1`.

Graphical LCD display	`Process Alert 1` [Alert Name]
LCD display	[Alert Name]
Local Operator Interface (LOI)	[Alert Name]

Recommended actions

1. Verify that the monitored variable is beyond the alert values.
2. Modify the alert settings or turn off the alert.

Process Alert 2

The device has detected a change in the monitored variable that exceeds the configured thresholds for `Process Alert 2`.

Graphical LCD display	`Process Alert 2` [Alert Name]
LCD display	[Alert Name]
Local Operator Interface (LOI)	[Alert Name]

Recommended actions

1. Verify that the monitored variable is beyond the alert values.
2. Modify the alert settings or turn off the alert.

6.4.4 Diagnostic message: `Out of Specification`

Pressure Out of Limits

The process pressure has exceeded the transmitter's maximum measurement range.

Graphical LCD display	`Pressure Out of Limits`
LCD display	`NO P UPDATE`
Local operator interface	`PRES OUT LIMITS`

Recommended actions

1. Verify the conditions of the process where the transmitter is installed.
2. Check the transmitter pressure connection to ensure it is not plugged and the isolating diaphragms are not damaged.
3. Replace sensor module.

Module Temperature Out of Limits

The module temperature has exceeded its normal operating range.

Graphical LCD display	`Module Temperature Out of Limits`
LCD display	`TEMP LIMITS`
Local operator interface (LOI)	**TEMP OUT LIMITS**

Recommended actions

1. Check the process and ambient temperatures to ensure they are within specifications.
2. Replace the sensor module.

Loop Current Saturated

The loop current is saturated due to the analog value being outside the saturation value range, or the primary variable is being saturated.

Graphical LCD display	`Loop Current Saturated`
LCD display	`ANLOG SAT`
Local operator interface (LOI)	**ANALOG SAT**

Recommended actions

1. Verify the conditions of the process where the transmitter is installed.

2. Verify the settings for the 4 mA and 20 mA range points and readjust if necessary.
3. Check the transmitter pressure connection to ensure it is not plugged and the isolating diaphragms are not damaged.
4. Replace the sensor module.

6.5 Disassembling the transmitter

⚠ WARNING

Explosion

Explosions could result in death or serious injury.

Do not remove the instrument cover in explosive atmospheres when the circuit is live.

6.5.1 Remove from service

⚠ WARNING

Follow all plant safety rules and procedures.

Procedure

1. Power down device.
2. Isolate and vent the process from the transmitter before removing the transmitter from service.
3. Remove all electrical leads and disconnect conduit.
4. Remove the transmitter from the process connection.
   - The Rosemount 3051C Transmitter is attached to the process connection by four bolts and two cap screws. Remove the bolts and screws and separate the transmitter from the process connection. Leave the process connection in place and ready for reinstallation. See Figure 3-4 for coplanar flange.
   - The Rosemount 3051T Transmitter is attached to the process by a single hex nut process connection. Loosen the hex nut to separate the transmitter from the process. Do not wrench on neck of transmitter. See warning in Inline gauge transmitter orientation.
5. Clean isolating diaphragms with a soft rag and a mild cleaning solution, and rinse with clear water.

   Note
   Do not scratch, puncture, or depress the isolating diaphragms.

6. For the Rosemount 3051C, whenever you remove the process flange or flange adapters, visually inspect the PTFE O-rings. Replace the O-rings if they show any signs of damage, such as nicks or cuts.

   Note
   You may reuse undamaged O-rings.

6.5.2 Remove terminal block

Electrical connections are located on the terminal block in the compartment labeled **FIELD TERMINALS**.

Procedure

1. Remove the housing cover from the field terminal side.
2. Loosen the two small screws located on the assembly in the 9 o'clock and 5 o'clock positions relative to the top of the transmitter.
3. Pull the entire terminal block out to remove it.

Related information

Safety messages

6.5.3 Remove electronics board

The transmitter electronics board is located in the compartment opposite the terminal side.

Procedure

1. Remove the housing cover opposite the field terminal side.
2. If you are disassembling a transmitter with an LCD display, loosen the two captive screws that are visible on the front of the LCD display.

   The two screws anchor the LCD display to the electronics board and the electronics board to the housing.
3. If you are disassembling a transmitter with a Local Operator Interface (LOI) or LCD display, loosen the two captive screws that are visible on the meter display.
4. See Figure 4-1 for screw locations. The two screws anchor the LOI/LCD display to the electronics board and the electronics board to the housing.

   Note
   The electronics board is electrostatically sensitive; observe handling precautions for static-sensitive components.

   Note
   If an LOI/LCD display is installed, use caution as there is an electronic pin connector that interfaces between the LOI/LCD display and electronics board.
5.

6.5.4 Remove sensor module from the electronics housing

Procedure

1. Remove the electronics board.

   Refer to Remove electronics board.

   NOTICE

   To prevent damage to the sensor module ribbon cable, disconnect it from the electronics board before you remove the sensor module from the electrical housing.

2. Carefully tuck the cable connector completely inside of the internal black cap.

NOTICE

Do not remove the housing until after you tuck the cable connector completely inside of the internal black cap. The black cap protects the ribbon cable from damage that can occur when you rotate the housing.

3. Using a 5/64-in. hex wrench, loosen the housing rotation set screw one full turn.
4. Unscrew the module from the housing, making sure the black cap on the sensor module and sensor cable do not catch on the housing.

6.6 Reassemble the transmitter

Procedure

1. Inspect all cover and housing (non-process wetted) O-rings and replace if necessary. Lightly grease with silicone lubricant to ensure a good seal.
2. Carefully tuck the cable connector completely inside the internal black cap. To do so, turn the black cap and cable counterclockwise one rotation to tighten the cable.
3. Lower the electronics housing onto the module. Guide the internal black cap and cable on the sensor module through the housing and into the external black cap.
4. Turn the module clockwise into the housing.

Note
Ensure the sensor ribbon cable and internal black cap remain completely free of the housing as you rotate it. Damage can occur to the cable if the internal black cap and ribbon cable become hung up and rotate with the housing.

5. Thread the housing completely onto the sensor module.

   The housing must be no more than one full turn from flush with the sensor module to comply with explosion proof requirements. See Safety messages for complete warning information.

6. Tighten the housing rotation set screw using a 5/64-in. wrench.

6.6.1 Attach electronics board

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

The transmitter covers must be engaged metal-to-metal to ensure a proper seal and to meet explosion-proof requirements.

Procedure

1. Remove the cable connector from its position inside of the internal black cap and attach it to the electronics board.
2. Using the two captive screws as handles, insert the electronics board into the housing.

Ensure the power posts from the electronics housing properly engage the receptacles on the electronics board. Do not force. The electronics board should slide gently on the connections.

3. Tighten the captive mounting screws.
4. Replace the electronics housing cover.

6.6.2 Install terminal block

Procedure

1. Gently slide the terminal block into place, making sure the two power posts from the electronics housing properly engage the receptacles on the terminal block.

⚠ WARNING

Electrical shock

Electrical shock can result in death or serious injury.

Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

2. Tighten the captive screws.
3. Replace the electronics housing cover.

⚠ WARNING

Explosions

Explosions could result in death or serious injury.

The transmitter covers must be fully engaged to meet explosion-proof requirements.

6.6.3 Reassemble the Rosemount 3051C process flange

See Safety messages for complete warning information.

Procedure

1. Inspect the sensor module PTFE O-rings.

   You may reuse undamaged O-rings. Replace O-rings that show any signs of damage, such as nicks, cuts, or general wear.

Note
If you are replacing the O-rings, be careful not to scratch the O-ring grooves or the surface of the isolating diaphragm when removing the damaged O-rings.

2. Install the process connection. Possible options include:
   - Coplanar process flange:
     a. Hold the process flange in place by installing the two alignment screws to finger tightness (screws are not pressure retaining). Do not over-tighten, as this will affect module-to-flange alignment.
     b. Install the four 1.75-in. (44 mm) flange bolts by finger tightening them to the flange.

- Coplanar process flange with flange adapters:
  a. Hold the process flange in place by installing the two alignment screws to finger tightness (screws are not pressure retaining). Do not over-tighten, as this will affect module-to-flange alignment.
  b. Hold the flange adapters and adapter O-rings in place while installing (in the desired of the four possible process connection spacing configurations) using four 2.88-in. (73 mm) bolts to mount securely to the coplanar flange. For gauge pressure configurations, use two 2.88-in. (73 mm) bolts and two 1.75-in. (44 mm) bolts.
- Manifold: Contact the manifold manufacturer for the appropriate bolts and procedures.

3. Tighten the bolts to the initial torque value using a crossed pattern.
   See Table 6-1 for appropriate torque values.
4. Using the same cross pattern, tighten bolts to final torque values seen in Table 6-1.

Note
If you replaced the PTFE sensor module O-rings, re-torque the flange bolts after installation to compensate for cold flow of the O-ring material.

Note
For Range 1 transmitters, after replacing O-rings and re-installing the process flange, expose the transmitter to a temperature of 185 °F (85 °C) for two hours. Then re-tighten the flange bolts in a cross pattern and again expose the transmitter to a temperature of 185 °F (85 °C) for two hours before calibration.

Table 6-1: Bolt installation torque values

Bolt material	Initial torque value	Final torque value
CS-ASTM-A445 Standard	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
316 SST—Option L4	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)
ASTM-A-19 B7M—Option L5	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
ASTM-A-193 Class 2, Grade B8M—Option L8	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)

6.6.4 Install drain/vent valve

Procedure

1. Apply sealing tape to the threads on the seat. Starting at the base of the valve with the threaded end pointing toward the installer, apply five clockwise turns of sealing tape.

NOTICE

Ensure the opening on the valve is placed so that process fluid will drain toward the ground and away from human contact when the valve is opened.

2. Tighten the drain/vent valve to 250 in.-lb. (28.25 N-m).

7 Safety Instrumented Systems (SIS) requirements

A two-wire, 4-20 mA signal representing pressure provides the safety-critical output of the Rosemount 3051 Pressure Transmitter. The Rosemount 3051 safety-certified pressure transmitter is certified to:

- Low and high demand: Type B element
- Route 2H, Low Demand application: SIL 2 for random integrity at HFT=0, SIL 3 for random integrity at HFT=1
- Route 2H, High Demand application: SIL 2 and SIL3 for random integrity at HFT=1
- Route 1H where the SFF ≥ 90%: SIL 2 for random integrity at HFT=0, SIL 3 for random integrity at HFT=1
- SIL 3 for systematic integrity

7.1 Identify Rosemount 3051 safety certification

You must identify all Rosemount 3051 transmitters as safety-certified before installing them into Safety Instrumented Systems (SIS). To identify a safety-certified Rosemount 3051:

Procedure

1. Check NAMUR Software Revision located on the metal device tag: `SW_._._`.

   NAMUR Software Revision Number: SW[6] 1.0.x-1.4.x and 2.0.x. See Table 2-1.

2. Verify that option code **QT** is included and **TR** is not included in the transmitter model code.

   Devices used in safety applications with ambient temperatures below -40 °F (-40 °C) require option codes **QT** and **BR5** or **BR6**.

7.2 Installation in Safety Instrumented Systems (SIS) applications

There are no additional instructions for installing the transmitter in SIS applications.

⚠ WARNING

Only allow qualified personnel to install the Rosemount 3051 in SIS applications.

Always ensure a proper seal by installing the electronics housing cover(s) so that metal contacts metal.

See the *Specifications* section of the Rosemount 3051 Product Data Sheet for environmental and operational limits.

Design the loop so that terminal voltage does not drop below 10.5 Vdc when the transmitter output is set to 23 mA.

(6) NAMUR Software Revision: Located on the metal device tag.

Set the **Security** switch to Lock to prevent accidental or deliberate change of configuration data during normal operation.

7.3 Configuring in Safety Instrumented Systems (SIS) applications

Use any HART® capable configuration tool to communicate with and verify configuration of the Rosemount 3051.

NOTICE

Transmitter output is not safety-rated during the following: configuration changes, multidrop, and loop test. Use alternative means to ensure process safety during transmitter configuration and maintenance activities.

7.3.1 Damping

User-selected damping affects the transmitter's ability to respond to changes in the applied process. The damping value + response time must not exceed the loop requirements.

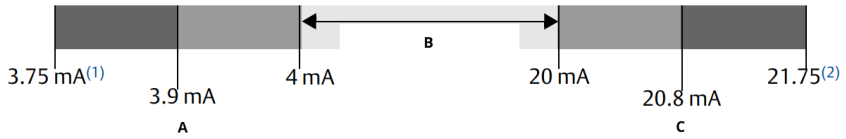
Reference Damping to change damping value.

7.3.2 Alarm and saturation levels

Configure DCS or safety logic solver to match transmitter configuration.

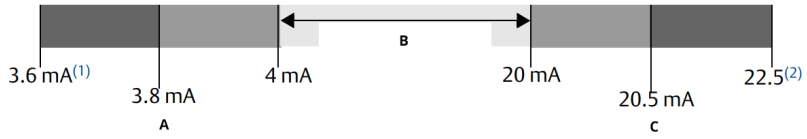
The figures below identify the three alarm levels available and their operation values.

Figure 7-1: Rosemount alarm level



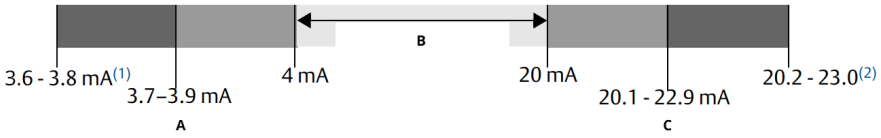
A. Low saturation
B. Normal operation
C. High saturation

Figure 7-2: NAMUR alarm level



A. Low saturation
B. Normal operation
C. High saturation

Figure 7-3: Custom alarm level



A. Low saturation
B. Normal operation
C. High saturation

1. Transmitter failure, hardware, or software alarm in LO position.
2. Transmitter failure, hardware, or software alarm in HI position.

7.4 Safety Instrumented Systems (SIS) operation and maintenance

7.4.1 Proof-tests

Emerson recommends the following proof-tests.

If you find an error in safety or functionality, you can document proof-test results and corrective actions taken at Contact Measurement Solutions Instrumentation Customer Service.

⚠ WARNING

Only allow qualified personnel to perform proof-tests.

Verify the **Security** switch is in the Unlock position during the proof-test and reposition it in the Lock position after the proof-test.

7.4.2 Perform a guided proof-test

If you select the guided proof-test option, the Rosemount 3051 will support a feature that can perform a guided partial or comprehensive proof-test.

This feature walks you through the necessary steps to perform a proof-test. The alarm levels and required steps will be provided without the need to look them up.

To access the guided proof-test option:

Procedure

Go to **Device Settings** → **Calibration** → **Proof Test** → **Perform Proof Tests**.

The guided proof-test option comes with a proof-test log. This log stores the ten most recent proof-tests directly in the transmitter. The log includes time stamp, communication source, Pass/Fail result, and any user-defined notes.

7.4.3 Partial proof-test

The simple suggested proof-test consists of a power cycle plus reasonability checks of the transmitter output.

See the Failure Modes, Effects, and Diagnostic Analysis Report.

Prerequisites

Required tools:

- Communication device
- mA meter

Procedure

1. Bypass the safety function and take appropriate action to avoid a false trip.
2. Use HART® communication to retrieve any diagnostics and take appropriate action.
3. Select a HART command to the transmitter to the high alarm current output and verify that the analog current reaches that value.(7)

   See Verifying alarm level.
4. Send a HART command to the transmitter to go to the low alarm current output and verify that the analog current reaches that value.(7)
5. Remove the bypass and otherwise restore the normal operation.
6. Place the **Security** switch in the Lock position.

7.4.4 Comprehensive proof-test

The comprehensive proof-test consists of performing the same steps as the simple suggested proof-test but with a two-point calibration of the pressure sensor instead of the reasonability check.

See the Failure Modes, Effects and Diagnostic Analysis Report for percent of possible DU failures in the device.

Prerequisites

Required tools:

- Communication device
- Pressure calibration equipment

Procedure

1. Bypass the safety function and take appropriate action to avoid a false trip.
2. Use HART communication to retrieve any diagnostics and take appropriate action.
3. Send a HART command to the transmitter to go to the high alarm current output and verify that the analog current reaches that value.(7)

   See Verifying alarm level.
4. Send a HART command to the transmitter to go to the low alarm current output and verify that the analog current reaches that value.(8)

(7) This tests for possible quiescent current related failures.
(8) This tests for compliance voltage problems, such as a low loop power supply voltage or increased wiring distance. This also tests for other possible failures.

5. Perform a two-point calibration of the sensor over the full working range and verify the current output at each point.

   See Trimming the pressure signal.

6. Remove the bypass and otherwise restore the normal operation.
7. Place the **Security** switch in the Lock position.

NOTICE

- You determine the proof-test requirements for impulse piping.
- Automatic diagnostics are defined for the corrected % DU. The device performs these tests internally during runtime without requiring you to enable or program the transmitter.

7.4.5 Calculation of average probability of failure on demand (PFD_{AVG})

See the Failure Mode, Effects and Diagnostic Analysis Report for the PFD_{AVG} calculation.

7.5 Inspection

7.5.1 Product repair

You can repair the transmitter by replacing major components.

Report all failures detected by the transmitter diagnostics or by the proof-test. Submit feedback electronically.

⚠ WARNING

Only allow qualified personnel to repair the product and replace parts.

7.5.2 3051 Safety Instrumented Systems (SIS) reference

Operate the transmitter in accordance with the functional and performance specifications provided in the *Specifications* section of the Rosemount 3051 Product Data Sheet.

7.5.3 Failure rate data

See the Failure Modes, Effects and Diagnostic Analysis Report for failure rates and common cause Beta factor estimates.

7.5.4 Failure values

Safety deviation	±2.0 percent
Transmitter response time	See the *Specifications* section of the Rosemount 3051 Product Data Sheet.
Self-diagnostics test interval	At least once every 60 minutes

7.5.5 Product life

Product life is 50 years. This is based on worst case component wear-out mechanisms. It is not based on wear-out of process wetted materials.

A Reference data

A.1 Ordering information, specifications, and drawings

To view current Rosemount 3051 ordering information, specifications, and drawings, follow these steps:

Procedure

1. Go to Emerson.com/Rosemount3051CP.
2. Scroll as needed to the green menu bar and click **Documents & Drawings**.
3. For installation drawings, click **Drawings & Schematics** and select the appropriate document.
4. For ordering information, specifications, and dimensional drawings, click **Data Sheets & Bulletins** and select the appropriate Product Data Sheet.
5. For the Declaration of Conformity, click **Certificates & Approvals** and select the most current document.

A.2 Product certifications

To view current Rosemount 3051 product certifications, see the Rosemount 3051 Quick Start Guide.

B Device Driver (DD) menu trees

Figure B-1: First level menu trees

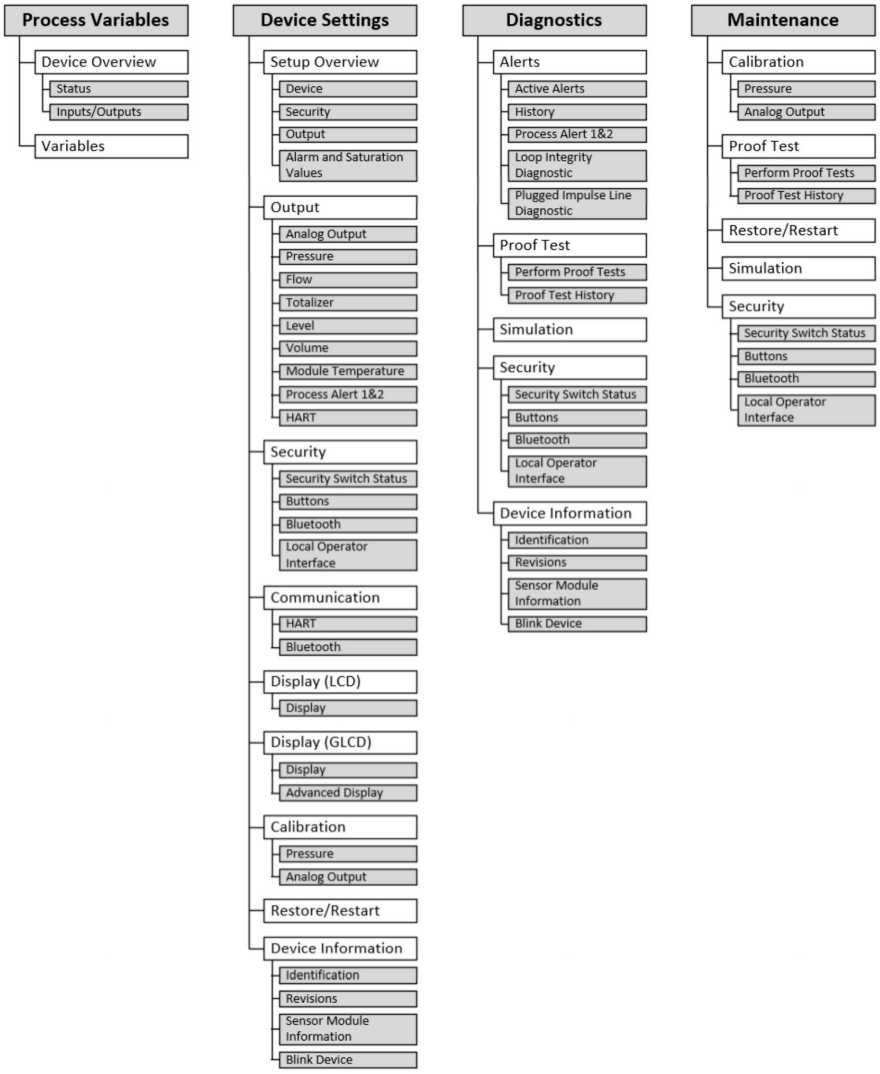


Figure B-2: *Process Variables* menu

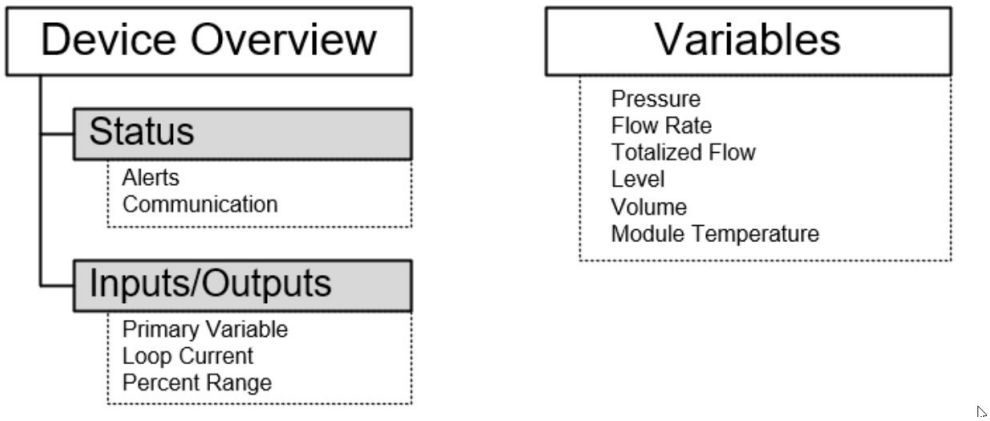


Figure B-3: *Device Settings* 1

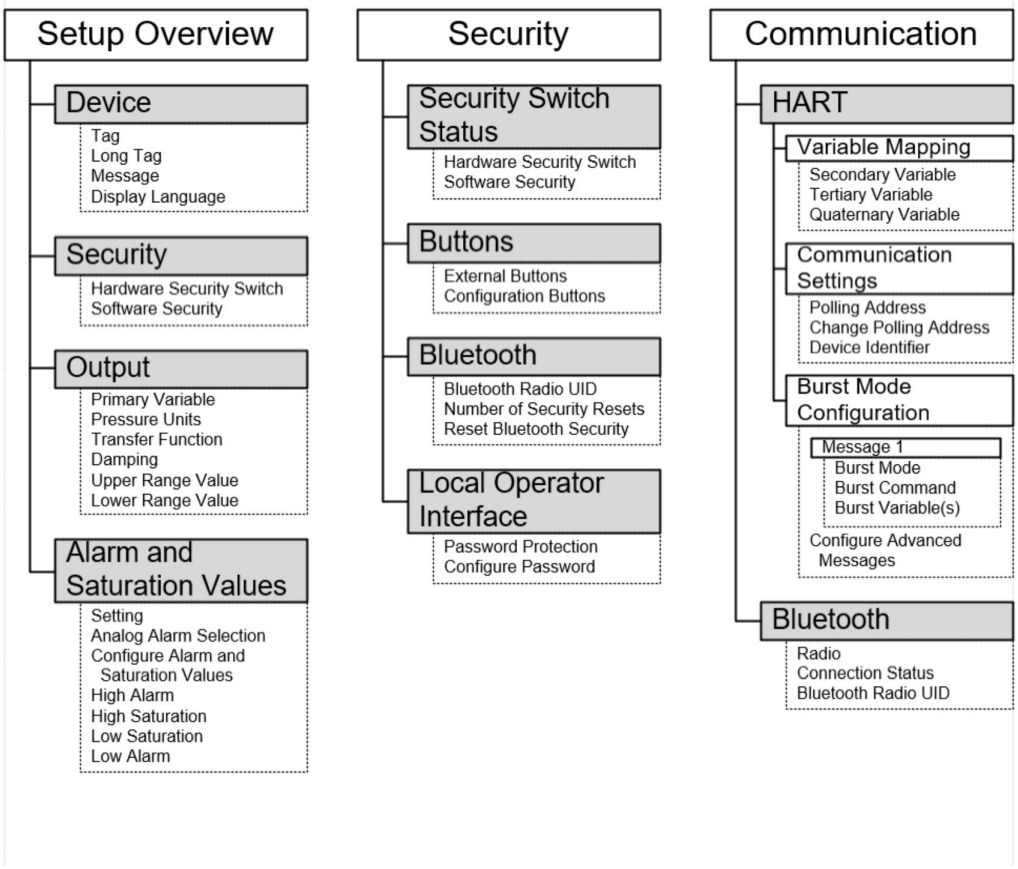


Figure B-4: *Device Settings* 2

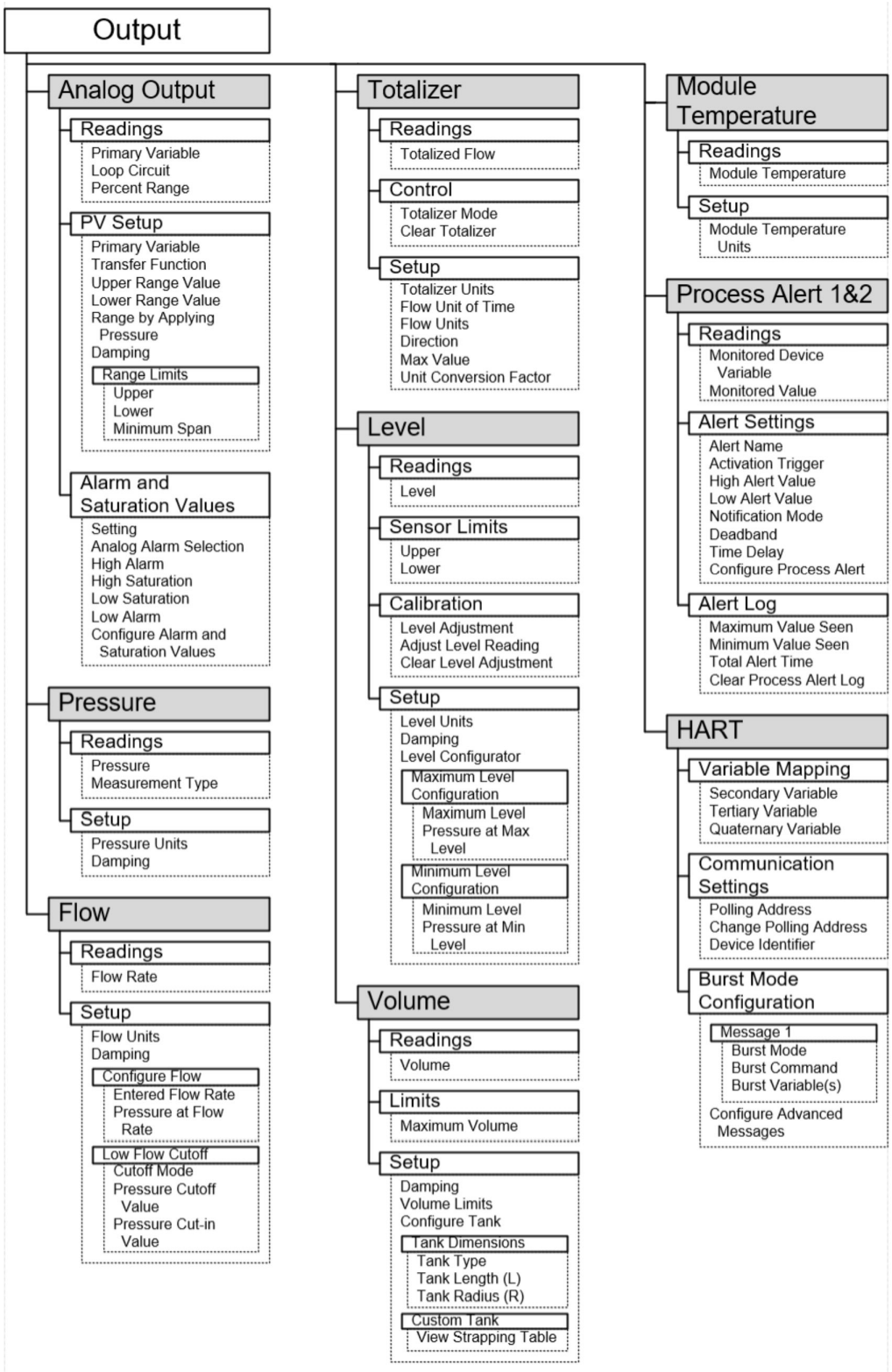


Figure B-5: *Device Settings* 3

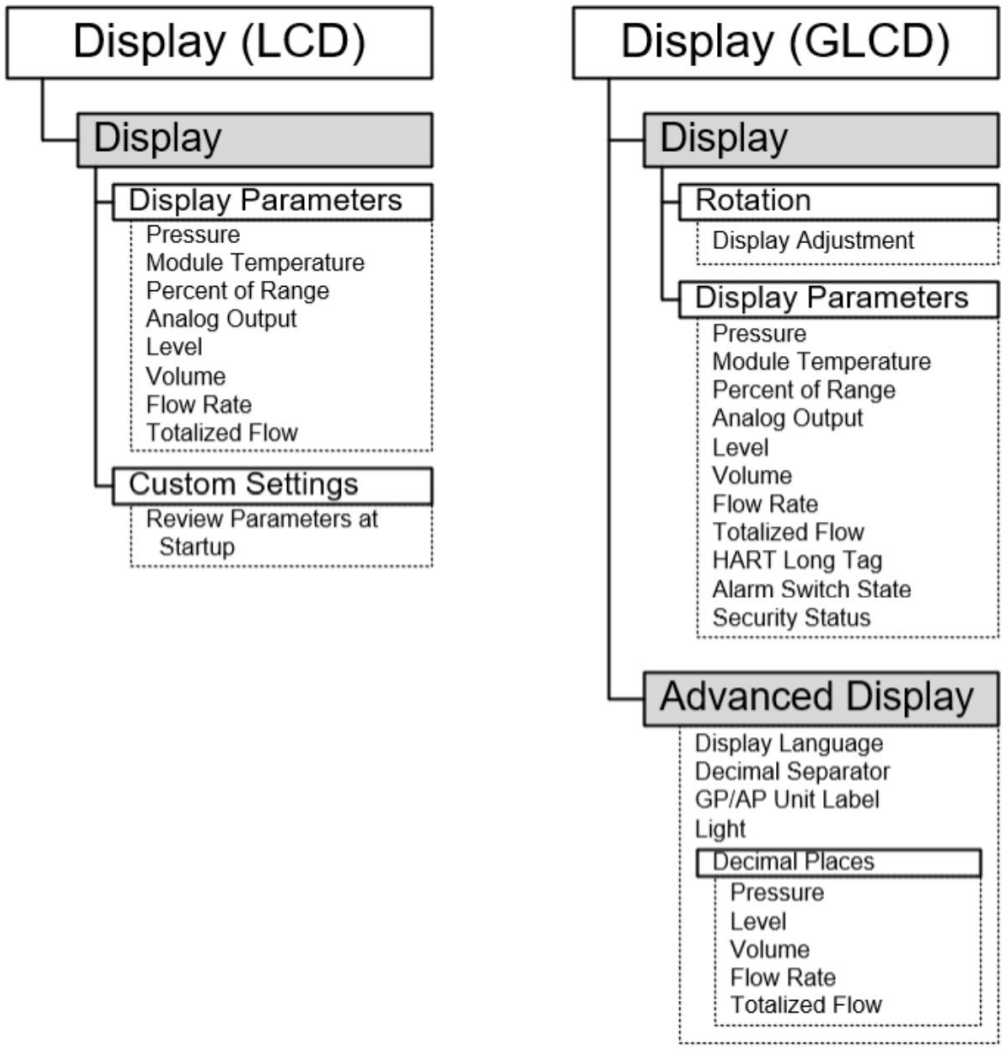


Figure B-6: *Device Settings* 4

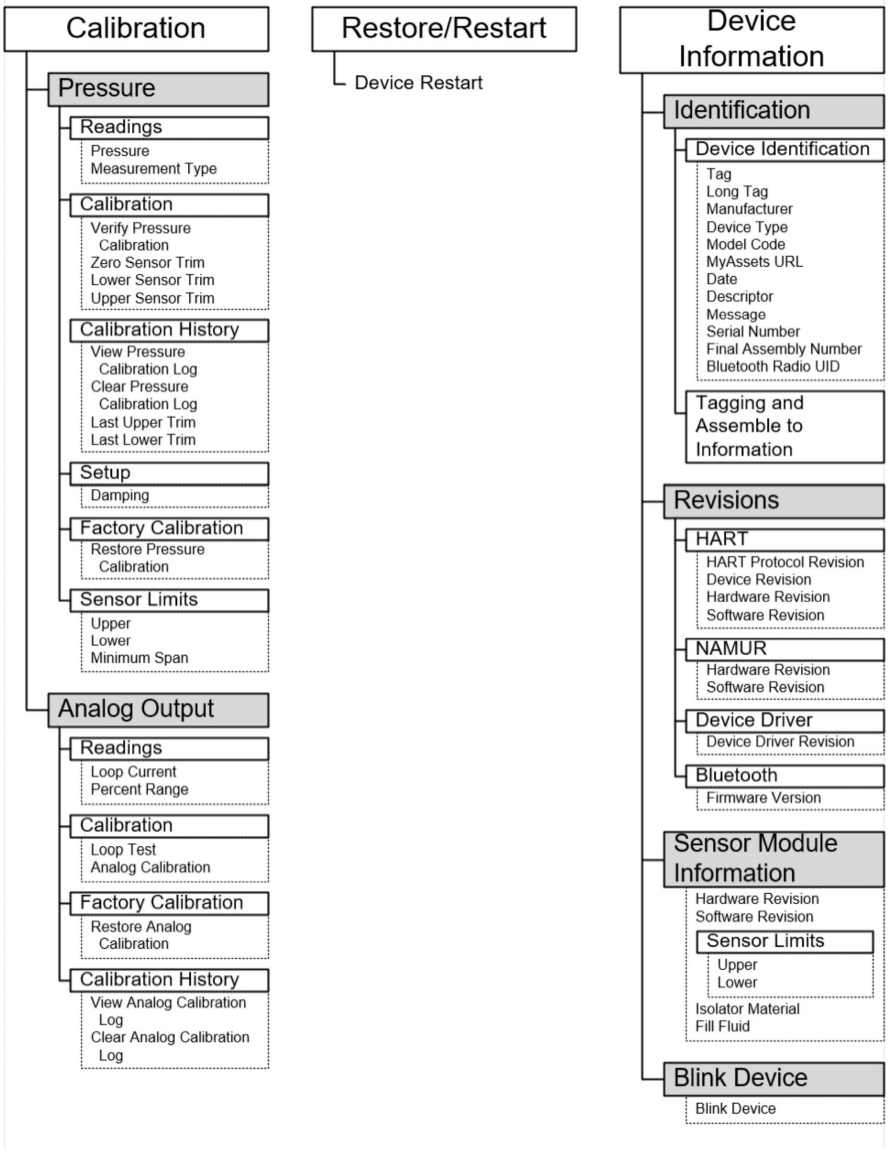


Figure B-7: *Diagnostics* 1

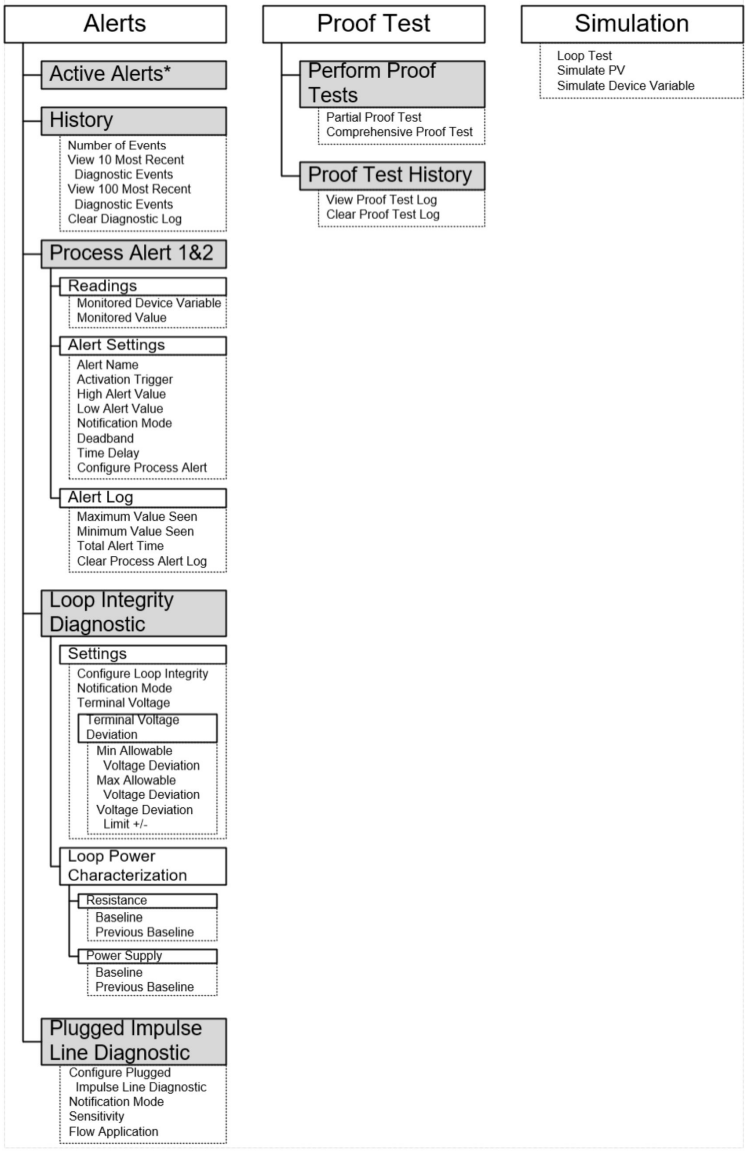


Figure B-8: *Diagnostics* 2

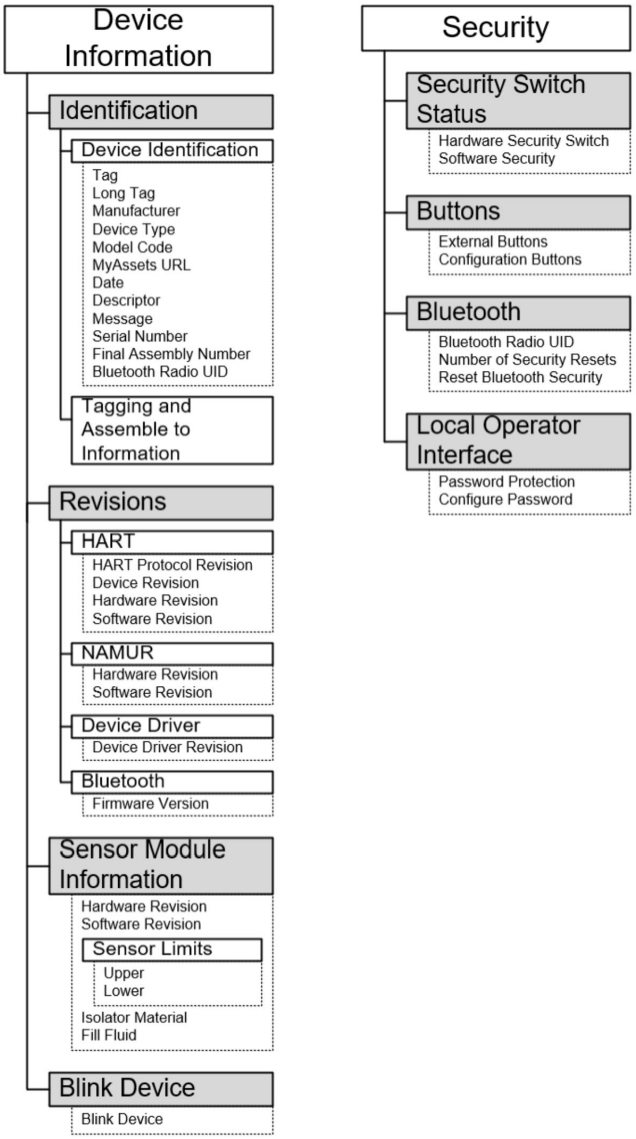


Figure B-9: *Maintenance* 1

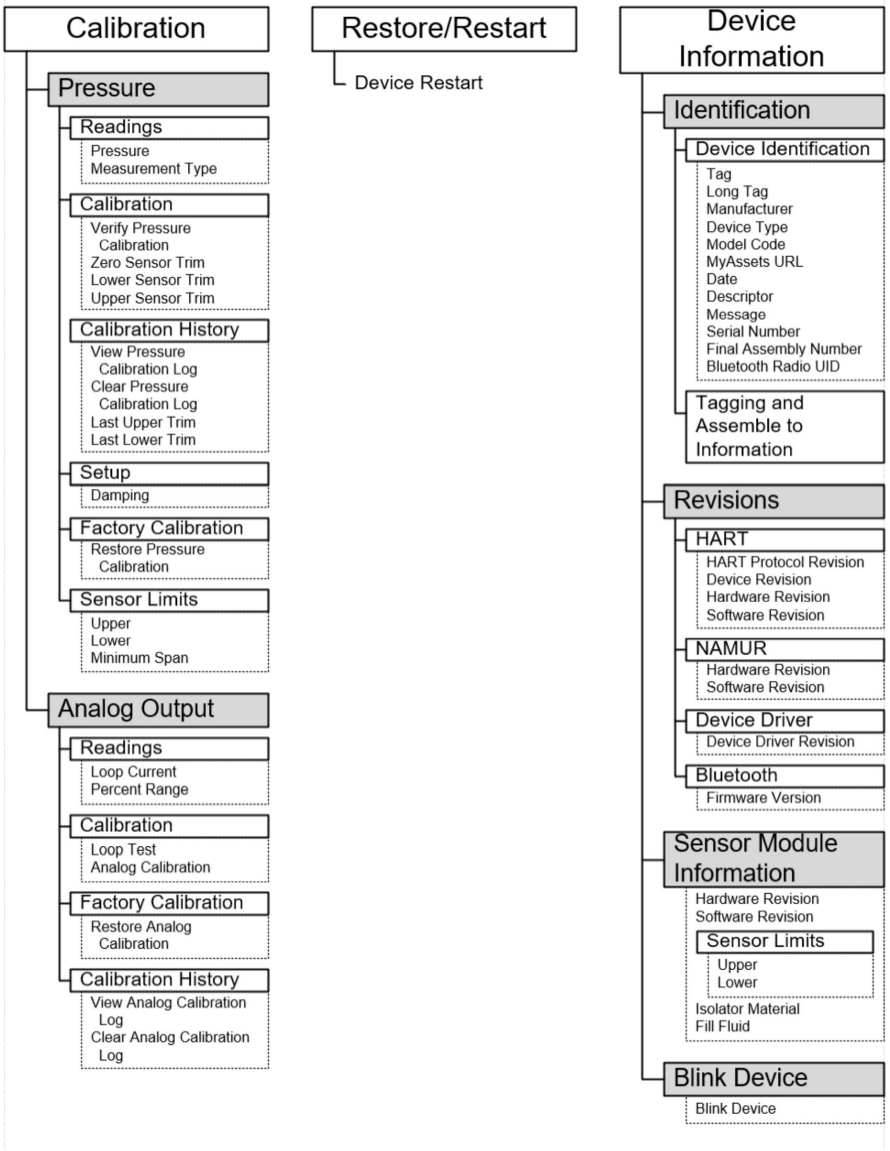
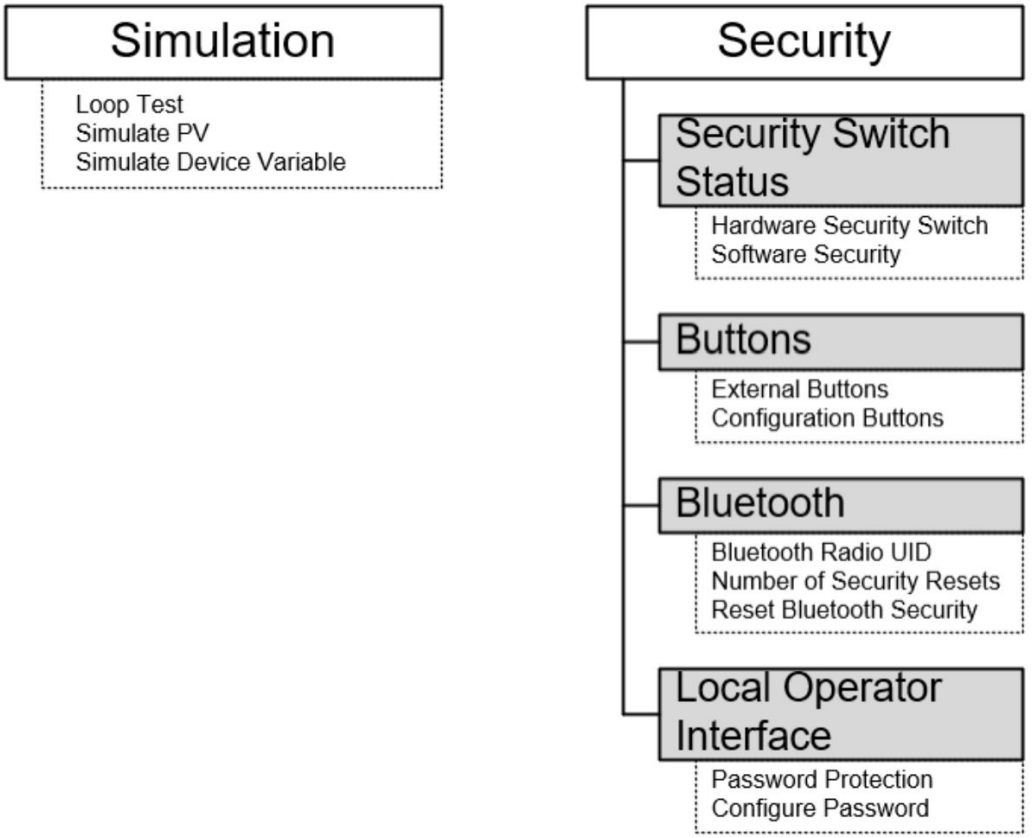


Figure B-10: *Maintenance* 2



C Quick Service buttons

Menu title	Button
View Config	PV (Primary Variable)
	PV Damping
	PV Upper Range Value (URV)
	PV Lower Range Value (LRV)
	AO Alarm (Analog Output)
	HI (High) Saturation
	LO (Low) Saturation
Zero	Trim to PV Zero
	Set current reading as 4 mA
Rerange	Set 4 mA
	Set 20 mA
Loop Test	Set 4 mA
	Set 8 mA
	Set 12 mA
	Set 16 mA
	Set 20 mA
Flip screen	Flip 180 Degrees

D Local operator interface (LOI)

D.1 Enter numbers in the Local Operator Interface (LOI)

You can enter floating-point numbers with the LOI using all eight number locations on the top line.

The steps below give an example of how to change a value of −0000022 to 000011.2.

When the number entry begins, the leftmost position is the selected position. In this example, the negative symbol "−" is flashing on the screen: -0000022

Procedure

1. Press the **Scroll** button until the 0 is blinking on the screen in the selected position.
   00000022
2. Press the **Enter** button to select 0 as an entry.
   The second digit from the left is blinking: 00000022
3. Press the **Enter** button to select 0 for the second digit.
   The third digit from the left is blinking: 00000022
4. Press the **Enter** button to select 0 for the third digit.
   The fourth digit from the left is blinking: 00000022
5. Press the **Enter** button to select 0 for the fourth digit.
   The fifth digit from the left is blinking: 00000022
6. Press the **Scroll** button to navigate through the numbers until 1 is on the screen.
   00001022
7. Press the **Enter** button to select 1 for the fifth digit.
   The sixth digit from the left is blinking: 00001022
8. Press the **Scroll** button to navigate through the numbers until 1 is on the screen.
   00001122
9. Press the **Enter** button to select 1 for the sixth digit.
   The seventh digit from the left is blinking: 00001122
10. Press the Scroll button to navigate through the numbers until the decimal "." is on the screen.
    000011.2
11. Press the **Enter** button to select the decimal "." for the seventh digit.
    After you press **Enter**, all digits to the right of the decimal become 0. The eight digit from the left is blinking: 000011.0
12. Press the **Scroll** button to navigate through the numbers until 2 is on the screen.
    000011.2
13. Press the **Enter** button to select 2 for the eight digit.
    000011.2

The number entry is complete. A ***SAVE*** screen appears.

Usage notes:

- To move backwards in the number, scroll to the Left arrow symbol and press **Enter**.

- The negative symbol is only allowed in the leftmost position.
- To enter numbers in scientific notation, place an `E` in the seventh position.

D.2 Enter text in the Local Operator Interface (LOI)

Depending on the edited item, you can enter text in up to eight locations on the top line.

Text entry follows the same rules as the number entry rules in Enter numbers in the Local Operator Interface (LOI), except the following characters are available in all locations: `A-Z`, `0-9`, `–`, `/`, space.

Note
If the current text contains a character the LOI cannot display, it will be shown as an asterisk "`*`".

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ROSEMOUNT™

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Reference Manual
00809-0700-4001, Rev AD
April 2024

Rosemount™ 3051P In-Line Pressure Transmitter

with HART® Protocol

ROSEMOUNT™

EMERSON™

Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations.

⚠ WARNING

Explosions could result in death or serious injury.

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Review the Product Certifications section of the Rosemount 3051P Quick Start Guide for any restrictions associated with a safe installation.

Before connecting a handheld communicator in an explosive atmosphere, be sure that the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the transmitter.

⚠ WARNING

Electrical shock could cause death or serious injury.

Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

⚠ WARNING

Process leaks could result in death or serious injury.

Install and tighten all four flange bolts before applying pressure.

Do not attempt to loosen or remove flange bolts while the transmitter is in service.

⚠ WARNING

Replacement equipment or spare parts not approved by Emerson for use as spare parts could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.

Use only bolts supplied or sold by Emerson as spare parts. Improper assembly of manifolds to traditional flange can damage sensor module.

⚠ WARNING

Improper assembly of manifolds to traditional flange can damage the device.

For safe assembly of manifold to traditional flange, bolts must break back plane of flange web (i.e., bolt hole) but must not contact sensor module housing.

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental in protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

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1 Introduction

1.1 Models covered

The following Rosemount Pressure Transmitters are covered by this manual:

- Rosemount 3051P In-Line Gauge Pressure Transmitter: Measures gauge pressure up to 4,000 psig (275.8 BarG).
- Rosemount 3051P In-Line Absolute Pressure Transmitter: Measures absolute pressure up to 4,000 psig (275.8 BarG).

1.2 Product recycling/disposal

Consider recycling equipment and packaging.

Dispose of the product and packaging in accordance with local and national legislation.

2 Configuration

2.1 System readiness

- If using HART® based control or asset management systems, confirm the HART capability of such systems prior to commissioning and installation. Not all systems are capable of communicating with HART Revision 7 devices.
- For instructions on how to change the HART revision of your transmitter, see Switching HART® revision.

2.1.1 Confirm correct device descriptor

Procedure

1. Verify the latest Device Driver (DD/DTM™) is loaded on your systems to ensure proper communications.
2. Reference Software Downloads & Drivers or FieldCommGroup.org for the latest DD.
3. Select desired product and download the DD.

   Reference Table 2-1 for the correct DD.

Table 2-1: Device Revisions and Files

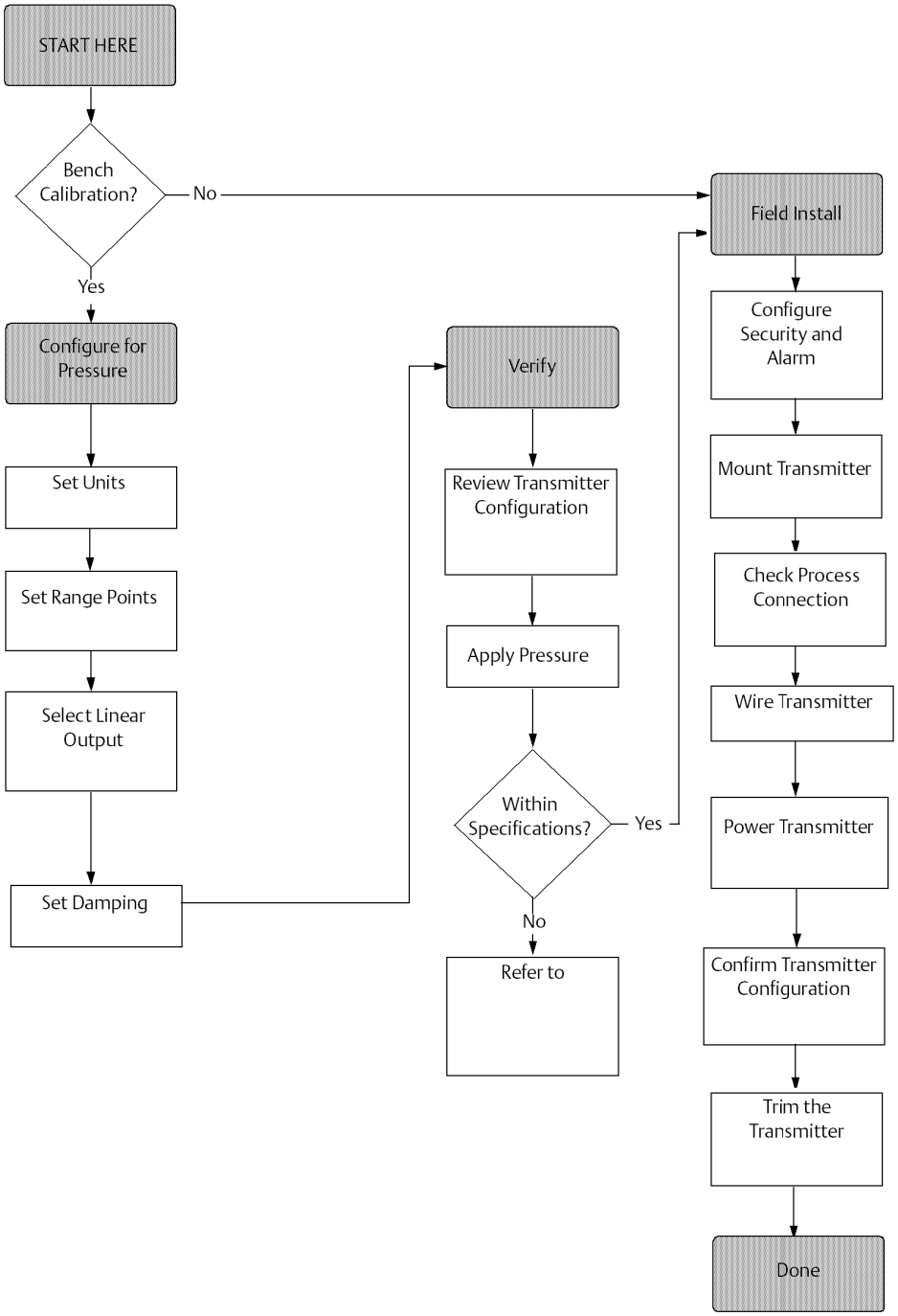
	Identify device			**Find device driver files**		**Review instructions**	**Review functionality**
Software release date	NAMUR hardware revision(1)	NAMUR software revision(1)	HART® software revision(2)	HART universal revision	Device revision(3)	Manual document number	Changes to software
August 2016	1.1.xx	1.0.xx	03	7	10	00809-0700-4001	• HART Revision 5 and 7 selectable • Local operator interface (LOI) • Scaled variable • Configurable alarms • Expanded engineering units • Updated electronics hardware design • Intrinsic Safety temperature classification change
				5	9		

(1) NAMUR revision is located on the hardware tag of the device. Differences in level 3 changes, signified above by xx, represent minor product changes as defined per NE53. Compatibility and functionality are preserved, and products can be used interchangeably.

(2) HART software revision can be read using a HART capable configuration tool. Value shown is minimum revision that could correspond to NAMUR revisions.

(3) Device driver file names use device and DD revision, e.g., 10_01. HART Protocol is designed to enable legacy device driver revisions to continue to communicate with new HART devices. To access new functionality, the new device driver must be downloaded. Emerson recommends downloading new device driver files to ensure full functionality.

2.2 HART® installation flowchart



2.3 Transmitter overview

The 3051P In-Line Pressure Transmitter is offered for Gauge Pressure (GP) and Absolute Pressure (AP) measurements. The transmitter uses piezoresistive sensor technology for AP and GP measurements.

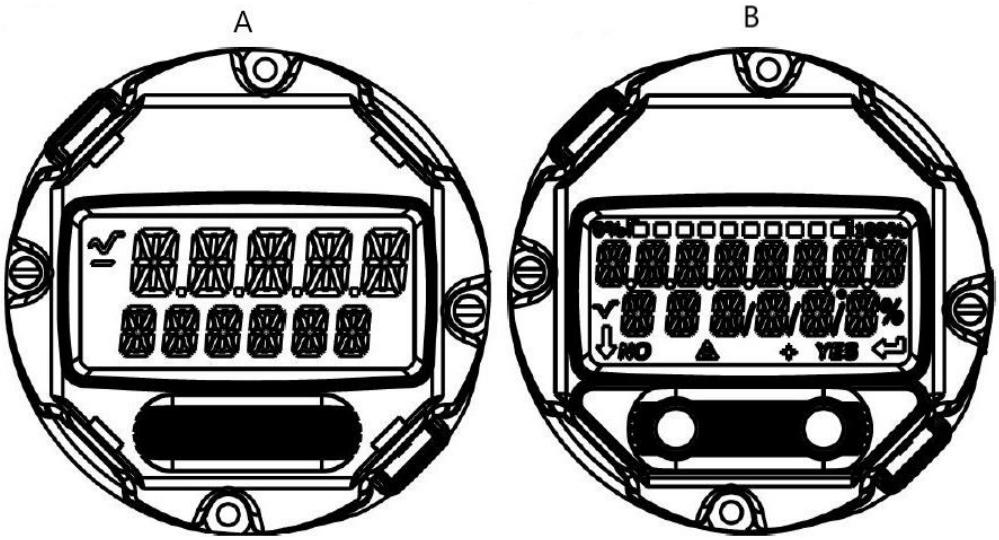
The major components of the transmitter are the sensor module and the electronics housing. The sensor module contains the oil-filled sensor system (isolating diaphragm, oil fill system, and sensor). The electronics board is located within the electronics housing. The electrical signals from the sensor module are transmitted to the electronics board which contains the memory module and the analog to digital signal converter (A/D converter). The signal is then converted to a 4–20mA analog output signal or HART® digital signal. The electronics housing contains the output electronics board, the optional external configuration buttons, and the terminal block. The basic block diagram of the transmitter is illustrated in Figure 2-2.

When pressure is applied to the isolating diaphragm, the oil deflects the sensor, which then changes its capacitance or voltage signal. This signal is then changed to a digital signal by the Signal Processing. The microprocessor then takes the signals from the Signal Processing and calculates the correct output of the transmitter. This signal is then sent to the D/A converter, which converts the signal back to the analog signal and then superimposes the HART signal on the 4–20 mA output.

An optional LCD display can be ordered that connects directly to the interface board, which maintains direct access to the signal terminals. The display indicates output and abbreviated diagnostic messages. A glass display cover is provided. For 4-20 mA HART output, the LCD display features a two-line display. The first line displays the actual measured value; the second line of six characters displays the engineering units. The LCD display can also display diagnostic messages.

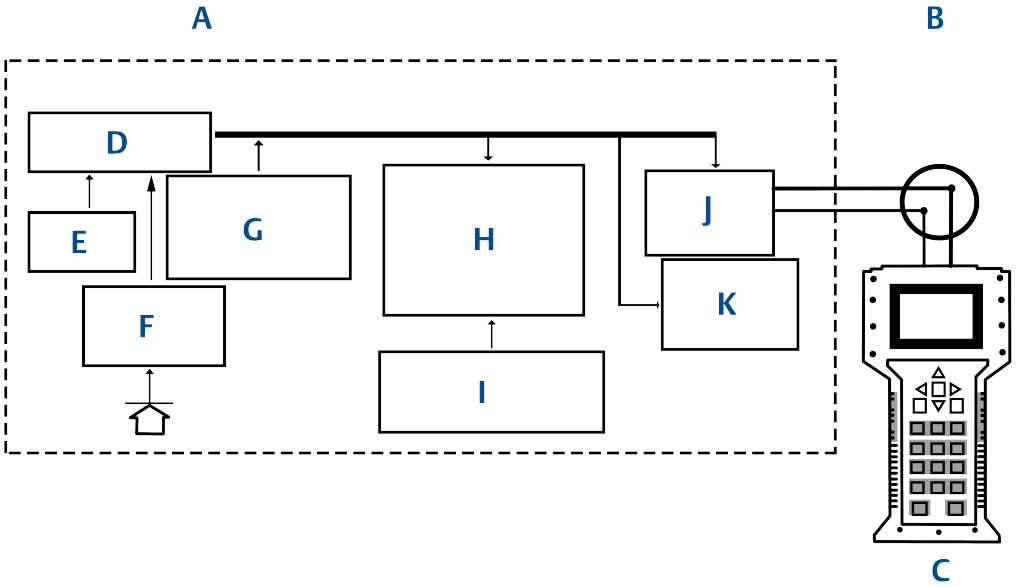
Note
LCD display uses a 5x6 character display and can display output and diagnostic messages. The Local Operator Interface (LOI) display uses an 8x6 character display and can display output and diagnostic messages as well as and LOI menu screens. The LOI display comes with two buttons mounted on the front of the display board. See Figure 2-1.

Figure 2-1: LCD/LOI display



A. LCD display
B. LOI display

Figure 2-2: Block Diagram of Operation



A. Sensor module and electronics
B. 4-20 mA signal to control system
C. Communication device
D. Signal processing
E. Temperature sensor
F. Pressure sensor
G. Sensor module memory
H. Microprocessor
- *Sensor linearization*
- *Rerange*
- *Damping*
- *Diagnostics*
- *Engineering units*
- *Communication*

I. Memory
- *Configuration*

J. Digital-to-analog signal conversion
K. Digital communication

2.4 Configuration overview

This section contains information on commissioning and tasks that should be performed on the bench prior to installation, as well as tasks performed after installation as described in Performing transmitter tests.

Field Communicator, AMS Device Manager, and Local Operator Interface (LOI) instructions are given to perform configuration functions. For convenience, Field Communicator Fast

Key sequences are labeled “Fast Keys,” and abbreviated LOI menus are provided for each function below.

Full Field Communicator menu trees and Fast Key sequences are available in Field Communicator menu trees and Fast Keys. LOI menu trees are available in Local Operator Interface (LOI).

2.5 Configuration basics

NOTICE

Set all transmitter hardware adjustments during commissioning to avoid exposing the transmitter electronics to the plant environment after installation.

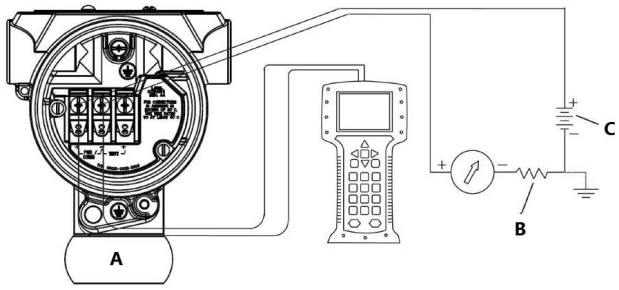
You can configure the transmitter either before or after installation. Configuring the transmitter on the bench using either a Field Communicator, AMS Device Manager, or LOI ensures all transmitter components are in working order prior to installation. Verify that the **security** switch is set in the unlock position (🔓) to proceed with configuration. See Figure 4-2 for switch location.

2.5.1 Configuring on the bench

To configure on the bench, you will need a power supply and a Field Communicator, AMS Device Manager, or Local Operator Interface (LOI), option M4.

Wire equipment as shown in Figure 2-3. To ensure successful HART® communication, a resistance of at least 250 Ωs must be present between the transmitter and the power supply; see Power supply for details. Connect the Field Communicator leads to the terminals labeled **COMM** on the terminal block.

Figure 2-3: Wiring the Transmitter (4–20 mA HART)



A. Vdc supply
B. $R_L \geq 250$ (necessary for HART communication only)

2.5.2 Configuration tools

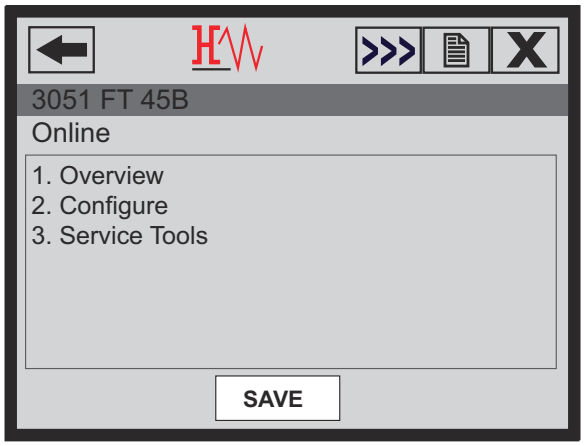
Configuring with a Field Communicator

There are two interfaces available with the Field Communicator: traditional and dashboard.

This manual describes all steps using a Field Communicator using dashboard interfaces. Figure 2-4 shows the Device Dashboard interface. As stated in System readiness, it is critical that the latest Device Descriptors (DD) are loaded into the Field Communicator. Visit Software Downloads & Drivers or FieldCommGroup.org to download the latest DD library.

Field Communicator menu trees and Fast Keys are available in Field Communicator menu trees and Fast Keys.

Figure 2-4: Device Dashboard



Configuring with AMS Device Manager

Full configuration capability with AMS Device Manager requires loading the most current Device Descriptor (DD) for this device. Download the latest DD at Software Downloads & Drivers or FieldCommGroup.org.

Note
This manual describes all steps using AMS Device Manager Version 11.5.

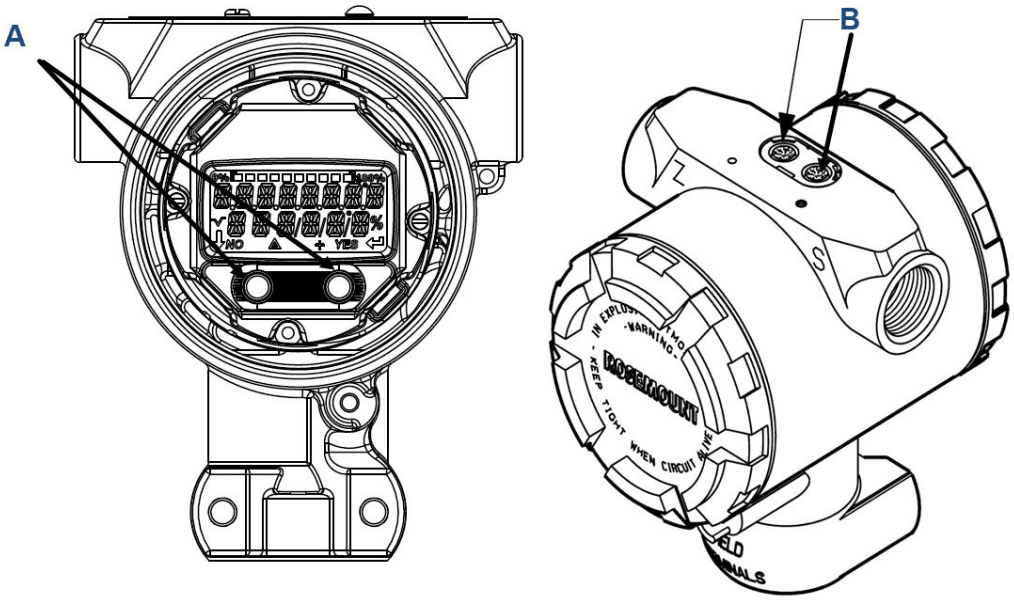
Configuring with a Local Operator Interface (LOI)

To use the LOI, order the transmitter with option code M4. To activate the LOI, push either configuration button. Configuration buttons are located on the LCD display (must remove housing cover to access), or underneath the top tag of the transmitter. See Table 2-2 for configuration button functionality and Figure 2-5 for configuration button location.

When using the LOI for configuration, several features require multiple screens for a successful configuration. Data entered will be saved on a screen-by-screen basis; the LOI will indicate this by flashing **SAVED** on the LCD display each time.

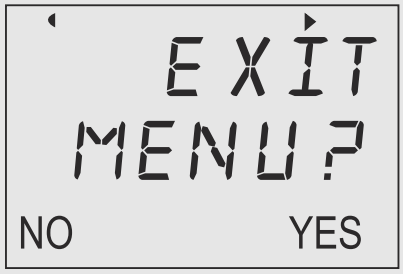
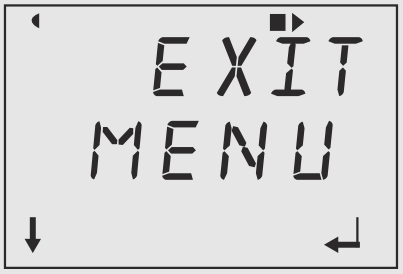
LOI menu trees are available in Local Operator Interface (LOI).

Figure 2-5: LOI Configuration Buttons



A. Internal configuration buttons
B. External configuration buttons

Table 2-2: LOI Button Operation

Button		
Left	**No**	SCROLL
Right	**Yes**	ENTER

2.5.3 Setting the loop to **Manual**

Whenever sending or requesting data that would disrupt the loop or change the output of the transmitter, set the process application loop to **Manual** control.

The Field Communicator, AMS Device Manager, or Local Operator Interface (LOI) will prompt you to set the loop to **Manual** when necessary. The prompt is only a reminder; acknowledging this prompt does not set the loop to manual. You must set the loop to **Manual** control as a separate operation.

2.6 Verifying configuration

Emerson recommends verifying various configuration parameters prior to installing them into the process.

The various parameters are detailed out for each configuration tool. Depending on what configuration tool(s) are available, follow the steps listed relevant to each tool.

2.6.1 Verifying configuration with Field Communicator

Review configuration parameters listed in Table 2-3 prior to transmitter installation. A full list of configuration parameters that can be reviewed and configured using a Field Communicator are located in Field Communicator menu trees and Fast Keys.

Fast Key sequences for the latest Device Descriptor (DD) are shown in Table 2-3. For Fast Key sequences for legacy DDs, contact your local Emerson Representative.

Procedure

From the ***HOME*** screen, enter the Fast Key sequences listed.

Table 2-3: Device Dashboard Fast Key Sequence

Function	Fast Key sequence	
	HART® 7	HART 5
Alarm and saturation levels	2, 2, 2, 5	2, 2, 2, 5
Damping	2, 2, 1, 1, 5	2, 2, 1, 1, 5
Primary variable	2, 1, 1, 4, 1	2, 1, 1, 4, 1
Range values	2, 1, 1, 4	2, 1, 1, 4
Tag	2, 2, 7, 1, 1	2, 2, 7, 1, 1
Transfer function	2, 2, 1, 1, 6	2, 2, 1, 1, 6
Units	2, 2, 1, 1, 4	2, 2, 1, 1, 4

2.6.2 Verifying configuration with AMS Device Manager

Procedure

1. Right click on the device and select **Configuration Properties** from the menu.
2. Navigate the tabs to review the transmitter configuration data.

2.6.3 Verifying configuration with Local Operator Interface (LOI)

Procedure

1. Press any configuration button to activate the LOI.
2. Select **VIEW CONFIG** to review the below parameters.
3. Use the configuration buttons to navigate through the menu.

   Review the following parameters prior to installation:

   - **Tag**
   - **Units**
   - **Transfer Function**

- **Alarm and Saturation Levels**
- **Primary Variable**
- **Range Values**
- **Damping**

2.6.4 Verifying process variables configuration

This section describes how to verify that the correct process variables are selected.

Verifying process variables with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence.

Device Dashboard Fast Keys: 3, 2, 1

Verifying process variables with AMS Device Manager

Procedure

1. Right click the device and select **Overview** from the menu.
2. Select the **All Variables** button to display the primary, secondary, tertiary, and quaternary variables.

2.7 Basic setup of the transmitter

This section provides the necessary steps for basic setup of a pressure transmitter.

When installing in DP level or DP flow applications, refer to Configuring scaled variable for setup instructions.

2.7.1 Setting pressure units

The pressure unit command sets the unit of measure for the reported pressure.

Setting pressure units with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence:

Device Dashboard Fast Keys: 2, 2, 1, 1, 4

Setting pressure units with AMS Device Manager

Procedure

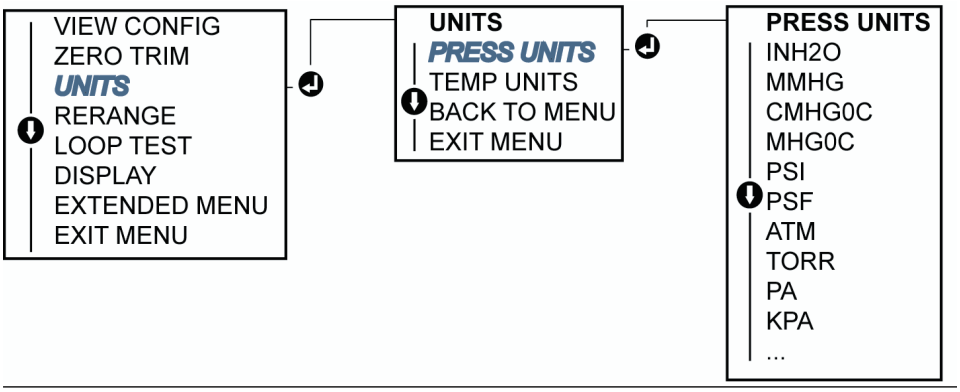
1. Right click the device and select **Configure**.
2. Select **Manual Setup** and select desired units from **Pressure Units** dropdown menu.
3. Select **Send** when complete.

Setting pressure units with a Local Operator Interface (LOI)

Procedure

1. Follow Figure 2-6 to select desired pressure and temperature units.
2. Use the **SCROLL** and **ENTER** buttons to select desired unit.
3. Save by selecting **SAVE** as indicated on the LCD display screen.

Figure 2-6: Selecting Units with LOI



2.7.2 Reranging the transmitter

The range values command sets each of the lower and upper range analog values to a pressure. The lower range point represents 0 percent of range and the upper range point represents 100 percent of range.

In practice, the transmitter range values may be changed as often as necessary to reflect changing process requirements.

Select from one of the methods below to rerange the transmitter. Each method is unique; examine all options closely before deciding which method works best for your process.

- Rerange by manually setting range points with a Field Communicator, AMS Device Manager, or Local Operator Interface (LOI).
- Rerange with a pressure input source and a Field Communicator, AMS Device Manager, LOI, or local zero and span buttons.

Manually rerange the transmitter by entering range points

Entering range points with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence:

Device Dashboard Fast Keys: 2, 2, 2, 1

Entering range points with AMS Device Manager

Procedure

1. Right click the device and select **Configure**.
2. Select **Manual Setup** and select **Analog Output**.
3. Enter upper and lower range values in the Range Limits box and click **Send**.

4. Carefully read the warning and click **Yes** if it is safe to apply the changes.

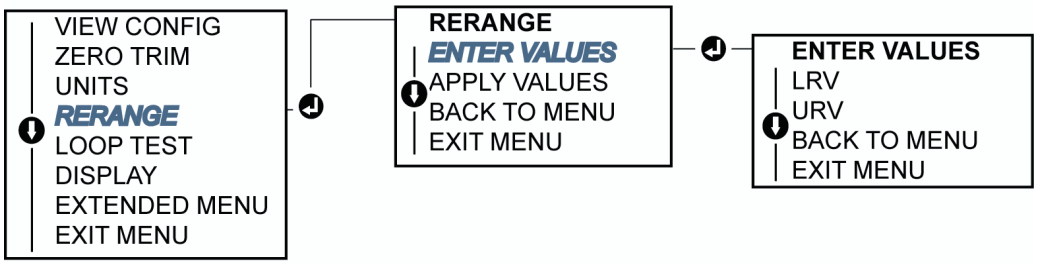
Entering range points with a Local Operator Interface (LOI)

See Figure 2-7 to rerange the transmitter using the LOI.

Procedure

Enter values using **SCROLL** and **ENTER** buttons.

Figure 2-7: Rerange with LOI



Reranging the transmitter with applied pressure source

Reranging using an applied pressure source is a way of reranging the transmitter without entering specific 4 and 20 mA points.

Reranging with an applied pressure source using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence:

Device Dashboard Fast Keys: 2, 2, 2, 2

Reranging with an applied pressure source using AMS Device Manager

Procedure

1. Right click the device; select **Configure**.
2. Select the **Analog Output** tab.
3. Select **Range by Applying Pressure** and follow the screen prompts range the transmitter.

Reranging with an applied pressure source using local zero and span buttons

If you order local **zero** and **span** buttons (option code D4), you can use them to rerange the transmitter with an applied pressure. Refer to Figure 2-8 for analog **zero** and **span** button location.

To rerange the transmitter using the **span** and **zero** buttons:

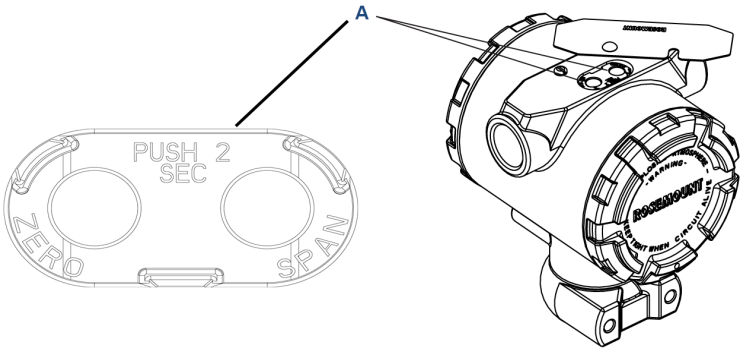
Procedure

1. Loosen the screw holding the top tag of the transmitter housing. Rotate the label to expose the **zero** and **span** buttons.
2. Confirm device has local **zero** and **span** buttons by verifying blue retainer under the tag.

3. Apply transmitter pressure.
4. Rerange the transmitter.
   a) To change the zero (4 mA) while maintaining the span: press and hold **zero** button for at least two seconds then release.
   b) To change the span (20 mA) while maintaining the zero point: press and hold the **span** button for at least two seconds and then release.

Note
4 mA and 20 mA points must maintain the minimum span defined in the 3051P In-Line Pressure Transmitter Product Data Sheet.

Figure 2-8: Analog Zero and Span Buttons



*A. **Zero** and **span** buttons*

Example

Note

- If the transmitter security is on, you cannot make adjustments to the zero and span. Refer to Configuring transmitter security for security information.
- The span is maintained when the 4 mA/1 V point is set. The span changes when the 20 mA/5 V point is set. If the lower range point is set to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.
- Regardless of the range points, the transmitter measures and reports all readings within the digital limits of the sensor. For example, if the 4 and 20 mA points are set to 0 and 10 inH_2O, and the transmitter detects a pressure of 25 inH_2O, it digitally outputs the 25 inH_2O reading and a 250 percent of range reading.

2.7.3 Damping

The **damping** command changes the response time of the transmitter; higher values can smooth variations in output readings caused by rapid input changes.

Determine the appropriate **damping** setting based on the necessary response time, signal stability, and other requirements of the loop dynamics within your system. The **damping** command utilizes floating point configuration, allowing you to input any **damping** value within 0.0–60.0 seconds.

Damping with a Field Communicator

Procedure

1. From the ***HOME*** screen, enter the Fast Key sequence:

   Device Dashboard Fast Keys: 2, 2, 1, 1, 5

2. Enter desired **damping** value and select **APPLY**.

Damping with AMS Device Manager

Procedure

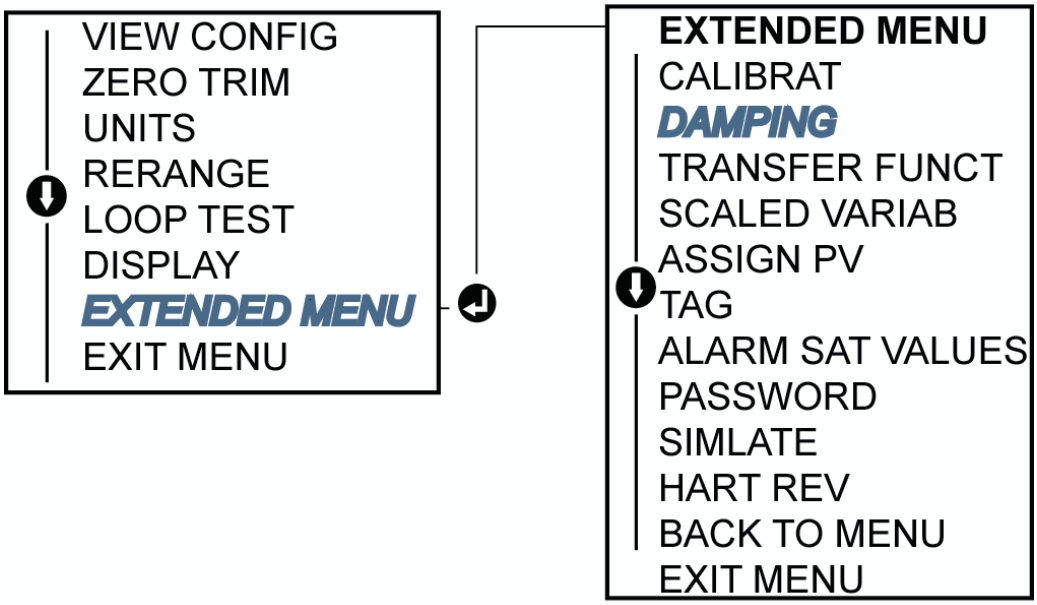
1. Right click the device and select **Configure**.
2. Select **Manual Setup**.
3. Within the ***Pressure Setup*** box, enter desired **damping** value and click **Send**.
4. Carefully read the warning and click **Yes** if it is safe to apply the changes.

Damping with a Local Operator Interface (LOI)

Procedure

Reference Figure 2-9 to enter **damping** values using an LOI.

Figure 2-9: Damping with LOI



2.8 Configuring the LCD display

The LCD display configuration command allows customization of the LCD display to suit application requirements.

The LCD display will alternate between the selected items:

- **Pressure Units**

- **% of Range**
- **Scaled Variable**
- **Sensor Temperature**
- **mA/Vdc Output**

Use the following instructions to configure the LCD display to display configuration information during the device startup. Select **Review Parameters** at start-up to enable or disable this functionality.

See Table 2-2 for an image of the LCD display screen.

2.8.1 Configuring LCD display with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 4.

2.8.2 Configuring LCD display with AMS Device Manager

Procedure

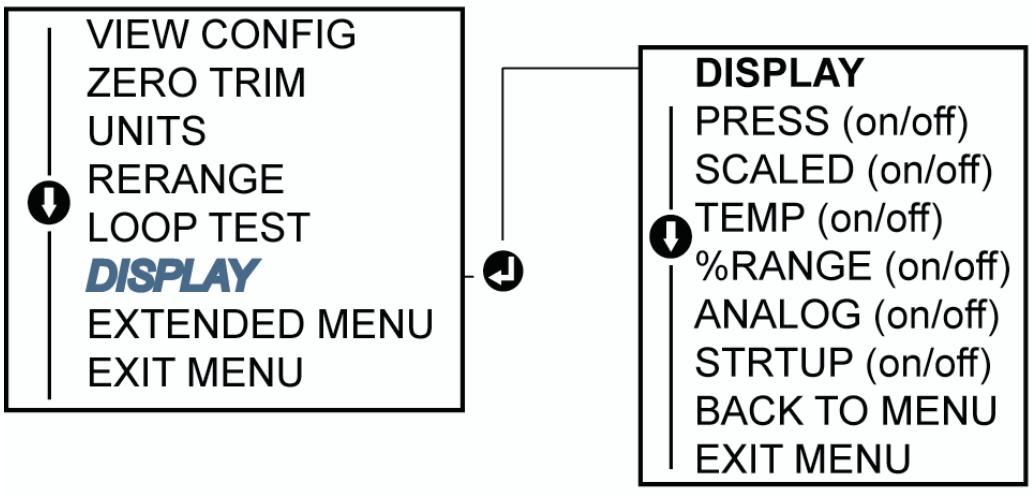
1. Right click on the device and select **Configure**.
2. Select **Manual Setup**; select the **Display** tab.
3. Select desired display options and click **Send**.

2.8.3 Configuring LCD display with a Local Operator Interface (LOI)

Procedure

Refer to Figure 2-10 for LCD display configuration using an LOI.

Figure 2-10: Display with LOI



2.9 Detailed transmitter setup

2.9.1 Configuring **alarm** and **saturation** levels

In normal operation, the transmitter will drive the output in response to pressure from the lower to upper saturation points. If the pressure goes outside the sensor limits, or if the output would be beyond the saturation points, the output will be limited to the associated saturation point.

The transmitter automatically and continuously performs self-diagnostic routines. If the self-diagnostic routines detect a failure, the transmitter drives the output to configured alarm and value based on the position of the **alarm** switch. See Setting transmitter alarm.

Table 2-4: Alarm and Saturation Values

Level	4–20 mA saturation	4–20 mA alarm
Low	3.90 mA	≤ 3.75 mA
High	20.80 mA	≥ 21.75 mA

Table 2-5: NAMUR-Compliant Alarm and Saturation Values

Level	4–20 mA saturation	4–20 mA alarm
Low	3.80 mA	≤ 3.60 mA
High	20.50 mA	≥22.50 mA

Table 2-6: Custom Alarm and Saturation Values

Level	4–20 mA saturation	4–20 mA alarm
Low	3.50 mA– 3.90 mA	3.40–3.80 mA
High	20.10 mA –22.90 mA	20.20 mA – 23.00 mA

You can configure **failure** mode **alarm** and **saturation** levels using a Field Communicator, AMS Device Manager, or Local Operator Interface (LOI). The following limitations exist for custom levels:

- **Low alarm** level must be less than the **low saturation** level.
- **High alarm** level must be higher than the **high saturation** level.
- **Alarm** and **saturation** levels must be separated by at least 0.1 mA.

The configuration tool will provide an error message if the configuration rule is violated.

Note
Transmitters set to HART® **multidrop** mode send all saturation and alarm information digitally; saturation and alarm conditions will not affect the analog output. See also Establishing multidrop communication.

Configuring alarm and saturation levels using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 2, 5.

Configuring alarm and saturation levels with AMS Device Manager

Procedure

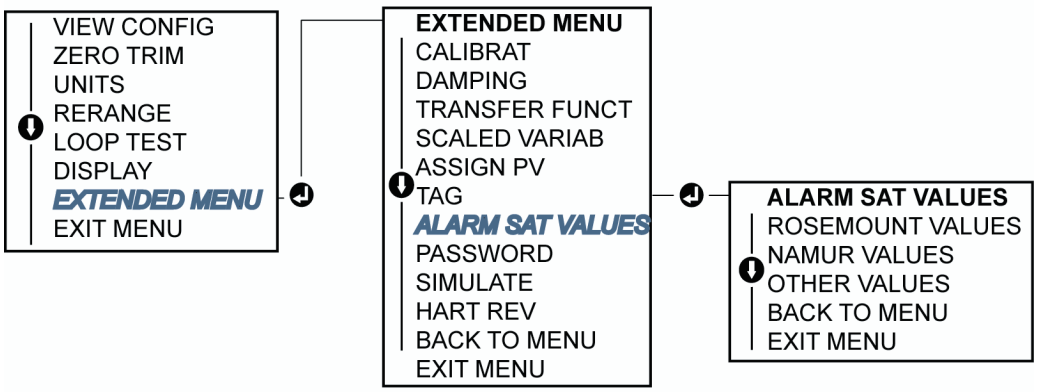
1. Right click on the device and select **Configure**.
2. Select **Configure Alarm and Saturation Levels**.
3. Follow screen prompts to configure **alarm** and **saturation** levels.

Configuring alarm and saturation levels using a Local Operator Interface (LOI)

Procedure

Refer to Figure 2-11 for instructions to configure **alarm** and **saturation** levels.

Figure 2-11: Configuring Alarm and Saturation with LOI



2.9.2 Configuring **scaled variable**

With the **scaled variable**, you can create a relationship/conversion between the **pressure units** and user-defined/custom units.

There are two use cases for **scaled variable**:

1. Allow custom units to be displayed on the transmitter's LCD/Local Operator Interface (LOI) display.
2. Allow custom units to drive the transmitters 4-20 mA output.

If the you want custom units to drive the 4–20 mA output, re-map the **scaled variable** as the **primary variable**. Refer to Re-mapping device variables.

The **scaled variable** configuration defines the following items:

Scaled variable units	Custom units to be displayed.
Scaled data options	Defines the transfer function for the application.
Pressure value position 1	Lower known value point with consideration of linear offset.
Scaled variable position 1	Custom unit equivalent to the lower known value point.
Pressure value position 2	Upper known value point.
Scaled variable position 2	Custom unit equivalent to the upper known value point.

Linear offset	The value required to zero out pressures affecting the desired pressure reading.

Configuring a scaled variable using a Field Communicator

Procedure

1. From the ***HOME*** screen, enter the Fast Key sequence: 2, 1, 4, 7.
2. Follow the screen prompts to configure **scaled variable**.
3. Select **Linear** under ***Select Scaled*** data options.

Configuring a scaled variable using AMS Device Manager

Procedure

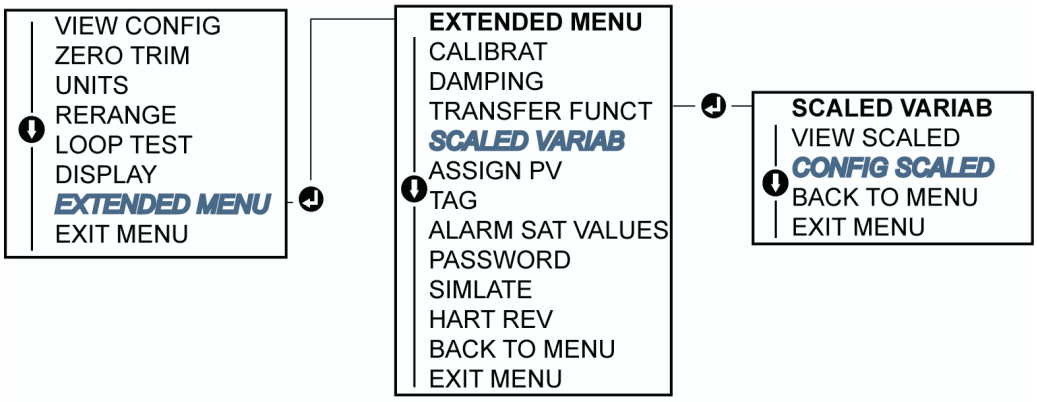
1. Right click on the device and, select **Configure**.
2. Select the ***Scaled Variable*** tab and select the **Scaled Variable** button.
3. Follow screen prompts to configure **scaled variable**.
    a) Select **Linear** under **Select Scaled data** options.

Configuring a scaled variable using a Local Operator Interface (LOI)

Procedure

Refer to Figure 2-12 for instructions to configure a **scaled variable** using an LOI.

Figure 2-12: Configuring Scaled Variable Using an LOI



2.9.3 Re-mapping device variables

The **re-mapping** function allows you to configure the transmitter **primary**, **secondary**, **tertiary**, and **quaternary** variables (PV, 2V, 3V, and 4V) as desired.

You can re-map the PV with a Field Communicator, AMS Device Manager, or a Local Operator Interface (LOI). You can only re-map variables 2V, 3V, and 4V via Field Communicator or AMS Device Manager.

Note
The variable assigned to the **primary variable** drives the 4–20 mA output. This value can be selected as **Pressure** or **Scaled Variable**. The 2, 3, and 4 variables only apply if using HART® **burst** mode.

Re-mapping device variables using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 1, 1, 3.

Re-mapping device variables using AMS Device Manager

Procedure

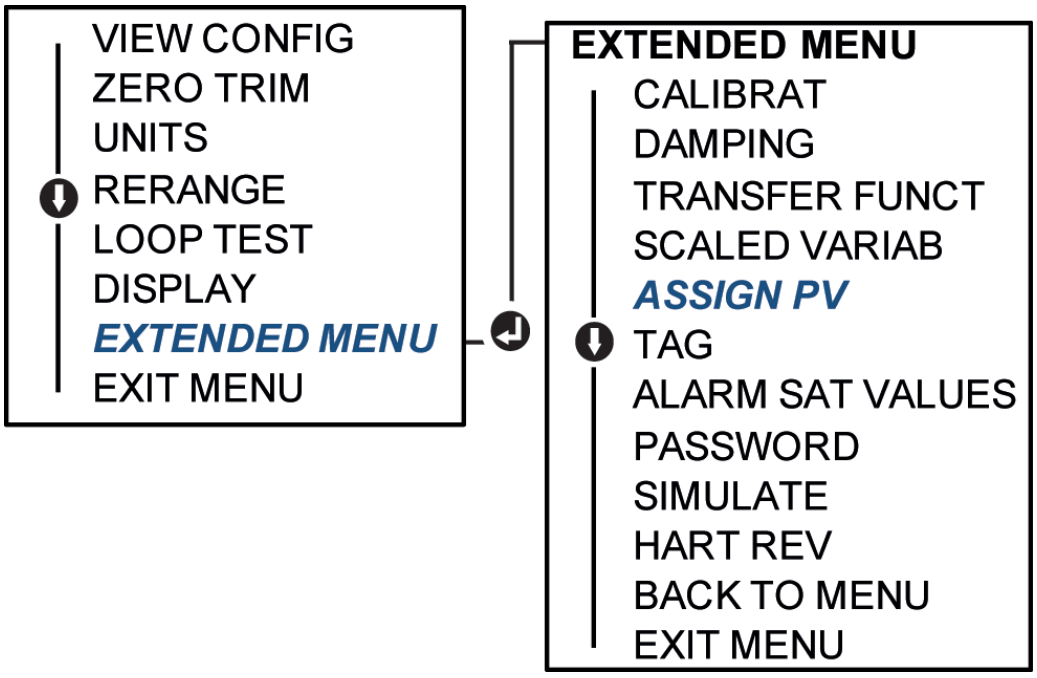
1. Right click the device and select **Configure**.
2. Select **Manual Setup** and click on the **HART** tab.
3. Assign primary, secondary, tertiary, and quaternary variables under **Variable Mapping**.
4. Select **Send**.
5. Carefully read the warning and select **Yes** if it is safe to apply the changes.

Re-mapping device variables using Local Operator Interface (LOI)

Procedure

Refer to Figure 2-13 for instructions on **re-mapping** the **primary variable** using an LOI.

Figure 2-13: Re-mapping with LOI



2.10 Performing transmitter tests

2.10.1 Verifying alarm level

If the transmitter is repaired or replaced, verify the transmitter alarm level before returning the transmitter to service.

This is useful in testing the reaction of the control system to a transmitter in an alarm state. It ensures that the control system recognizes the alarm when activated. To verify the transmitter alarm values, perform a **loop test** and set the transmitter output to the alarm value (see Table 2-4, Table 2-5, and Table 2-6).

Note
Before returning transmitter to service, verify **security** switch is set to the correct position. Refer to Verifying configuration.

2.10.2 Performing an **analog loop test**

The **analog loop test** command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. Emerson recommends testing the 4-20 mA points in addition to alarm levels when installing, repairing, or replacing a transmitter.

The host system may provide a current measurement for the 4–20 mA HART® **output**. If it does not, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block, or shunting transmitter power through the meter at some point in the loop.

Performing an analog loop test using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 3, 5, 1.

Performing an analog loop test using AMS Device Manager

Procedure

1. Right click on the device and hover the cursor over **Diagnostics and Test** in the ***Methods*** dropdown menu. From the ***Diagnostics and Test*** dropdown menu, select **Loop Test**.
2. Select **Next** after setting the **control loop** to **Manual**.
3. Follow screen prompts to perform a **loop test**.
4. Select **Finish** to acknowledge the method is complete.

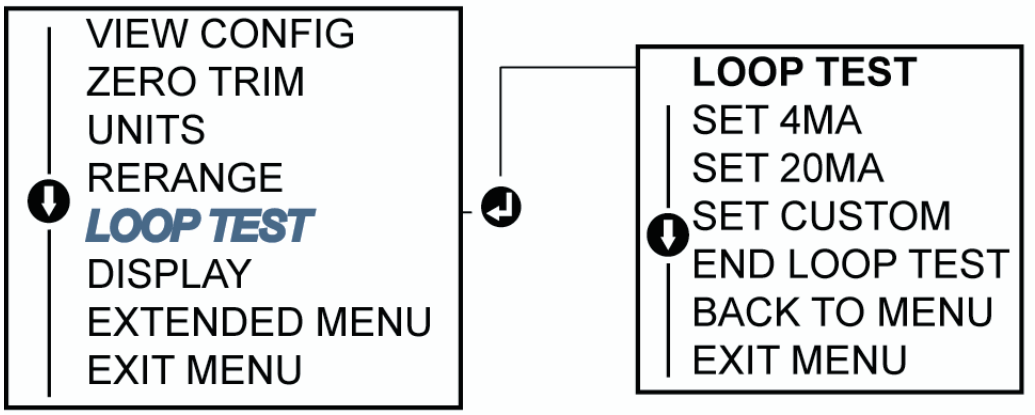
Performing an analog loop test using a Local Operator Interface (LOI)

To perform an **analog loop test** using the LOI, manually set the 4 mA, 20 mA, and **custom** mA point.

Procedure

Reference Figure 2-14 for instructions on how to perform a transmitter **loop test** using an LOI.

Figure 2-14: Performing an Analog Loop Test Using an LOI



2.10.3 Simulating device variables

You can temporarily set the **pressure**, **sensor temperature**, or **scaled variable** to a user-defined fixed value for testing purposes. Once the simulated variable method is left, the process variable will be automatically returned to a live measurement.

You can only simulate device variables in HART® Revision 7 mode.

Simulating digital signal with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 3, 5.

Simulating digital signal with AMS Device Manager

Procedure

1. Right click on the device and select **Service Tools**.
2. Select **Simulate**.
3. Under ***Device Variables*** select a digital value to simulate:
   - **Pressure**
   - **Sensor temperature**
   - **Scaled variable**
4. Follow the screen prompts to simulate selected digital value.

2.11 Configuring burst mode

Burst mode is compatible with the analog signal. Because the HART® protocol features simultaneous digital and analog data transmission, the analog value can drive other equipment in the loop while the control system is receiving the digital information.

Burst mode applies only to the transmission of dynamic data (**pressure** and **temperature** in **engineering units**, **pressure** in **percent of range**, **scaled variable**, and/or analog output), and does not affect the way other transmitter data is accessed. However, when activated, **burst** mode can slow down communication of non-dynamic data to the host by 50 percent.

Access to information other than dynamic transmitter data is obtained through the normal poll/response method of HART communication. A Field Communicator, AMS Device Manager, or the control system may request any of the information that is normally available while the transmitter is in **burst** mode. Between each message sent by the transmitter, a short pause allows the Field Communicator, AMS Device Manager, or a control system to initiate a request.

Choosing burst mode options in HART 5

Message content options:

- **PV only**
- **Percent of Range**
- PV, 2V, 3V, 4V
- **Process Variables**
- **Device Status**

Choosing burst mode options in HART 7

Message content options:

- **PV only**
- **Percent of Range**
- PV, 2V, 3V, 4V
- **Process Variables and Status**
- **Process Variables**
- **Device Status**

Choosing a HART 7 trigger mode

When in HART 7, you can select the following **trigger** modes:

- **Continuous** (same as HART 5 **burst** mode)
- **Rising**
- **Falling**
- **Windowed**
- **On Change**

Note
Consult your host system manufacturer for **burst** mode requirements.

2.11.1 Configuring **burst** mode using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 5, 3.

2.11.2 Configuring **burst** mode using AMS Device Manager

Procedure

1. Right click on the device and select **Configure**.
2. Select the **HART** tab.

3. Enter the configuration in **Burst Mode Configuration** fields.

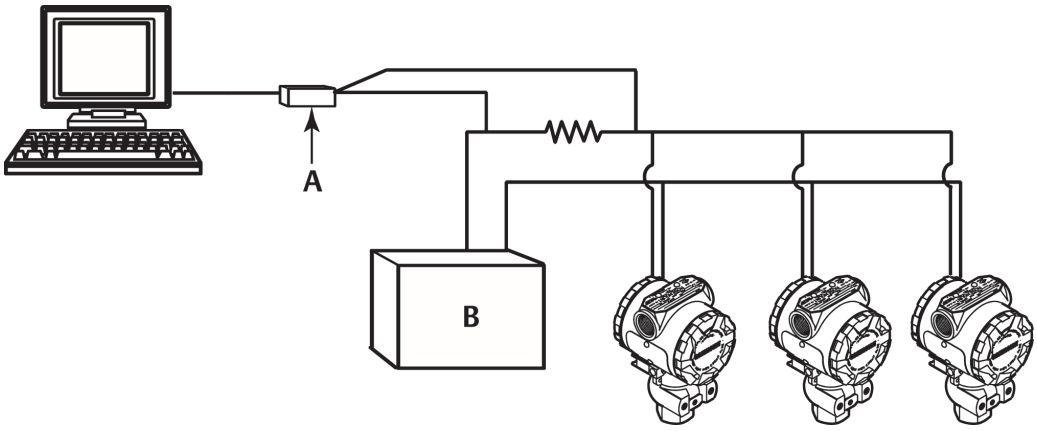
2.12 Establishing multidrop communication

Multidropping transmitters refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated.

Multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Use HART® modems and a host implementing HART protocol to communicate with transmitters. Each transmitter is identified by a unique address and responds to the commands defined in the HART protocol. Field Communicators and AMS Device Manager can test, configure, and format a multidropped transmitter the same way as a transmitter in a standard point-to-point installation.

Figure 2-15 shows a typical multidrop network. This figure is not intended as an installation diagram.

Figure 2-15: Typical Multidrop Network (4–20 mA Only)



A. HART modem
B. Power supply

The Rosemount 3051P is set to address zero at the factory, which allows operation in the standard point-to-point manner with a 4–20 mA output signal. To activate multidrop communication, change the transmitter address to a number from 1 to 15 for HART Revision 5, or 1 to 63 for HART Revision 7. This change deactivates the 4–20 mA analog output, sending it to 4 mA . It also disables the **failure mode alarm** signal, which is controlled by the **upscale/downscale** switch position. Failure signals in multidropped transmitters are communicated through HART messages.

2.12.1 Changing a transmitter address

To activate multidrop communication, assign the transmitter poll address to a number from 1 to 15 for HART® Revision 5, and 1 to 63 for HART Revision 7. Each transmitter in a multidropped loop must have a unique poll address.

Changing transmitter address using a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence:

- **HART® Revision 5:** 2, 2, 5, 2, 1
- **HART Revision 7:** 2, 2, 5, 2, 2

Changing transmitter address using AMS Device Manager

Procedure

1. Right click the device and select **Configure**.
2. In HART® Revision 5 mode:
   a) Select **Manual Setup** and then select the ***HART*** tab.
   b) In the ***Communication Settings*** box enter **polling address** in the Polling Address box and then select **Send**.
3. In HART Revision 7 mode:
   a) Select **Manual Setup**, select the ***HART*** tab, and select the **Change Polling Address** button.
4. Carefully read the warning and click **Yes** if it is safe to apply the changes.

2.12.2 Communicating with a multidropped transmitter

To communicate with a multidrop transmitter you must set up the Field Communicator or AMS Device Manager for polling.

Communicating with a multidropped transmitter using a Field Communicator

Procedure

1. Select **Utility** and **Configure HART Application**.
2. Select **Polling Addresses**.
3. Enter **0–63**.

Communicating with a multidropped transmitter using AMS Device Manager

Procedure

Select the HART® modem icon and select **Scan All Devices**.

3 Hardware installation

3.1 Overview

The information in this section covers installation considerations for the transmitter with HART® protocol.

Emerson ships a Quick Start Guide with every transmitter to describe recommended pipe-fitting and wiring procedures for initial installation. Dimensional drawings for each transmitter variation and mounting configuration are included in Mounting brackets.

Note
For transmitter disassembly and reassembly refer to Disassembly procedures, and Reassembly procedures.

3.2 Considerations

3.2.1 Installation considerations

Measurement accuracy depends upon proper installation of the transmitter and impulse piping. Mount the transmitter close to the process and use a minimum of piping to achieve best accuracy.

Keep in mind the need for easy access, personnel safety, practical field calibration, and a suitable transmitter environment. Install the transmitter to minimize vibration, shock, and temperature fluctuation.

⚠ WARNING

Install the enclosed pipe plug (found in the box) in an unused housing conduit opening with a minimum of five threads of engagement to comply with explosion-proof requirements.

Always ensure a proper seal by installing the electronics housing cover(s) so that metal contacts metal.

Emerson recommends using Rosemount O-rings.

3.2.2 Environmental considerations

Best practice is to mount the transmitter in an environment that has minimal ambient temperature change. The transmitter electronics temperature operating limits are –40 to 185 °F (–40 to 85 °C).

Refer to the Rosemount 3051P Product Data Sheet for the sensing element operating limits. Mount the transmitter so that it is not susceptible to vibration and mechanical shock and does not have external contact with corrosive materials.

3.2.3 Mechanical considerations

Steam service

For steam service or for applications with process temperatures greater than the limits of the transmitter, do not blow down impulse piping through the transmitter. Flush lines with the blocking valves closed and refill lines with water before resuming measurement.

Refer to Figure 3-3 through Figure 3-5 for correct mounting orientation.

3.3 Installation procedures

3.3.1 Mounting the transmitter

The approximate weight of the transmitter is 2.44 lb. (1.11 kg).

In many cases, the transmitter's compact size and light weight makes it possible to mount directly to the respective apparatus without using an additional mounting bracket. When this is not desirable, mount directly to a wall, panel, or 2-in. (50.8 mm) pipe using the optional mounting bracket (see Mounting brackets).

For dimensional drawing information, refer to the Rosemount 3051P Product Data Sheet.

Note
Most transmitters are calibrated in the upright position. Mounting the transmitter in any other position will shift the zero point to the equivalent amount of liquid head pressure caused by the varied mounting position. To reset zero point, refer to Sensor trim overview.

Electronics housing clearance

Mount the transmitter so the terminal side is accessible. Clearance of 0.75 in. (19 mm) is required for cover removal.

Use a conduit plug in the unused conduit opening. If a meter is installed, then 3 in. (76.2 mm) of clearance is required for cover removal.

Environmental seal for housing

Thread sealing (PTFE) tape or paste on male threads of conduit is required to provide a water/dust-tight conduit seal and meets requirements of NEMA® Type 4X, IP66, and IP68.

If other Ingress Protection ratings are required, then consult factory.

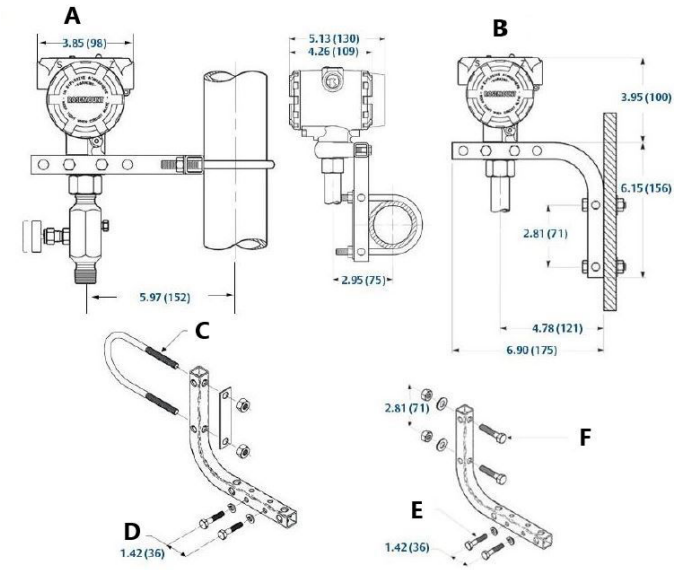
For M20 threads, install conduit plugs to full thread engagement or until mechanical resistance is met.

Mounting brackets

You can panel mount or pipe mount the transmitter via an optional mounting bracket (option code B4).

See Figure 3-1 and for dimensional and mounting configuration information.

Figure 3-1: Mounting Bracket Option Code B4

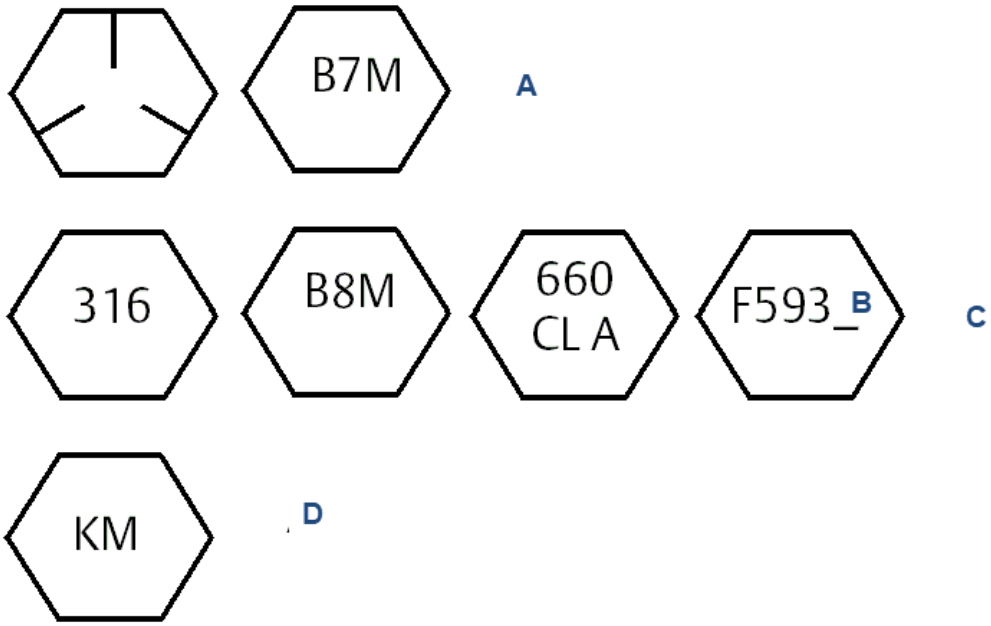


A. Pipe mounting
B. Panel mounting
C. 2-in. (50.8 mm) U-bolt for pipe mounting (1)
D. ¼ x 1¼ bolts for transmitter mounting (2)
E. ¼ x 1¼ bolts for transmitter mounting (2)
F. 5/16 x 1½ bolts for panel mounting (2)

Note
Dimensions are in inches (millimeters).

(1) Clamp shown.
(2) Not supplied.

Figure 3-2: Head Markings



A. Carbon steel (CS) head markings
B. The last digit in the F593_ head marking may be any letter between A and M.
C. Stainless steel (SST) head markings
D. Alloy K-500 head marking

3.3.2 Impulse piping

Mounting requirements

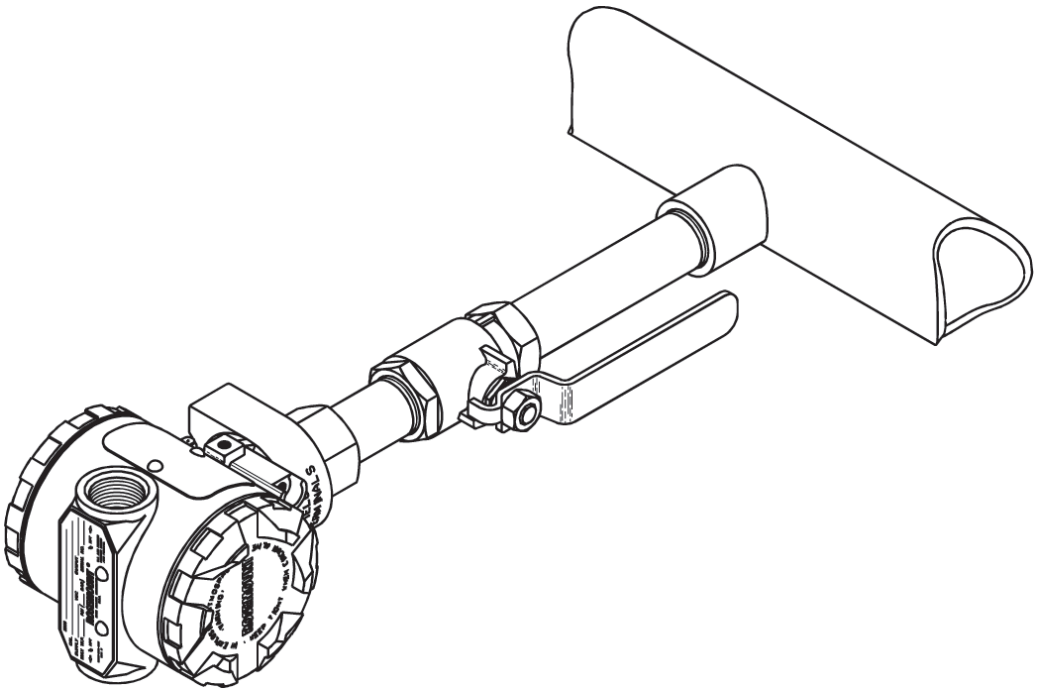
Impulse piping configurations depend on specific measurement conditions.

Refer to Figure 3-3 through Figure 3-5 for examples of the following mounting configurations.

Liquid measurement

- Place taps to the side of the line to prevent sediment deposits on the transmitter's process isolator.
- Mount the transmitter beside or below the taps so gases can vent into the process line.
- Mount drain/vent valve upward to allow gases to vent.

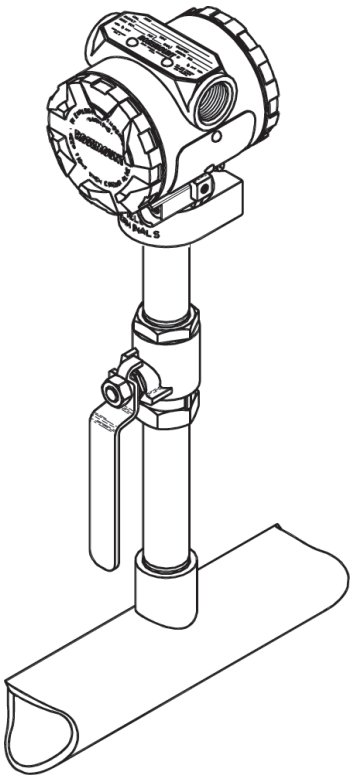
Figure 3-3: Liquid Applications Installation Example



Gas measurement

- Place tap in the top or side of the line.
- Mount the transmitter beside or above the tap so liquid will drain into the process line.

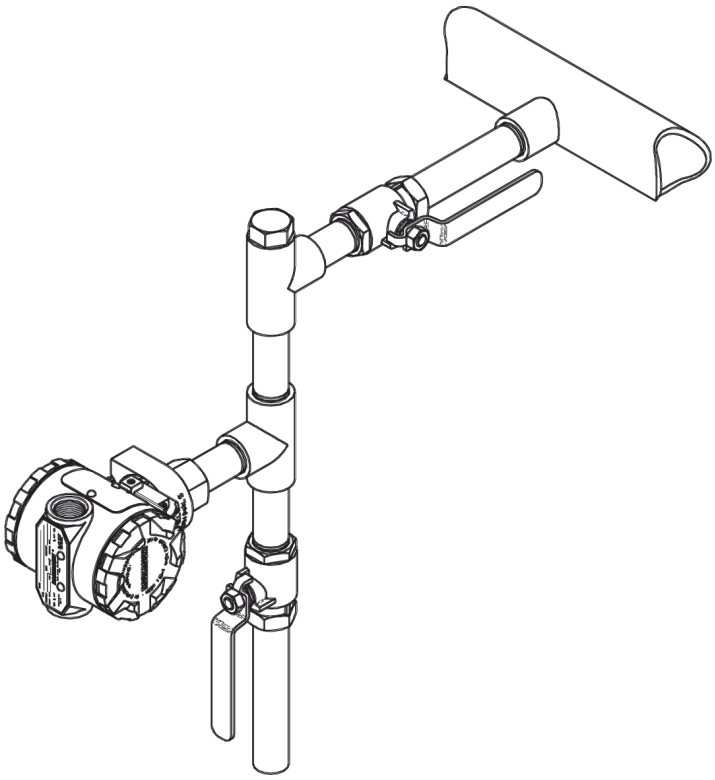
Figure 3-4: Gas Applications Installation Example



Steam measurement

- Place tap to the side of the line.
- Mount the transmitter below the taps to ensure the impulse piping will stay filled with condensate.
- In steam service above 250 °F (121 °C), fill impulse line with water to prevent steam from contacting the transmitter directly and to ensure accurate measurement start-up.

Figure 3-5: Steam Applications Installation Example



⚠ CAUTION

For steam or other elevated temperature services, it is important that temperatures at the process connection do not exceed the transmitter's process temperature limits.

Best practices

The piping between the process and the transmitter must accurately transfer the pressure to obtain accurate measurements.

Possible sources of error:

- Pressure transfer
- Leaks
- Friction loss (particularly if purging is used)
- Trapped gas in a liquid line
- Liquid in a gas line
- Density variations between the legs

The best location for the transmitter in relation to the process pipe is dependent on the process.

To determine transmitter location and placement of impulse piping:

- Keep impulse piping as short as possible.

- For liquid service, slope the impulse piping at least 1 in./ft (8 cm/m) upward from the transmitter toward the process connection.
- For gas service, slope the impulse piping at least 1 in./ft (8 cm/m) downward from the transmitter toward the process connection.
- Avoid high points in liquid lines and low points in gas lines.
- Use impulse piping large enough to avoid friction effects and blockage.
- Vent all gas from liquid piping legs.
- When purging, make the purge connection close to the process taps and purge through equal lengths of the same size pipe. Avoid purging through the transmitter.
- Keep corrosive or hot (above 250 °F [121 °C]) process material out of direct contact with the sensor module and flanges.
- Prevent sediment deposits in the impulse piping.
- Avoid conditions that might allow process fluid to freeze within the process flange.

3.3.3 In-line process connection

In-line gauge transmitter orientation

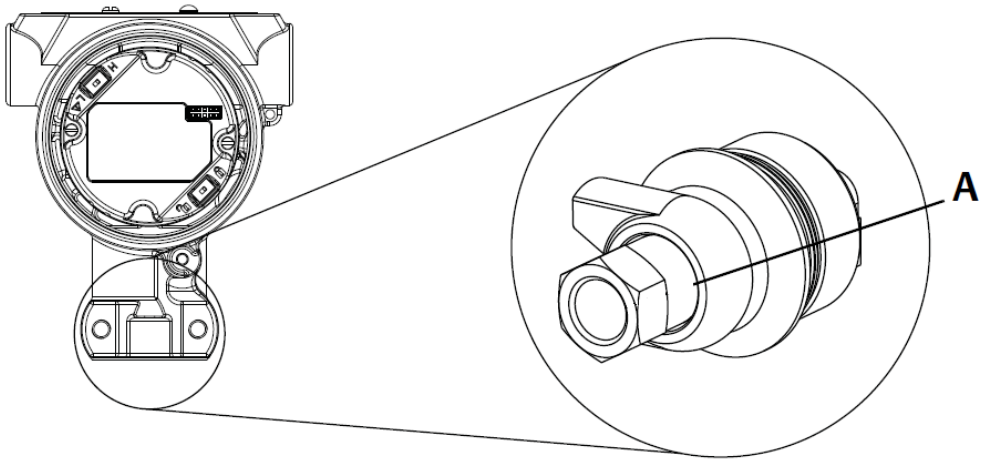
⚠ CAUTION

Interfering or blocking the atmospheric reference port will cause the transmitter to output erroneous pressure values.

The low side pressure port on the inline gauge transmitter is located in the neck of the transmitter, behind the housing. The vent path is 360 degrees around the transmitter between the housing and sensor (See Figure 3-6).

Keep the vent path free of any obstruction, such as paint, dust, and lubrication by mounting the transmitter so the process can drain away.

Figure 3-6: In-Line Gauge Low Side Pressure Port

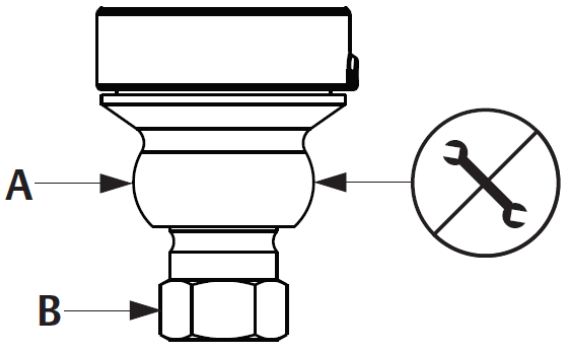


A. Low side pressure port (atmospheric reference)

⚠ CAUTION

Rotation between the sensor module and the process connection can damage the electronics.

Do not apply torque directly to the sensor module.
To avoid damage, apply torque only to the hex-shaped process connection.

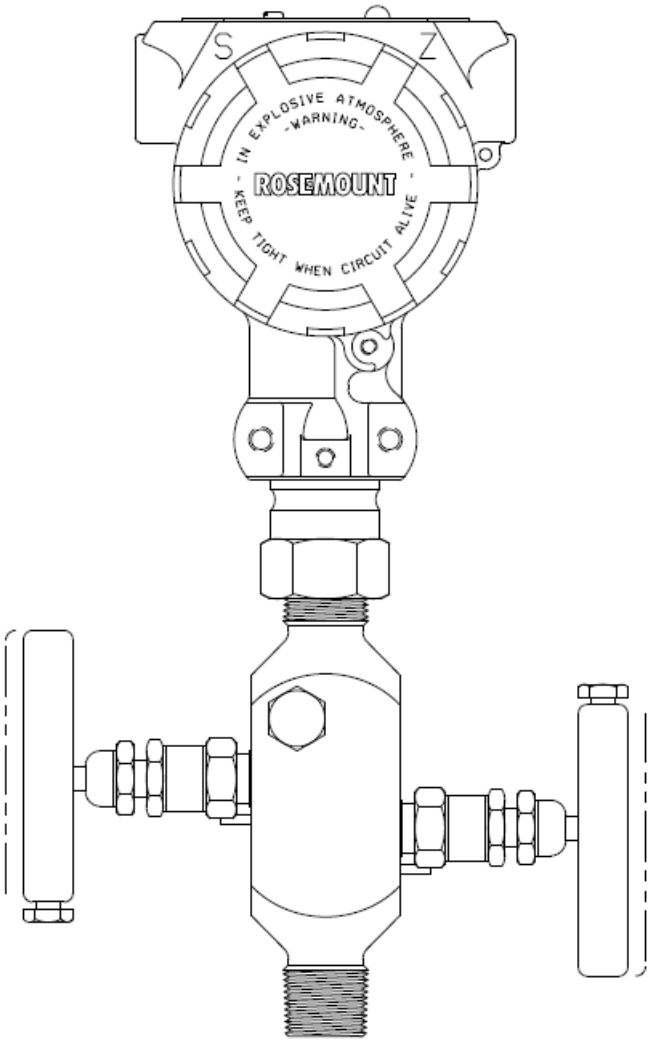


1. Sensor module
2. $_{1/2}$ inch - 14 NPT Female connection

3.4 Rosemount 306 Manifold

The Rosemount 306 Integral Manifold is used with the Rosemount 3051P In-Line Transmitter to provide block-and-bleed valve capabilities of up to 10000 psi (690 bar).

Figure 3-7: Rosemount 3051P and 306 In-line Manifold



3.4.1 Rosemount 306 Integral Manifold installation procedure

Assemble the Rosemount 306 Manifold to the Rosemount 3051P In-Line Transmitter with a thread sealant.

4 Electrical installation

4.1 Overview

The information in this section covers installation considerations for the Rosemount 3051P.

Emerson ships a Quick Start Guide with every transmitter to describe pipe-fitting, wiring procedures, and basic configuration for initial installation.

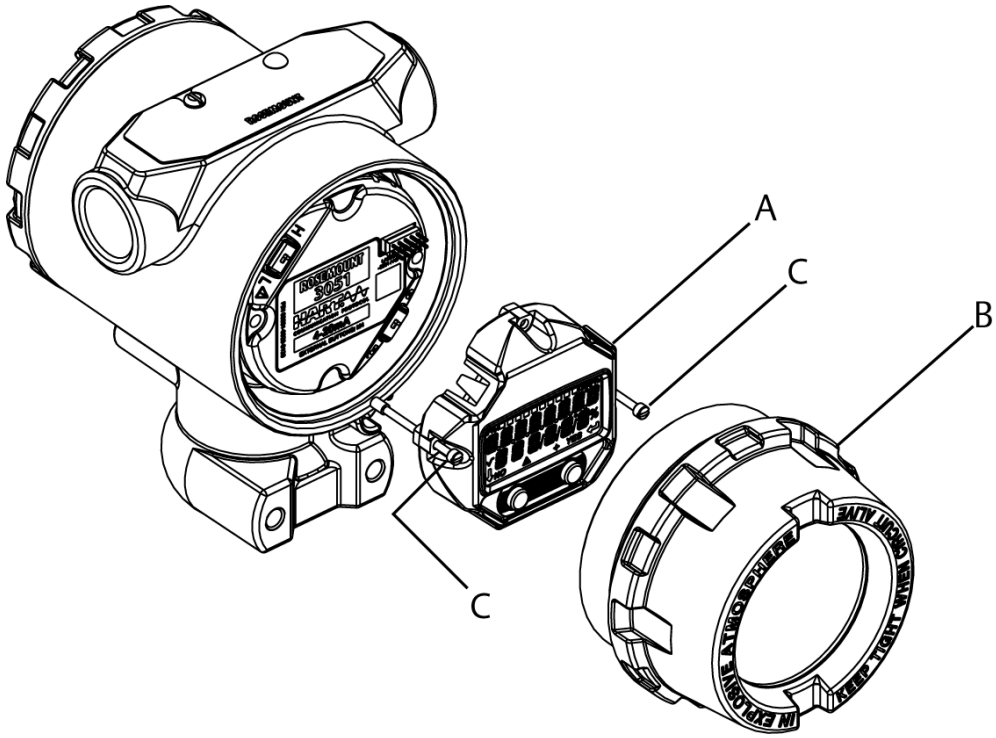
Note
For transmitter disassembly and reassembly, refer to Disassembly procedures and Reassembly procedures.

4.2 Local Operating Interface (LOI)/LCD display

Emerson ships transmitters ordered with the LCD display option (M5) or LOI option (M4) with the display installed.

Installing the display on an existing transmitter requires a small instrument screwdriver. Carefully align the desired display connector with the electronics board connector. If connectors don't align, the display and electronics board are not compatible.

Figure 4-1: LOI Display Assembly



A. LCD/LOI display
B. Extended cover
C. Captive screws

4.2.1 Rotating LCD/Local Operator Interface (LOI) display

Procedure

1. Secure the loop to **manual** control and remove power to transmitter.
2. Remove transmitter housing cover.
3. Remove screws form the LCD/LOI display and rotate to desired orientation.

   Insert 10-pin connector into the display board for the correct orientation. Carefully align pins for insertion into the output board.
4. Re-insert screws.
5. Reattach transmitter housing cover.

   ⚠ WARNING

   Explosions

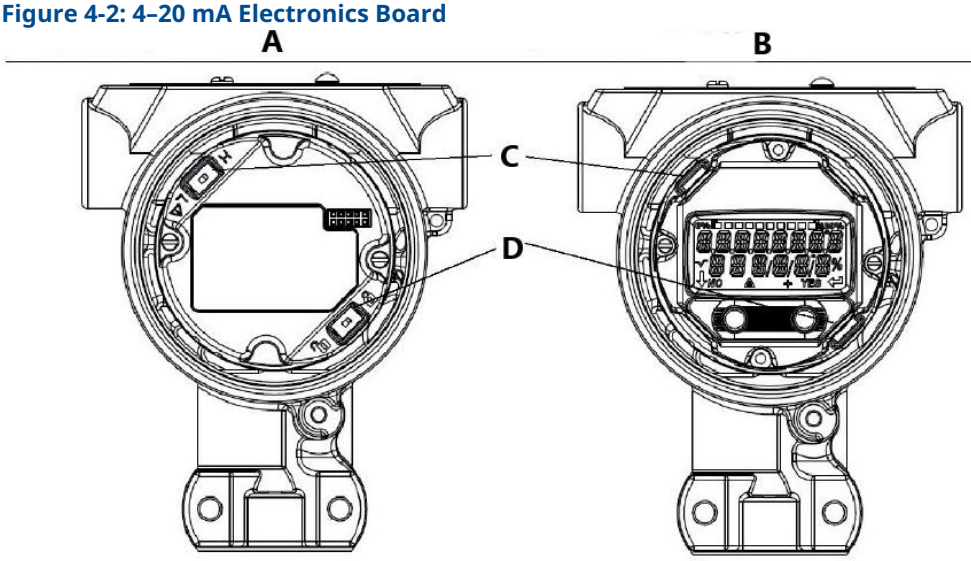
   Cover must be fully engaged to comply with explosion-proof requirements.
6. Reattach power and return loop to **Automatic** control.

4.3 Configuring transmitter security

The transmitter has four security methods.

- **Security** switch
- **HART Lock**
- **Configuration buttons lock**
- Local Operator Interface (LOI) password

Figure 4-2: 4–20 mA Electronics Board



A. *Without LCD display meter*
B. *With LCD display/LOI display*
C. ***Alarm***
D. ***Security***

4.3.1 Setting the **security** switch

The security switch is used to prevent changes to the transmitter configuration data. If the **security** switch is set to the locked location (🔒), any transmitter configuration requests sent via HART®, Local Operator Interface (LOI), or local configuration buttons will be rejected by the transmitter, and the transmitter configuration data will not be modified.

See Figure 4-2 for the location of the **security** switch.

To enable the **security** switch:

Procedure

1. Set loop to **Manual** and remove power.
2. Remove transmitter housing cover.
3. Use a small screwdriver to slide the switch to the lock (🔒) position.
4. Replace transmitter housing cover.

⚠ WARNING

Cover must be fully engaged to comply with explosion-proof requirements.

4.3.2 HART Lock

The **HART Lock** prevents changes to the transmitter configuration from all sources; all changes requested via HART, Local Operator Interface (LOI), and local configuration buttons will be rejected.

You can only set the **HART Lock** via HART communication, and it is only available in HART Revision 7 mode. Enable or disable the **HART lock** with a Field Communicator or AMS Device Manager.

Configuring HART Lock using Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 6, 4.

Configuring HART Lock using AMS Device Manager

Procedure

1. Right click the device and select **Configure**.
2. Under **Manual** setup, select the ***Security*** tab.
3. Select **Lock/Unlock** button under ***HART Lock (Software)*** and follow the screen prompts.

4.3.3 Configuration button lock

The **configuration button lock** disables all local button functionality. Changes to the transmitter configuration from the Local Operator Interface (LOI) and local buttons will be rejected.

You can only lock local external keys via HART® communication.

Configuring button lock using the Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 6, 3.

Configuring button lock using AMS Device Manager

Procedure

1. Right click the device and select **Configure**.
2. Under ***Manual Setup***, select the ***Security*** tab.
3. From the ***Configuration Buttons*** dropdown menu, select **Disabled** to lock external local keys.
4. Select **Send**.
5. Confirm service reason and select **Yes**.

4.3.4 Local Operator Interface (LOI) password

You can enter and enable an LOI password to prevent review and modification of device configuration via the LOI.

This does not prevent configuration from HART® or external keys (**analog zero** and **span**; **digital zero trim**). The LOI password is a four digit code that is to be set by the user.

Note
If the password is lost or forgotten, then remember that the master password is **9307**.

You can figure and enable or disable the LOI password with HART® communication via a Field Communicator, AMS Device Manager, or the LOI.

Configuring Local Operator Interface (LOI) password with Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence: 2, 2, 6, 5, 2.

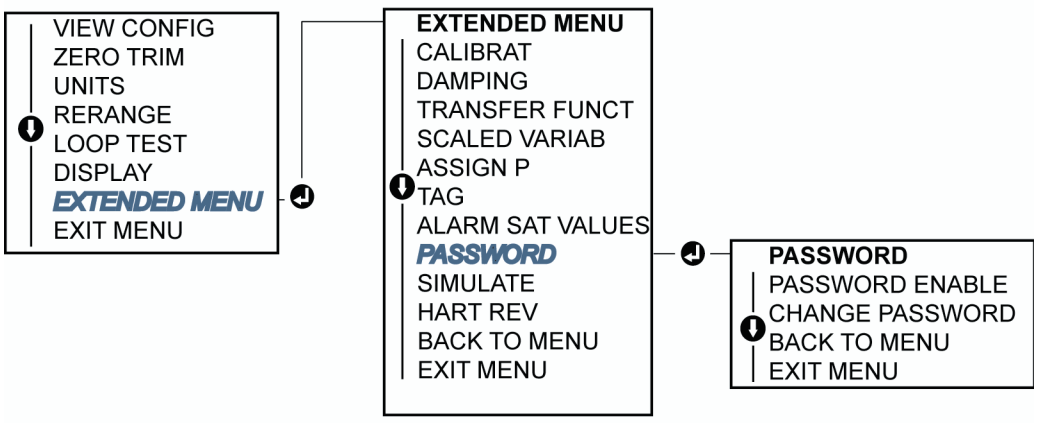
Configuring Local Operator Interface (LOI) password with AMS Device Manager

Procedure

1. Right click the device and select **Configure**.
2. Under ***Manual Setup***, select the ***Security*** tab.
3. Within the LOI, select the **Configure Password** button and follow the screen prompts.

Configuring Local Operator Interface (LOI) password using LOI

Figure 4-3: LOI Password



4.4 Setting transmitter alarm

There is an **alarm** switch on the electronics board. See Figure 4-2 for switch location.

To change the alarm switch location:

Procedure

1. Set loop to **Manual** and remove power.
2. Remove transmitter housing cover.
3. Use a small screwdriver to slide switch to desired position.
4. Replace transmitter cover.

⚠ WARNING

Cover must be fully engaged to comply with explosion-proof requirements.

4.5 Electrical considerations

⚠ WARNING

Ensure all electrical installation is in accordance with national and local code requirements.

Do not run signal wiring in conduit or open trays with power wiring or near heavy electrical equipment.

4.5.1 Conduit installation

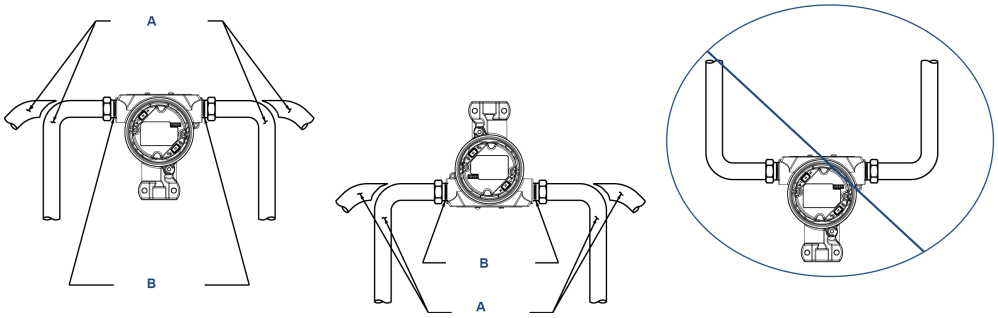
⚠ CAUTION

If all connections are not sealed, excess moisture accumulation can damage the transmitter.

Ensure to mount the transmitter with the electrical housing positioned downward for drainage.

To avoid moisture accumulation in the housing, install wiring with a drip loop. Ensure the bottom of the drip loop is mounted lower than the conduit connections of the transmitter housing.

Figure 4-4: Recommended Conduit Installation Diagrams



A. Possible conduit line positions
B. Sealing compound

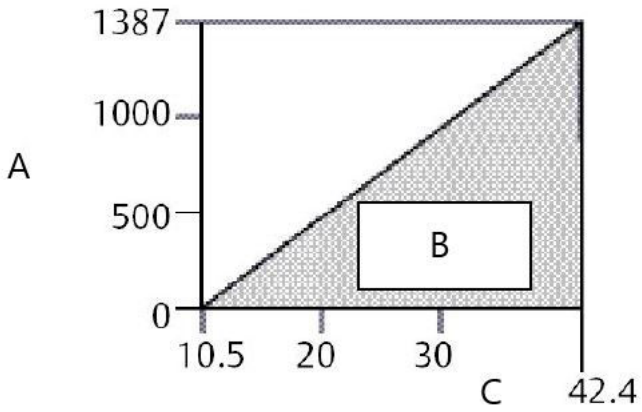
4.5.2 Power supply

4–20 mA HART® (Option code A)

Transmitter operates on 10.5–42.4 Vdc at the terminal of the transmitter. The Dc power supply should provide power with less than two percent ripple. A minimum of 16.6 V is required for loops with a 250 Ω resistance.

Note
A minimum loop resistance of 250 Ω is required to communicate with a Field Communicator. If a single power supply is used to power more than one transmitter, the power supply used, and circuitry common to the transmitters, must not have more that 20 Ω of impedance at 1200 Hz.

Figure 4-5: Load Limitation



Maximum loop resistance = 43.5 x (Power supply voltage – 10.5)

A. Load (Ωs)
B. Operating region

The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, Intrinsically Safe (IS) barriers, and related pieces. If intrinsic safety barriers are used, then the resistance and voltage drop must be included.

4.5.3 Wiring the transmitter

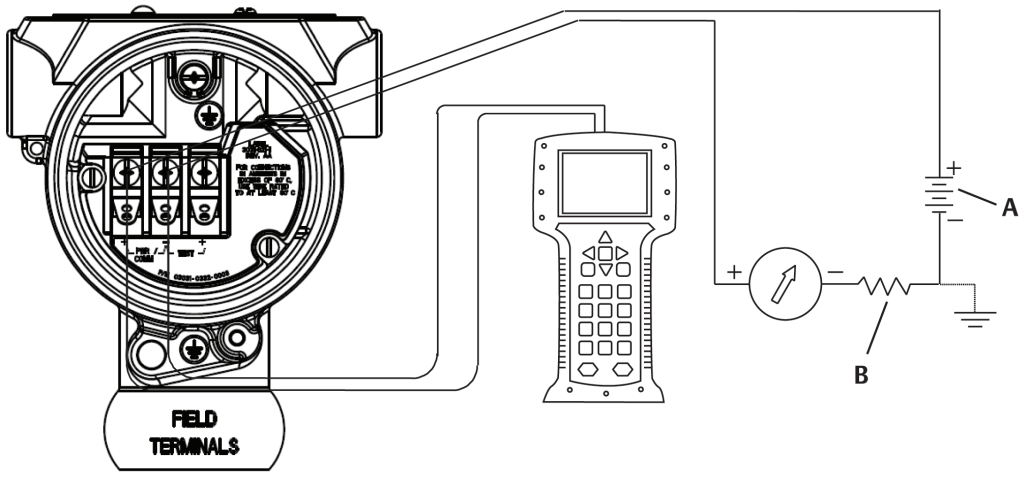
⚠ CAUTION

Incorrect wiring can damage test circuits.

Do not connect the power signal wiring to the test terminals.

Note
Use shielded twisted pairs to yield best results. To ensure proper communication, use 24 AWG or larger wire and do not exceed 5,000 ft. (1500 m).

Figure 4-6: 4–20 mA HART®



A. Dc power supply
B. $R_L \geq 250$ (necessary for HART communication only)

To make wiring connections:

Procedure

1. Remove the housing cover on terminal compartment side.

   ⚠ WARNING

   Signal wiring supplies all power to the transmitter. Do not remove the cover in explosive atmospheres when the circuit is live.

2. For 4–20 mA HART output, connect the positive lead to the terminal marked (**pwr/comm+**) and the negative lead to the terminal marked (**pwr/comm–**).

   ⚠ CAUTION

   Power could damage the test diode.

   Do not connect the powered signal wiring to the test terminals.

3. Ensure full contact with terminal block screw and washer. When using a direct wiring method, wrap wire clockwise to ensure it is in place when tightening the terminal block screw.

   ⚠ CAUTION

   The connection may be susceptible fo loosening over time or under vibration.

   Emerson does not recommend using a pin or ferrule wire.

4. Plug and seal unused conduit connection on the transmitter housing to avoid moisture accumulation in the terminal side.

4.5.4 Grounding the transmitter

Signal cable shield grounding

Figure 4-7 summarizes signal cable shield grounding. Trim and insulate the signal cable shield and unused shield drain wire to ensure that the signal cable shield and drain wire do not come in contact with the transmitter.

See Transmitter case grounding for instructions on grounding the transmitter case. Follow the steps below to correctly ground the signal cable shield.

Procedure

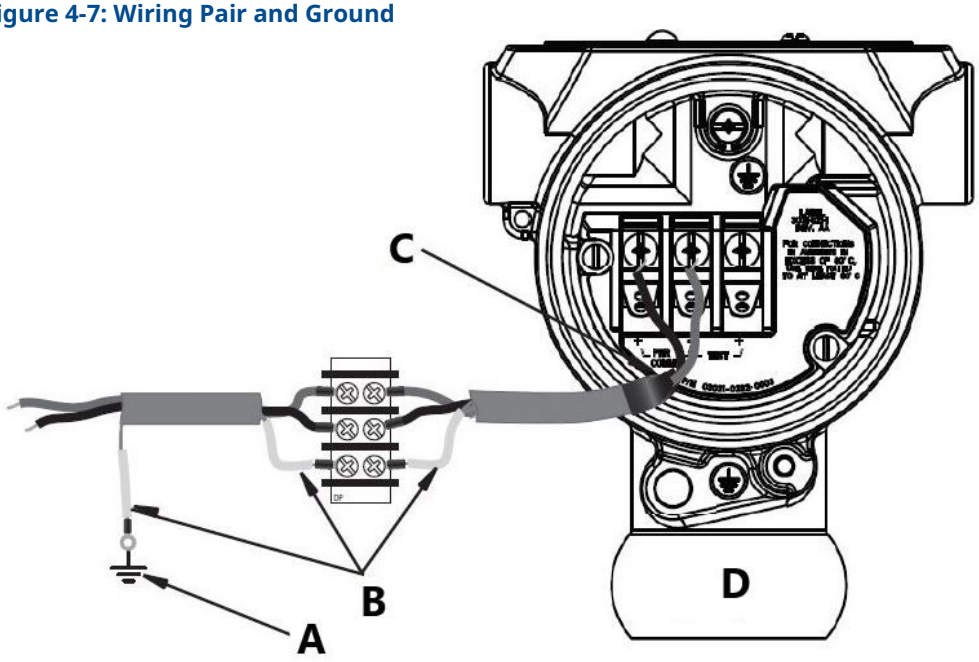
1. Remove the field terminals housing cover.
2. Connect the signal wire pair at the field terminals as indicated in Figure 4-6.
3. At the field terminals, trim the cable shield and shield drain wire close and insulate them from transmitter housing.
4. Reattach the field terminals housing cover.

   ⚠ WARNING

   Cover must be fully engaged to comply with explosion-proof requirements.

5. At terminations outside the transmitter housing, ensure that the cable shield drain wire is continuously connected.
   a) Prior to the termination point, insulate any exposed shield drain wire as shown in Figure 4-7.
6. Properly terminate the signal cable shield drain wire to an earth ground at or near the power supply.

Figure 4-7: Wiring Pair and Ground



A. Terminate cable shield drain wire to earth ground
B. Insulate exposed shield drain wire
C. Insulate shield and shield drain wire
D. Field terminals

Transmitter case grounding

The most effective transmitter case grounding method is a direct connection to earth ground with minimal impedance.

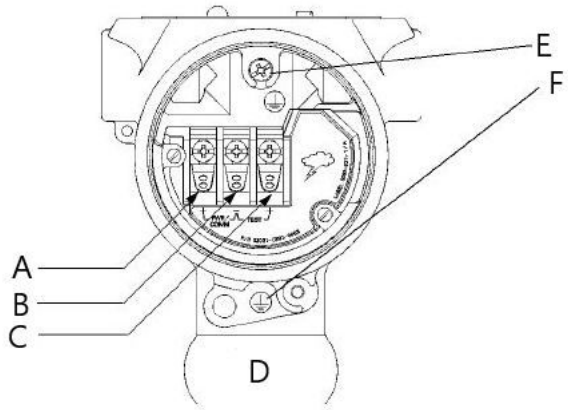
⚠ WARNING

Always ground the transmitter case in accordance with national and local electrical codes.

Methods for grounding the transmitter case include:

- Internal ground connection: the internal ground connection screw is inside the **FIELD TERMINALS** side of the electronics housing. This screw is identified by a ground symbol (⏚). The ground connection screw is standard on all Rosemount 3051P Transmitters. Refer to Figure 4-8.

Figure 4-8: Internal Ground Connection



A. Positive
B. Negative
C. Test
D. Field terminals
E. Internal ground location
F. External ground location

- External ground connection: The external ground connection is located on the exterior of the transmitter housing. Refer to Figure 4-8. This connection is only available with option T1.

⚠ WARNING

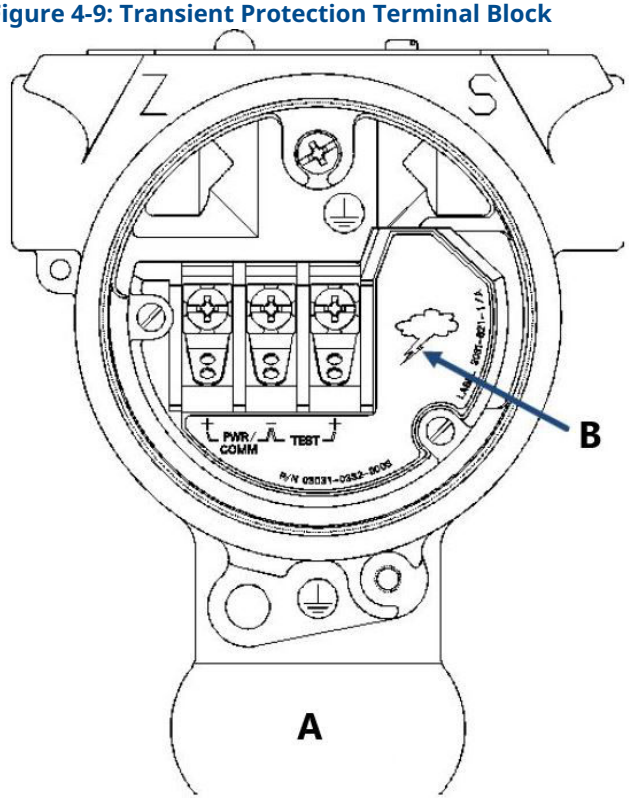
Grounding the transmitter case via threaded conduit connection may not provide sufficient ground continuity.

Transient protection terminal block grounding

The transmitter can withstand electrical transients of the energy level usually encountered in static discharges or induced switching transients. However, high-energy transients, such as those induced in wiring from nearby lightning strikes, can damage the transmitter.

You can order the transient protection terminal block as an installed option (option code T1) or as a spare part to retrofit existing Rosemount 3051P Transmitters in the field. See the Rosemount 3051P In-Line Pressure Transmitter Product Data Sheet for part numbers. The lightning bolt symbol shown in Figure 4-9 identifies the transient protection terminal block.

Figure 4-9: Transient Protection Terminal Block



A. Field terminals
B. Lightning bolt location

Note
The transient protection terminal block does not provide transient protection unless the transmitter case is properly grounded. Use the guidelines to ground the transmitter case. Refer to Figure 4-8.

5 Operation and maintenance

5.1 Overview

This section contains information on calibrating Rosemount 3051P Pressure Transmitters.

This section gives instructions on using the Field Communicator, AMS Device Manager and Local Operator Interface (LOI) to calibrate the transmitter.

5.2 Recommended calibration tasks

⚠ CAUTION

Emerson calibrates absolute pressure transmitters at the factory.

Trimming adjusts the position of the factory calibration curve. If you trim the transmitter improperly or with inaccurate equipment, you may degrade the transmitter's performance.

5.2.1 Calibrating in the field

Procedure

1. Perform **sensor zero/lower** trim: Compensate for mounting pressure effects

   Refer to Rosemount 306 Manifold for manifold operation instructions to properly drain/vent valves.

2. Set/check basic configuration parameters:
   - **Output units**
   - **Range points**
   - **Output type**
   - **Damping value**e

5.2.2 Calibrating on the bench

Procedure

1. Perform optional **4–20 mA output trim**.
2. Perform a **sensor trim**:
   a) **Zero/lower** trim using line pressure effect correction.

      Reference Hardware installation for manifold drain/vent valve operation instructions.

   b) Perform an optional **full scale trim**.

      This sets the span of the device and requires accurate calibration equipment.

   c) Set and check basic configuration parameters.

5.3 Calibration overview

Emerson fully calibrates the Rosemount 3051P at the factory to ensure accuracy. You can also calibrate the transmitter in the field to meet plant requirements or industry standards. Complete calibration of the transmitter can be split into two halves: **sensor calibration** and **analog output calibration**.

With **sensor calibration**, you can adjust the **pressure** (digital value) reported by the transmitter to be equal to a pressure standard. The **sensor calibration** can adjust the pressure offset to correct for mounting conditions or line pressure effects. Emerson recommends making this correction. The calibration of the pressure range (pressure span or gain correction) requires accurate pressure standards (sources) to provide a full calibration.

Like the **sensor calibration**, you can calibrate the **analog output** to match the user measurement system. The **analog output trim** (4–20 mA) will calibrate the loop at the 4 m and 20 mA points.

The **sensor calibration** and the **analog output** calibration combine to match the transmitter's measurement system to the plant standard.

Calibrate the sensor

- Performing a sensor trim
- Performing a digital zero trim (Option DZ)

Calibrate the 4–20 mA output

- Performing digital-to-analog trim (4–20 mA output trim)
- Performing digital-to-analog trim (4–20 mA output trim) using other scale

5.3.1 Determining necessary **sensor trims**

Bench calibrations allow for calibrating the instrument for its desired range of operation. Straight forward connections to pressure source allow for a full calibration at the planned operating points. Exercising the transmitter over the desired pressure range allows for verification of the analog output.

Trimming the pressure signal outlines how the trim operations change the calibration. It is possible to degrade the performance of the transmitter if a trim is done improperly or with inaccurate equipment. To set the transmitter back to factory settings, see Recalling factory trim — Sensor trim.

To determine the necessary trims:

Procedure

1. Apply pressure.
2. Check **digital pressure**. If the **digital pressure** does not match the applied pressure, then perform a **digital trim**.

   See Performing a sensor trim.
3. Check reported **analog output** against the live **analog output**. If they do not match, then perform an **analog output trim**.

   See Performing digital-to-analog trim (4–20 mA output trim).

Trimming with configuration buttons

Local configuration buttons are external buttons located underneath the top tag of the transmitter. There are two possible sets of local configuration buttons you can order with the transmitter and use to perform trim operations: **Digital zero trim** and **LOI**.

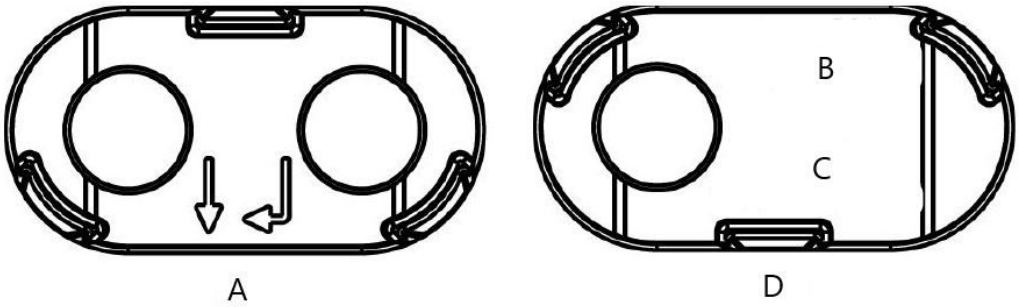
Procedure

To access the buttons, loosen screw and rotate top tag until buttons are visible.

- **LOI** (M4): Can perform both **digital sensor trim** and the 4–20 mA **output trim** (**analog output trim**). Follow the same procedures listed in trimming with Field Communicator or AMS Device Manager listed below.
- **Analog zero and span** (D4): Used to rerange the transmitter with an applied pressure.
- **Digital zero trim** (DZ): Used for performing a **sensor zero trim**. See Determining calibration frequency for trim instructions.

Monitor all configuration changes either on the display or by measuring the loop output.. Figure 5-1 shows the physical differences between the two sets of buttons.

Figure 5-1: Local Configuration Button Options



A. ***Analog zero and span*** *(D4); Green retainer*
B. ***Digital zero trim***
C. *Push for 2 seconds*
D. ***Digital zero trim*** *(DZ); Blue retainer*

5.3.2 Determining calibration frequency

Calibration frequency can vary greatly depending on the application, performance requirements, and process conditions.

To determine the calibration frequency that meets the needs of your application:

Procedure

1. Determine the performance required for your application.

   Example

Required Performance:	0.50 percent of span

2. Determine the operating conditions.

   Example

Transmitter	Rosemount 3051P, Range 1 [URL = 30 psi (2.1 bar)]

Calibrated span	30 psi (2.1 bar)
Ambient temperature change	±50 °F (28 °C)

3. Calculate the Total Probable Error (TPE).

   Example

   TPE $\sqrt{(\text{ReferenceAccuracy})^2 + (\text{TemperatureEffect})^2 + (\text{StaticPressureEffect})^2}$ = 0.303 percent of span

   Where:

Reference accuracy	± 0.040 percent of span
Ambient temperature effect	±(0.05 percent URL + 0.25 percent of span) per 50 °F (28 °C) = ±0.3 percent of span
Static pressure effect	0 percent (does not apply to in-line products)

4. Calculate the stability per month.

   Example

   Stability $\text{Stability} = \pm\left[\frac{(0.200 \times \text{URL})}{\text{Span}}\right]\%$ of span for 10 years = ±0.0017% of URL for 1 month

5. Calculate the calibration frequency.

   Example

   Calibration frequency $\text{Cal. Freq.} = \frac{(\text{Req. Performance} - \text{TPE})}{\text{Stability per Month}} = \frac{(0.5\% - 0.303\%)}{0.0017\%} = 118$ months

5.4 Trimming the pressure signal

5.4.1 **Sensor trim** overview

A **sensor trim** corrects the pressure offset and pressure range to match a pressure standard. The **upper sensor trim** corrects the pressure range, and the **lower sensor trim** (zero trim) corrects the pressure offset. An accurate pressure standard is required for full calibration. You can perform a **zero trim** if the process is vented.

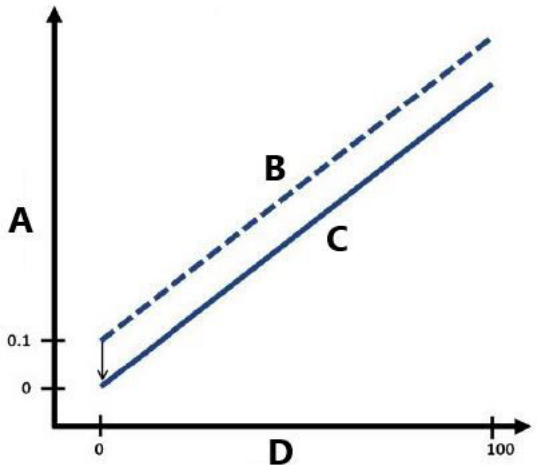
Zero trim is a single-point offset adjustment. It is useful for compensating for mounting position effects and is most effective when performed with the transmitter installed in its final mounting position. Since this correction maintains the slope of the characterization curve, do not use it in place of a **sensor trim** over the full sensor range.

Note
Do not perform a **zero trim** on Rosemount 3051P Absolute Pressure Transmitters. **Zero trim** is zero based, and absolute pressure transmitters reference absolute zero. To correct mounting position effects on an absolute pressure transmitter, perform a **low trim** within the **sensor trim** function. The **low trim** function provides an offset correction similar to the **zero trim** function, but it does not require zero-based input.

Upper and **lower sensor trim** is a two-point sensor calibration where two end-point pressures are applied and all output is linearized between them; this trim requires an accurate pressure source. Always adjust the **low trim** value first to establish the correct offset. Adjustment of the **high trim** value provides a slope correction to the

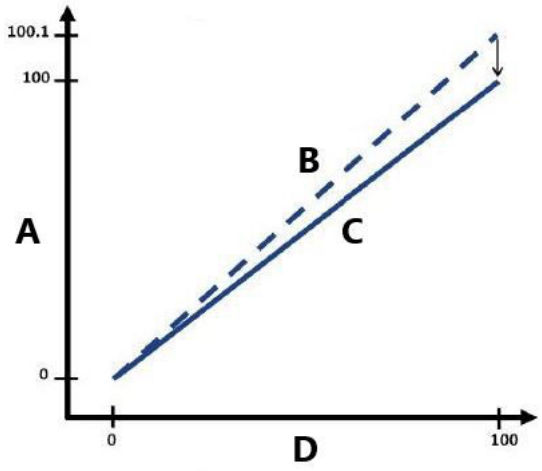
characterization curve based on the **low trim** value. The trim values help optimize performance over a specific measurement range.

Figure 5-2: Zero/lower sensor trim example



A. Pressure reading
*B. Before **trim***
*C. After **trim***
D. Pressure input

Figure 5-3: Upper sensor trim example



A. Pressure reading
*B. Before **trim***
*C. After **trim***
D. Pressure input

5.4.2 Performing a **sensor trim**

When performing a **sensor trim**, you can trim both the upper and lower limits. If doing both **upper** and **lower trims**, perform the **lower trim** before the **upper trim**.

Note
Use a pressure input source that is at least four times more accurate than the transmitter. Allow the input pressure to stabilize for 10 seconds before entering any values.

Performing a sensor trim with a Field Communicator

From the ***HOME*** screen, enter the Fast Key sequence and follow the steps within the Field Communicator to complete the **sensor trim**.

Device Dashboard Fast Keys: 3, 4, 1

To calibrate the sensor with a Field Communicator using the **sensor trim** function:

Procedure

1. Select **2: Lower Sensor Trim**.

   Note
   Select pressure points so that lower and upper values are equal to or outside the expected process operation range. To do this, see Reranging the transmitter.

2. Follow the commands provided by the Field Communicator to complete the adjustment of the lower value.
3. Select **3: Upper Sensor Trim**.
4. Follow the commands provided by the Field Communicator to complete the adjustment of the upper value.

Performing a sensor trim with AMS Device Manager

Procedure

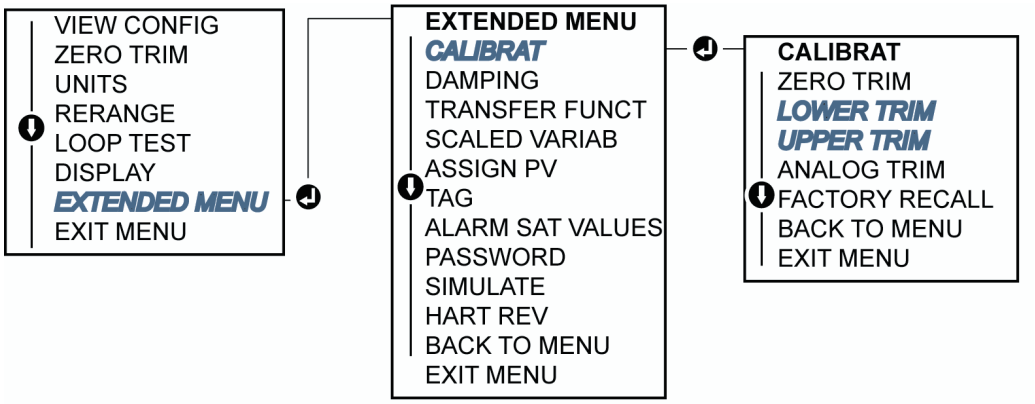
1. Right click the device and, under the ***Method*** dropdown menu, move the cursor over **Calibrate**.
2. Under ***Sensor Trim***, select **Lower Sensor Trim**.
3. Follow the screen prompts to perform a **sensor trim** using AMS Device Manager.
4. If desired, repeat Step 1.
5. Under ***Sensor Trim***, select **Upper Sensor Trim**.

Performing a sensor trim using Local Operator Interface (LOI)

Procedure

See Figure 5-4 to perform an **upper** and **lower sensor trim**.

Figure 5-4: Sensor Trim with LOI



Performing a digital zero trim (Option DZ)

A **digital zero trim** provides the same function as a **zero/lower sensor trim**, but you can complete it in hazardous areas at any given time by pushing the **Zero Trim** button when the transmitter is at zero pressure.

If the transmitter is not close enough to zero when the button is pushed, the command may fail due to excess correction. If ordered, you can use external configuration buttons located underneath the top tag of the transmitter to perform a **digital zero trim**. See Figure 5-1 for DZ button location.

Procedure

1. Loosen the top tag of the transmitter to expose buttons.
2. Press and hold the digital zero button for at least two seconds; then release to perform a digital zero trim.

5.4.3 Recalling factory trim — Sensor trim

The **recall factory trim-sensor trim** command allows the restoration of the as-shipped factory settings of the **sensor trim**. You can use this command to recover from an inadvertent **zero trim** of an absolute pressure unit or inaccurate pressure source.

Recalling factory trim with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence and follow the steps within the Field Communicator to complete the sensor trim.

Device Dashboard Fast Keys: 3, 4, 3

Recalling factory trim with AMS Device Manager

Procedure

1. Right click on the device and, under the ***Method*** dropdown menu, move cursor over **Calibrate** and select **Restore Factory Calibration**.
2. Set the control loop to **Manual**.
3. Select **Next**.
4. Select **Sensor Trim** under ***Trim to recall*** and click **Next**.

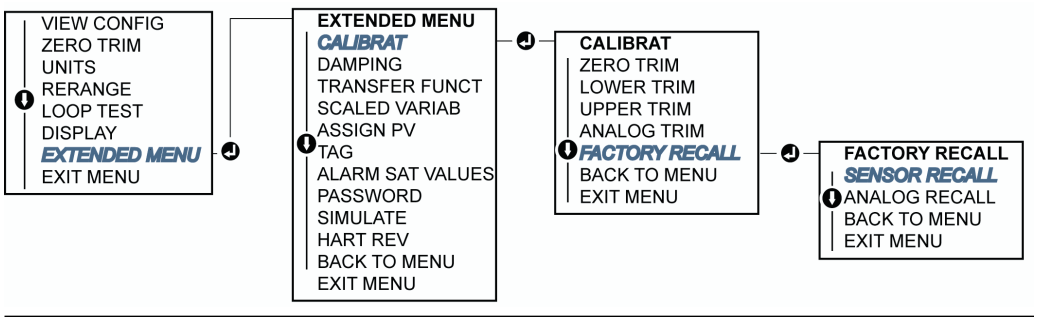
5. Follow the screen prompts to **recall Sensor Trim**.

Recalling factory trim with Local Operator Interface (LOI)

Procedure

Refer to Figure 5-5 to **recall factory sensor trim**.

Figure 5-5: Recall Factory Trim with LOI

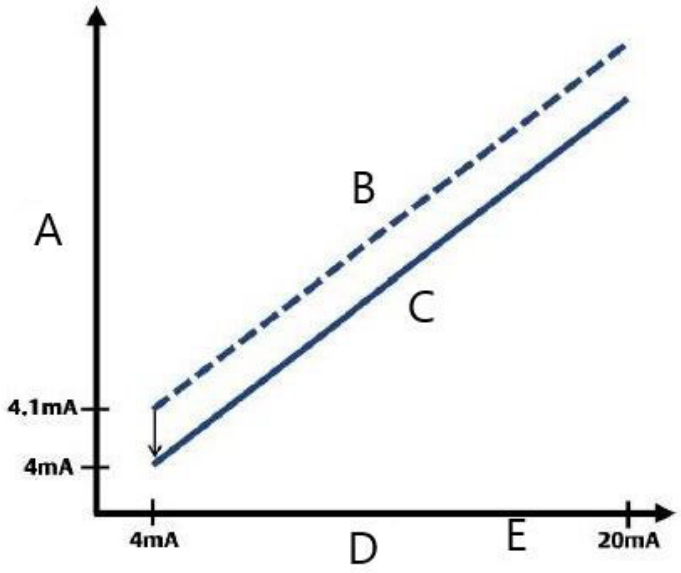


5.5 Trimming the analog output

The **Analog Output Trim** commands allow you to adjust the transmitter's current output at the 4 and 20 mA points to match the plant standards.

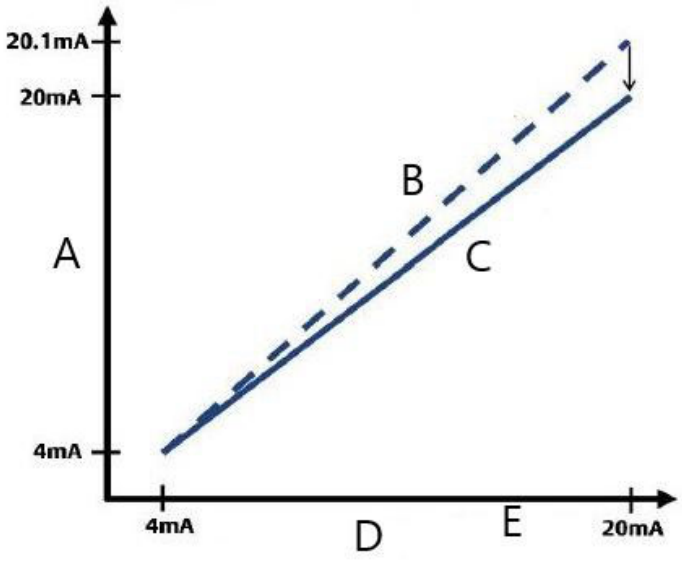
Perform this trim after the digital to analog conversion, so only the 4–20 mA analog signal will be affected. Figure 5-6 and Figure 5-7 graphically show the two ways the characterization curve is affected when an **analog output trim** is performed.

Figure 5-6: 4-20 mA output trim - Zero/lower trim example



A. Meter reading
*B. Before **trim***
*C. After **trim***
*D. **Digital pressure** reading*
E. mA output

Figure 5-7: 4-20 mA output trim - Upper trim example



A. Meter reading
*B. Before **trim***
*C. After **trim***
*D. **Digital pressure** reading*
E. mA output

5.5.1 Performing digital-to-analog trim (4–20 mA output trim)

Note
If adding a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with additional loop resistance.

Related information

Power supply

Performing a 4–20 mA output trim with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence and follow the steps within the Field Communicator to complete the 4–20 mA **output trim**.

Device Dashboard Fast Keys: 3, 4, 2, 1

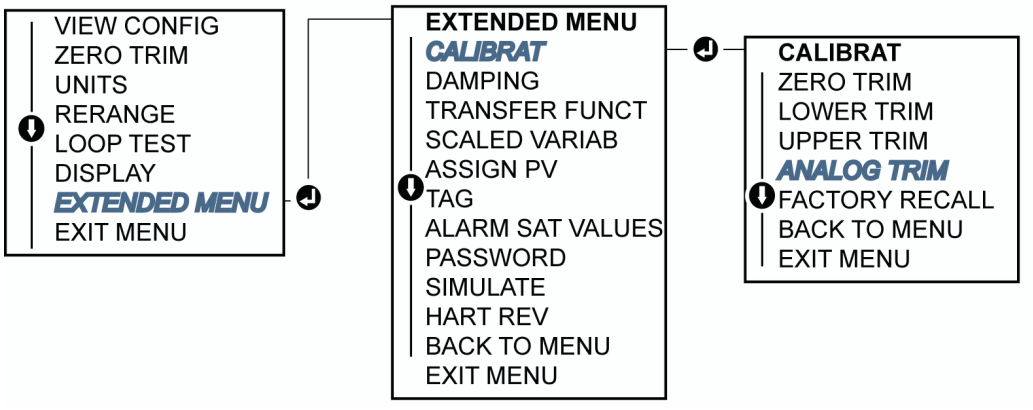
Performing a 4–20 mA output trim with AMS Device Manager

Procedure

1. Right click the device. Under the ***Method*** dropdown menu, move the cursor over **Calibrate** and select **Analog Calibration**.
2. Select **Digital to Analog Trim**.
3. Follow the screen prompts to perform a 4–20 mA **output trim**.

Performing a 4–20 mA output trim using Local Operator Interface (LOI)

Figure 5-8: 4–20 mA Output Trim using LOI



5.5.2 Performing digital-to-analog trim (4–20 mA output trim) using other scale

The **scaled 4–20 mA output trim** command matches the 4 and 20 mA points to a user selectable reference scale other than 4 and 20 mA (e.g., 2 to 10 volts if measuring across a 500 Ω load, or 0 to 100 percent if measuring from a Distributed Control System [DCS]). To perform a **scaled 4–20 mA output trim**, connect an accurate reference meter to the transmitter and trim the **output signal** to **scale**, as outlined in the **output trim** procedure.

Performing a 4–20 mA output trim using other scale with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence and follow the steps within the Field Communicator to complete the 4–20 mA **output trim** using other scale.

Device Dashboard Fast Key: 3, 4, 2, 2

Performing a 4–20 mA output trim using other scale with AMS Device Manager

Procedure

1. Right click the device. Under the ***Method*** dropdown menu, move the cursor over **Calibrate** and select **Analog Calibration**.
2. Select **Scaled Digital to Analog Trim**.
3. Follow screen prompts to perform a 4–20mA **output trim**.

5.5.3 Recalling factory trim — Analog output

The **Recall Factory Trim — Analog Output** command allows the restoration of the as-shipped factory settings of the **analog output trim**.

This command can be useful for recovering from an inadvertent trim, incorrect plant standard, or faulty meter.

Recalling factory trim - Analog output with a Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence and follow the steps within the Field Communicator to complete the recall factory trim - analog output.

Device Dashboard Fast Keys: 3, 4, 3

Recall factory trim - Analog output with AMS Device Manager

Procedure

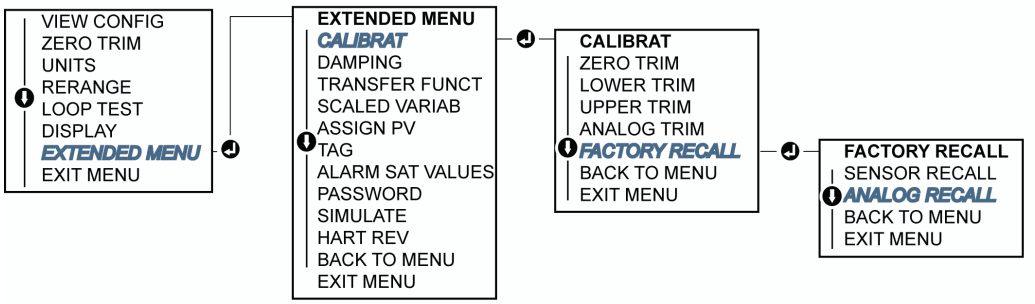
1. Right click the device and, under the ***Method*** dropdown menu, move the cursor over **Calibrate** and select **Restore Factory Calibration**.
2. Select **Next** to set the control loop to **Manual**.
3. Select **Analog Output Trim** under ***Select Trim*** to recall and click **Next**.
4. Follow screen prompts to **recall analog output trim**.

Recall factory trim - Analog output with Local Operator Interface (LOI)

Procedure

Reference Figure 5-9 for LOI instructions.

Figure 5-9: Recall Factory Trim – Analog Output with LOI



5.6 Switching HART® revision

Some systems are not capable of communicating with HART Revision 7 devices. The following procedures list how to change HART revisions between HART Revision 7 and HART Revision 5.

5.6.1 Switch HART® revision with generic menu

If the HART configuration tool is not capable of communicating with a HART Revision 7 device, it should load a generic menu with limited capability. The following procedures allow for switching between HART Revision 7 and HART Revision 5 from a generic menu.

Procedure

1. To change to HART Revision 5, enter **HART5** in the **Message** field.
2. To change to HART Revision 7, enter **HART7** in the **Message** field.

5.6.2 Switch HART® revision with Field Communicator

Procedure

From the ***HOME*** screen, enter the Fast Key sequence and follow steps within the Field Communicator to complete the HART revision change.

	HART5	HART7
Device Dashboard Fast Keys	2, 2, 5, 2, 4	2, 2, 5, 2, 3

5.6.3 Switch HART® revision with AMS Device Manager

Procedure

1. Select **Manual Setup** and select **HART**.
2. Select **Change HART Revision**; then follow the on screen prompts.

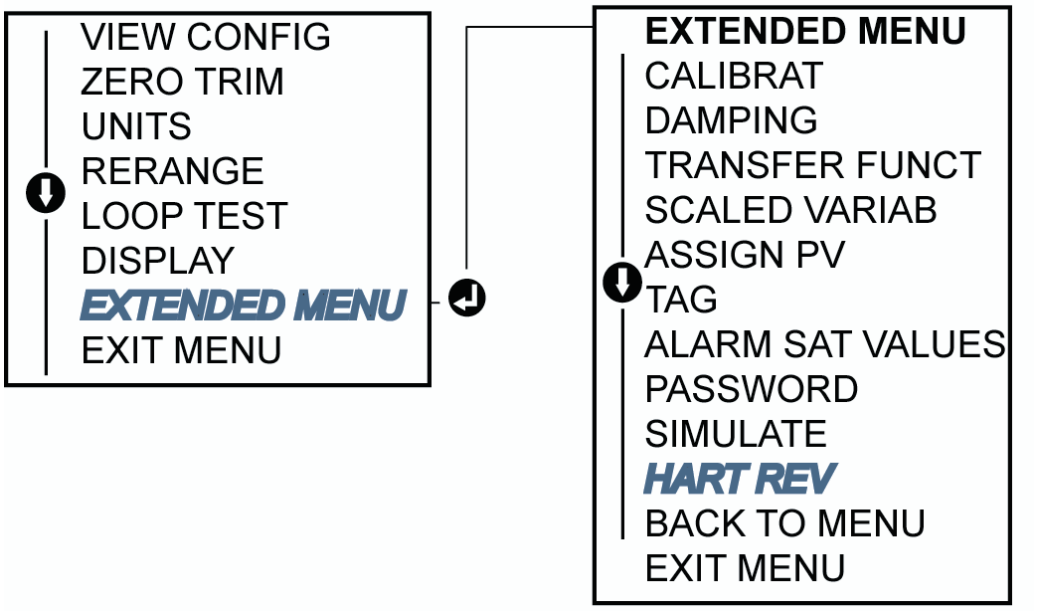
Note
AMS Device Manager versions 10.5 or greater are compatible with HART Revision 7.

5.6.4 Switch HART® revision with Local Operator Interface (LOI)

Procedure

Navigate to **HART REV** within the ***EXTENDED MENU*** and select either **HART REV 5** or **HART REV 7**. Use Figure 5-10 to change HART Revision.

Figure 5-10: Change HART Revision with LOI



6 Troubleshooting

6.1 Overview

This section provides summarized maintenance and troubleshooting suggestions for the most common operating problems.

If you suspect malfunction despite the absence of any diagnostic messages on the Field Communicator display, consider using Diagnostic messages to identify any potential problem.

6.2 Troubleshooting for 4-20 mA output

6.2.1 Transmitter milliamp reading is zero

Recommended actions

1. Verify terminal voltage is 10.5 to 42.4 Vdc at signal terminals.
2. Check power wires for reversed polarity.
3. Check that power wires are connected to signal terminals.
4. Check for open diode across test terminal.

6.2.2 Transmitter not communicating with communication device

Recommended actions

1. Verify terminal voltage is 10.5 to 42.2 Vdc.
2. Check loop resistance.

   Note
   (Power supply voltage - terminal voltage)/loop current must be 250 Ω minimum.

3. Check that power wires are connected to signal terminals and not test terminals.
4. Verify clean Dc power to transmitter.

   Note
   Maximum AC noise is 0.2 volts peak to peak.

5. Verify the output is between 4 and 20 mA or saturation levels.
6. Use the communication device to poll for all addresses.

6.2.3 Transmitter milliamp reading is low or high

Recommended actions

1. Verify applied pressure.
2. Verify 4 and 20 mA range points.
3. Verify **output** is not in **alarm** condition.

4. Perform **analog trim**.
5. Check that power wires are connected to the correct signal terminals (positive to positive, negative to negative) and not the test terminal.

6.2.4 Transmitter will not respond to changes in applied pressure

Recommended actions

1. Check impulse piping or manifold for blockage.
2. Verify applied pressure is between 4 and 20 mA points.
3. Verify the **output** is not in **Alarm** condition.
4. Verify transmitter is not in **Loop Test** mode.
5. Verify transmitter is not in **Multidrop** mode.
6. Check test equipment.

6.2.5 **Digital pressure** variable reading is low or high

Recommended actions

1. Check impulse piping for blockage or low fill in wet leg.
2. Verify transmitter is calibrated properly.
3. Check test equipment (verify accuracy).
4. Verify pressure calculations for application.
5. Restore pressure calibration. Go to **Device Settings** → **Calibration** → **Pressure** → **Factory Calibration** → **Restore Pressure Calibration**.

6.2.6 **Digital pressure** variable reading is erratic

Recommended actions

1. Check application for faulty equipment in pressure line.
2. Verify transmitter is not reacting directly to equipment turning On/Off.
3. Verify damping is set properly for application.

6.2.7 Milliamps reading is erratic

Recommended actions

1. Verify power source to transmitter has adequate voltage and current.
2. Check for external electrical interference.
3. Verify transmitter is properly grounded.
4. Verify shield for twisted pair is only grounded at one end.

6.3 Diagnostic messages

The following are possible messages that will appear on either the LCD/LOI display, a Field Communicator, or an AMS Device Manager system:

- **Advisory**

- **Failed – Fix now**
- **Good**
- **Maintenance – Fix soon**

6.3.1 Status: **Advisory**

Analog Output Fixed

LCD display screen	**ANLOG FIXED**
Local Operator Interface (LOI) screen	**ANALOG FIXED**

The analog output is fixed and does not represent the process measurement. This may be caused by other conditions in the device or because the device has been set to **Loop Test** or **Multidrop** mode.

Recommended actions

1. Take action on any other notifications from the device.
2. If the device is in **Loop Test** mode and should no longer be, disable or momentarily remove power.
3. If the device is in **Multidrop** mode and should not be, re-enable loop current by setting the polling address to 0.

Analog Output Saturated

LCD display screen	**ANLOG SAT**
Local Operator Interface (LOI) screen	**ANALOG SAT**

The analog output is saturated either high or low due to the pressure either above or below the range values.

Recommended actions

1. Check the pressure applied to ensure it is between the 4 and 20 mA points.
2. Check the transmitter pressure connection to ensure it is not plugged and the isolating diaphragms are not damaged.
3. Replace the pressure transmitter.

Configuration Changed

LCD display screen	(None)
Local Operator Interface (LOI) screen	(None)

A recent change has been made to the device by a secondary HART® master, such as a communication device.

Recommended actions

1. Verify that the device's configuration change was intended and expected.
2. Clear this alert by selecting **Clear Configuration Changed Status**.
3. Connect a HART master, such as AMS Device Manager or similar, which will automatically clear the alert.

LCD Display Update Failure

LCD display screen	(Not updating)
Local Operator Interface (LOI) screen	(Not updating)

The LCD display is not receiving updates from the pressure sensor.

Recommended actions

1. Check the connection between the LCD display and the circuit board.
2. Replace the LCD display.
3. Replace the pressure transmitter.

Loop Current Saturated

The loop current is saturated due to the analog value being outside the saturation value range, or the primary variable is being saturated.

LCD display	**ANLOG SAT**
Local Operator Interface (LOI)	**ANALOG SAT**

Recommended actions

1. Verify the conditions of the process where the transmitter is installed.
2. Verify the settings for the 4 mA and 20 mA range points and readjust if necessary.
3. Check the transmitter pressure connection to ensure it is not plugged and the isolating diaphragms are not damaged.
4. Replace the pressure transmitter.

Non-Critical User Data Warning

LCD display screen	**MEMRY WARN**
Local Operator Interface (LOI) screen	**MEMORY WARN**

A user-written parameter does not match expected value.

Recommended actions

1. Confirm and correct all parameters listed in ***Device Information***.
2. Perform a device reset.
3. Replace the pressure transmitter.

Sensor Parameter Warning

LCD display screen	**MEMRY WARN**
Local Operator Interface (LOI) screen	**MEMORY WARN**

A user-written parameter does not match expected value.

Recommended actions

1. Confirm and correct all parameters listed in ***Device Information***.
2. Perform a device reset.
3. Replace pressure transmitter.

Simulation Active

LCD display screen	(None)
Local Operator Interface (LOI) screen	(None)

The device is in **Simulation** mode and may not be reporting actual information.

Recommended actions

1. Verify that simulation is no longer required.
2. Disable **Simulation** mode in ***Service Tools***.
3. Reset the device.

6.3.2 Status: Maintenance - Fix Soon

Configuration Buttons Operator Error

LCD display screen	**STUCK BUTTO**N
Local Operator Interface (LOI) screen	**STUCK BUTTON**

Device is not responding to button presses.

Recommended actions

1. Check configuration buttons are not stuck.
2. Replace the pressure transmitter.

Electronics Board Parameter Error

LCD display screen	**MEMRY WARN** (also in advisory)
Local Operator Interface (LOI) screen	**MEMORY WARN** (also in advisory)

A device parameter does not match the expected value. The error does not affect transmitter operation or analog output.

Recommended action

Replace the pressure transmitter.

Module Temperature Out of Limits

The module temperature has exceeded its normal operating range.

LCD display	**TEMP LIMITS**
Local Operator Interface (LOI)	**TEMP OUT LIMITS**

Recommended actions

1. Check the process and ambient temperatures to ensure they are within specifications.
2. Replace the pressure transmitter.

No Temperature Updates

There are no temperature updates from the sensor to the electronics.

LCD display	**NO T UPDATE**
Local Operator Interface (LOI)	**NO TEMP UPDATE**

Recommended actions

1. Ensure the sensor cable connection to the electronics is tight.
2. Replace the pressure transmitter.

Pressure Out of Limits

The process pressure has exceeded the transmitter's maximum measurement range.

LCD display	**NO P UPDATE**
Local Operator Interface (LOI)	**PRES OUT LIMITS**

Recommended actions

1. Verify the conditions of the process where the transmitter is installed.
2. Check the transmitter pressure connection to ensure it is not plugged and the isolating diaphragms are not damaged.
3. Replace the pressure transmitter.

Sensor Temperature Beyond Limits

LCD display screen	**TEMP LIMITS**
Local Operator Interface (LOI) screen	**TEMP OUT LIMITS**

The sensor temperature has exceeded its safe operating range.

Recommended actions

1. Check the process and ambient conditions are within -85 to 194 °F (-65 to 90 °C).
2. Replace the pressure transmitter.

6.3.3 Status: **Failed - Fix Now**

Critical Electronics Data Error

LCD display screen	**MEMRY ERRO**R
Local Operator Interface (LOI) screen	**MEMORY ERROR**

A user-written parameter does not match the expected value.

Recommended actions

1. Confirm and correct all parameters listed in ***Device Information***.
2. Perform a device reset.
3. Replace pressure transmitter.

Critical Sensor Data Error

LCD display screen	**MEMRY ERROR**
Local Operator Interface (LOI) screen	**MEMORY ERROR**

A user-written parameter does not match the expected value.

Recommended actions

1. Confirm and correct all parameters listed in ***Device Information***.
2. Perform a device reset.
3. Replace pressure transmitter.

Electronics Board Failure

A failure has been detected in the electronics circuit board.

LCD display	**FAIL BOARD**
Local Operator Interface (LOI)	**FAIL BOARD**

Recommended action

Replace the pressure transmitter.

Incompatible Sensor Module

The electronic circuit board has detected a sensor module that is incompatible with the system.

Graphical LCD display	Incompatible Sensor Module

LCD display	**XMTR MSMTCH**
Local Operator Interface (LOI)	**XMTR MSMTCH**

Recommended action

Replace the pressure transmitter.

No Pressure Updates

There are no pressure updates from the sensor to the electronics.

LCD display	**NO P UPDATE**
Local Operator Interface (LOI)	**NO PRESS UPDATE**

Recommended actions

1. Ensure the sensor cable connection to the electronics is tight.
2. Replace the transmitter.

Sensor Module Failure

A failure has been detected in the sensor module.

LCD display	**FAIL SENSOR**
Local Operator Interface (LOI)	**FAIL SENSOR**

Recommended action

Replace pressure transmitter.

6.4 Disassembly procedures

⚠ WARNING

Do not remove cover in explosive atmospheres when the circuit is live.

6.4.1 Removing from service

⚠ WARNING

Follow all plant safety rules and procedures.

Procedure

1. Power down transmitter.
2. Isolate and vent the process from the transmitter before removing the transmitter from service.
3. Remove all electrical leads and disconnect conduit.
4. Remove the transmitter from the process connection.

a) The transmitter is attached to the process by a single hex nut process connection. Loosen the hex nut to separate the transmitter from the process.

NOTICE

Do not wrench on neck of transmitter. See warning in In-line process connection.

5. Do not scratch, puncture, or depress the isolating diaphragms.
6. Clean isolating diaphragms with a soft rag and a mild cleaning solution and rinse with clear water.

6.4.2 Removing terminal block

Electrical connections are located on the terminal block in the compartment labeled **FIELD TERMINALS**.

Procedure

1. Remove the housing cover from the field terminal side.
2. Loosen the two small screws located on the assembly in the 9 and 5 o'clock positions relative to the top of the transmitter.
3. Pull the entire terminal block out to remove it.

6.4.3 Removing the Local Operator Interface (LOI) or LCD display

Rosemount 3051P transmitters with M4 or M5 option codes have an LOI or LCD display. The transmitter LOI/LCD display is located in the compartment opposite the terminal side. To remove and/or replace the LOI/LCD display:

Procedure

1. Remove the housing cover opposite the field terminal side.
2. Loosen the two captive screws that are visible.

   See Figure 4-2 for screw locations. The two screws anchor the LOI/LCD display to the electronics board and the electronics board to the housing.
3. After the loosening the screws, pull the LOI/LCD display off the electronics board and out of the housing.

NOTICE

Ensure to pull directly backwards to avoid bending or damaging the connection pins on the electronics board.

Do not attempt to pull out the electronics board from the housing, as this could permanently damage the transmitter.

6.5 Reassembly procedures

6.5.1 Installing the Local Operator Interface (LOI) or LCD display

Procedure

1. While aligning the captive screws with the respective holes on the electronics board, connect the LCD/LOI display to the electronics board by pressing down firmly.
2. Ensure the connecting pins on the back of the LCD fully connect to the front of the electronics board.
3. Fully tighten down the captive screws.
4. Replace the housing cover.

⚠ WARNING

Ensure the transmitter is fully engaged to meet explosion-proof requirements.

7 Safety instrumented systems requirements

7.1 Safety Instrumented Systems (SIS) certification

The safety-critical output of the Rosemount 3051P is provided through a 2-wire, 4 - 20 mA signal representing pressure. The Rosemount 3051P safety certified pressure transmitter is certified to: Low Demand; Type B. SIL 2 for random integrity @ HFT=0 SIL 3 for random integrity @ HFT=1 SIL 3 for systematic integrity

7.2 Safety certified identification

All Rosemount 3051P Transmitters must be identified as safety certified before installing into SIS systems.

To identify a safety certified Rosemount 3051P:

Procedure

1. Check Namur Software Revision located on the metal device tag. "SW _._._".

   Example

   Namur Software Revision Number

SW	1.0.x - 1.4.x

   Note
   Namur Software Revision: Located on the metal device tag.

2. Verify that option code **QT** is included in the transmitter model code.

7.3 Installing in Safety Instrumented Systems (SIS) applications

Only qualified personnel should install the transmitter in SIS applications. No special installation is required in addition to the standard installation practices outlined in this document.

⚠ WARNING

Always ensure a proper seal by installing the electronics housing cover(s) so that metal contacts metal.

Environmental and operational limits are available in the Rosemount 3051P Product Data Sheet.

Design the loop so that the terminal voltage does not drop below 10.5 Vdc when the transmitter output is set to 23 mA. For more information, see the Rosemount 3051P Product Data Sheet.

Position the **security** switch to the (🔒) position to prevent accidental or deliberate change of configuration data during normal operation.

7.4 Configuring in Safety Instrumented Systems (SIS) applications

Use any HART® capable configuration tool to communicate with and verify configuration of the Rosemount 3051P.

Note
Transmitter output is not safety-rated during the following: configuration changes, **multidrop**, and **loop test**. Use alternative means to ensure process safety during transmitter configuration and maintenance activities.

7.4.1 Damping

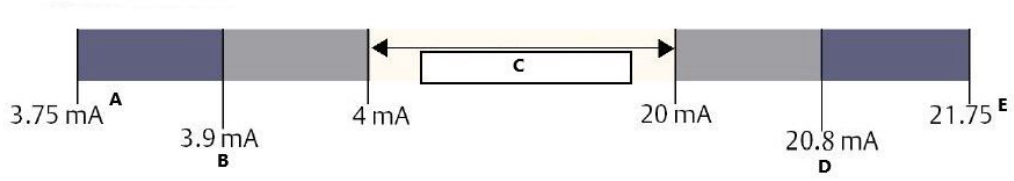
User-selected **damping** will affect the transmitters ability to respond to changes in the applied process. The **damping** value and response time must not exceed the loop requirements.

Reference Damping to change **damping** value.

7.4.2 Alarm and saturation levels

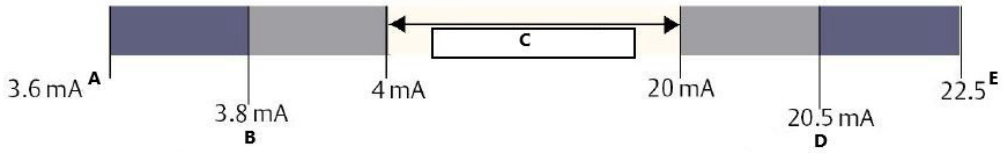
Configure DCS or safety logic solver to match transmitter configuration. Figure 7-1, Figure 7-2, and Figure 7-3 identify the three alarm levels available and their operation values.

Figure 7-1: Rosemount alarm levels



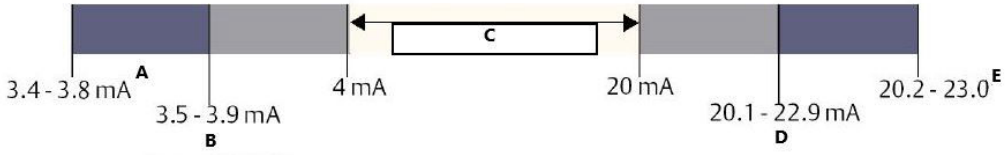
*A. Transmitter failure; hardware or software alarm in **LO** position*
B. Low saturation
C. Normal operation
D. High saturation
*E. Transmitter failure; hardware or software alarm in **HI** position*

Figure 7-2: Namur alarm level



*A. Transmitter failure; hardware or software alarm in **LO** position*
B. Low saturation
C. Normal operation
D. High saturation
*E. Transmitter failure; hardware or software alarm in **HI** position*

Figure 7-3: Custom alarm level



*A. Transmitter failure; hardware or software alarm in **LO** position*
B. Low saturation
C. Normal operation
D. High saturation
*E. Transmitter failure; hardware or software alarm in **HI** position*

7.5 Safety Instrumented Systems (SIS) operation and maintenance

7.5.1 Proof tests

Emerson recommends the following proof tests. Ensure that only qualified personnel perform proof tests.

Use Fast Keys to perform a **loop test**, **analog output trim**, or **sensor trim**. Place the **security** switch in the (🔓) position during proof test execution and reposition it in the (🔒) position after execution.

7.5.2 Partial proof test

The partial suggested proof test consists of a power cycle plus reasonability checks of the transmitter output. Reference the *FMEDA Report* for percent of possible DU failures in the device.

See the FMEDA Report.

Prerequisites

Required tools: Field Communicator and mA meter

Procedure

1. Bypass the safety function and take appropriate action to avoid a false trip.
2. Use HART® communications to retrieve any diagnostics and take appropriate action.
3. Send a HART command to the transmitter to go to the high alarm current output and verify that the analog current reaches that value.

   Note
   This tests for compliance voltage problems such as a low loop power supply voltage or increased wiring distance. This also tests for other possible failures.

   See Verifying alarm level.

4. Send a HART command to the transmitter to go to the low alarm current output and verify that the analog current reaches that value.

   Note
   This tests for possible quiescent current related failures.

5. Inspect the device for any leaks, visible damage, or contamination.
6. Remove the bypass and otherwise restore the normal operation.
7. Place the **Security** switch in the (🔒) position.

7.5.3 Comprehensive proof test

The comprehensive proof test consists of performing the same steps as the partial proof test, but with a two point calibration of the pressure sensor in place of the reasonability check. Reference the FMEDA Report for percent of possible DU failures in the device.

Prerequisites

Required tools: Field Communicator and pressure calibration equipment

Procedure

1. Bypass the safety function and take appropriate action to avoid a false trip.
2. Use HART® communications to retrieve any diagnostics and take appropriate action.
3. Send a HART command to the transmitter to go to the high alarm current output and verify that the analog current reaches that value.

   Note
   This tests for compliance voltage problems such as a low loop power supply voltage or increased wiring distance. This also tests for other possible failures.

   See Verifying alarm level.
4. Send a HART command to the transmitter to go to the low alarm current output and verify that the analog current reaches that value.
   This tests for possible quiescent current related failures.
5. Inspect the device for any leaks, visible damage or contamination.
6. Perform a two-point calibration of the sensor (see Trimming the pressure signal) over the full working range and verify the current output at each point.
7. Remove the bypass and otherwise restore the normal operation.
8. Place the **Security** switch in the (🔒) position.

   Note
   - The user determines the proof test requirements for impulse piping.
   - Automatic diagnostics are defined for the corrected % DU: The tests performed internally by the device during runtime without requiring enabling or programming by the user.

7.6 Inspection

7.6.1 Visual inspection

This is not required.

7.6.2 Special tools

This is not required.

7.6.3 Product repair

The transmitter is repairable with limited replacement options.

Report all failures detected by the transmitter diagnostics or by the proof test. Submit feedback electronically at Emerson.com/Rosemount/Report-A-Failure

NOTICE

Emerson recommends that only qualified personnel repair the product and replace parts.

7.6.4 Safety Instrumented Systems (SIS) reference

Operate the transmitter in accordance to the functional and performance specifications provided in the Rosemount 3051P Product Data Sheet.

7.6.5 Failure rate data

The FMEDA Report includes failure rates.

7.6.6 Failure values

Safety deviation (defines what is dangerous FMEDA):

Safety accuracy: +-2.0% of analog output span

Transmitter response time: 1.5 seconds

Self-diagnostic test: At least once every 60 minutes.

7.6.7 Product life

50 years: Based on worst case component wear-out mechanisms; not based on process-wetted materials wearing out.

A Reference data

A.1 Product certifications and installation drawings

To view current Rosemount 3051P product certifications and installation drawings:

1. Go to Emerson.com/Rosemount-3051P.
2. Scroll to the green menu bar and select **Documents and Drawings**.
3. Select **Certificates & Approvals**.

A.2 Ordering information, specifications, and dimensional drawings

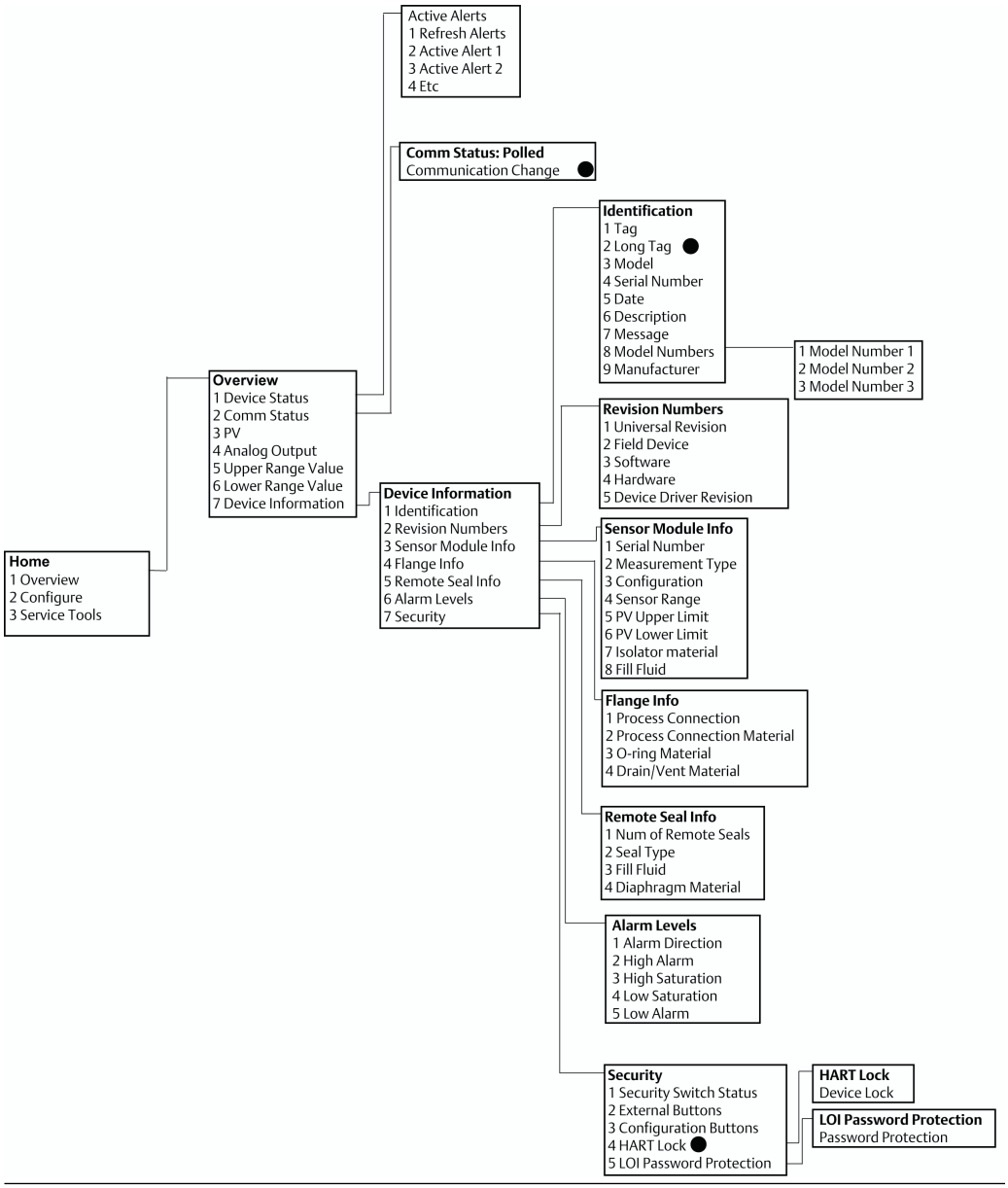
To view current Rosemount 3051P ordering information, specifications, and dimensional drawings:

1. Go to Emerson.com/Rosemount-3051P.
2. Scroll to the green menu bar and select **Documents and Drawings**.
3. Select **Data Sheets & Bulletins**.
4. Select the appropriate Product Data Sheet.

B Field Communicator menu trees and Fast Keys

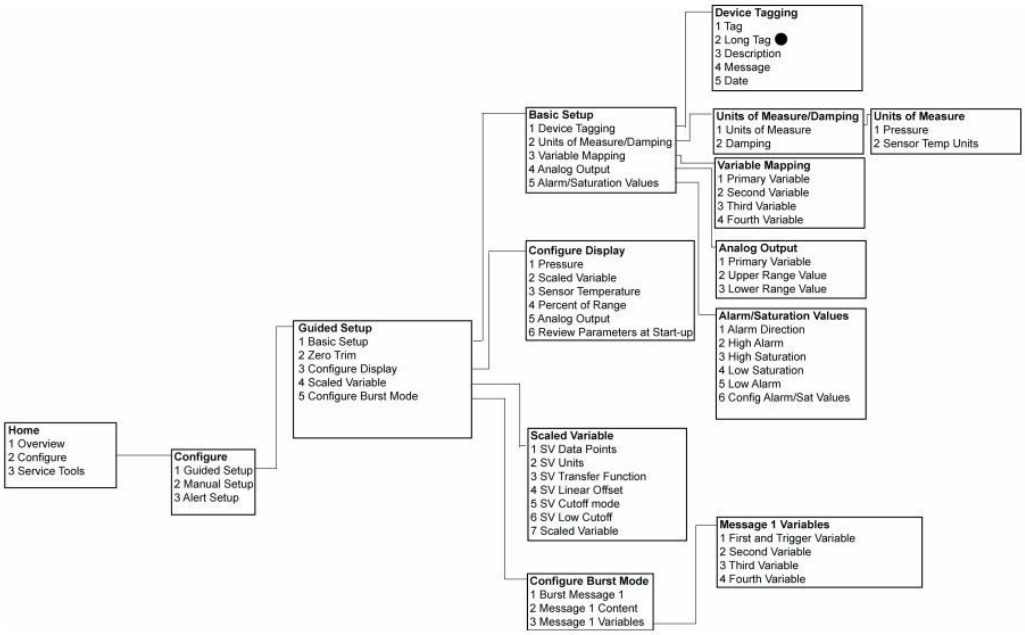
B.1 Menu trees

Figure B-1: *Overview*



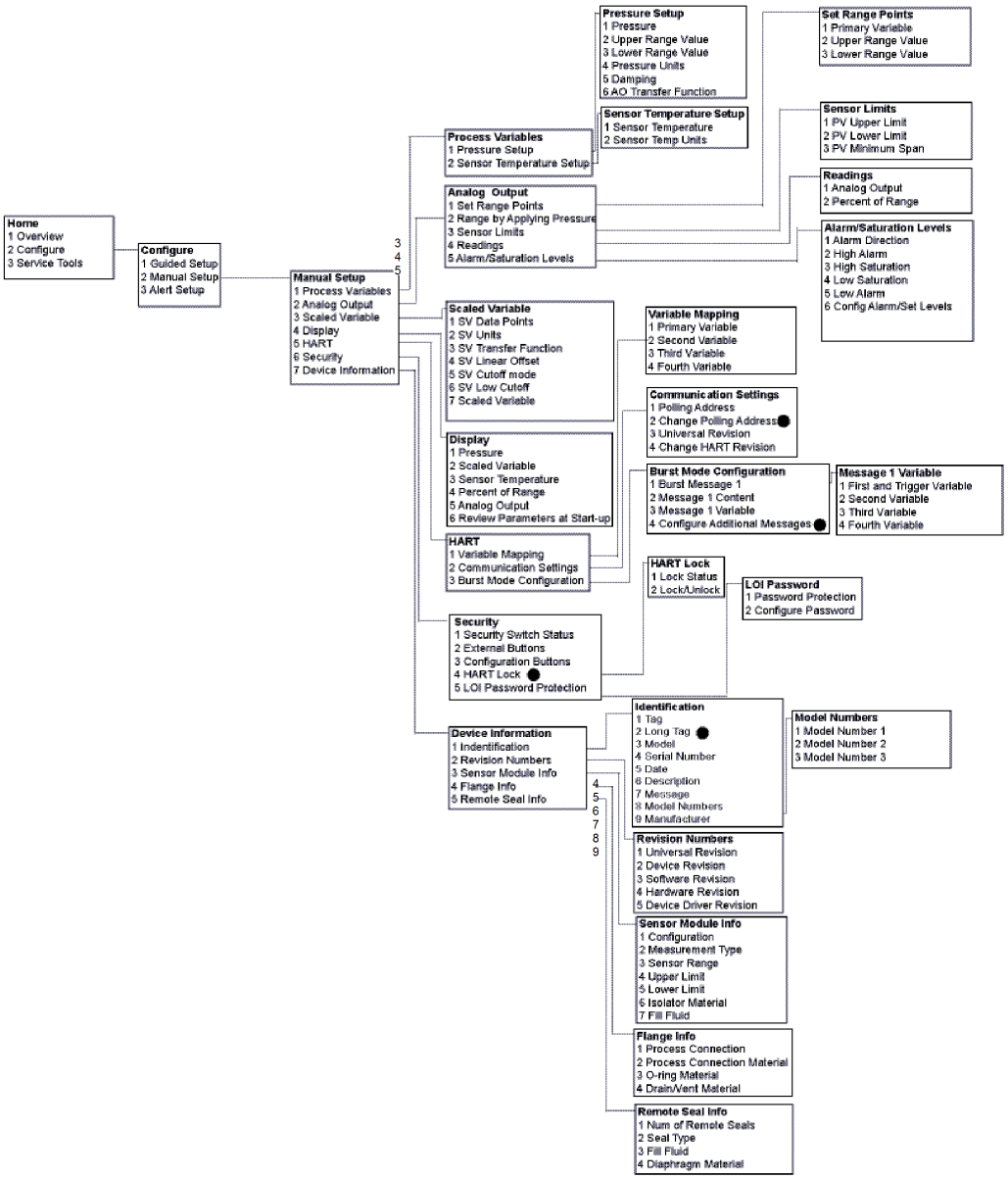
Note
Selections with black circle are only available in HART® Revision 7 mode. Selection will not appear in the HART Revision 5 Device Descriptor (DD).

Figure B-2: *Configure: Guided Setup*



Note
Selections with black circle are only available in HART Revision 7 mode. Selection will not appear in the HART Revision 5 DD.

Figure B-3: *Configure: Manual Setup*



Note

Selections with black circle are only available in HART Revision 7 mode. Selection will not appear in HART Revision 5 DD.

Figure B-4: *Configure: Alert Setup*

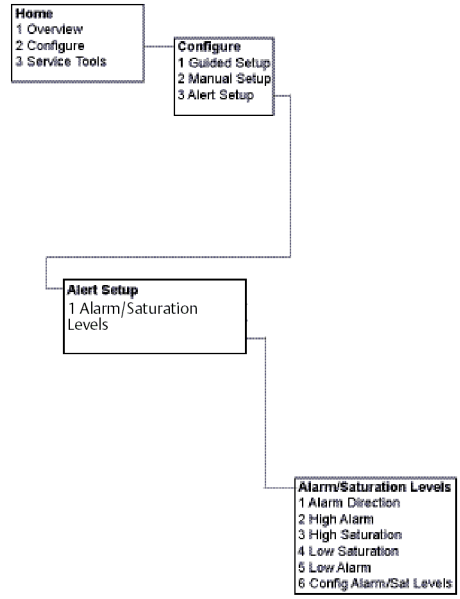
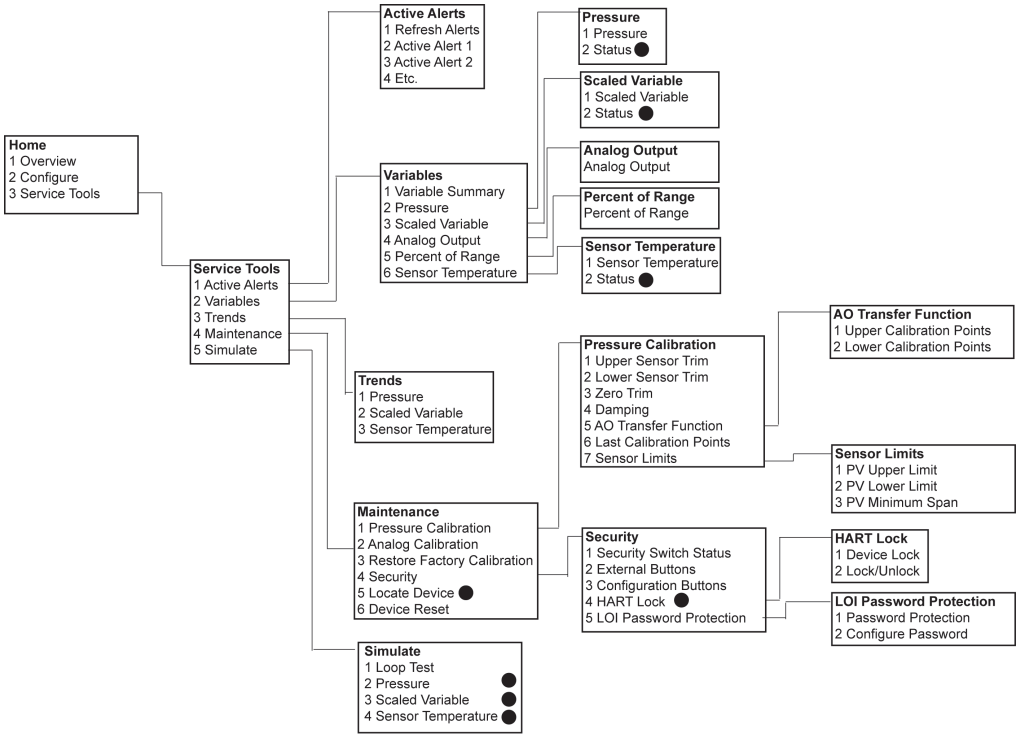


Figure B-5: *Service Tools*



Note

Selections with black circle are only available in HART Revision 7 mode. Selection will not appear in the HART Revision 5 DD.

B.2 Fast Keys

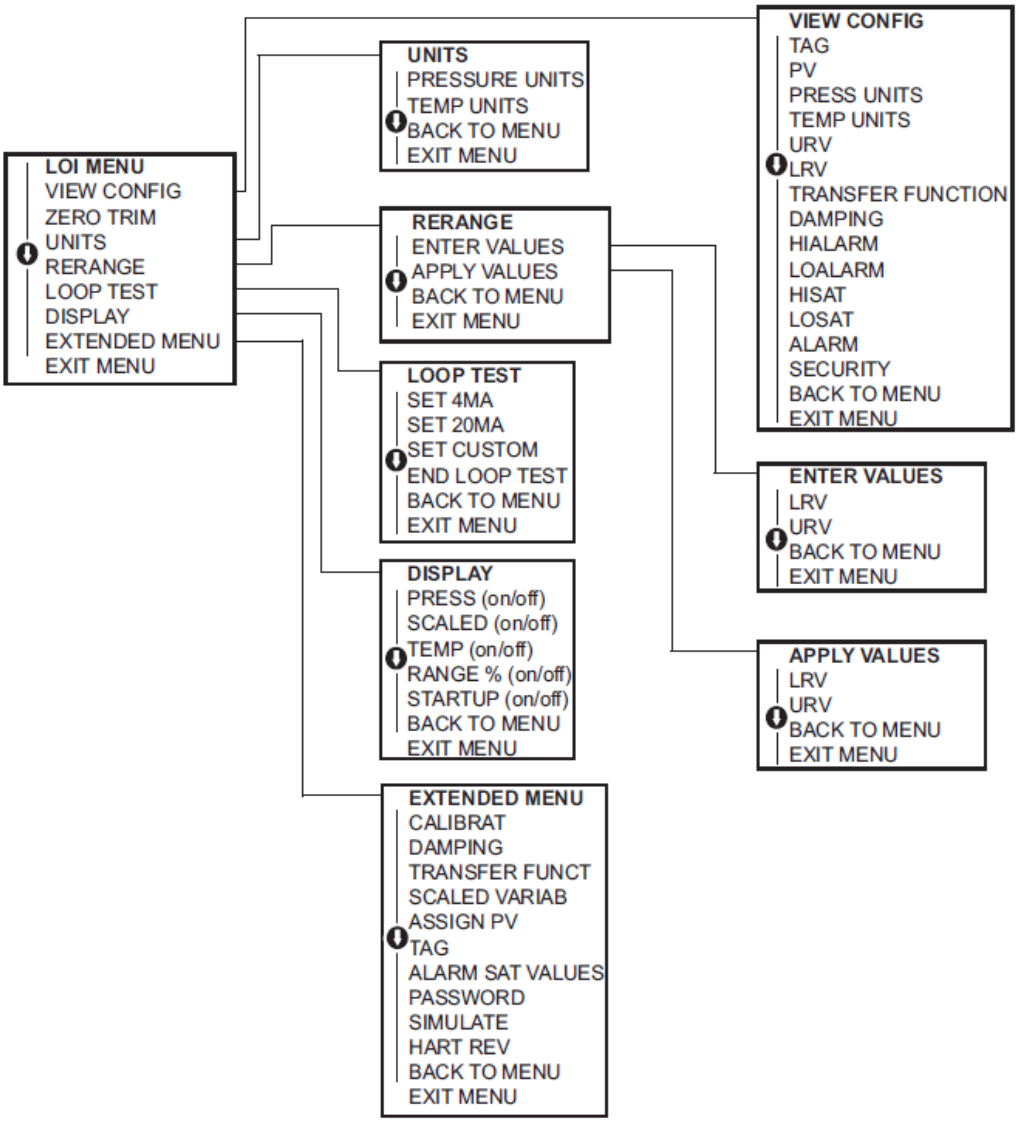
- A (✓) indicates the basic configuration parameters. At minimum, verify these parameters as a part of configuration and startup.
- A (7) indicates availability only in HART® revision 7 mode.

Table B-1: Device Revision 9 and 10 (HART 7), Device Descriptor (DD) Revision 1 Fast Key Sequence

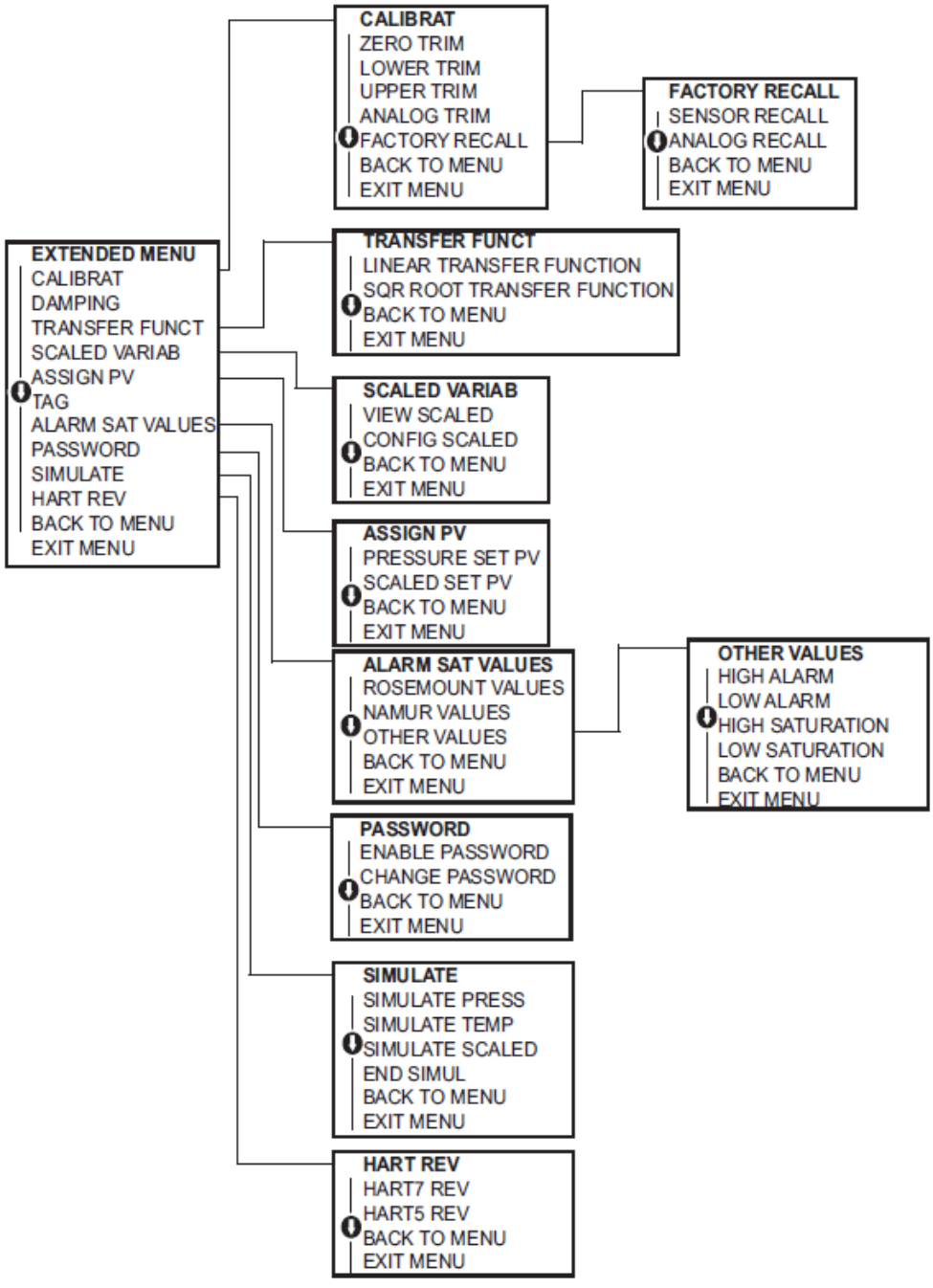
	Function	Fast Key sequence	
		HART 7	HART 5
✓	Alarm and saturation levels	2, 2, 2, 5	2, 2, 2, 5
✓	Damping	2, 2, 1, 1, 5	2, 2, 1, 1, 5
✓	Primary variable	2, 2, 5, 1, 1	2, 2, 5, 1, 1
✓	Range values	2, 2, 2, 1	2, 2, 2, 1
✓	Tag	2, 2, 7, 1, 1	2, 2, 7, 1, 1
✓	Transfer function	2, 2, 1, 1, 6	2, 2, 1, 1, 6
✓	Pressure units	2, 2, 1, 1, 4	2, 2, 1, 1, 4
	Date	2, 2, 7, 1, 5	2, 2, 7, 1, 4
	Descriptor	2, 2, 7, 1, 6	2, 2, 7, 1, 5
	Digital to analog trip (4–20 mA V output)	3, 4, 2, 1	3, 4, 2, 1
	Digital zero trim	3, 4, 1, 3	3, 4, 1, 3
	Display configuration	2, 2, 4	2, 2, 4
	Local Operator Interface (LOI) password protection	2, 2, 6, 5	2, 2, 6, 4
	Loop test	3, 5, 1	3, 5, 1
	Lower sensor trim	3, 4, 1, 2	3, 4, 1, 2
	Message	2, 2, 7, 1, 7	2, 2, 7, 1, 6
	Pressure trend	3, 3, 1	3, 3, 1
	Rerange with keypad	2, 2, 2, 1	2, 2, 2, 1
	Scaled D/A trim (4–20 mA output)	3, 4, 2, 2	3, 4, 2, 2
	Scaled variable	2, 2, 3	2, 2, 3
	Sensor temperature trend	3, 3, 3	3, 3, 3
	Switch HART Revision	2, 2, 5, 2, 4	2, 2, 5, 2, 3
	Upper sensor trim	3, 4, 1, 1	3, 4, 1, 1
7	Long tag	2, 2, 7, 1, 2	
7	Locate device	3, 4, 5	
7	Simulate digital signal	3, 5	

C Local Operator Interface (LOI)

C.1 Local Operator Interface (LOI) menu tree



C.2 Local Operator Interface (LOI) menu tree - *EXTENDED MENU*



C.3 Entering numbers

You can enter floating-point numbers with the Local Operator Interface (LOI).

You can use all eight number locations on the top line for number entry. Refer to Table 2-2 for LOI button operation. Below is a floating-point number entry example for changing a value of **-0000022** to **000011.2**

Step	Instruction	Current position (indicated by underline)
1	When the number entry begins, the leftmost position is the selected position. In this example, the negative symbol, "**-**", will start flashing on the screen.	-0000022
2	Press the scroll button until the **0** is blinking on the screen in the selected position.	00000022
3	Press **Enter** to select the **0** as an entry. The second digit from the left will start blinking.	00000022
4	Press the **Enter** button to select **0** for the second digit. The third digit from the left will start blinking.	00000022
5	Press **Enter** to select **0** for the third digit. The fourth digit from the left will start blinking.	00000022
6	Press **Enter** to select **0** for the fourth digit. The fifth digit from the left will start blinking.	00000022
7	Press **Scroll** to navigate through the numbers until the **1** is on the screen.	00001022
8	Press **Enter** to select **1** for the fifth digit. The sixth digit from the left will start blinking.	00001022
9	Press **Scroll** to navigate through the numbers until **1** is on the screen.	00001122
10	Press **Enter** to select **1** for the sixth digit. The seventh digit from the left will start blinking.	00001122
11	Press **Scroll** to navigate through the numbers until the decimal, "**.**", is on the screen.	000011.2
12	Press **Enter** to select the decimal, "**.**", for the seventh digit. After pressing **Enter**, all digits to the right of the decimal will now be zero. The eighth digit from the left will start blinking.	000011.0
13	Press **Scroll** to navigate through the numbers until **2** is on the screen.	000011.2
14	Press **Enter** to select **2** for the eighth digit. The number entry will be complete, and a ***SAVE*** screen is shown.	000011.2

Note

- To move backwards in the number, scroll to the left arrow symbol and press **Enter**.
- The negative symbol is only allowed in the leftmost position.
- To enter numbers in scientific notation, place an **E** in the 7th position.

C.4 Entering text

You can enter text with the Local Operator Interface (LOI).

Depending on the edited item, up to eight locations on the top line can be used for text entry. Text entry follows the same rules as the number entry rules in Entering numbers, except the following characters are available in all locations: **A**-**Z**, **0**-**9**, **-**, **/**, space.

Note
If the current text contains a character the LOI cannot display, it will be shown as an asterisk "*****".

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Rev. AD
2024

For more information: **Emerson.com/global**

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ROSEMOUNT™

EMERSON™

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

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☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

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By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

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☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

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Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

©COPYRIGHT 2023 JACOBS

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

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☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

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Comments: _____

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I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35(PI/PE)3238	Series 40 Flanged Pressure Sensor, 4", w/ Ashcroft Pressure Gauge"	Red Valve	P4U0402000-00004	Section 40 91 00	09-I-003, 4091-304D
002	1	C35(PI/PE)3211	Series 742 Pressure Sensor, 2", w/ Ashcroft Pressure Gauge	Red Valve	P2U0200000-00008	Section 40 91 00	09-I-004, 4091-304C
003	1	C35(PI/PE)3212	Series 742 Pressure Sensor, 2", w/ Ashcroft Pressure Gauge	Red Valve	P2U0200000-00008	Section 40 91 00	09-I-004, 4091-304C
004	1	C35(PI/PE)3221	Series 40 Flanged Pressure Sensor, 4", w/ Ashcroft Pressure Gauge"	Red Valve	P4U0402000-00004	Section 40 91 00	09-I-004, 4091-304D
005	1	C35(PI/PE)3222	Series 40 Flanged Pressure Sensor, 4", w/ Ashcroft Pressure Gauge"	Red Valve	P4U0402000-00004	Section 40 91 00	09-I-004, 4091-304D
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Antec Corporation
www.anteccorporation.com
12622 – 412th Ave SE, PO Box 1609
North Bend, WA 98045

425-888-9090 (o) ● 425-888-6492 (f) ● 206-660-1311 (c)

WWTP1 PHASE 1A IMPROVEMENTS – COOS BAY, OR

AIS COMPLIANT

Item	Qty	Product & Description
1	2	**2" RED VALVE Series 42 … PRESSURE SENSOR** Steel Body and Threaded End Caps, Buna-N Elastomeric Sleeve, Red Enamel 4.5" Stainless Steel Ashcroft Gauge, Ethylene Glycol / Water or Propylene Glycol.
2	3	**4" RED VALVE Series 40 … FLANGED PRESSURE SENSOR** Steel Body & Flanges, ANSI Class 150# Flange Drilling, Silicone Oil Filled Sensing System, BUNA-N Sleeve, STD Red Enamel, 4.5" Ashcroft Gauge, Ethylene Glycol/ Water or Propylene Glycol

Lead Time: 12-16 Weeks
FOB: GASTONIA, NC 28052

SHIPPING OPTIONS:

a. FOB Factory, Freight Pre-Paid & Added at FULL RATE
b. Freight Collect via specified Carrier & Account, FOB Factory

Quotations are valid for 30 days. Lead times are based upon current production levels. Terms are NET 30 with open account.
ACCEPTANCE OF RED VALVE'S TERMS & CONDITIONS REQUIRED TO PURCHASE

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Series 40 Pressure Sensor

- Protects and isolates instrumentation
- Full 360° pressure reading
- Self-cleaning, flexing action
- Won't clog like traditional diaphragm seals
- Accomodates both positive and negative pressures

Red Valve's Series 40 Pressure Sensor is the industry standard for protecting instrumentation and assuring accurate, dependable pressure measurement of slurry and corrosive fluids.

The 360˚ flexible rubber sleeve senses the line pressure. The captive fluid is displaced through the pressure sensor body to the instrument's Bourdon Tube. All instruments are isolated and protected from the process, ensuring positive and accurate readings.

The full-faced, thru-bolted Series 40 installs directly in-line. Costly installation and maintenance of pipe stands and saddle welds, which are required when installing antiquated diaphragm seals, are eliminated. The thru-bolted Series 40 can be mounted in any flow direction, submerged in a tank, or mounted with a blind flange as a dead end to monitor tank levels.

The Red Valve standard gauge is bottom mounted, with a 2.5" diameter steel case. Accuracy of this gauge is 1% of the gauge reading. Standard gauge is 0-100 psi gauge, unless otherwise specified. Optional gauge ranges are available.

All Red Valve Pressure Sensors and Gauges are tested and calibrated through the mid-range to assure the highest level of accuracy. Pressure gauges, transmitters, transducers, recorders, differential pressure or vacuum switches are factory filled and mounted to the Series 40.

Materials of Construction

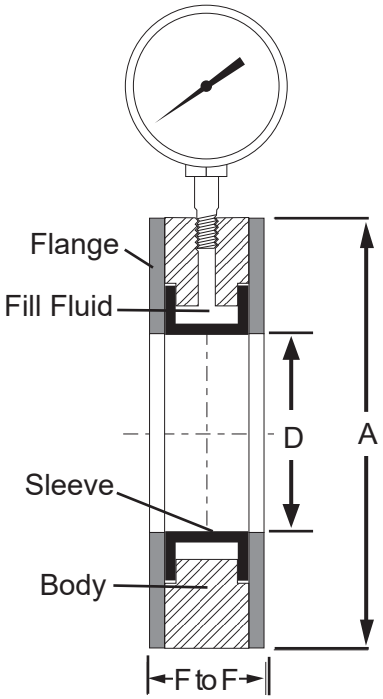
- **Body:** Carbon Steel, 316 Stainless Steel.
- **Sleeves:** Pure Gum Rubber (PGR), Ethylene Propylene Diene Terpolymer (EPDM)*, Acrylonitrile-Butadiene (NBR), Fluoroelastomer (FKM)*, Chloroprene (CR)*, Chlorosulfonated Polyethylene (CSM), Chloro-Isobutylene-Isoprene (CIIR).
  * White food grade options available.
- **Drilled Flanges:** ASME 150 in Carbon Steel, 316 Stainless Steel or Polytetrafluoroethylene (PTFE)-Coated Carbon Steel.
- **Fill Fluids:** Silicone Oil (400° F), Ethylene Glycol and Water (200° F), Vegetable Oil (230° F).

SERIES 40

	DIMENSIONS in/mm		
SIZE D	OUTSIDE DIAMETER A	LENGTH F TO F	WEIGHT lbs/kg
1" 25mm	4.50 114	1.88 48	6 3
1.5" 40mm	5.00 127	1.88 48	8 4
2" 50mm	6.00 152	1.88 48	12 5
2.5" 65mm	7.00 178	1.88 48	16 7
3" 80mm	7.50 191	1.88 48	18 8
4" 100mm	9.00 229	2.13 54	27 12
5" 125mm	10.00 254	2.25 57	32 15
6" 150mm	11.00 279	2.25 57	37 17
8" 200mm	13.50 343	2.50 64	58 26

Product pressure ratings are consistent with the pressure ratings of the 150# flanges to which they are mated. Contact Red Valve for use with other flange classes.

Contact Red Valve for sizes 10" through 36".



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Series 42 Pressure Sensor & Series 742 Diaphragm Seal

- Series 742 can be finished or rodded clean without removal from the line or disassembly
- Protects and isolates instrumentation from chemical or slurry plugging
- Lower installation and operating costs
- Accomodates both positive and negative pressures

Red Valve's Series 42 Pressure Sensor and Series 742 Diaphragm Seal isolate and provide accurate instrument reading of gauges, transmitters and pressure switches, making them ideal for use in chemical or slurry service. The Series 42 and Series 742 can be mounted in any flow direction and have threaded ends manufactured to standard NPT pipetap dimensions for smaller pipelines.

The Series 42 Pressure Sensor's principle of operation is simple. As process pressure is sensed by the 360° elastomer sleeve, the captive fluid transfers the process pressure to the instrument, providing a consistent, accurate reading.

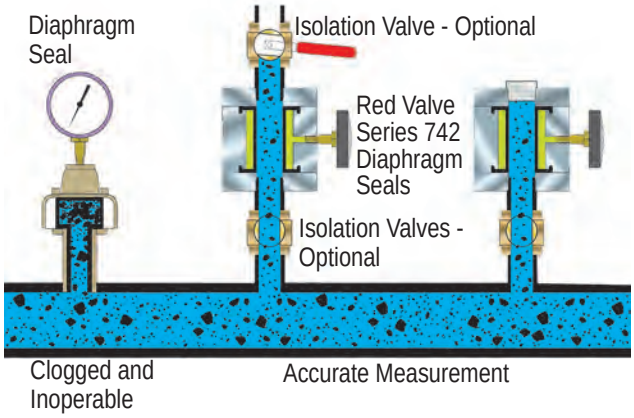
The Series 742 Diaphragm Seal offers a significant advantage over traditional diaphragm seals. When installed perpendicular to the pipeline, the Series 742 can be isolated so that in the event of plugging, the elastomer slurry ring area (which isolates the instrument) can be flushed (*Figure 1*) or rodded clean (*Figure 2*).

Series 42 Pressure Sensors and Series 742 Diaphragm Seals are available in sizes 0.5" - 2". The Series 42 features a top mounted gauge, while the Series 742 is supplied with a standard back mounted gauge. The elastomer sleeve extends to the flange face, eliminating the need for additional gaskets.

Materials of Construction

- **Body and Upper and Lower Case:** Carbon Steel or 316 Stainless Steel.
- **Sleeves:** Pure Gum Rubber (PGR), Ethylene Propylene Diene Terpolymer (EPDM)*, Acrylonitrile-Butadiene (NBR), Fluoroelastomer (FKM)*, Chloroprene (CR)*, Chlorosulfonated Polyethylene (CSM), Chloro-Isobutylene-Isoprene (CIIR).
  * White food grade options available.
- **Fill Fluids:** Silicone Oil (400° F), Ethylene Glycol and Water (200° F), Vegetable Oil (230° F).

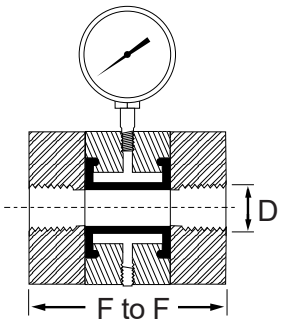
Figure 1 ***Figure 2***



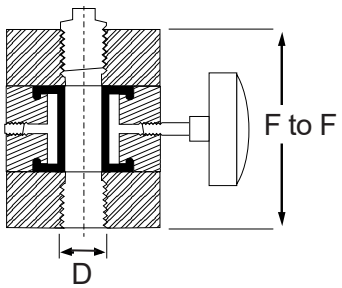
SERIES 42 & SERIES 742

	DIMENSIONS in/mm		
SIZE D	LENGTH F TO F	WORKING PRESSURE psi/kPa	WEIGHT lbs/kg
0.5" 15mm	2.88 73	720 4960	5 2
1" 25mm	3.38 86	720 4960	6 3
1.5" 40mm	3.38 86	720 4960	15 7
2" 50mm	3.38 86	720 4960	20 9

Series 42



Series 742



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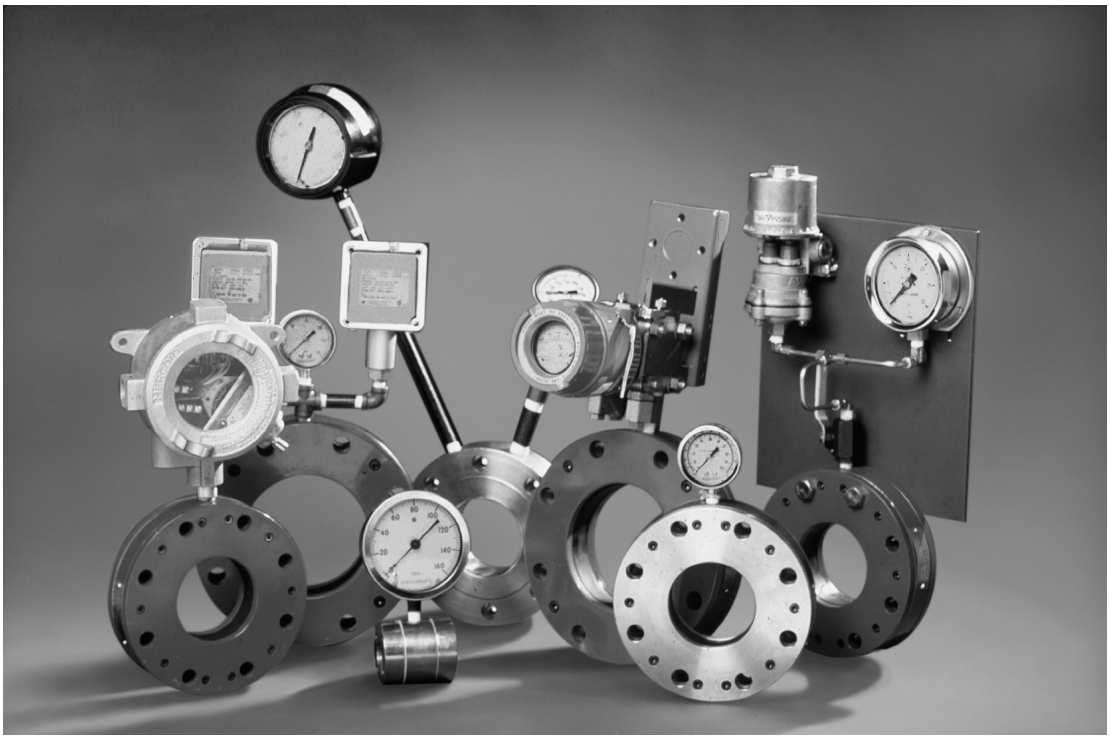
Red Valve®

IOM RV06.02-1
February 2023

Series 40 / Series 42 / Series 48 Pressure Sensors Installation, Operation and Maintenance Manual



IMPORTANT

Please take a moment to review this manual. Before performing any maintenance on the pressure sensors be sure the pipeline has been de-pressurized. The improper installation or use of this product may result in personal injury, product failure, or reduced product life. Red Valve Co., Inc. can accept NO liability resulting from the improper use or installation of this product. If you have any questions or problems, please call the customer service department at (412) 279-0044. We appreciate your comments. Thank you for choosing Red Valve.

OPERATION

Red Valve Sensors are a sealed system.

These Sensors must be properly filled and sealed before any pressure is applied. Do not loosen the retaining bolts on the Series 40, Series 48 or Series 42. If this equipment is removed, air can be introduced into the sensing fluid, which can cause inaccurate readings. Great care should be taken to eliminate all air in the system. If the instrumentation is removed, or the bolts or end caps loosened, the sensor should be properly refilled (see fill instructions).

Gauge cocks can be used to isolate the instrumentation, however, when the instrument is removed there is going to be some fluid lost, possibly causing an inaccurate reading. Quick disconnect couplings with two-way check valves, which minimize fluid loss, can also be furnished.

Red Valve sensors have very sensitive sleeves for more accurate readings. The sleeves do not act as pressure snubbers. If a sensor is used near a pump or equipment which produces frequent pressure surges, a pressure snubber or liquid-filled gauge should be used.

NOTE: If a pressure snubber is used, the sensor should be vacuum filled to ensure complete removal of air from the instrumentation.

FLUID VOLUME: Red Valve Pressure Sensors are manufactured with a small volume of sensing fluid. Some types of pressure switches require a large amount of sensing fluid. If these switches or multiple instruments are used, check the amount of fluid required to operate the instruments. The amount of usable fluid in the sensor is slightly less than the total fluid volume. In sensors with elastomer sleeves, the approximate amount of usable fluid in cubic inches is .25 x Nominal Pipe Size. If a larger volume of usable fluid is needed, an Extra Large Volume (XLV) sensor should be specified on the purchase order.

INSPECTION: Red Valve Pressure Sensors should be periodically inspected for wear or aging of the elastomer sleeve. Since there is very little sleeve movement, the wear on the sleeve is minimal. The sleeves are, however, subject to chemical attack from the process fluids. The entire sleeve should be periodically checked for cracks, cuts and blisters and replaced if necessary. The inspection interval should be determined by the severity of the service.

INSTALLATION

Standard Series 40 Sensors have ANSI 125/150 class bolting dimensions, and flat flange faces. Series 40W and 48W use the sleeve face to act as the flange gasket. Only use flat face flanges and tighten according to bolt grade and lubrication used for the installation. The maximum working pressure of a standard Series 40 is 225 psi. Series 40 sensors with higher pressure ratings are also available. Series 48 Sensors fit between ANSI 125/150 flanges.

1. Full face gaskets should be used, flanges with raised faces may distort the sensor and cause an inaccurate reading.

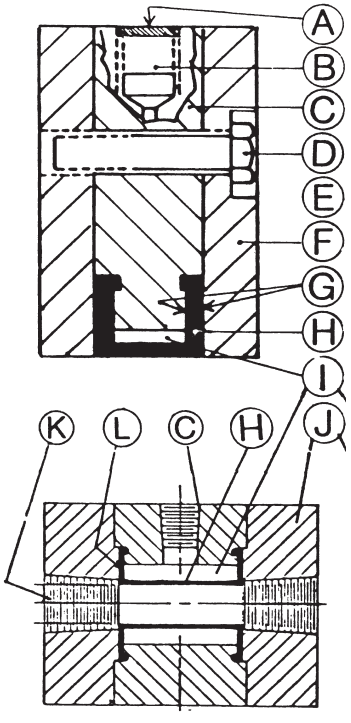
2. Bolt the sensor between two flanges and tighten the bolts to the recommended torque.

   Series 42 Sensors have a standard NPT end connections and 1/4"-18 NPT gauge connections. When installing the sensor in the pipe line, be sure to tighten the NPT end connections by gripping the end caps of the sensor.

CODE

A. Epoxy Fill	H. Sleeve
B. Hex Socket	I. Fill Fluid
C. Body	J. End Cap
D. Retaining Bolts	K. End Connection
E. Retainer Ring	L. Lubricant
F. Flange	M. 1/4" NPT
G. Sealant	

SERIES 40/48



Series 42

Teflon tape should be used on all NPT connections (end connections and gauge connections).

NOTE: Great care must be taken not to strip the NPT end connections if PVC end caps are used.

High Pressure Series 42 Sensors can have either a standard NPT or Autoclave end and gauge connection. When installing the sensor in the pipe line, be sure to tighten the end connections by gripping the end cap. Only use Teflon tape on NPT connections.

REPLACING SLEEVE

Replacement Sleeves are available in a wide variety of rubber compounds. The following compounds are available: Buna-N, Pure Gum Rubber, Butyl, EPDM, Neoprene®, Hypalon® and Viton®. Food grade rubber is available in white: Neoprene, EPDM, Buna-N and Butyl along with Black Viton.

Neoprene, Hypalon and Viton are Registered Trademarks of E.I. DuPont.

1. Remove the sensor from the line.
2. Remove the gauge or instrumentation, to avoid damaging the equipment.
3. Chip away the epoxy fill covering the pipe plug.
4. Remove the pipe plug.
5. Drain the fluid from the sensor.
6. Remove the retaining bolts in the Series 40 and Series 42, unscrew the end caps of the Series 42.
7. Remove the sleeve with a blunt instrument.
8. Thoroughly clean the body and flanges. Remove any fragments of rubber or pieces of Teflon tape. Loose fragments may clog gauges or instruments.
9. Inspect metal parts for sharp edges. Remove any sharp edges with a fine metal file or fine grinding wheel. Be sure to remove only enough metal to smooth surface.
10. Clean the new sleeve and body with a compatible fluid.
11. Install the new sleeve. Be very careful not to damage the sleeve with sharp instruments during installation.

NOTE: Series 42 sleeves maybe lubricated with petroleum jelly (Not compatible with EPDM, natural gum rubber, SBR, and Butyl at any temp. PVC and PP at elevated temp), soapy water or another compatible fluid to ease installation. Do not lubricate any other sleeves at this stage.

12. Series 40/48: Bolt the flanges of the sensor together until no gap exists between the flanges and the body. Be sure to tighten all of the bolts evenly.

NOTE: Sensors with working pressures over 5,000 psi must have the antiextrusion rings installed before the flanges are assembled.

Teflon Series 40/48: Apply a layer of sealant to both sides of the sleeve flanges. Use Dow Corning Silicone Sealant, number RTV-732-Clear, or equivalent.

Series 42: Lubricate the exposed faces of the sleeve with petroleum jelly (Not compatible with EPDM, natural gum rubber, SBR, and Butyl at any temp. PVC and PP at elevated temp), or other compatible lubricant, and screw the end caps into the body. Tighten the end caps until they are snug.

High Pressure Series 42: Be sure to install the anti-extrusion rings in sensors with 5000 PSI and greater pressure ratings. For bolted models, tighten the bolts until there is no gap between the body and the end caps. Be sure to tighten all of the bolts evenly.

13 Reinstall the gauge or instrument. Use three layers of Teflon tape on the NPT connection. For food grade applications use only approved sealants.

14. Fill sensor per the instructions below. Recommended fill fluids include: a 50/50 mix of ethylene glycol and water, distilled water, FDA approved Silicone oil (Dow Corning 200-350). Fluorolube, vegetable oil and mineral oil.

NOTE: For food grade applications use only sterile fill equipment.

STORAGE

Complete sensors and replacement sleeves should be stored in a cool, dark place. Exposure to heat, extreme cold or sunlight will damage sleeves. The sleeves also should not be exposed to electrical equipment which produces ozone, because, this will damage the sleeves. Red Valve will not be liable for parts which are improperly stored.

FILL PROCEDURES

GRAVITY FILL

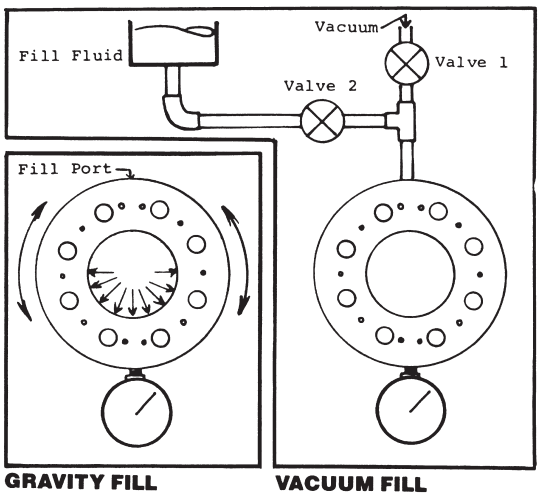
1. Turn sensor as shown in Figure or place the gauge or instrument in the bottom connection. If the sensor is still in line. If a sensor is filled while it is still in line, be sure that there is no pressure in the line.

   NOTE: Some types of pressure switches will not operate unless they are mounted upright.
2. Remove the NPT plug. It may be necessary to remove an epoxy fill covering the plug.
3. Pour fill fluid into the port until the threaded is half full.
4. Press on the inside diameter of the sleeve in several places. Bubbles should be visible in the top NPT connection, and the fluid level will decease. The sensor may also be rotated approximately 45˚ if possible, this will help to get air bubbles out of the gauge or instrument.
5. Repeat steps 3 and 4 until the fluid level in the NPT connection does not change and no bubbles appear.
6. Fill the NPT connection to within a 1/4" inch of the outside diameter of the sensor.
7. Wrap the pipe plug with three layers of Teflon tape. Insert the plug into the port and tighten.

VACUUM FILL

1. Connect the sensor to the assembly shown.
2. Close valve #2 and open valve #1.
3. Pull a 20" inch of mercury vacuum for at least 2 minutes on the sensor.
   NOTE: If a pressure snubber or pulsation dampener is used, keep the vacuum on the sensor for an additional 3 minutes.
4. Close valve #1 and open valve #2, this allows the fill fluid to be pulled into the sensor.
5. Remove the assembly and fill the NPT connection to within 1/4" inch of the outside diameter of the sensor.
6. Wrap the pipe plug with three layers of Teflon tape. Insert the plug into the port and tighten.

   If the gauge or instrument can not be installed in the bottom connection, fill the sensor as described. Then turn the instrument upside down and completely fill it with fluid. Cover the ends with Saran wrap and wrap teflon tape around the threads. Puncture the Saran wrap with a pin and install the instrument into the gauge connection.



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Limited Warranty

Red Valve Company (“Seller”) manufactured products, auxiliaries and parts thereof that we manufacture for a period of twenty-four (24) months from date of shipment from Seller’s factory, are warranted to the original purchaser only against defective workmanship and material, but only if properly stored, installed, operated, and serviced in accordance with Seller’s recommendations and instructions.

For items proven to be defective within the warranty period, your exclusive remedy under this limited warranty is repair or replacement of the defective item, at Seller’s option, FCA Incoterms 2020 Seller’s facility with removal, transportation, and installation at your cost.

Products or parts manufactured by others but furnished by Seller are not covered by this limited warranty. Seller may provide repair or replacement for other’s products or parts only to the extent provided in and honored by the original manufacturer’s warranty to Seller, in each case subject to the limitations contained in the original manufacturer’s warranty.

No claim for transportation, labor, or special or consequential damages or any other loss, cost or damage is being provided in this limited warranty. You shall be solely responsible for determining suitability for use and in no event shall Seller be liable in this respect.

This limited warranty does not warrant that any Seller product or part is resistant to corrosion, erosion, abrasion or other sources of failure, nor does Seller warrant a minimum length of service.

Your failure to give written notice to us of any alleged defect under this warranty within twenty (20) days of its discovery, or attempts by someone other than Seller or its authorized representatives to remedy the alleged defects therein, or failure to return product or parts for repair or replacement as herein provided, or failure to store, install, or operate said products and parts according to the recommendations and instructions furnished by Seller shall be a waiver by you of all rights under this limited warranty.

This limited warranty is voided by any misuse, modification, abuse or alteration of Seller’s product or part, accident, fire, flood or other Act of God, or your failure to pay entire contract price when due.

The foregoing limited warranty shall be null and void if, after shipment from our factory, the item is modified in any way or a component of another manufacturer, such as but not limited to; an actuator is attached to the item by anyone other than a Seller factory authorized service personnel.

All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous warranty, and this shall be the only effective guarantee or warranty binding on Seller, despite anything to the contrary contained in the purchase order or represented by any agent or employee of Seller in writing or otherwise, notwithstanding, including but not limited to implied warranties.

THE FOREGOING REPAIR AND REPLACEMENT LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS AND LIABILITIES, INCLUDING, BUT NOT LIMITED TO, ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR OF MERCHANTABILITY OR OTHERWISE, EXPRESSED OR IMPLIED IN FACT OR BY LAW, AND STATE SELLER’S ENTIRE AND EXCLUSIVE LIABILITY AND YOUR EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS. NEITHER ANY PERFORMANCE OR OTHER CONDUCT, NOR ANY ORAL OR WRITTEN INFORMATION, STATEMENT, OR ADVICE PREPARED BY SELLER OR ANY OF OUR EMPLOYEES OR AGENTS WILL CREATE A WARRANTY, OR IN ANY WAY INCREASE THE SCOPE OR DURATION OF THIE LIMITED WARRANTY.

Limitation of Liability

IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, PUNITIVE, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, DAMAGE TO OR LOSS OF OTHER PROPERTY OR EQUIPMENT, BUSINESS INTERUPTION, COST OF SUBSTITUTE PRODUCTS, LOSS OF TIME, LOSS PROFITS OR REVENUE, COST OF CAPITAL, LOSS OF USE, OR DIMINUTION IN VALUE) WHATSOEVER, AND SELLER’S LIABILITY, UNDER NO CIRCUMSTANCES, WILL EXCEED THE CONTRACT PRICE FOR THE GOODS AND/OR SERVICES FOR WHICH LIABILITY IS CLAIMED. ANY ACTION FOR BREACH OF CONTRACT BY YOU, OTHER THAN RIGHTS RESPECTING OUR LIMITED WARRANTY DESCRIBED ABOVE, MUST BE COMMENCED WITHIN 12 MONTHS AFTER THE DATE OF SALE.

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:

Web site: RedValve.com E-Mail: support@redvalve.com

Red Valve®

750 Holiday Drive, Suite 400, Pittsburgh, PA 15220 • Phone: 412-279-0044

Red Valve Company reserves the right to incorporate our latest design and material changes without notice or obligation. Design features, materials of construction and dimensional data, as described in this manual, are provided for your information only and should not be relied upon unless confirmed in writing by Red Valve Company. Certified drawings are available upon request.

February 2023

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Red Valve Company, Inc.

Pressure Sensor Technical Information

Sensor Fill Volumes

-Red Valve designed the Series 40 and 42 Pressure Sensors to have a minimum volume of sensing liquid in order to eliminate inaccuracy due to temperature fluctuation. This results in a higher degree of accuracy since the unit is not subject to false increased pressure readings due to thermal expansion of the sensing liquid.

Fill Liquid

50/50 mixture of Ethylene Glycol and Water
Other sensing liquids are available as follows:

- Vegetable Oil
  For food applications. + 230°F
- Silicone Oil
  DOW-200 Silicone Oil is offered for higher temperature applications. + 450°F
- Distilled Water
  Is available when Ethylene Glycol/Water mixture is considered hazardous. + 200°F

Fluid Displacement

There are various styles of pressure switches and other types of instrumentation that are bellows actuated. These gauges require a larger volume of liquid to actuate the full range of the instrument. When specifying Bellows type instrumentation, or when mounting 2 instruments on a Series 40 Sensor, please review the below chart to insure that there is enough fluid displacement in the sensor to actuate the bellows instruments, or the dual instruments.

Important! No more than two instruments can be mounted to the Series 40. Only one instrument can be mounted to the Series 42.

Fill Volume

The following is a chart indicating the fill volume for various size Pressure Sensors.

SERIES 40

SIZE (in.)	FLUID VOL. (cu. in.)	FLUID VOL. (cu. cm.)
1"	0.777	12.74
1-1/2"	0.597	9.78
2"	0.754	12.36
2-1/2"	0.912	14.95
3"	1.732	28.39
4"	2.703	44.30
5"	3.276	53.69
6"	3.924	64.32
8"	3.556	58.29
10"	5.278	86.50
12"	10.29	168.7
14"	11.96	196.0
16"	14.26	233.7
18"	16.02	262.6
20"	18.00	295.1
24"	22.04	361.3

SERIES 42

SIZE (in.)	FLUID VOL. (cu. in.)	FLUID VOL. (cu. cm.)
3/8"	0.390	6.40
1/2"	0.443	7.26
1"	0.607	9.94
1-1/2"	0.835	13.70
2"	1.603	26.30

*Above volumes do not include volume required for gauge or adjoining piping.

*Add 1/4" cu. in. displacement for gauge fill.

*Add approximately 2 cu. in. for pipe fill if additional instrumentation is specified.

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Pressure Sensor Technical Information

Filling Procedure

CAUTION: The Sensor must be removed from the pipeline or the pressure in the pipeline must be reduced to zero before performing the following procedures.

Vacuum Filling

Vacuum filling is the most desirable method of filling pressure sensors in the field.

1. Remove the sensor from the pipeline. For Series 40 and 48 install appropriate gaskets and blind flanges on each end. One blind flange must be drilled and tapped to accept a vacuum fitting. For Series 42, use a pipe plug in one end and a pipe fitting in the other end to accept the vacuum line. Use 3 wraps of Teflon tape on the NPT threads to achieve a vacuum tight seal.
2. Remove the NPT plug. Connect the sensor as shown in Figure I.
3. With valves 2 and 4 closed, open valves 1 and 3. Turn on the vacuum pump.
4. Pull a vacuum of at least 28 inches of mercury (in/HG). Hold this vacuum for a minimum of 5 minutes.
5. Close valves 1 and 3.
6. Open valve 2.
7. Open valve 4 to fill sensor. Wait 1 minute for complete filling and the pressures to equalize.
8. Close valves 2 and 4.
9. Remove the filling connection. Wrap the pipe plug with 3 turns of Teflon tape and reinstall it in the filling port of the sensor. The sensor is now filled.
10. Remove the vacuum line from the blind flange or pressure fitting. If a calibrated pressure source is available, this connection can be used to check the accuracy of the filled assembly.
11. Remove the blind flanges or pipe fittings. The sensor assembly is now ready for installation.

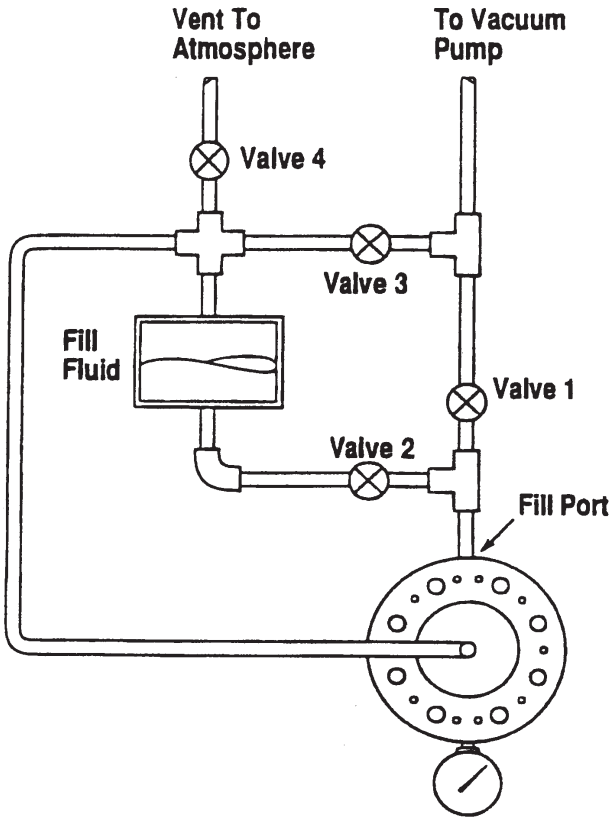

Figure 1 (Vacuum Filling)

Gravity Filling

(sensor removed from pipeline)

1. Remove the sensor from the pipeline.
2. Remove the defective gauge from the sensor.
3. Using a hypodermic syringe, fill the bourdon tube of the new gauge with sensing liquid.
4. Install the new gauge in the sensor body using 3 wraps of Teflon tape to achieve a pressure tight seal.
5. Orient the assembly with the gauge down, as shown in Figure 2.
6. Remove the NPT plug from the filling port.
7. Pour sensing liquid into the NPT filling port until the threaded hole is half full.
8. Press and release the inside diameter of the sleeve a number of times in several places to displace trapped air and dislodge bubbles. The sensor should also be rotated 45 degrees if possible during this operation.
9. Repeat steps 7 and 8 until the liquid level in the NPT filling port does not change and all bubbles are completely gone.
10. Adjust the liquid level in the NPT filling port, to be within 1/4 inch of the outside diameter of the sensor.
11. Wrap the pipe plug with 3 turns of Teflon tape. Install in the filling port and tighten. The sensor assembly is now ready for installation.

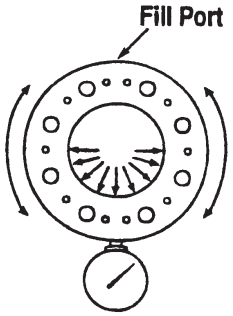

Figure 2
(Gravity Filling - Sensor Removed From Pipeline)

Gravity Filling

(sensor installed on pipeline)

1. Remove the defective gauge from the sensor. *(Figure 3)*
2. Using a hypodermic syringe, fill the bourdon tube of the new gauge with sensing liquid. Cover the end of the gauge pressure port with one layer of plastic food wrap ("Saran" wrap) and wrap the threads with 3 turns of Teflon tape.
3. Pour sensing fluid into the NPT port until the threaded hole is filled to within 1/4 inch of the sensor outside diameter.
4. Puncture the plastic wrap in the gauge pressure port with a pin or needle and install the gauge in the gauge connection of the sensor. Tighten as required. The sensor assembly is now ready for use.

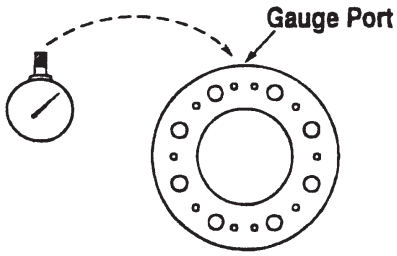

Figure 3
(Gravity Filling - Sensor Installed in Pipeline)

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

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Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

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Comments: _____

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Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C35LI3237	Loop Powered Process Indicator RIA15	Endress+Hauser	RIA15-F1B3+PC	Section 40 91 00	09-I-005
002	1	C40LI0211	Loop Powered Process Indicator RIA15	Endress+Hauser	RIA15-F1B3+PC	Section 40 91 00	09-I-005
003	1	C40LI0411	Loop Powered Process Indicator RIA15	Endress+Hauser	RIA15-F1B3+PC	Section 40 91 00	09-I-005, 4091-265
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Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71157731	Loop Powered Process Indicator RIA15 RIA15-F1B3+PC	1	PC

010	Approval:	F1	FM IS, CI. I, Div. 1, Gr. ABCD
020	Housing:	B	Field housing Alu 131x81.5x55.5mm
030	Input:	3	4-20mA current signal + HART + level, option for FMR20 + FMR20B + FMR30B + FMX21 + FMG50
620	>>Accessory Enclosed:	PC	Weather protection cover

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TI01043K/09/EN/09.24-00
71681515
2024-09-30

Technical Information
RIA15

Loop-powered Ex ia process indicator as a field device or panel-mounted instrument for 4 to 20 mA signals or HART® protocol

Application

- Display of 4 to 20 mA measured values or optionally up to four of a sensor's HART® process variables in all industries
- Use as primary or secondary HART® master
- Panel-mount housing or field housing as local display
- Scalable display value

Your benefits

- No external power supply required
- Voltage drop ≤1 V (HART® ≤1.9 V)
- 5-digit measured value display with 17 mm (0.67 in) digit height with dimension, bar graph and activatable backlight
- Minimal installation depth
- Easy 3-key operation for configuring the device
- International approvals such as ATEX, IECEx, FM, CSA, NEPSI, JPN Ex, UK-CA, UL C/US, marine approval
- SIL option for use in safety equipment according to IEC 61508 up to SIL 2

Endress+Hauser
People for Process Automation

Function and system design

Measuring principle

The RIA15 process indicator is integrated into the 4 to 20 mA or HART loop and transmits the measuring signal or HART process variables in digital form. The process indicator does not require an external power supply. It is powered directly from the current loop.

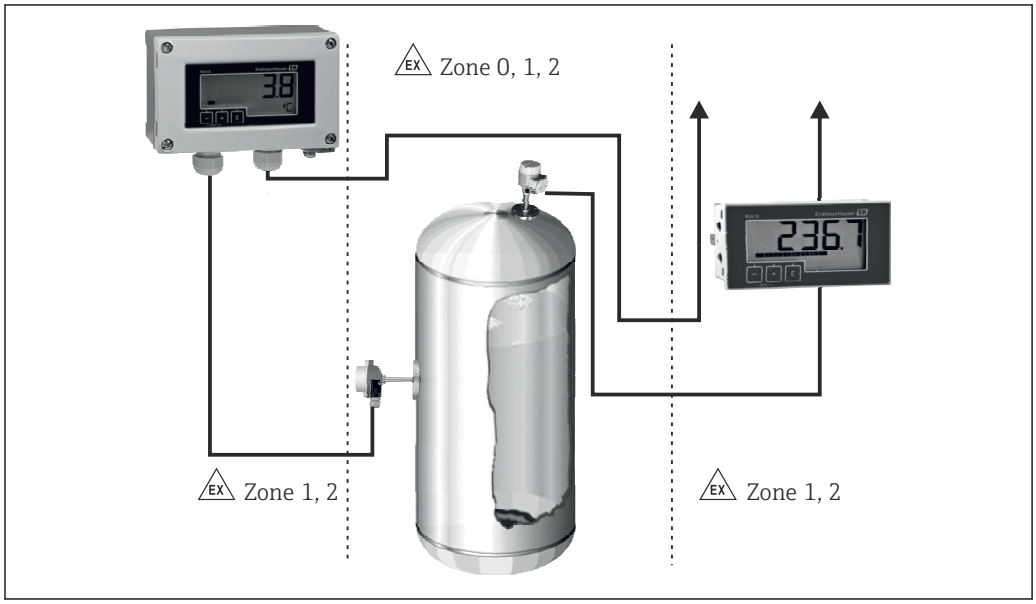
The device meets the requirements of the HART Communication Protocol Specifications and can be used with devices with HART Revision ≥ 5.0 and higher.

The LC display is easy to read even in bright sunlight and enables 5-digit, scalable measured value display. In addition to measured value display, the associated value dimension and a bar graph can be easily configured with simple 3-key operation.

The device can also be operated with backlighting where necessary. In such cases pay attention to the higher voltage drop.

For certain Endress+Hauser sensors/transmitters, the RIA15 can be used to configure the sensors in addition to displaying measured values. For this, the RIA15 must be ordered with the corresponding option "Level" or "Analysis".

Measuring system



1 RIA15 as field and panel display

Input

Voltage drop	
Standard device with 4 to 20 mA communication	≤ 1.0 V
Device with HART communication	≤ 1.9 V
Display lighting	Additional 2.9 V

HART input impedance
Rx = 40 kΩ
Cx = 2.3 nF

Measured variable

The 4 to 20 mA current signal or the HART signal is the input variable.

HART signals are not affected.

Measuring range

4 to 20 mA (scalable, reverse polarity protection)

Max. input current 200 mA

Power supply

Terminal assignment

NOTICE

SELV/Class 2 device

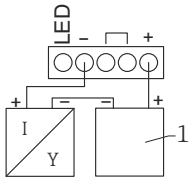
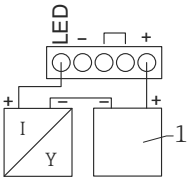
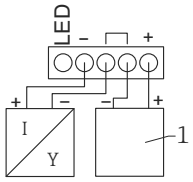
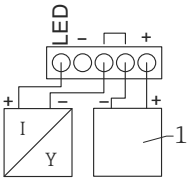
- The device may only be powered by a power unit with an energy-limited circuit in accordance with IEC 61010-1: 'SELV or Class 2 circuit'.

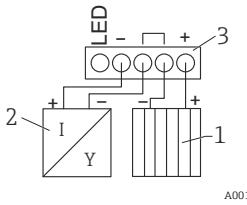
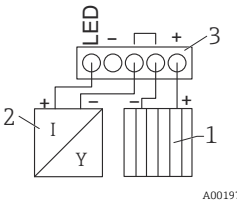
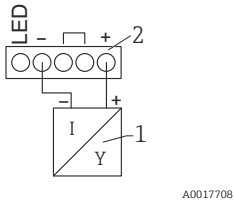
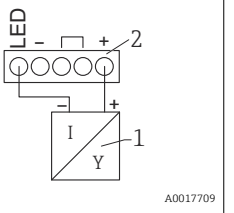
Device destroyed if current too high

- Do not operate the device at a voltage source without a current limiter. Instead, operate the device only in the current loop with a transmitter.

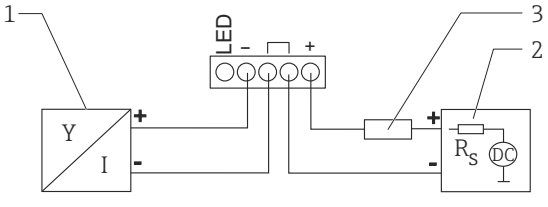
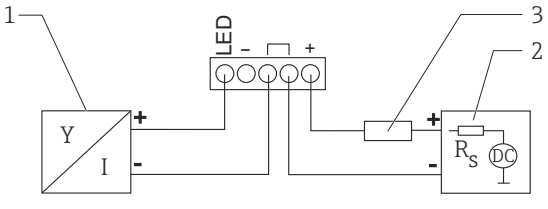
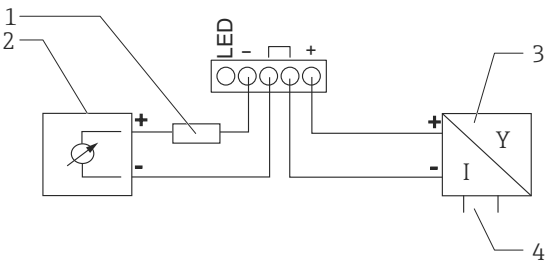
Terminal	Description
+	Positive connection, current measurement
-	Negative connection, current measurement (without backlighting)
LED	Negative connection, current measurement (with backlighting)
⌐¬	Auxiliary terminals (electrically connected internally)
⏚	Functional grounding: ▪ Panel-mounted device: Terminal on the rear of the housing ▪ Field device: Terminal in the housing

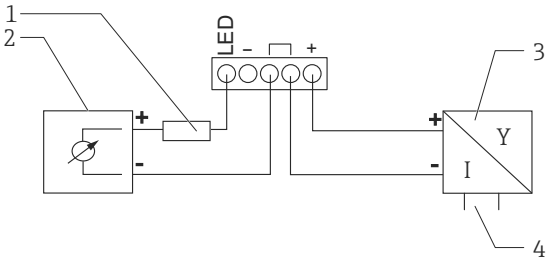
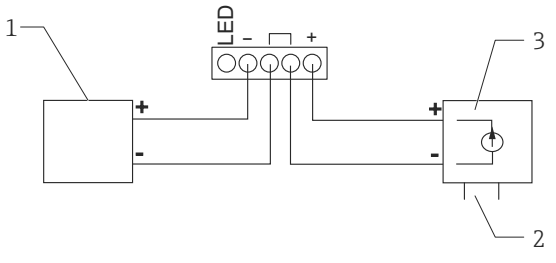
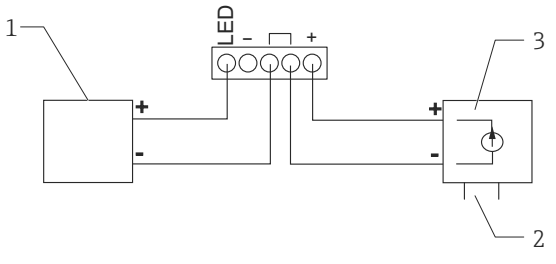
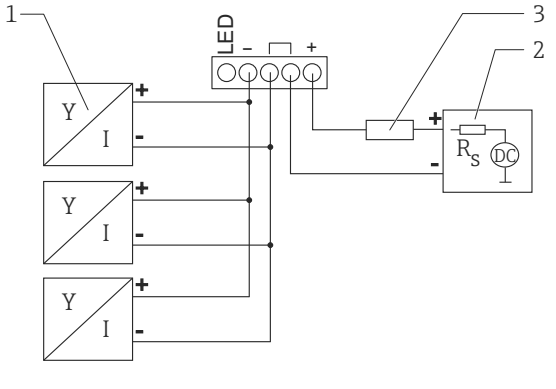
4 to 20 mA connection

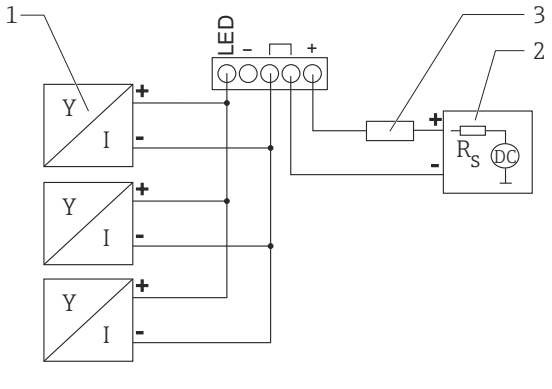
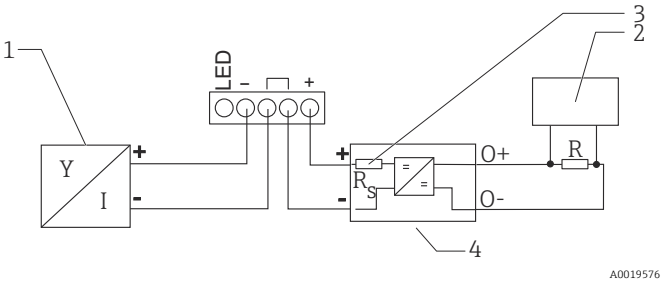
	Connection without backlighting	Connection with backlighting
Connection with transmitter power supply and transmitter	 A0017704 *1 Transmitter power supply*	 A0017705 *1 Transmitter power supply*
Connection with transmitter power supply and transmitter using the auxiliary terminal	 A0017706 *1 Transmitter power supply*	 A0017707 *1 Transmitter power supply*

	Connection without backlighting	Connection with backlighting
Connection with PLC and transmitter	 *1 PLC* *2 Transmitter* *3 RIA15*	 *1 PLC* *2 Transmitter* *3 RIA15*
Connection without transmitter power supply directly in the 4 to 20 mA circuit	 *1 4 to 20 mA power source* *2 RIA15*	 *1 4 to 20 mA power source* *2 RIA15*

HART connection

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 *1 Sensor* *2 Power supply* *3 Additional 230 to 600 Ω HART resistor inserted*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 *1 Sensor* *2 Power supply* *3 Additional 230 to 600 Ω HART resistor inserted*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 *1 HART resistor* *2 Current meter* *3 Sensor* *4 Power supply*

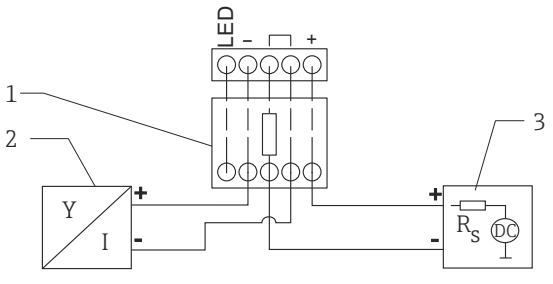
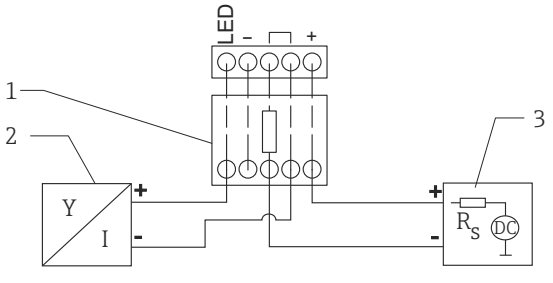
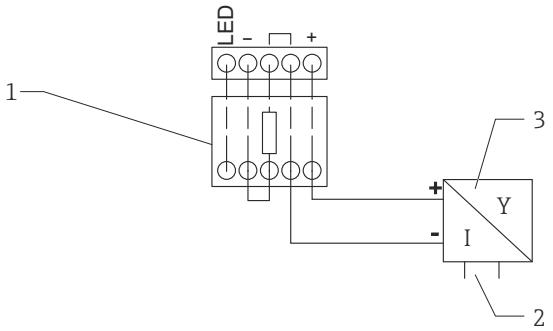
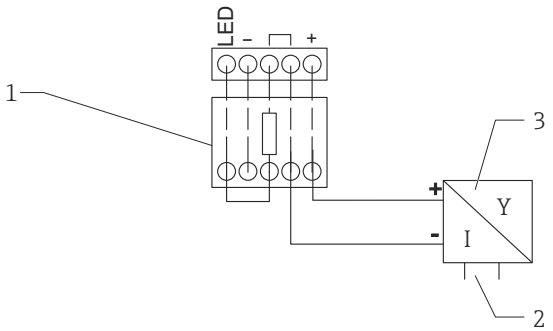
	Circuit diagram / Description
4-wire sensor with process indicator and transmitter power supply, with backlighting	 *1 HART resistor* *2 Current meter* *3 Sensor* *4 Power supply*
Current output with process indicator and actuator (e.g. actuator valve), without backlighting	 *1 Actuator* *2 Power supply* *3 Current output*
Current output with process indicator and actuator (e.g. actuator valve), with backlighting	 *1 Actuator* *2 Power supply* *3 Current output*
Multidrop 2-wire sensors with process indicator and transmitter power supply	 *1 Sensors* *2 Power supply* *3 HART resistor*

	Circuit diagram / Description
Multidrop 2-wire sensors with process indicator and transmitter power supply, with backlighting	 *1 Sensors* *2 Power supply* *3 HART resistor*
2-wire sensor with process indicator and active barrier (e.g. Endress+Hauser RN series) as transmitter power supply	 *1 Sensor* *2 HART primary master* *3 HART resistor* *4 Active barrier*

The 230 Ω HART communication resistor in the signal line is always necessary in the case of a low-impedance power supply. It must be installed between the power supply and the indicator.

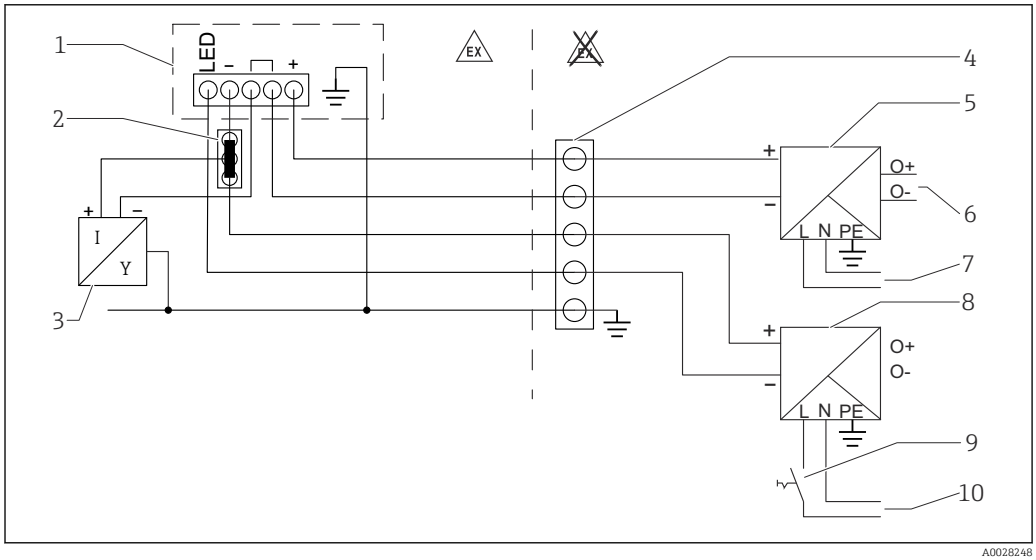
A HART communication resistance module is available as an accessory .

Connection with optional HART communication resistance module

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020839 *1 HART communication resistance module* *2 Sensor* *3 Power supply*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020840 *1 HART communication resistance module* *2 Sensor* *3 Power supply*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020837 *1 HART communication resistance module* *2 Power supply 4-wire device* *3 Sensor*
4-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020838 *1 HART communication resistance module* *2 Power supply 4-wire device* *3 Sensor*

Wiring with switchable backlighting

An additional current-limited power source (e.g. active barrier from the Endress+Hauser RN product family) is required to implement switchable backlighting. This power source is used to supply the LED backlighting of up to seven RIA15 process indicators without generating an additional voltage drop in the measuring loop. The backlighting can be switched on and off using an external switch.



A0028248

1 *RIA15 process indicator*
2 *3-wire connector, e.g. WAGO 221 series*
3 *2-wire sensor*
4 *Terminal block on DIN rail*
5 *Active barrier (e.g. Endress+Hauser RN series)*
6 *4 to 20 mA output to the control unit*
7 *Power supply*
8 *Power source (e.g. Endress+Hauser RN series)*
9 *Switch to activate backlighting*
10 *Power supply*

Supply voltage

NOTICE

SELV/Class 2 device

- The device may be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1 Paragraph 9.4 or Class 2 as per UL 1310: 'SELV or Class 2 circuit'.

The process indicator is loop-powered and does not require any external power supply. The voltage drop is ≤1 V in the standard version with 4 to 20 mA communication, ≤1.9 V with HART communication and an additional 2.9 V if display lighting is used.

Performance characteristics

Reference operating conditions

Reference temperature 25 °C ±5 °C (77 °F ±9 °F)

Humidity 20 to 60 % relative humidity

Maximum measured error

Input	Range	Measured error of measuring range
Current	4 to 20 mA Over range up to 22 mA	±0.1 %

Resolution

Signal resolution > 13 bit

Influence of ambient temperature

< 0.02 %/K (0.01 %/°F) of measuring range

Warm-up period	10 minutes

Installation

Mounting location	**Panel housing** The device is designed for use in a panel. Required panel cutout 45x92 mm (1.77x3.62 in) **Field housing** The field housing version is designed for use in the field. The unit is mounted directly on a wall, or on a pipe with a diameter of up to 2 " with the aid of an optional mounting bracket. An optional weather protection cover protects the device from the effects of weather conditions.
Orientation	**Panel housing** The orientation is horizontal. **Field housing** The device must be mounted in such a way that the cable entries point downwards.

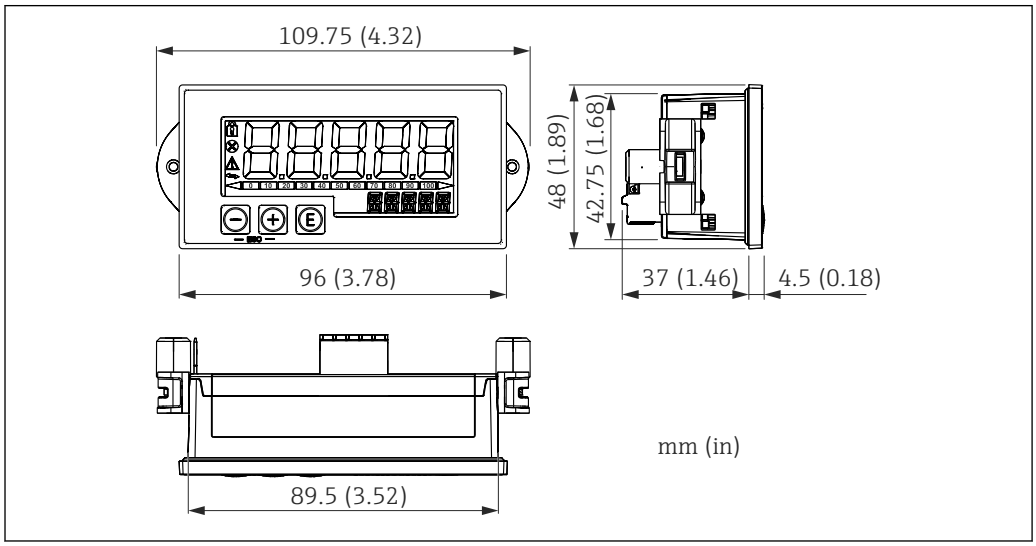
Environment

Ambient temperature range	–40 to 60 °C (–40 to 140 °F) At temperatures below –25 °C (–13 °F) the readability of the display can no longer be guaranteed.
Storage temperature	–40 to 85 °C (–40 to 185 °F)
Climate class	IEC 60654-1, Class B2
Operating altitude	Up to 5 000 m (16 400 ft) above MSL in accordance with IEC61010-1
Degree of protection	**Panel housing** IP65 at front, IP20 at rear **Field housing** Aluminum housing: degree of protection IP66/67, NEMA 4x Plastic housing: degree of protection IP66/67
Electromagnetic compatibility	▪ Interference immunity: As per IEC61326 (Industrial Environments) / NAMUR NE 21 Maximum measured error < 1 % o. MR ▪ Interference emission: As per IEC61326, Class B
Electrical safety	Class III, overvoltage protection category II, pollution degree 2

Mechanical construction

Design, dimensions

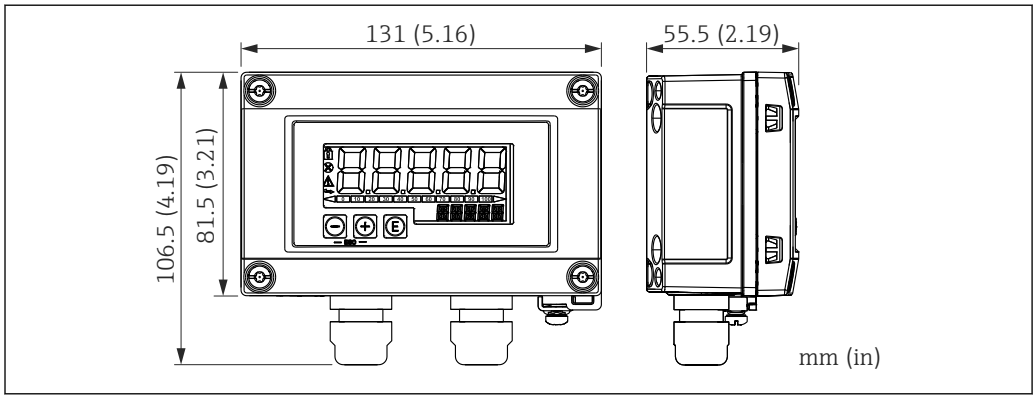
Panel-mount housing



2 Dimensions of the panel housing

Required panel cutout 45x92 mm (1.77x3.62 in), max. panel thickness 13 mm (0.51 in).

Field housing



3 Dimensions of the field housing incl. cable entries (M16)

Weight

Panel-mount housing

115 g (0.25 lb.)

Field housing

- Aluminum: 520 g (1.15 lb)
- Plastic: 300 g (0.66 lb)

Materials

Panel-mount housing

Front: aluminum

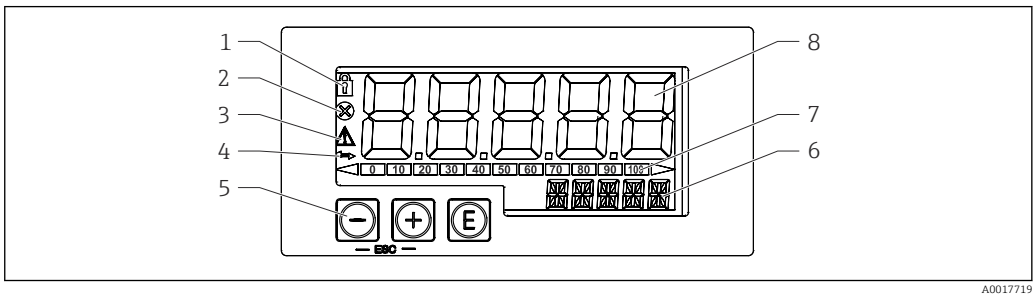
Rear panel: polycarbonate PC

Field housing

Aluminum or plastic (PBT with steel fibers, antistatic)

Operability

On-site operation



4 *Display and operating elements of the process indicator*

1 *Symbol: operating menu disabled*
2 *Symbol: error*
3 *Symbol: warning*
4 *Symbol: communication active (only for HART option)*
5 *Operating keys "-", "+", "E"*
6 *14-segment display for unit/TAG*
7 *Bar graph with indicators for under range and over range*
8 *5-digit 7-segment display for measured value, digit height 17 mm (0.67 in), display range -19999 to 99999*

The device is operated with the 3 operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

A0017716	Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu
A0017714	Selecting and setting values in the operating menu; pressing the - and + keys simultaneously takes the user back up a menu level. The configured value is not saved (ESC)
A0017715	

RIA15 in conjunction with the Micropilot FMR20/ FMR20B/FMR30B

The RIA15 can be used for the basic commissioning of the Micropilot.

The following settings can be made for the Micropilot via the 3 operating keys on the front of the RIA15:
- Units
- Empty and full calibration
- Mapping

The following order options are available to be able to use this function:
- FMR20 product structure, feature 620 "Accessory enclosed":
  Option R4: "Remote display RIA15, non-hazardous"
  Option R5: "Remote display RIA15, hazardous"
- Product structure, FMR20B and FMR30B, feature 620 "Accessory enclosed":
  Option R1: "Remote display RIA15, non-hazardous"
  Option R2: "Remote display RIA15, hazardous"
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level"

RIA15 in conjunction with the Waterpilot FMX21

The RIA15 can be used for the basic commissioning of the Waterpilot FMX21 hydrostatic level sensor.

The following settings can be made for the FMX21 via the 3 operating keys on the front of the RIA15:
- Pressure unit
- Level unit
- Temperature unit
- Zero adjustment (only for gauge pressure measuring cells)

- Empty and full pressure adjustment
- Empty and full level calibration
- Reset to factory defaults

The following order options are available to be able to use this function:
- FMX21 product structure, feature 620 "Accessory enclosed":
  Option R4: "Remote display RIA15, non-hazardous"
  Option R5: "Remote display RIA15, hazardous"
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level"
- RIA15 product structure, feature 620 "Accessory enclosed":
  Option PF: "1 x cable gland M16 with pressure compensation membrane for FMX21"

RIA15 in conjunction with the Gammapilot FMG50

The RIA15 can be used for the basic commissioning of the Gammapilot FMG50 transmitter.

The following settings can be made for the FMG50 via the 3 operating keys on the front of the RIA15:
- Basic configuration of the "Level" operating mode (continuous level measurement)
- Basic configuration of the "Point Level" operating mode (point level measurement)
- Basic configuration of the "Density" operating mode (density measurement)

The following order options are available to be able to use this function:
- Product structure FMG50, feature 620 "Accessory enclosed":
  Option PE: "Remote display RIA15, non-hazardous"
  Option PF: "Remote display RIA15, hazardous"
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level ... FMG50"

RIA15 in conjunction with the Proservo NMS8x servo tank gauging device

The RIA15 can be used for the basic commissioning of the Proservo NMS80, NMS81 and NMS83 servo tank gauging devices.

The following settings can be made for the NMS8x via the 3 operating keys on the front of the RIA15:
- Measurement command
- Measurement status
- Balance status

The following order options are available to be able to use this function:
- Product structure NMS8x, feature 620 "Accessory enclosed":
  Option R5 "RIA15, aluminum, no cable"
- RIA15 product structure, feature 030 "Input":
  Option 5: "4 to 20 mA current signal + HART + level ... NMS8x"

RIA15 in conjunction with the Liquiline CM82

The RIA15 can be used for the basic commissioning of the Liquiline CM82 transmitter.

The following settings can be made for the CM82 via the 3 operating keys on the front of the RIA15:
- Units for the connected sensor
- Current output range
- Diagnostic information

The following order options are available to be able to use this function:
- CM82 product structure, feature 620 "Accessory enclosed":
  Option R4: "Remote display RIA15, non-hazardous"
  Option R5: "Remote display RIA15, hazardous"
- RIA15 product structure, feature 030 "Input":
  Option 4: "4 to 20 mA current signal + HART + analysis"

Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

Ordering information

Detailed ordering information is available from your nearest sales organization www.addresses.endress.com or in the Product Configurator at www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Configuration**.

Product Configurator - the tool for individual product configuration

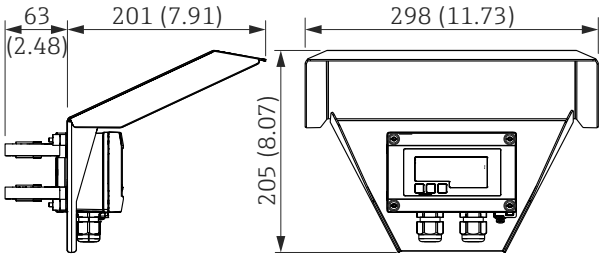
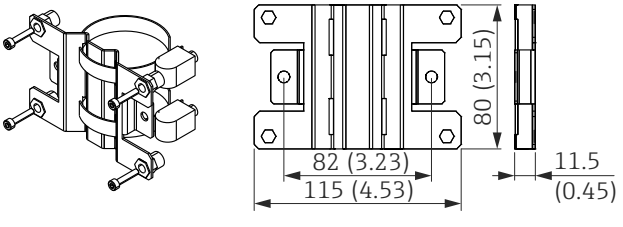
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

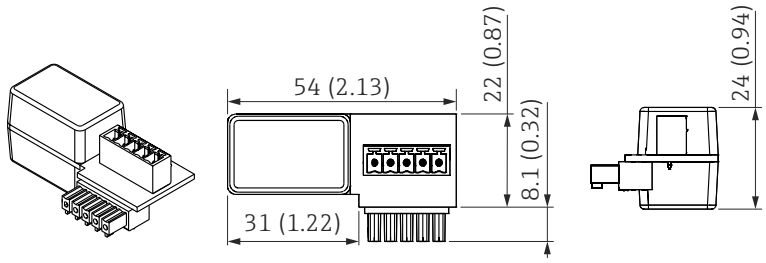
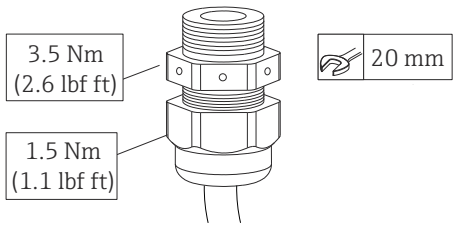
Accessories

The accessories currently available for the product can be selected at www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Spare parts & Accessories**.

Device-specific accessories

Weather protection cover	 *5 Dimensions of protective cover, engineering unit mm (in)*
Mounting kit for wall/ pipe mounting Material: SS 316L	 *6 Dimensions of mounting bracket, engineering unit mm (in)*

HART® communication resistance module	 7 *Dimensions of communication resistance module, engineering unit mm (in)*
M16 cable gland with integrated pressure compensation membrane	

Online tools

Product information over the entire life cycle of the device: www.endress.com/onlinetools

System components

RN series active barrier

Single- or two-channel active barrier for safe separation of 0/4 to 20 mA standard signal circuits with bidirectional HART transmission. In the signal duplicator option, the input signal is transmitted to two galvanically isolated outputs. The device has one active and one passive current input; the outputs can be operated actively or passively.

For more information, please refer to: www.endress.com

Documentation

The following types of documentation are available on the product pages and in the Download Area of the Endress+Hauser website (www.endress.com/downloads) (depending on the selected device version):

Document	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.
Operating Instructions (BA)	**Your reference document** These Operating Instructions contain all the information that is required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning, through to troubleshooting, maintenance and disposal.
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.

Document	Purpose and content of the document
Safety instructions (XA)	Safety Instructions (XA) are supplied with the device, depending on the approval. These are an integral part of the Operating Instructions. The nameplate indicates which Safety Instructions (XA) apply to the device.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.

www.addresses.endress.com

Endress+Hauser

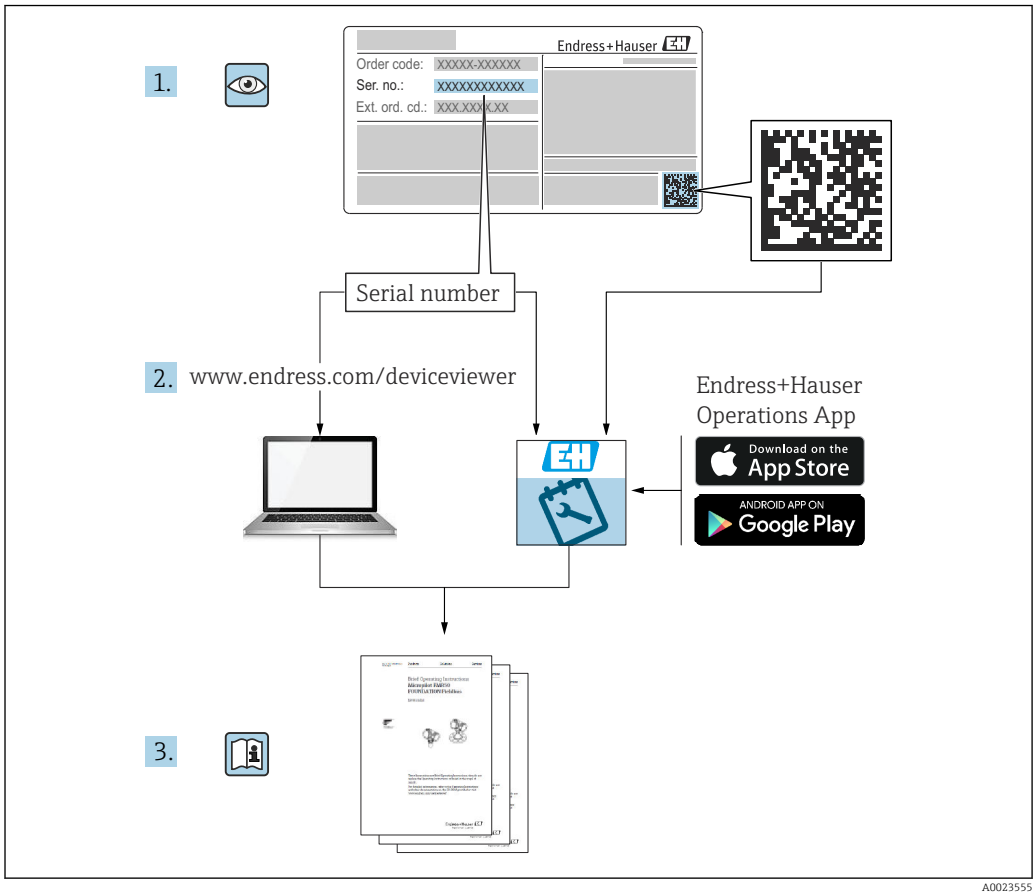
People for Process Automation

FY01098K/09/EN/02.24-00
71663787
2024-05-31

Functional Safety Manual
RIA15 process indicator

Loop-powered Ex ia process indicator as a field device or panel-mounted instrument for 4 to 20 mA signals or HART® protocol

Endress+Hauser
People for Process Automation


1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XXX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
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1 Manufacturer's declaration

SIL_00514_01.23

Endress+Hauser
People for Process Automation

Herstellererklärung - Manufacturer Declaration
Funktionale Sicherheit - Functional Safety (IEC 61508:2010)
Beiblatt 1 / NE130 Formblatt B1 – Supplement 1 / NE130 From B.1

Endress+Hauser Wetzer GmbH+Co. KG Obere Wank 1, 87484 Nesselwang

erklärt als Hersteller, dass der folgende schleifengespeister Anzeiger für 4 ... 20 mA ,
oder 4 ... 20 mA mit HART® Kommunikation
declares as manufacturer, that the following loop-powered process indicator for 4 to 20mA
or 4 to 20mA with HART® communication

RIA15-SIL

in sicherheitsrelevanten Anwendungen SIL2 (HFT=0) nach IEC61508:2010 eingesetzt werden kann.
is suitable for use in saftey relevant applications up to SIL2 (HFT=0) according to IEC 61508:2010.

Für einen Einsatz in sicherheitsrelevanten Anwendungen entsprechend IEC 61508 sind die Angaben des Handbuchs zur Funktionalen Sicherheit zu beachten.
In safety relevant applications according to IEC 61508, the instructions of the Safety Manual have to be followed.

Nesselwang, 14.09.2023
Endress+Hauser Wetzer GmbH+Co. KG

ppa. Harald Müller
Director Technology

i.V. Robert Zeller
Head of Department R&D-Components

1/3

A0054143

1.1 Safety-related characteristic values

SIL_00514_01.23

Endress+Hauser
People for Process Automation

Allgemein			
Gerätebezeichnung und zulässige Ausführungen	RIA15 (Bestellmerkmal "Weitere Zulassungen": Option LA "SIL")		
Sicherheitsbezogene Ausgangssignale	4...20mA		
Fehlerstrom	≤ 3,6 mA oder ≥ 21,0 mA		
Bewertete Messgröße / Funktion	Messwert Anzeige		
Sicherheitsfunktion(en)	weiterleiten des Messsignals		
Gerätetyp gem. IEC 61508-2	☑ Typ A	☐ Typ B	
Betriebsart	☑ Low Demand Mode	☑ High Demand	☐ Continuous Mode
Gültige Hardware-Version	V01.00 oder höher		
Gültige Firmware-Version	n/a		
Sicherheitshandbuch	FY01098K/09		
Art der Bewertung (nur eine Variante wählbar)	☐	Vollständige entwicklungsbegleitende HW/SW Bewertung inkl. FMEDA und Änderungsprozess nach IEC 61508-2, 3	
	☐	Bewertung über Nachweis der Betriebsbewährung HW/SW inkl. FMEDA und Änderungsprozess nach IEC 61508-2, 3	
	☐	Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendung" gem. IEC 61511	
	☑	Bewertung durch FMEDA gem. IEC 61508-2 für Geräte ohne Software	
Bewertung durch / Zertifikatsnummer	Internes Assessment		
Prüfungsunterlagen	Entwicklungsdokumente, Testreports, Datenblätter		

SIL - Integrität			
Systematische Sicherheitsintegrität		☑ SC 2 fähig	☐ SC 3 fähig
Hardware Sicherheitsintegrität	Einkanaliger Einsatz (HFT = 0)	☑ SIL 2 fähig	☐ SIL 3 fähig
	Mehrkanaliger Einsatz (HFT ≥ 1)	☑ SIL 2 fähig	☐ SIL 3 fähig

FMEDA	RIA15
Sicherheitsfunktion(en)	weiterleiten des Messsignals
λ_{DU} [1),2)]	10 FIT
λ_{DD} [1),2)]	0 FIT
λ_S [1),2)]	21 FIT
SFF - Safe Failure Fraction	68%
PFD_{avg} für T1 = 1 Jahr [2)] (einkanalige Architektur)	$4.4 \cdot 10^{-5}$
PFD_{avg} für T1 = 5 Jahre [2)] (einkanalige Architektur)	$2.2 \cdot 10^{-4}$
PFH	$1.0 \cdot 10^{-8} \cdot 1/h$
PTC [3)]	99 %
Fehlerreaktionszeit [4)]	n/a
Diagnose-Testintervall [5)]	n/a
Prozesssicherheitszeit [6)]	n/a
MTTF [7)]	414 years

Erklärung	
☑	Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden sicherheitsrelevanten systematischen Fehlern sicher.

[1)] FIT = Failure In Time, Anzahl der Ausfälle pro 10^9 h
[2)] Gültig für gemittelte Umgebungstemperaturen bis zu +40 °C (+104 °F)
Bei einer durchschnittlichen Dauereinsatztemperatur nahe +60 °C (+140 °F) sollte ein Faktor von 2,1 berücksichtigt werden
[3)] PTC = Proof Test Coverage (Diagnoseaufdeckungsgrad von Gerätefehlern bei manueller Wiederholungsprüfung)
[4)] Maximale Zeit zwischen Fehlererkennung und Fehlerreaktion
[5)] In dieser Zeit werden alle online Diagnosefunktionen mindestens 1x ausgeführt (32 min inkl. Speichertest)
[6)] Die Prozesssicherheitszeit beträgt: Diagnose-Testintervall x 100 (Berechnung nach IEC 61508)
[7)] MTTF (Mean Time To Failure) Dieser Wert berücksichtigt alle Ausfallarten der Elektronikkomponenten gemäß Siemens SN29500

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General				
Device designation and permissible types	RIA15 (Order code for "Additional approval": Option LA "SIL")			
Safety-related output signal	4...20mA			
Fault current	≤ 3,6 mA or ≥ 21,0 mA			
Process variable/function	measurement indication			
Safety function(s)	forwarding the measurement signal			
Device type acc. to IEC 61508-2	☑ Type A	☐ Type B		
Operating mode	☑ Low Demand Mode	☑ High Demand	☐ Continuous Mode	
Valid Hardware-Version	01.00 or higher			
Valid Software-Version	n/a			
Safety manual	FY01098K/09			
Type of evaluation (check only one box)	☐ Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3			
	☐ Evaluation of "Proven-in-use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3			
	☐ Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511			
	☑ Evaluation by FMEDA acc. to IEC61508-2 for devices w/o software			
Evaluation through / certificate no.	internal assessment			
Test documents	development documents, test reports, data sheets			
SIL - Integrity				
Systematic safety integrity		☑ SIL 2 capable	☐ SIL 3 capable	
Hardware safety integrity	Single channel use (HFT = 0)	☑ SIL 2 capable	☐ SIL 3 capable	
	Multi-channel use (HFT ≥ 1)	☑ SIL 2 capable	☐ SIL 3 capable	

FMEDA	RIA15
Safety function	forwarding the measurement signal
λ_{DU} [1) 2)]	10 FIT
λ_{DD} [1) 2)]	0 FIT
λ_S [1) 2)]	21 FIT
SFF - Safe Failure Fraction	68%
PFD_{avg} T1 = 1 year [2)]	$4.4 \cdot 10^{-5}$
PFD_{avg} T1 = 5 years [2)]	$2.2 \cdot 10^{-4}$
PFH	$1.0 \cdot 10^{-8}$ 1/h
PTC [3)]	99 %
Fault reaction time [4)]	n/a
Diagnostic test interval [5)]	n/a
Process safety time [6)]	n/a
MTTF [7)]	414 years

Declaration	
☑	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future

1) FIT = Failure In Time, Number of failures per 10^9 h
2) Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2 should be applied
3) PTC = Proof Test Coverage
4) Maximum time between error recognition and error response
5) All online diagnostic functions are performed at least once within the Diagnostic test interval (32 min incl. memory test)
6) The Process safety time is: Diagnostic test interval x 100 (calculated acc. to IEC 61508)
7) MTTF (Mean Time To Failure) is the predicted elapsed time between inherent failures of a system during operation in accordance to Siemens SN29500

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2 About this document

2.1 Document function

This Safety Manual applies in addition to the Operating Instructions, Technical Information and Ex-specific Safety Instructions. The supplementary device documentation

must be observed during installation, commissioning and operation. The requirements specific to the protection function are described in this Safety Manual.

General information on functional safety (SIL) is available at:
www.endress.com/SIL

2.2 Symbols used

2.2.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

2.2.2 Symbols for certain types of information and graphics

Tip
Indicates additional information

Reference to documentation

Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps

Result of a step

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

2.3 Supplementary device documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following document types are available in the download area of the Endress+Hauser website (www.endress.com/downloads):

2.3.1 Further applicable documents

Technical Information (TI)

Planning aid
The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

Brief Operating Instructions (KA)

Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Operating Instructions (BA)

Your reference guide
These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Functional Safety Manual (FY)

Depending on the SIL approval, the Functional Safety Manual (FY) is an integral part of the Operating Instructions and applies in addition to the Operating Instructions, Technical Information and ATEX Safety Instructions.

The different requirements that apply for the protective function are described in the Functional Safety Manual (FY).

3 Design

3.1 Permitted devices types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified firmware version.

Unless otherwise specified, all subsequent versions can also be used for safety functions.

A modification process according to IEC 61508 is applied for any device modifications.

Any exemptions from possible combinations of features are saved in the Endress +Hauser ordering system.

Valid device versions for safety-related use:

3.1.1 Ordering features

RIA15-

Feature: 010 "Approval"
Version: all

Feature: 020 "Housing"
Version: all

Feature: 030 "Input"
Version: all

Feature: 550 "Calibration"
Version: all

Feature: 570 "Service"
Version: all

Feature: 580 "Test, Certificate"
Version: all

Feature: 590 "Additional Approval"
Version: LA
Version **"LA"** must be selected for use as a safety function as per IEC 61508. All other versions are permitted in addition to **"LA"**.

Feature: 610 "Accessory Mounted"
Version: all

Feature: 620 "Accessory Enclosed"
Version: all

Feature: 895 "Marking"
Version: all

3.2 Identification marking

SIL-certified devices are marked with the SIL logo on the nameplate.

3.3 Safety function

The device's safety function is:
Transmit the measuring signal without distortion

3.3.1 Safety-related measuring signal

The safety-related measuring signal is the 4 to 20 mA signal (NE 43), which is transmitted without distortion.

The display function (current signal/HART communication) of the device is **not** part of the safety function.

NOTICE

In an alarm condition

- Ensure that the equipment under control achieves or maintains a safe state.

3.4 Basic conditions for use in safety-related applications

The measuring system must be used correctly for the specific application, taking into account the installation and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The

application-specific limits must be observed. The specifications in the Operating Instructions and the Technical Information must not be exceeded.

3.4.1 Safety-related failures according to IEC/EN 61508

No device error
- No failure
- No effect on the safety-related measuring signal

λS (Safe)
- Safe failure
- No effect on the safety-related measuring signal:

λ_{DD} (Dangerous detected)
- Dangerous failure which can be detected
- Affects the safety-related measuring signal: low alarm or high alarm

λ_{DU} (Dangerous undetected)
- Dangerous failure which cannot be detected
- Affects the safety-related measuring signal: can distort the measuring signal

3.4.2 Restrictions for safety-related use

- The 0 to 20 mA transmission range must not be used in safety-related applications.
- Take the voltage drop at the RIA15 into account when supplying the current loop. See BA, TI, KA.
- If there is no low voltage detection in the current loop, a voltage drop of at least 3 V at the RIA15 without backlight function must be taken into account when designing the current loop.

3.5 Dangerous undetected failures in this scenario

An incorrect measuring signal that deviates from the value specified in this manual, but is still in the range of 4 to 20 mA, is considered a "dangerous, undetected failure".

3.6 Useful lifetime of electrical components

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2:2010 section 7.4.9.5 note 3.

In accordance with DIN EN 61508-2:2011 section 7.4.9.5, national footnote N3, appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

This device does not contain any electronic components as per the "EMCRH Electrical & Mechanical Component Reliability Handbook" Third Edition (exida.com) that have a useful lifetime less than 50 years.

However, the useful lifetime can be significantly shorter if the device is operated at higher temperatures.

4 Commissioning (installation and configuration)

4.1 Requirements for personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Personnel must be authorized by the plant owner/operator.
- Be familiar with federal/national regulations.
- Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:

- Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Personnel follow the instructions in this manual.

4.2 Installation

The mounting and wiring of the device and the permitted orientations are described in the Operating Instructions pertaining to the device.

Correct installation is a prerequisite for safe operation of the device.

4.3 Commissioning

The commissioning of the device is described in the Operating Instructions pertaining to the device.

Before operating the device in a safety instrumented system, perform a verification using a test sequence → 12.

4.4 Operation

The operation of the device is described in the Operating Instructions pertaining to the device.

4.5 Device configuration for safety-related applications

4.5.1 Configuration of the measured value display

Refer to the Operating Instructions for information on configuration. The settings do not have a modifying effect and do not affect the current signal. The additional voltage drop in the current loop must be taken into account when switching to HART® communication.

4.5.2 Device protection

The device must be protected (to lock operation).

5 Operation

5.1 Device behavior when switched on

The measured value is displayed when current flows in the range of 4 to 20 mA.

5.2 Safe states

Safe state/measuring signal:

- Measured value not distorted
- I ≤ 3.6 mA (Low alarm)
- I ≥ 21 mA (High alarm)

6 Proof testing

NOTICE

- ▶ The functional integrity of the device must be verified during commissioning, in the event of changes and at appropriate intervals. The time intervals must be specified by the operator.

⚠ CAUTION

The safety function is not guaranteed during a proof test

Suitable measures must be taken to guarantee process safety during the test.

- ▶ The safety-related output signal 4 to 20 mA must not be used for the safety instrumented system during testing.
- ▶ A completed test must be documented; the template provided in the Appendix can be used for this purpose. (See Section 8.2)
- ▶ The operator specifies the test interval and this must be taken into account when determining the probability of failure PFD_{avg} of the sensor system.

If no operator-specific proof-testing requirements have been defined, the following is a possible alternative for testing the device. The individual proof test coverages (PTC) that can be used for calculation are specified for the test sequences described below.

NOTICE

- ▶ If there is a fault in the current loop before testing starts, the cause of the fault must be first eliminated.

Proof testing and optimization of subsystems

The NAMUR worksheet NA106 "Flexible proof testing of field devices in safety instrumented systems" describes how the test activities can be optimized for safety instrumented systems with regard to interruptions in operation while maintaining the required safety integrity of the installed PCS safety instrumented systems.

Proof testing of the device can be performed as follows:
Test sequence: Verification of the measurement accuracy in the range of 4 to 20 mA

Note the following for the test sequences:

- The device must be checked in the closed current loop with the measuring instruments installed.
- The accuracy of the measuring instrument used must meet the required accuracy of the application.

6.1 Test sequence

Preparation

1. Device identification:
Check device tag, device name, serial number and hardware version

2. Visual inspection:
- Wiring
- Housing/housing cover
- Mechanical and electrical installation

Proof test procedure

1. Simulation of a high alarm (≥ 21 mA) in the current loop.

2. Check the accuracy of the measuring signal in the current loop using appropriate measuring equipment, e.g. read out the measured value at the safety control.

3. A deviation in the measuring signal from the expected accuracy means that the device has failed the proof test.

This test detects 99 % of dangerous, undetected failures (proof test coverage, PTC = 0.99). If these three points are covered by the test sequence of the sensor used, the check can be carried out in combination with the sensor.

6.2 Verification criterion

If the test criteria from the test sequence described above is not satisfied, the device may no longer be used as part of a safety instrumented system.
- The purpose of proof-testing is to detect dangerous undetected device failures (λ_{DU}).
- The impact of systematic failures on the safety function is not covered by this test and must be assessed separately.
- Systematic faults can be caused by operating conditions and the installation, for example.

7 Repair and error handling

7.1 Maintenance

Alternative monitoring measures must be taken to ensure process safety during configuration, proof testing and maintenance work on the device.

7.2 Repair

Repair means restoring functional integrity by replacing defective components.

Only original Endress+Hauser spare parts may be used for this purpose.

Document the repair with the following information:
- Serial number of the device
- Date of the repair
- Type of repair
- Person who performed the repair

Components may be repaired/replaced by the customer's technical staff if **original Endress+Hauser spare parts** are used (they can be ordered by the end user), and if the relevant installation instructions are followed.

A proof test must always be performed after every repair.

Installation Instructions are supplied with the original spare part and can also be accessed in the Download Area at www.endress.com

Send in replaced components to Endress+Hauser for fault analysis.

When returning the defective component, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in a safety instrumented system".

Information on returns: http://www.endress.com/support/return-material

7.3 Modification

Modifications are changes to SIL devices that are already delivered or installed:
- **Modifications to SIL devices by the user are not permitted because they can impair the functional safety of the device**
- Modifications to SIL devices may be performed onsite at the user's plant following approval by the Endress+Hauser manufacturing center
- Modifications to SIL devices must be performed by personnel authorized to do so by Endress+Hauser
- Only **original spare parts** from Endress+Hauser may be used for modifications
- All modifications must be documented in the Endress+Hauser Device Viewer (www.endress.com/deviceviewer)
- All modifications require a change nameplate or replacement of the original nameplate.

7.4 Decommissioning

When decommissioning, the requirements according to IEC 61508-1:2010 section 7.17 must be observed.

7.5 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

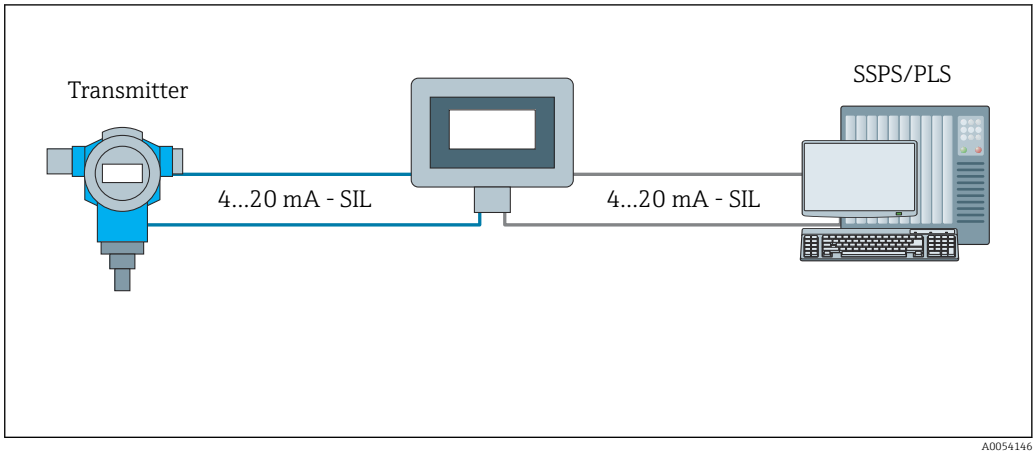
8 Appendix

8.1 Structure of the measuring system

The RIA15 loop-powered indicator is used to display a measuring signal proportional to the current signal of a 4 to 20 mA current loop or alternatively to display a measured value scanned via HART® communication.

The display function (current signal/HART® communication) of the device is not part of the safety function.

The safety-related measuring signal is the 4 to 20 mA signal (NE 43), which is transmitted without distortion.



8.2 Commissioning or proof test report

8.2.1 Test report – Page 1

Company/contact person	/
Tester	

Device information	
Plant	Measuring point/TAG no.:
Device type/Order code	
Serial number	Hardware version

Verification information
Date/time
Performed by

Verification result		
Overall result	☐ Passed	☐ Failed

Comment:

Date	Signature of customer	Signature Tester

8.2.2 Test report – Page 2

Type of safety function
☐ Safe measurement

Proof testing
☐ Test sequence

This report is based on the specifications in the Functional Safety Manual: FY01098K

Proof test report			
Test step	Target value	Actual value	Pass
1. Simulation of a high alarm (≥ 21 mA) in the current loop			☐ Passed ☐ Failed
2. High alarm, measurement accuracy complies with technical data			☐ Passed ☐ Failed

Comment:

8.3 Version history

Version of manual	Changes	Valid as of firmware version	Reference to NE 53 customer information
FY01098K/09/EN/01.23	First version	01.05.01	-
FY01098K/09/EN/02.24	Addition of the note in Section 6.1 Test sequence	01.05.01	-

www.addresses.endress.com

Endress+Hauser

People for Process Automation

KA01141K/09/EN/06.24-00
71681514
2024-09-30

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Brief Operating Instructions
RIA15

Loop-powered Ex ia process indicator as a field device or panel-mounted instrument for 4 to 20 mA signals or HART® protocol

These Brief Operating Instructions are not a substitute for the Operating Instructions pertaining to the device. Detailed information can be found in the Operating Instructions and the additional documentation.

Available for all device versions via:
- Internet: www.endress.com/deviceviewer
- Smartphone/tablet: Endress+Hauser Operations app

Safety instructions

Requirements for the personnel

The personnel must fulfill the following requirements for its tasks:
- ▶ Trained, qualified specialists must have a relevant qualification for this specific function and task.
- ▶ Are authorized by the plant owner/operator.
- ▶ Are familiar with federal/national regulations.
- ▶ Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- ▶ Follow instructions and comply with basic conditions.

Intended use

The process indicator displays analog process variables or HART process variables (option) on its screen.

By means of HART communication, selected Endress+Hauser field devices/ sensors (with the appropriate option) can also be very flexibly configured and commissioned or their diagnostic messages read out and displayed.

The device is powered via the 4 to 20 mA current loop and does not require an additional power supply.

- The manufacturer accepts no liability for damages resulting from improper or non-intended use. The device must not be converted or modified in any way.
- Panel-mounted device:
  The device is designed for installation in a panel and must only be operated in an installed state.
- Field device:
  The device is designed for mounting in the field.
- The device may be operated only under the permitted ambient conditions .

Product liability

The manufacturer does not accept any responsibility for damage that results from non-designated use and from failure to comply with the instructions in this manual.

Workplace safety

When working on and with the device:
- ▶ Wear the required personal protective equipment as per national regulations.

Operational safety

Damage to the device!
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for the interference-free operation of the device.

Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. The manufacturer confirms this by affixing the CE mark to the device.

Incoming acceptance and product identification

Product identification

Name and address of manufacturer

Name of manufacturer:	Endress+Hauser Wetzer GmbH + Co. KG
Address of manufacturer:	Obere Wank 1, D-87484 Nesselwang or www.endress.com

Endress+Hauser
People for Process Automation

Mounting

Installation conditions

- Operating altitude: according to IEC61010-1 up to 5000 m (16400 ft) above MSL
- Electrical safety: protection class III, overvoltage protection category II, pollution degree 2
- The permitted storage temperature is: –40 to +85 °C (–40 to +185 °F); it is possible to store the device at borderline temperatures for a limited period (48 hours maximum).

Permitted ambient temperature: –40 to 60 °C (–40 to 140 °F)

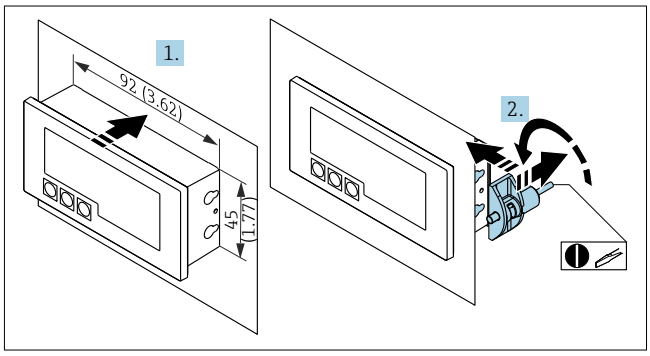
At temperatures below –25 °C (–13 °F) the readability of the display can no longer be guaranteed.

installation instructions

For the dimensions of the device, see the "Technical data" section in the relevant Operating Instructions.

Panel housing

- Degree of protection: IP65 front, IP20 rear (not evaluated by UL)
- Mounting position: horizontal



1 *Installation instructions for the panel housing*

Installation in a panel with a panel cutout 92x45 mm (3.62x1.77 in), max. panel thickness 13 mm (0.51 in).

1. Slot the device into the panel cutout from the front.
2. Fit the mounting clips on the side of the housing and tighten the threaded rods (tightening torque: 0.4 to 0.6 Nm).

Field housing

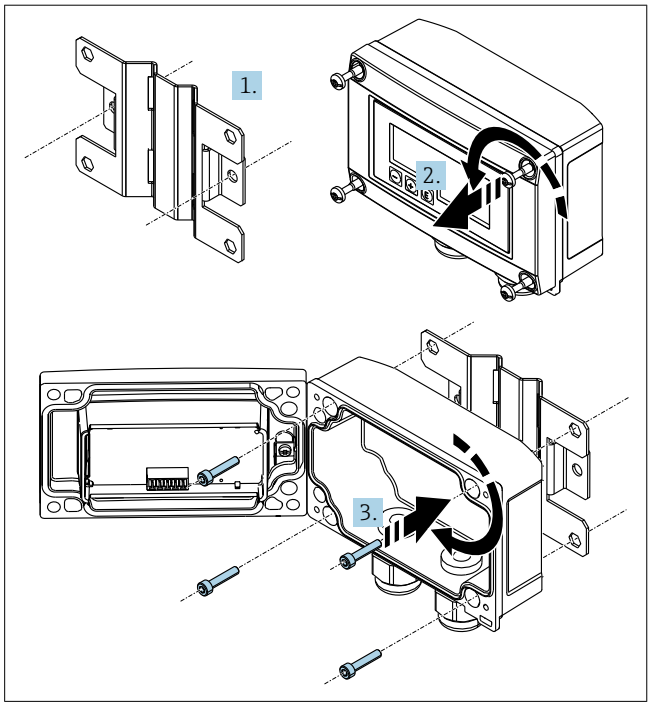
- Degree of protection for aluminum housing: IP66/67, NEMA 4X (not evaluated by UL)
- Degree of protection for plastic housing: IP66/67 (not evaluated by UL)

Wall mounting

Wall mounting without a mounting kit:

1. Open the housing.
2. Use the device as a stencil for 4 6 mm (0.24 in) bore holes, 99 mm (3.9 in) apart on the horizontal plane, 66 mm (2.6 in) apart on the vertical plane.
3. Secure the indicator on the wall with 4 screws.
4. Close the cover and tighten the housing screws.

Wall mounting with mounting kit (optionally available):



2 *Mounting the process indicator on a wall*

1. Use the mounting plate as a stencil for 2 6 mm (0.24 in) bore holes, 82 mm (3.23 in) apart, and secure the plate on the wall with 2 screws (not supplied).
2. Open the housing.
3. Secure the indicator on the mounting plate with the 4 screws supplied.
4. Close the cover and tighten the screws.

For information on pipe mounting of the field housing, see the relevant Operating Instructions.

For information on mounting the optional HART communication resistance module, see the relevant Operating Instructions.

Post-installation check

Display unit in the panel-mount housing

- Is the seal undamaged?
- Are the mounting clips securely fastened on the housing of the device?
- Are the threaded rods properly tightened?
- Is the device located in the center of the panel cutout?

Display unit in the field housing

- Is the seal undamaged?
- Is the housing firmly screwed to the mounting plate?
- Is the mounting bracket firmly secured on the wall/pipe?
- Are the housing screws firmly tightened?

Wiring

WARNING

Danger! Electric voltage

- ▶ The entire connection of the device must take place while the device is de-energized.

Only certified devices (optionally available) may be connected in the hazardous area

- ▶ Observe the corresponding notes and wiring diagrams in the Ex-specific supplement to these Operating Instructions.

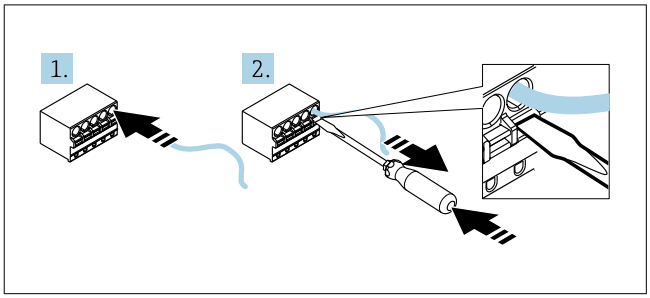
NOTICE

Device destroyed if current too high

- ▶ The device must be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1, Section 9.4 and the requirements in Table 18.
- ▶ Do not operate the device at a voltage source without a current limiter. Instead, operate the device only in the current loop with a transmitter.

- **Panel housing:**
  The terminals are located on the rear of the housing.
- **Field housing:**
  The terminals are located inside the housing. The device has two M16 cable entries. The housing must be opened for wiring purposes.

Operation of the spring terminals



3 *Operation of the spring terminals*

1. If using rigid cables or flexible cables with a ferrule, insert only the cable into the terminal to connect. No tools required. If using flexible cables without ferrules, the spring mechanism must be activated as shown in step 2.
2. In order to loosen the cable, push the spring mechanism in completely using a screwdriver or other suitable tool and pull out the cable.

For details on the HART connection (option), see the relevant Operating Instructions.

For details on the connection to functional ground, see the relevant Operating Instructions.

For details on wiring with switchable backlighting, see the relevant Operating Instructions.

Quick wiring guide

Terminal	Description
+	Positive connection, current measurement
-	Negative connection, current measurement (without backlighting)
LED	Negative connection, current measurement (with backlighting)
⊓	Auxiliary terminals (electrically connected internally)
⏚	Functional grounding: ▪ Panel-mounted device: Terminal on the rear of the housing
	▪ Field device: Terminal in the housing

Shielding and grounding

Optimum electromagnetic compatibility (EMC) can only be guaranteed if the system components and, in particular, the lines are shielded and the shield forms as complete a cover as possible.

HART communication allows three different types of shielding:
- Shielding at both ends
- Shielding at one end on the feed side with capacitance termination at the field device
- Shielding at one end on the feed side

The best results with regard to EMC are achieved in most cases with one-sided shielding on the feed side (without capacitance termination at the field device). Operation in the event of disturbance variables as per NAMUR NE21 is thus guaranteed.

NOTICE

If the shielding of the cable is grounded at more than one point in systems without potential matching, power supply frequency equalizing currents can occur that damage the signal cable or have a serious effect on signal transmission.

▶ In such cases the shielding of the signal cable should be grounded on one side only, i.e. it must not be connected to the ground terminal of the housing. The shield that is not connected should be insulated!

Ensuring the degree of protection

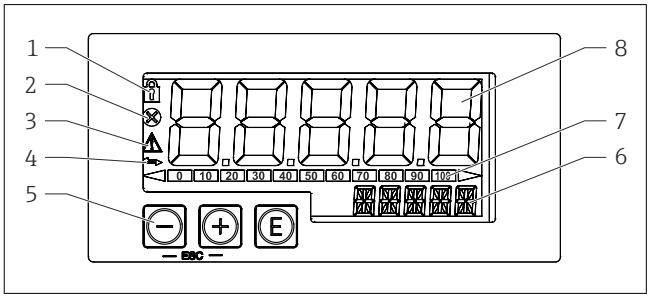
Field housing

The devices meet all the requirements of IP67. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:
- The housing seal must be clean and undamaged when inserted into the groove. The seal must be cleaned, dried or replaced if necessary.
- The cables used for connection must be of the specified outside diameter (e.g. M16 x 1.5, cable diameter 5 to 10 mm (0.2 to 0.39 in)).
- Mount the measuring instrument in such a way that the cable entries point downwards.
- Replace unused cable entries with dummy plugs.
- The housing cover and the cable entries must be firmly tightened.

Panel housing

The front of the device meets the requirements of IP65. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:
- The seal between the front of the housing and the panel must be clean and undamaged. The seal must be cleaned, dried or replaced if necessary.
- The threaded rods of the panel mounting clips must be firmly tightened (tightening torque: 0.4 to 0.6 Nm).

Operation



4 *Display and operating elements of the process indicator*

1 Symbol: operating menu disabled
2 Symbol: error
3 Symbol: warning
4 Symbol: HART communication active (option)
5 Operating keys "-", "+", "E"
6 14-segment display for unit/TAG
7 Bar graph with indicators for under range and over range
8 5-digit 7-segment display for measured value, digit height 17 mm (0.67 in)

The device is operated using three operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

A0017716	Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu
A0017714	Selecting and setting/changing values in the operating menu; pressing the '-' and '+' keys simultaneously takes the user back up a menu level. The configured value is not saved.
A0017715	

For more details on operation and commissioning, see the relevant Operating Instructions.

Maintenance and cleaning

No special maintenance work is required for the device.

Cleaning of surfaces not in contact with the medium

- Recommendation: Use a lint-free cloth that is either dry or slightly dampened using water.
- Do not use any sharp objects or aggressive cleaning agents that corrode the surfaces (displays, housing, for example) and seals.
- Do not use high-pressure steam.
- Observe the degree of protection of the device.

The cleaning agent used must be compatible with the materials of the device configuration. Do not use cleaning agents with concentrated mineral acids, bases or organic solvents.

BA01170K/09/EN/09.24-00
71681509
2024-09-30

Valid as of firmware version:
ISU00XA (Standard+FMG50): V01.07.xx
ISU01XA (CM82): V01.05.xx
ISU03XA (NMS8x): V01.06.xx

Operating Instructions
RIA15

Loop-powered Ex ia process indicator as a field device or panel-mounted instrument for 4 to 20 mA signals or HART® protocol

Endress+Hauser
People for Process Automation

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1 About this document

1.1 Document conventions

1.1.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

1.1.2 Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓ ~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⊕	**Potential equalization connection (PE: protective earth)** Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: ▪ Interior ground terminal: potential equalization is connected to the supply network. ▪ Exterior ground terminal: device is connected to the plant grounding system.

1.1.3 Symbols for certain types of information

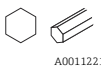
Symbol	Meaning
✓	**Permitted** Procedures, processes or actions that are permitted.
✓✓	**Preferred** Procedures, processes or actions that are preferred.
✗	**Forbidden** Procedures, processes or actions that are forbidden.
ℹ	**Tip** Indicates additional information.
📖	Reference to documentation
📄	Reference to page

Symbol	Meaning
	Reference to graphic
	Notice or individual step to be observed
1., 2., 3...	Series of steps
	Result of a step
	Help in the event of a problem
	Visual inspection

1.1.4 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3,...	Item numbers	1., 2., 3...	Series of steps
A, B, C, ...	Views	A-A, B-B, C-C, ...	Sections
	Hazardous area		Safe area (non-hazardous area)

1.1.5 Tool symbols

Symbol	Meaning
A0011220	Flat-blade screwdriver
 A0011221	Allen key
A0011222	Open-ended wrench
A0013442	Torx screwdriver

1.2 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following document types are available in the Downloads area of the Endress+Hauser website (www.endress.com/downloads), depending on the device version:

Document type	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Document type	Purpose and content of the document
Operating Instructions (BA)	**Your reference document** The Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.
Safety instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. These are an integral part of the Operating Instructions. The nameplate indicates which Safety Instructions (XA) apply to the device.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is a constituent part of the device documentation.

1.3 Registered trademarks

HART®
Registered trademark of the HART® Communication Foundation

2 Safety instructions

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

The operating personnel must fulfill the following requirements:
- Are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Follow the instructions in this manual.

2.2 Intended use

The process indicator displays analog process variables or HART process variables (option) on its screen.

By means of HART communication, selected Endress+Hauser field devices/sensors (with the appropriate option) can also be very flexibly configured and commissioned or their diagnostic messages read out and displayed.

The device is powered via the 4 to 20 mA current loop and does not require an additional power supply.

- The manufacturer accepts no liability for damages resulting from improper or non-intended use. The device must not be converted or modified in any way.
- Panel-mounted device:
  The device is designed for installation in a panel and must only be operated in an installed state.
- Field device:
  The device is designed for mounting in the field.
- The device may be operated only under the permitted ambient conditions → 63.

2.3 Product liability

The manufacturer does not accept any responsibility for damage that results from non-designated use and from failure to comply with the instructions in this manual.

2.4 Workplace safety

When working on and with the device:
- ▶ Wear the required personal protective equipment as per national regulations.

2.5 Operational safety

Damage to the device!
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for the interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers!
- ▶ If modifications are nevertheless required, consult with the manufacturer.

Repair

To ensure continued operational safety and reliability:
- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to the repair of an electrical device.
- ▶ Use only original spare parts and accessories.

2.6 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. The manufacturer confirms this by affixing the CE mark to the device.

2.7 IT security

The manufacturer warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Product description

3.1 Function

The RIA15 process indicator is integrated into the 4 to 20 mA/HART loop and displays the measuring signal in digital form. The process indicator does not require an external power supply. It is powered directly from the current loop.

By means of HART communication, the RIA15 enables extremely flexible configuration and commissioning of selected field devices and readouts of device/sensor diagnostic messages. The prerequisite is that the RIA15 was ordered with the appropriate "level" or "analysis" option (e.g. RIA15 level option FMR20 + FMR20B + FMR30B + FMX21+ FMG50).

Detailed description of supported applications → 🖹 8

The device meets the requirements of the HART Communication Protocol Specifications and can be used with devices with HART Revision ≥ 5.0 and higher.

3.2 Operating modes

The process indicator can be used purely as an indicator or as an indicator with an onsite configuration/diagnostic function.

3.2.1 Display functions

The indicator supports two different display modes:

4 to 20 mA mode:

In this operating mode, the process indicator is incorporated into the 4 to 20 mA current loop and measures the transmitted current. The variable calculated based on the current value and range limits is displayed in digital form on the 5-digit LCD. In addition, the associated unit and a bar graph can be displayed.

HART mode:

The device functions as an indicator even when operating with a HART sensor/actuator. In this case, the indicator is also powered from the current loop.

In the HART loop, the process indicator has the option of functioning either as a primary master or as a secondary master (default). When it functions as a master, the device can read process values from the measuring instrument and display them. HART communication operates according to the master/slave principle. As a general rule, the sensor/actuator is a slave and only transmits information if a request has been made by the master.

A HART loop can have a maximum of two HART masters at any one time. For these HART masters, a distinction is made between the primary (e.g. the control system) and the secondary master (e.g. a handheld device for on-site operation of the measuring instruments). The two masters in the loop/in the network cannot be masters of the same type, e.g. they cannot be two "secondary masters".

If a third HART master is added to the network, one of the other masters must be disabled; otherwise a collision occurs in the network.

If the process indicator is operating as a "secondary master", for example, and another "secondary master" (e.g. a handheld device) is added to the network, the device interrupts HART communication as soon as it detects the presence of another "secondary master". The display alternates between error message C970 "Multi master collision" and "- - -". A measured value is not displayed in this case. The device leaves the HART loop for 30

seconds and then tries to re-establish HART communication once again. Once the additional "secondary master" is removed from the network, the device continues communication and displays the measured values of the sensor/actuator once more.

Please note that if two process indicators are to be used in a Multidrop connection, one device must be configured as the "primary master" and the other as the "secondary master" to prevent a master collision.

In HART mode, the process indicator can display up to four device variables of a multivariable measuring instrument. These variables are referred to as the Primary Variable (PV), Secondary Variable (SV), Tertiary Variable (TV) and Quaternary Variable (QV). These variables are placeholders for measured values that can be retrieved using HART communication.

For a flowmeter, such as the Promass, these four values can be as follows:
- Primary process variable (PV) → Mass flow
- Secondary process variable (SV) → Totalizer 1
- Third process variable (TV) → Density
- Fourth process variable (QV) → Temperature

The HART section at the end of these Operating Instructions provides examples of these four device variables for multivariable measuring instruments → 🖹 73.

Refer to the Operating Instructions for each device for details on the variables that are set as default on the sensor/actuator and how they can be changed.

The process indicator can show each of these values. The individual values must be activated in the **SETUP** – **HART1** to **HART4** menu for this purpose. The individual parameters are assigned to fixed process variables in the device in this case:

HART1 = PV

HART2 = SV

HART3 = TV

HART4 = QV

For example, if the PV and TV are to be displayed on the process indicator, **HART1** and **HART3** must be activated.

The values can either be shown alternately on the process indicator or one value is displayed continuously and the other values are only shown by pressing '+' or '–'. The switching time can be configured in the **EXPRT – SYSTM – TOGTM** menu.

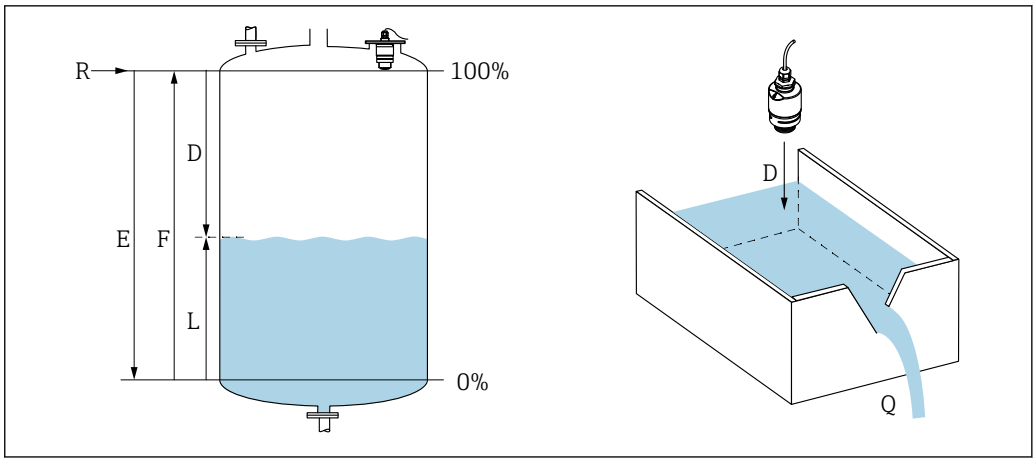
3.2.2 The RIA15 as an indicator with configuration function

For specific sensors/transmitters from Endress+Hauser, the RIA15 can be used for configuration/diagnostics in addition to its display function.

The RIA15 as a remote indicator and for operation of the Micropilot FMR20/ FMR20B/FMR30B

The Micropilot is a "downward-looking" measuring system that functions according to the time-of-flight (ToF) method. It measures the distance from the reference point (process connection of measuring instrument) to the surface of the medium. Radar signals are transmitted via an antenna, reflected by the surface of the medium and received back by the radar system.

In the HART mode, the RIA15 with the "level" option supports basic configuration of the Micropilot. The Micropilot can be adjusted under the **SETUP → LEVEL** menu item (see operating matrix). The value displayed on the RIA15 in display mode corresponds to the linearized level. In addition, the measured distance, the relative echo amplitude and the temperature of the sensor can be displayed.



1 *Calibration parameter Micropilot*

E Empty calibration (= zero)
F Full calibration (= span)
D Measured distance
L Level (L = E - D)
Q Flow rate at measuring weirs or channels (calculated from the level using linearization)

Operating principle of the Micropilot FMR20/FMR20B/FMR30B

The reflected radar signals are received by the antenna and transmitted to the electronics module. There, a microprocessor evaluates the signal and identifies the level echo caused by the reflection of the radar signals off the surface of the medium.

The distance **D** to the surface of the medium is proportional to the time-of-flight **t** of the radar signal:

$D = c \cdot t/2$,

where **c** is the speed of light.

Based on the known empty distance **E**, the level **L** is calculated:

$L = E - D$

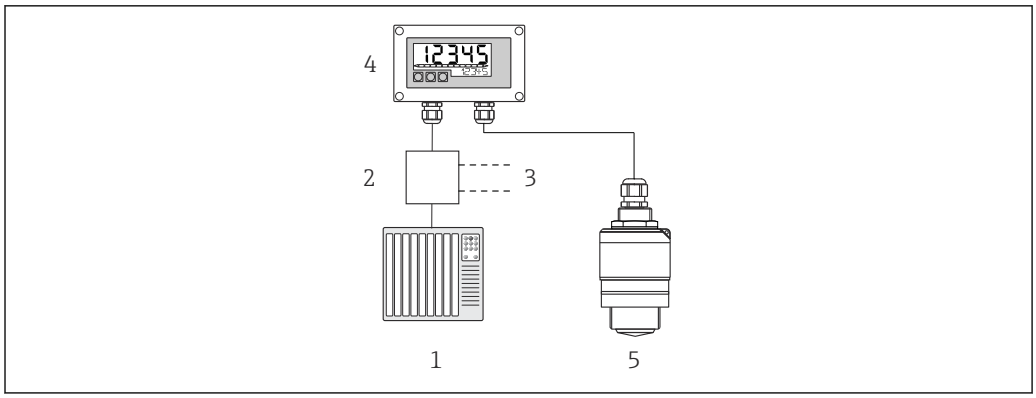
The Micropilot is calibrated by entering the empty distance **E** (= zero point) and the full distance **F** (= span).

Outputs and basic commissioning of the Micropilot FMR20/FMR20B/FMR30B

The RIA15 can be used as a local indicator of measured values as well as for the basic commissioning of the Micropilot radar level sensor via HART.

The following values are output here:

Digital output (HART):
PV: Level linearized
SV: Distance
TV: Relative echo amplitude
QV: Temperature (sensor)



2 Remote operation of the Micropilot via the RIA15

1 PLC
2 Transmitter power supply (with communication resistor) e.g. Endress+Hauser RN series active barrier
3 Connection for Commubox FXA195 and Field Communicator 375, 475
4 Loop-powered RIA15 process indicator
5 Micropilot transmitter

The following settings for the Micropilot can be made using the three operating keys on the front of the RIA15:
- Units
- Empty and full calibration
- Mapping

Further information on the operating parameters → 41

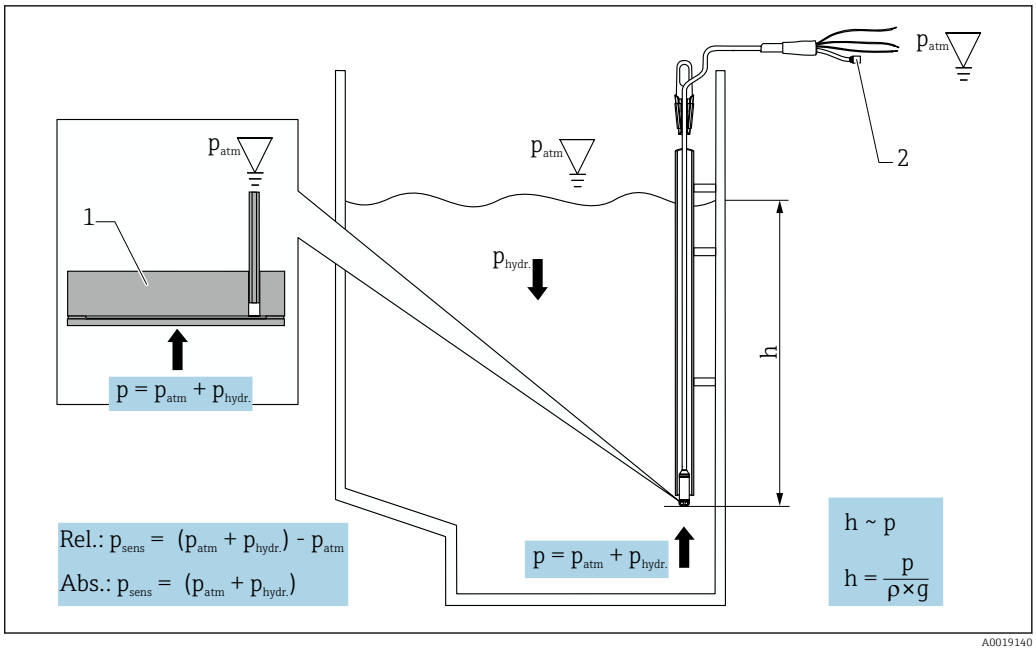
The following order options are available to be able to use this function:
- FMR20, FMR20B or FMR30B product structure
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level, option for FMR20 etc"

The RIA15 as a remote indicator and for operation of the Waterpilot FMX2

The Waterpilot is a transmitter with a capacitance, oil-free ceramic measuring cell for hydrostatic level measurement. The device with integrated temperature measurement is certified for drinking water applications. A version for wastewater applications and sludges as well as a metal-free version for use in saltwater are also available.

In the HART mode, the RIA15 with the "level" option supports basic configuration of the FMX21. The FMX21 can be adjusted under the **SETUP → LEVEL** menu item (see operating matrix). The value displayed on the RIA15 in display mode corresponds to the level measured (initial setting). The pressure and the temperature can also be displayed.

When the **LEVEL** menu is called up, the RIA15 automatically performs the following initial settings on the FMX21:
- Operating mode: level
- Calibration mode: dry
- Level selection: in pressure
- Lin mode: linear



3 *Waterpilot FMX21 calibration parameters*

1 *Ceramic measuring cell*
2 *Pressure compensation tube*
h *Level height*
p *Total pressure = atmospheric pressure + hydrostatic pressure*
ρ *Density of the medium*
g *Acceleration due to gravity*
$P_{hydr.}$ *Hydrostatic pressure*
P_{atm} *Atmospheric pressure*
P_{sens} *Sensor gauge pressure*

Operating principle of the FMX21

The total pressure, comprising atmospheric pressure and hydrostatic pressure, acts directly on the process membrane of the Waterpilot FMX21. Changes in air pressure are guided through a cable gland with pressure compensation membrane installed in the RIA15 via the pressure compensation tube in the extension cable to the rear of the ceramic process membrane in the FMX21 and are compensated for.

A pressure-dependent change in capacitance, caused by the movement of the process membrane, is measured at the electrodes of the ceramic carrier. The electronics unit then converts this to a signal that is proportional to the pressure and linear to the level.

The Waterpilot FMX21 is calibrated by configuring the lower-range value and the upper-range value by entering pressure and level values. For devices with a gauge pressure measuring cell, there is the option of performing a zero-point adjustment.

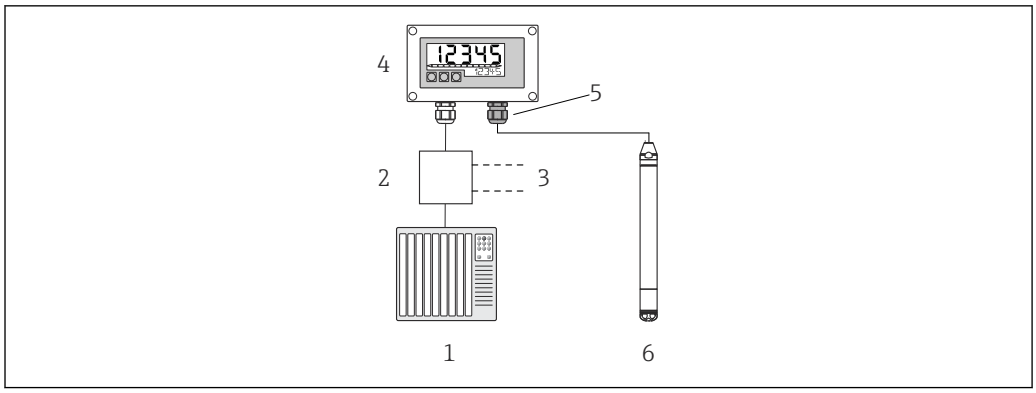
The preset span corresponds to 0 to URL, where **URL** is the upper range limit of the selected sensor. A different span can be ordered from the factory by selecting a customer-specific measuring range.

Output and basic commissioning of the FMX21

The RIA15 can be used as a local indicator and for the basic configuration of the Waterpilot FMX21 hydrostatic level sensor via HART.

The following values are output here:

Digital output (HART):
PV: Level linearized
SV: Measured pressure
TV: Pressure after position adjustment
QV: Temperature (sensor)



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4 *Remote operation of the FMX21 via RIA15*

1 *PLC*
2 *Transmitter power supply (with communication resistor) e.g. Endress+Hauser RN series active barrier*
3 *Connection for Commubox FXA195 and Field Communicator 375, 475*
4 *Loop-powered RIA15 process indicator*
5 *Cable gland M16 with pressure compensation membrane*
6 *FMX21 transmitter*

The following settings for the FMX21 can be made using the three operating keys on the front of the RIA15:
- Pressure unit
- Level unit
- Temperature unit
- Zero adjustment (only for gauge pressure measuring cells)
- Empty and full pressure adjustment
- Empty and full level calibration
- Reset to factory defaults

Further information on the operating parameters → 42

The following order options are available to be able to use this function:
- FMX21 product structure
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level... FMX21"

NOTICE

Compensation of atmospheric pressure

- ▶ When installing the FMX21, compensation of the atmospheric pressure must be guaranteed. Pressure compensation takes place through a pressure compensation tube in the extension cable of the FMX21 in conjunction with a special cable gland with integrated pressure compensation membrane, which must be attached on the right of the RIA15. This cable gland is supplied in black so that it can be easily distinguished from other cable glands.
- ▶ If necessary, the cable gland with integrated pressure compensation membrane can be ordered as a spare part at a later stage→ 61.

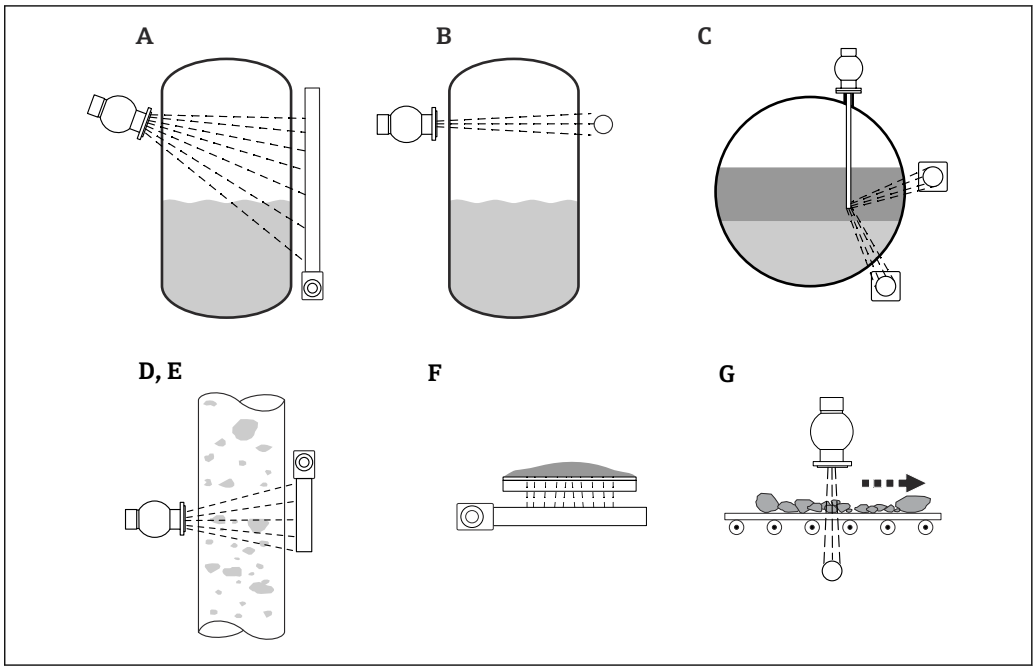
The RIA15 as a remote indicator and for operation of the Gammapilot FMG50

The Gammapilot FMG50 is a compact transmitter for non-contact measurement through vessel walls.

Applications
- Measurement of level, interface, density and concentration, as well as point level measurement
- Measurement in liquids, solids, suspensions or sludges
- Use under extreme process conditions
- All types of process vessels

Operating principle of the Gammapilot FMG50

The radiometric measuring principle is based on the fact that gamma radiation experiences attenuation when it penetrates materials. Radiometric measurement can be used for a variety of measuring tasks:



5 *Measuring tasks of the Gammapilot FMG50*

A Continuous level measurement
B Point level measurement
C Interface measurement
D Density measurement
E Concentration measurement (density measurement followed by linearization)
F Concentration measurement with radiating media
G Measurement of mass flow (solids)

Continuous level measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. The radiation given off by the radiation source is absorbed by the medium in the vessel. The higher the level rises, the more radiation is absorbed by the medium. This means that the Gammapilot FMG50 receives less radiation the more the level of the medium rises. This effect is used to determine the current level of the medium in the vessel. As the Gammapilot FMG50 is available in different lengths, the detector can be used for measuring ranges of different sizes.

Point level measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a vessel. The radiation given off by the radiation source is absorbed by the medium in the vessel. In the case of point level detection, the radiation received by the Gammapilot FMG50 is normally absorbed completely if the beam path between the radiation source and the detector is completely filled with medium. In this case, the level of the medium in the vessel is at the defined limit value. The Gammapilot FMG50 indicates the uncovered state (no medium in the beam path) as 0% and the covered state (beam path filled with medium) as 100%.

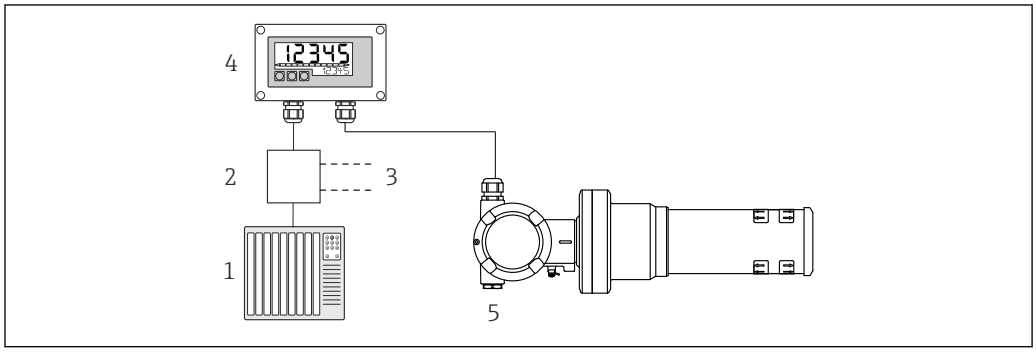
Density measurement

A source container with a radiation source and a Gammapilot FMG50 (to receive the gamma radiation) are mounted on opposite sides of a pipe. The radiation given off by the radiation source is absorbed by the medium in the vessel. The denser the medium in the beam path between the radiation source and the detector, the more radiation is absorbed.

The Gammapilot FMG50 therefore receives less radiation the more the density of the medium increases. This effect is used to determine the current density of the medium in the vessel. The density unit can be selected via a menu.

Outputs and basic configuration of the FMG50

The RIA15 can be used as a local display unit for measured values and for the basic configuration of the Gammapilot FMG50 via HART. 4 HART output values (PV, SV, TV and QV) can be configured via the FMG50.



6 Remote operation of the FMG50 via RIA15

1 PLC
2 Transmitter power supply (with communication resistor) e.g. Endress+Hauser RN series active barrier
3 Connection for Commubox FXA195 and Field Communicator 375, 475
4 Loop-powered RIA15 process indicator
5 Gammapilot FMG50

The following settings for the FMG50 can be made using the three operating keys on the front of the RIA15:
- Basic configuration of the "Level" operating mode (continuous level measurement)
- Basic configuration of the "Point Level" operating mode (point level measurement)
- Basic configuration of the "Density" operating mode (density measurement)

Further information on the operating parameters → 43

The following order options are available to be able to use this function:
- FMG50 product structure
- RIA15 product structure, feature 030 "Input":
  Option 3: "4 to 20 mA current signal + HART + level ... FMG50"

The RIA15 as a remote indicator and for operation of the Proservo NMS8x

The Proservo NMS8x series of intelligent tank gauges has been designed for highly accurate liquid level measurement in storage and process applications. The devices are perfectly tailored to the demands of tank inventory management, inventory control, custody transfer and loss control, while also offering cost savings and operational safety.

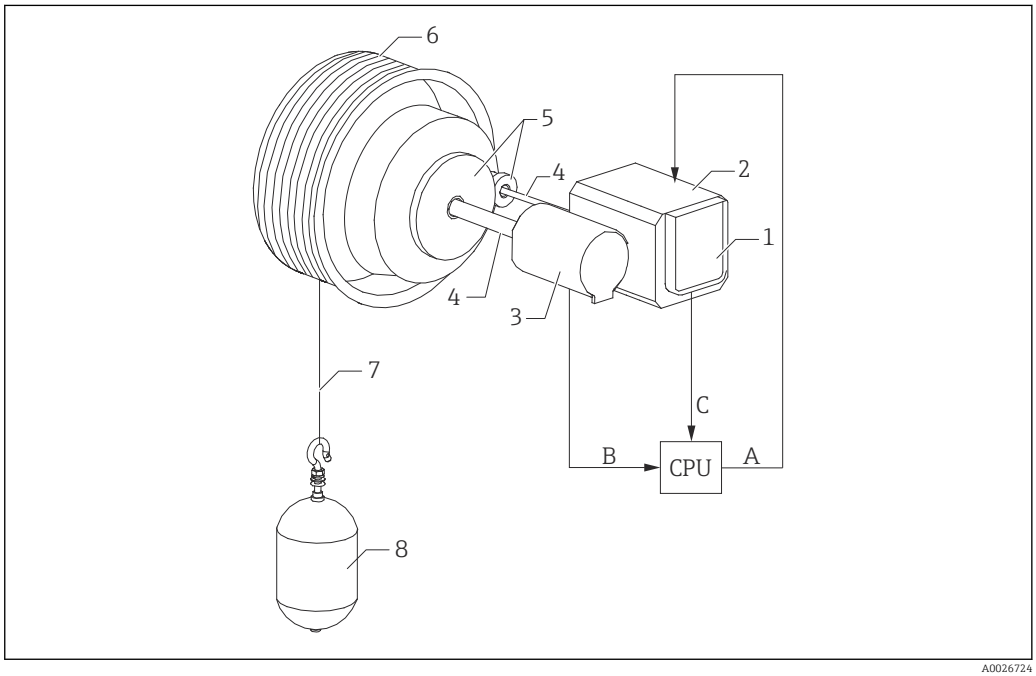
Operating principle of the NMS8x

NMS8x is an intelligent tank gauge for measuring liquid levels with high precision. The system is based on the principle of gauging displacement. A small displacer is accurately positioned in a liquid medium using a stepping motor. The displacer is then suspended on a measuring wire which is wound onto a finely grooved measuring drum. The NMS8x counts the rotations of the measuring drum in order to calculate how much wire is unwound and therefore calculate the change in the liquid level.

The drum is driven via coupling magnets that are completely separated by the drum housing. The outer magnets are connected to the measuring drum, and the inner magnets are connected to the drive motor. As the inner magnets turn, their magnetic attraction causes the outer magnets to turn as well, causing the entire drum assembly to rotate. The weight of the displacer on the wire causes a torque on the outer magnets, which causes a

change in the magnetic flux. These changes acting between the components of the measuring drum are detected by a special electromagnetic transducer on the inner magnets. The transducer transmits the weight signal to a CPU according to a patented non-contact principle. The motor is actuated to keep the weight signal constant at a predefined value which was defined by the measurement command.

When the displacer is lowered and touches the liquid, the weight of the displacer is reduced by the buoyancy force of the liquid, which is measured by a temperature-compensated magnetic transducer. As a result, the torque in the magnetic coupling changes, and this is measured by six hall sensors. A signal indicating the weight of the displacer is sent to the motor control circuit. Whenever the liquid levels rise or fall, the position of the displacer is adjusted accordingly by the drive motor. The rotation of the measuring drum is continuously evaluated to determine the level value using a magnetic rotary encoder. In addition to measuring the level, the NMS8x can also measure the interfaces between up to three liquid phases as well as the tank bottom, the spot density and profile density.

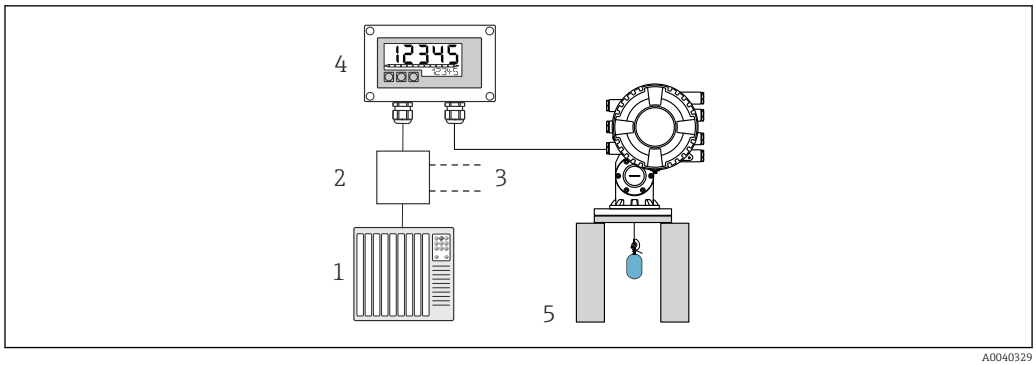


7 *NMS8x operating principle*

A Displacer position data
B Weight data
C CPU
1 Encoder
2 Motor
3 Rotary encoder
4 Shafts
5 Gears
6 Measuring drum
7 Measuring wire
8 Displacer

Outputs and basic configuration of the NMS8x

The RIA15 can be used as a local display unit for measured values and for the basic configuration of the NMS8x. Furthermore, measurement commands can be sent to the NMS8x via HART and the measuring status of the NMS8x can be displayed. 4 HART output values (PV, SV, TV and QV) can be configured via the NMS8x.



8 Remote operation of the NMS8x via the RIA15

1 PLC
2 Transmitter power supply (with communication resistor) e.g. Endress+Hauser RN series active barrier
3 Connection for Commubox FXA195 and Field Communicator 375, 475
4 Loop-powered RIA15 process indicator
5 NMS8x

The following settings for the NMS8x can be made using the three operating keys on the front of the RIA15:
- Measurement command
- Measurement status
- Balance status

Further information on the operating parameters → 47

The following order options are available to be able to use this function:
- NMS8x product structure
- RIA15 product structure, feature 030 "Input":
  Option 5: "4 to 20 mA current signal + HART + level, option for NMS8x"

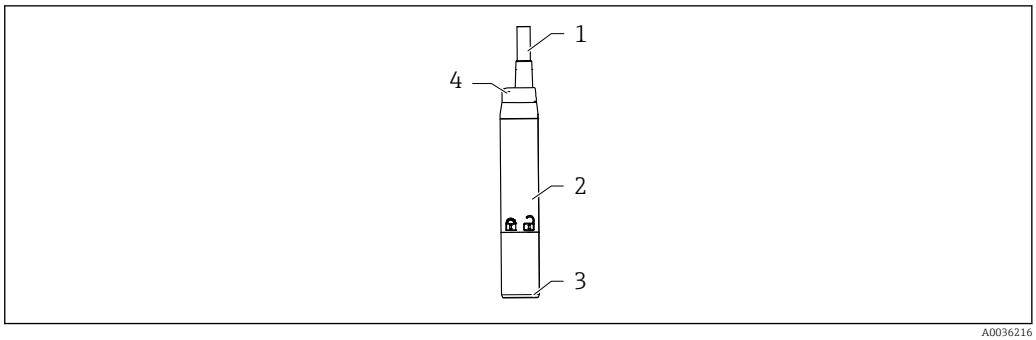
The RIA15 as a remote indicator and for operation of the Liquiline CM82

The Liquiline CM82 is a compact two-wire single-channel transmitter for connecting digital sensors with Memosens technology. It is suitable for demanding applications in the Life Sciences, water/wastewater and chemical industries.

The RIA15 with the "analysis" option supports basic configuration of the CM82 in the HART mode. The CM82 can be adjusted under the **SETUP → CT** menu item (see operating matrix). The value displayed on the RIA15 in display mode corresponds to the measured value (default setting).

Operating principle of the CM82

Digital sensors are connected via Memosens to the Liquiline CM82 transmitter using Plug and Play. The sensor's Memosens technology digitizes the sensor's measured value and transfers it to the transmitter via a non-contact connection. The transmitter converts this measured value to a 4 to 20 mA and HART signal for direct connection to the PLC. Maintenance and commissioning of the transmitter can be performed via the Bluetooth interface using a smartphone, tablet or laptop. The RIA15 (HART) can be used for basic configuration and local display of the measured values.



9 *Design of the Liquiline CM82*

1 *Measuring cable*
2 *Housing*
3 *Memosens connection*
4 *LED for status display*

Measuring ranges and sensor connection

The CM82 transmitter is designed for digital Memosens sensors with an inductive plug-in head. The Memosens sensor is easily connected to the CM82 using Plug and Play.

Sensor types	Sensors
Digital sensors with Memosens protocol without additional internal power supply	▪ pH sensors ▪ ORP sensors ▪ pH/ORP combination sensors ▪ Oxygen sensors ▪ Conductivity sensors

The measuring ranges are dependent on the connected sensor and can be found in the relevant sensor documentation.

Local measured value display and basic commissioning of the CM82

The RIA15 can be used as a local indicator of the measured values as well as for the basic commissioning of the Liquiline CM82 via HART.

The following values are output here:

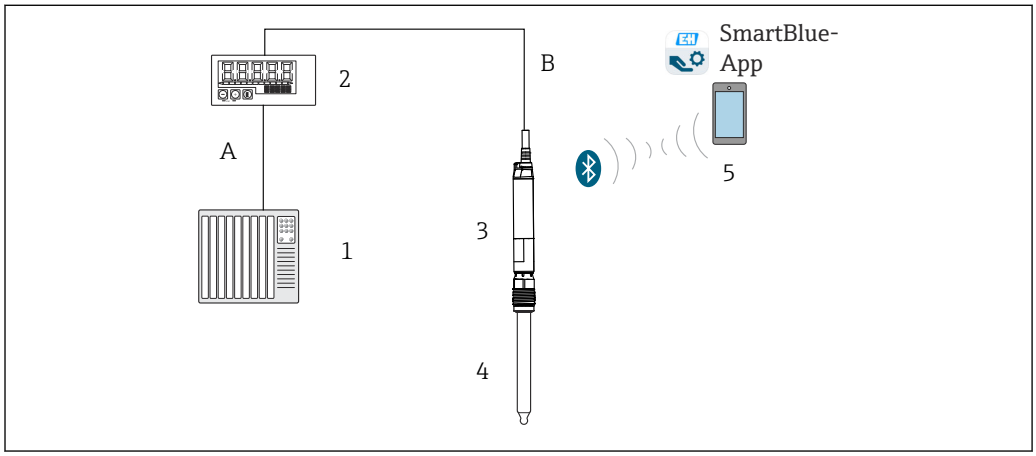
Digital output (HART): measured value and unit depending on the connected sensor
PV: Configured primary value (CMAIN operating parameter)
SV: Temperature (sensor)
TV: Dependent on the connected transmitter parameter + sensor type
QV: Dependent on the connected transmitter parameter + sensor type

Transmitter parameter	Sensor type	"TV" value	"QV" value
pH	Glass	Raw value in mV	Glass impedance in MOhm
pH	ISFET	Raw value in mV	Leak current in nA
pH	ORP	Relative ORP value as %	Raw value in mV
pH	pH/ORP combined sensor	pH	ORP in mV
Conductivity		Resistance	Conductivity raw value
Dissolved oxygen		Liquid concentration	Saturation as %

If "UC170" is displayed instead of the unit, see → 54

The following settings for the CM82 can be made using the three operating keys on the front of the RIA15:
- Units of connected sensor
- Current output range
- Retrieval of diagnostic information

Further information on the operating parameters → 50



10 *Remote operation of the CM82 via the RIA15*

1 *PLC*
2 *Loop-powered RIA15 process indicator*
3 *CM82 transmitter*
4 *Memosens sensor (e.g. pH sensor)*
5 *Connection via Bluetooth to the SmartBlue app*

The following order options are available to be able to use this function:
- CM82 product structure
- RIA15 product structure, feature 030 "Input":
  Option 4: "4 to 20 mA current signal + HART + analysis, option for CM82"

For further information on the CM82, see the associated Operating Instructions → BA01845C

3.3 Input channels

The process indicator has one analog 4 to 20 mA input. In "HART" operating mode, this channel can be used to retrieve and display HART values of a connected sensor/actuator. Here, a HART device can be directly connected to the process indicator in a point-to-point connection, or the process indicator can be incorporated into a HART Multidrop network.

4 Incoming acceptance and product identification

4.1 Incoming acceptance

On receipt of the delivery:

1. Check the packaging for damage.
   ↳ Report all damage immediately to the manufacturer.
   Do not install damaged components.
2. Check the scope of delivery using the delivery note.

3. Compare the data on the nameplate with the order specifications on the delivery note.
4. Check the technical documentation and all other necessary documents, e.g. certificates, to ensure they are complete.

If one of the conditions is not satisfied, contact the manufacturer.

4.2 Product identification

The device can be identified in the following ways:
- Nameplate specifications
- Enter the serial number from the nameplate into *Device Viewer* (www.endress.com/deviceviewer): all the information about the device and an overview of the Technical Documentation supplied with the device are displayed.
- Enter the serial number from the nameplate into the *Endress+Hauser Operations app* or scan the 2-D matrix code (QR code) on the nameplate with the *Endress+Hauser Operations app*: all the information about the device and the technical documentation pertaining to the device is displayed.

4.2.1 Nameplate

Do you have the correct device?

The nameplate provides you with the following information on the device:
- Manufacturer identification, device designation
- Order code
- Extended order code
- Serial number
- Tag name (TAG) (optional)
- Technical values, e.g. supply voltage, current consumption, ambient temperature, communication-specific data (optional)
- Degree of protection
- Approvals with symbols
- Reference to Safety Instructions (XA) (optional)

▶ Compare the information on the nameplate with the order.

4.2.2 Name and address of manufacturer

Name of manufacturer:	Endress+Hauser Wetzer GmbH + Co. KG
Address of manufacturer:	Obere Wank 1, D-87484 Nesselwang or www.endress.com

4.3 Storage and transport

Storage temperature: −40 to +85 °C (−40 to +185 °F)

Maximum relative humidity: < 95 % as per IEC 60068-2-30

Pack the device for storage and transportation in such a way that it is reliably protected against impact and external influences. The original packaging offers the best protection.

Avoid the following environmental influences during storage:
- direct sunlight
- proximity to hot objects
- mechanical vibration
- aggressive media

5 Mounting

5.1 Installation conditions

Permitted ambient temperature: –40 to 60 °C (–40 to 140 °F)

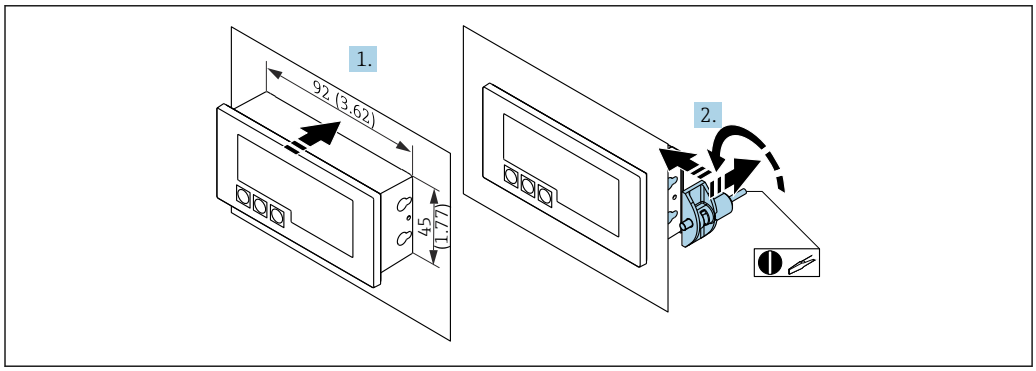
At temperatures below –25 °C (–13 °F) the readability of the display can no longer be guaranteed.

5.2 installation instructions

For the dimensions of the device, see "Technical data".

5.2.1 Panel housing

- Degree of protection: IP65 front, IP20 rear (not evaluated by UL)
- Mounting position: horizontal



11 *Installation instructions for the panel housing*

Installation in a panel with a panel cutout 92x45 mm (3.62x1.77 in), max. panel thickness 13 mm (0.51 in).

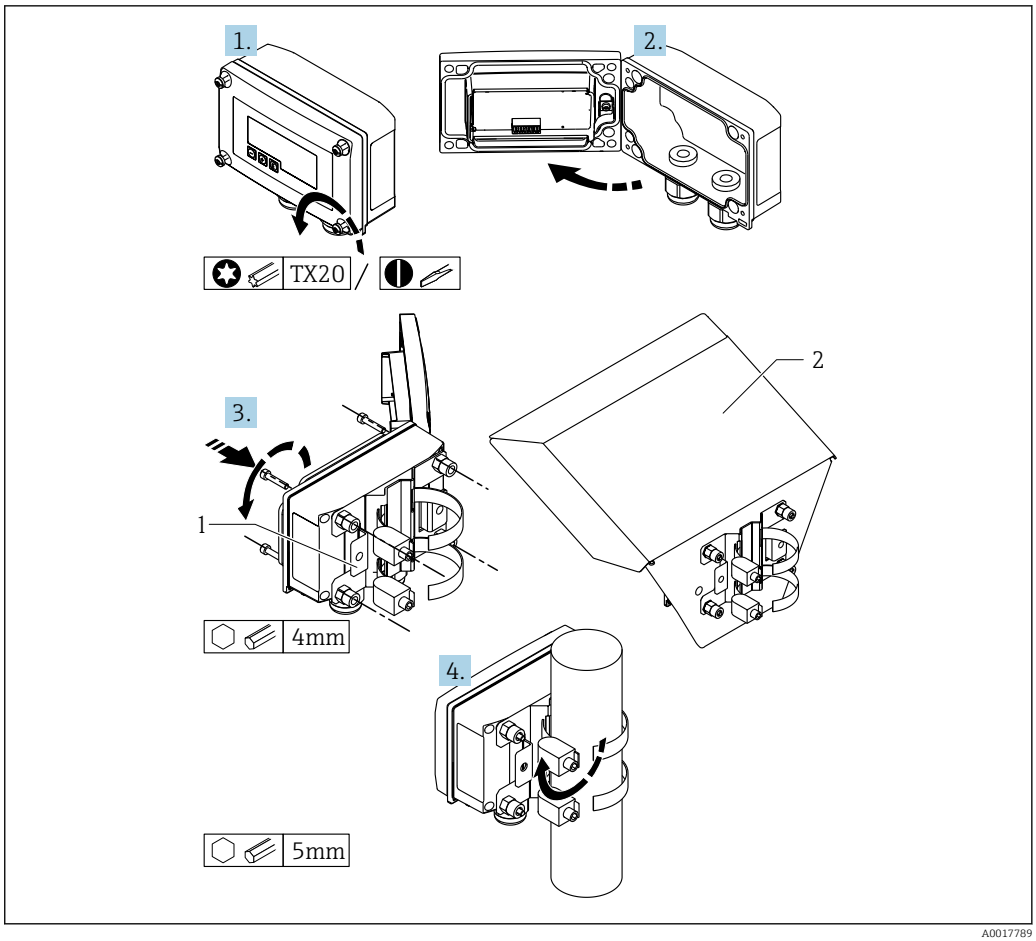
1. Slot the device into the panel cutout from the front.
2. Fit the mounting clips on the side of the housing and tighten the threaded rods (tightening torque: 0.4 to 0.6 Nm).

5.2.2 Field housing

- Degree of protection for aluminum housing: IP66/67, NEMA 4X (not evaluated by UL)
- Degree of protection for plastic housing: IP66/67 (not evaluated by UL)

Pipe mounting (with optional mounting kit)

The device can be mounted on a pipe with a diameter of up to 50.8 mm (2 in) with the mounting kit (optionally available).



12 *Mounting the process indicator on a pipe*

1 Mounting plate for pipe/wall mounting
2 Weather protection cover (optional)

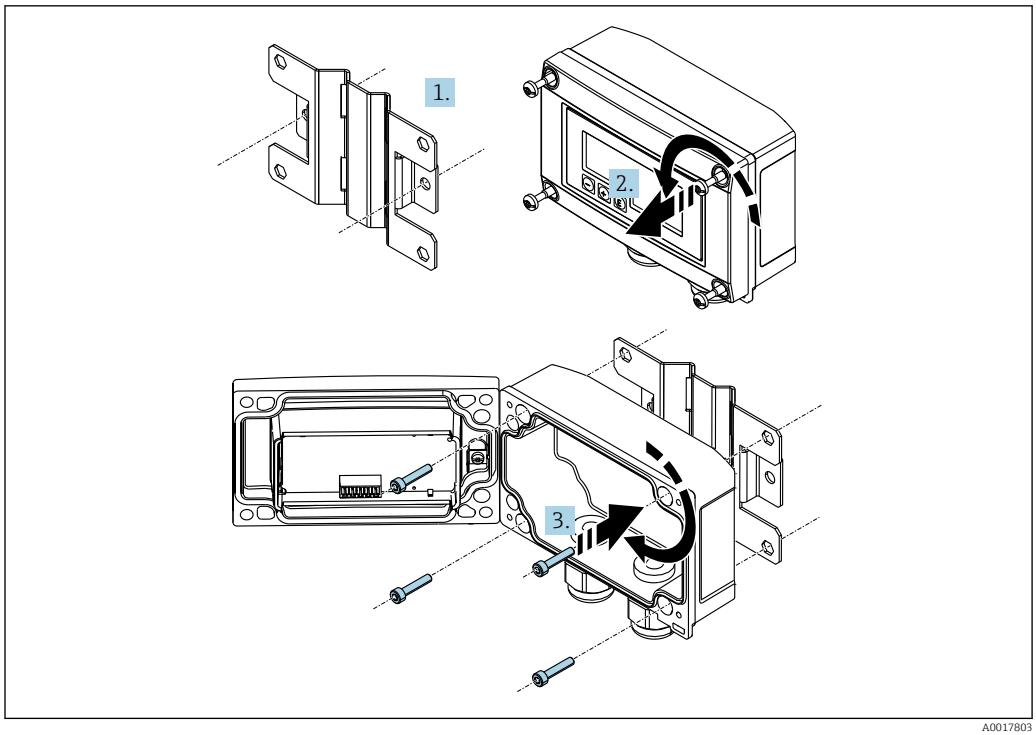
1. Release the 4 housing screws
2. Open the housing
3. Secure the mounting plate to the rear of the device with 4 screws supplied. The optional weather protection cover can be secured between the device and the mounting plate.
4. Guide the two gripper clamps through the mounting plate, fit them around the pipe and tighten.

Wall mounting

Wall mounting without a mounting kit:

1. Open the housing.
2. Use the device as a stencil for 4 6 mm (0.24 in) bore holes, 99 mm (3.9 in) apart on the horizontal plane, 66 mm (2.6 in) apart on the vertical plane.
3. Secure the indicator on the wall with 4 screws.
4. Close the cover and tighten the housing screws.

Wall mounting with mounting kit (optionally available):

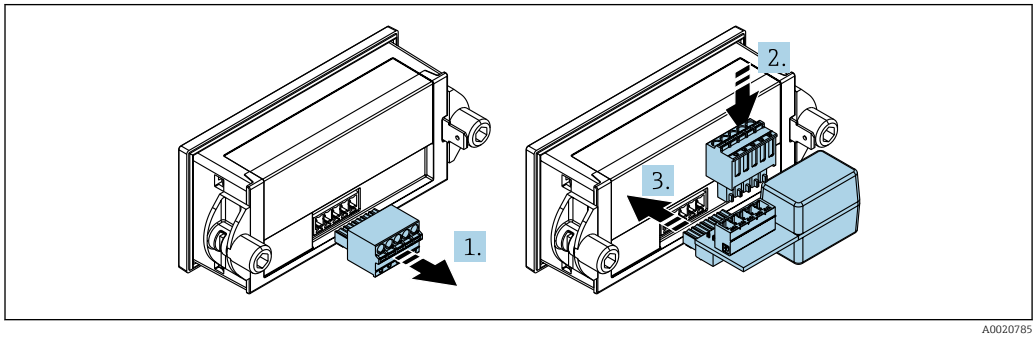


13 *Mounting the process indicator on a wall*

1. Use the mounting plate as a stencil for 2 6 mm (0.24 in) bore holes, 82 mm (3.23 in) apart, and secure the plate on the wall with 2 screws (not supplied).
2. Open the housing.
3. Secure the indicator on the mounting plate with the 4 screws supplied.
4. Close the cover and tighten the screws.

5.2.3 Installing the optional HART communication resistance module

The HART communication resistance module is available as an accessory; see the "Accessories" section.



14 *Installing the optional HART communication resistance module*

1. Disconnect the plug-in terminal block.
2. Insert the terminal block into the slot provided on the HART communication resistance module.
3. Insert the HART communication resistance module into the slot in the housing.

5.3 Post-installation check

5.3.1 Display unit in the panel-mount housing

- Is the seal undamaged?
- Are the mounting clips securely fastened on the housing of the device?
- Are the threaded rods properly tightened?
- Is the device located in the center of the panel cutout?

5.3.2 Display unit in the field housing

- Is the seal undamaged?
- Is the housing firmly screwed to the mounting plate?
- Is the mounting bracket firmly secured on the wall/pipe?
- Are the housing screws firmly tightened?

6 Wiring

⚠ WARNING

Danger! Electric voltage

▶ The entire connection of the device must take place while the device is de-energized.

Only certified devices (optionally available) may be connected in the hazardous area

▶ Observe the corresponding notes and wiring diagrams in the Ex-specific supplement to these Operating Instructions.

NOTICE

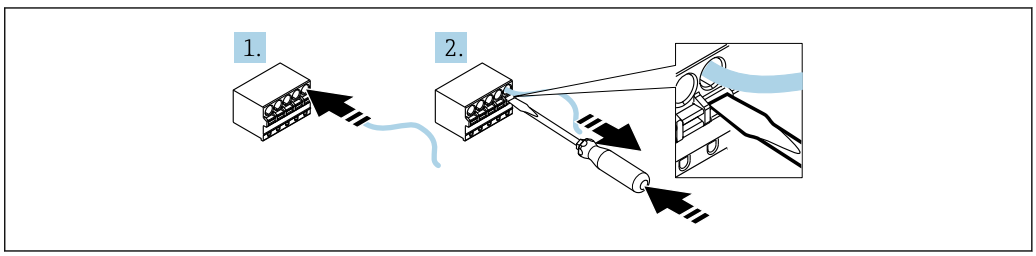
Device destroyed if current too high

▶ The device must be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1, Section 9.4 and the requirements in Table 18.

▶ Do not operate the device at a voltage source without a current limiter. Instead, operate the device only in the current loop with a transmitter.

- **Panel housing:**
  The terminals are located on the rear of the housing.
- **Field housing:**
  The terminals are located inside the housing. The device has two M16 cable entries. The housing must be opened for wiring purposes.

Operation of the spring terminals



15 *Operation of the spring terminals*

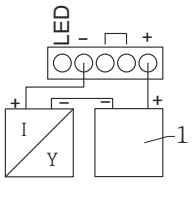
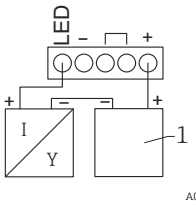
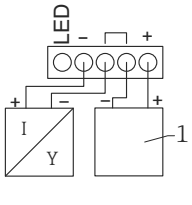
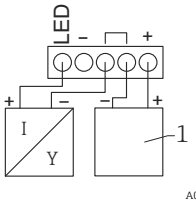
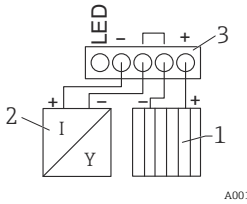
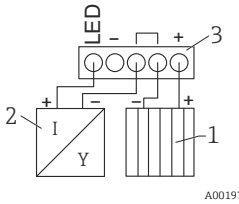
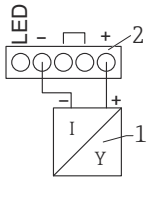
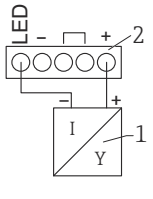
1. If using rigid cables or flexible cables with a ferrule, insert only the cable into the terminal to connect. No tools required. If using flexible cables without ferrules, the spring mechanism must be activated as shown in step 2.
2. In order to loosen the cable, push the spring mechanism in completely using a screwdriver or other suitable tool and pull out the cable.

6.1 Quick wiring guide

Terminal	Description
+	Positive connection, current measurement
-	Negative connection, current measurement (without backlighting)
LED	Negative connection, current measurement (with backlighting)
⊓	Auxiliary terminals (electrically connected internally)
⏚	Functional grounding: ▪ Panel-mounted device: Terminal on the rear of the housing ▪ Field device: Terminal in the housing

6.2 Connection in the 4 to 20 mA operating mode

The following diagrams show in a simplified way how the process indicator is connected in the 4 to 20 mA operating mode.

	Connection without backlighting	Connection with backlighting
Connection with transmitter power supply and transmitter	 *1 Transmitter power supply*	 *1 Transmitter power supply*
Connection with transmitter power supply and transmitter using the auxiliary terminal	 *1 Transmitter power supply*	 *1 Transmitter power supply*
Connection with PLC and transmitter	 *1 PLC* *2 Transmitter* *3 RIA15*	 *1 PLC* *2 Transmitter* *3 RIA15*
Connection without transmitter power supply directly in the 4 to 20 mA circuit	 *1 4 to 20 mA power source* *2 RIA15*	 *1 4 to 20 mA power source* *2 RIA15*

6.3 Connection in HART mode

The following diagrams show in a simplified way how the process indicator is connected in the HART operating mode.

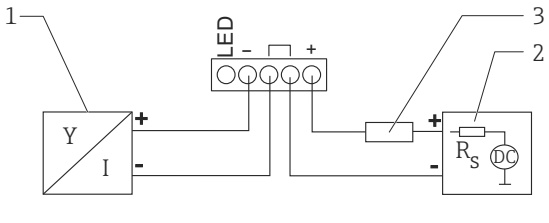
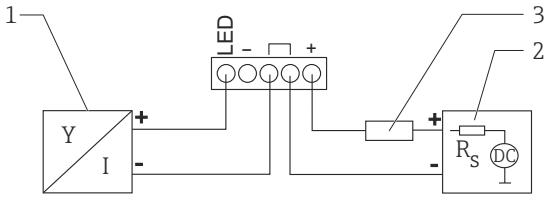
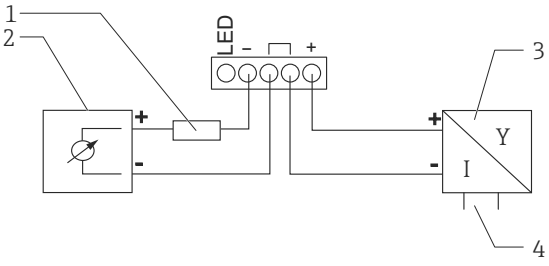
6.3.1 HART connection

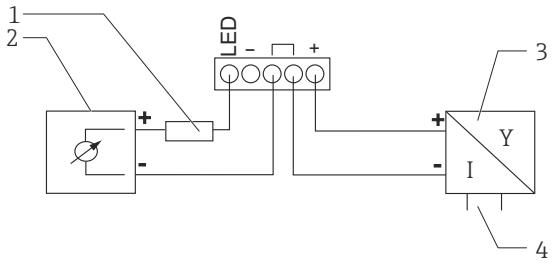
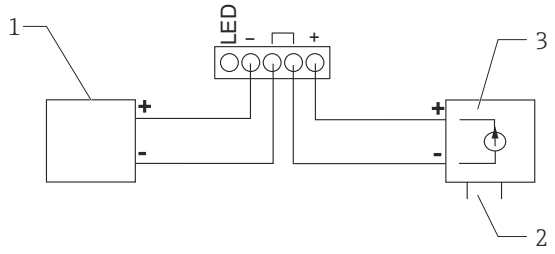
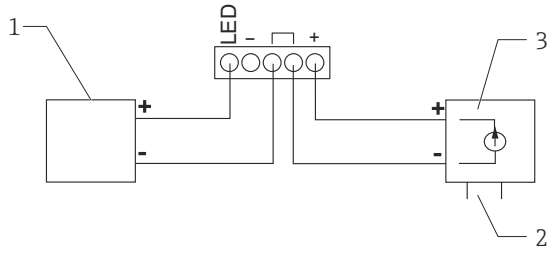
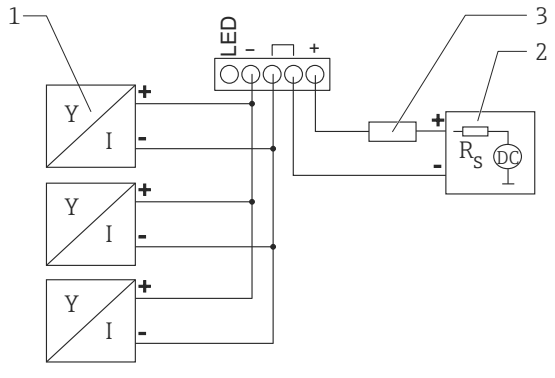
NOTICE

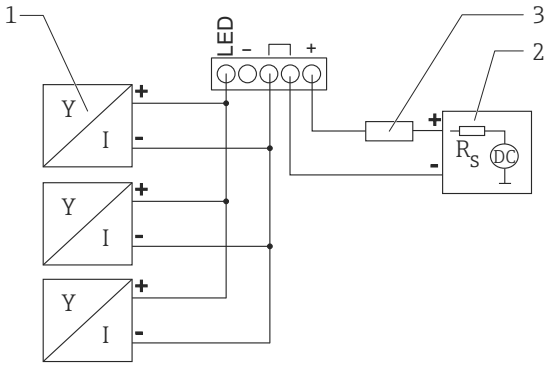
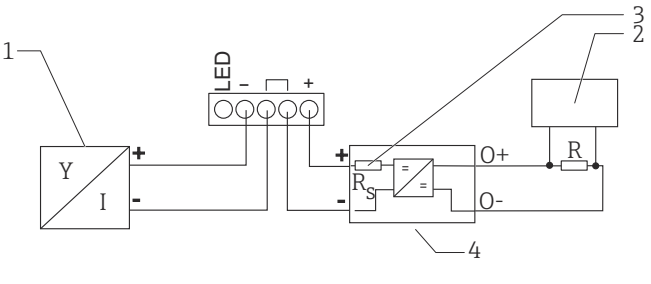
Undefined behavior due to incorrect wiring of an actuator

- When installing the process indicator together with an actuator, the Operating Instructions for the actuator must always be followed.

The 230 Ω HART communication resistor in the signal line is always necessary in the case of a low-impedance power supply. It must be installed between the power supply and the indicator.

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 A0019567 *1 Sensor* *2 Power supply* *3 Additional 230 to 600 Ω HART resistor inserted*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 A0019568 *1 Sensor* *2 Power supply* *3 Additional 230 to 600 Ω HART resistor inserted*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 A0019570 *1 HART resistor* *2 Current measuring instrument (optional)* *3 Sensor* *4 Power supply 4-wire device*

	Circuit diagram / Description
4-wire sensor with process indicator and transmitter power supply, with backlighting	 A0019571 *1 HART resistor* *2 Current measuring instrument (optional)* *3 Sensor* *4 Power supply 4-wire device*
Current output with process indicator and actuator (e.g. actuator valve), without backlighting	 A0019573 *1 Actuator* *2 Power supply 4-wire device* *3 Current output*
Current output with process indicator and actuator (e.g. actuator valve), with backlighting	 A0019574 *1 Actuator* *2 Power supply 4-wire device* *3 Current output*
Multidrop 2-wire sensors with process indicator and transmitter power supply	 A0019575 *1 Sensors* *2 Power supply* *3 HART resistor*

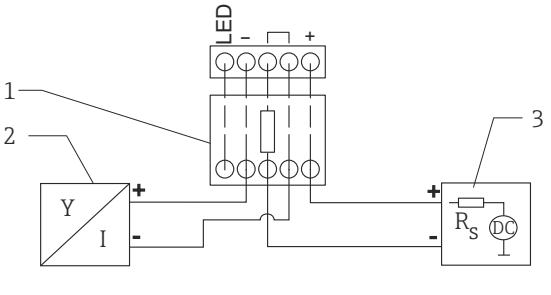
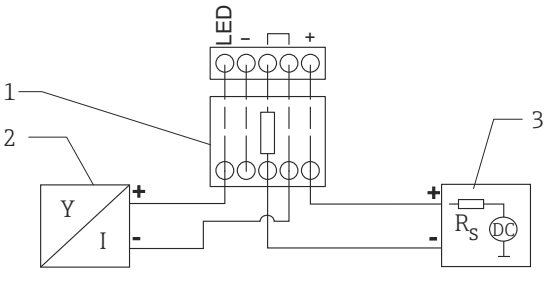
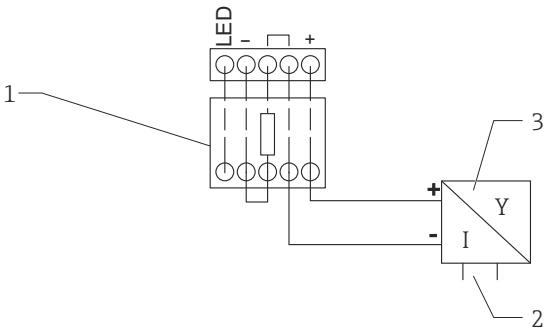
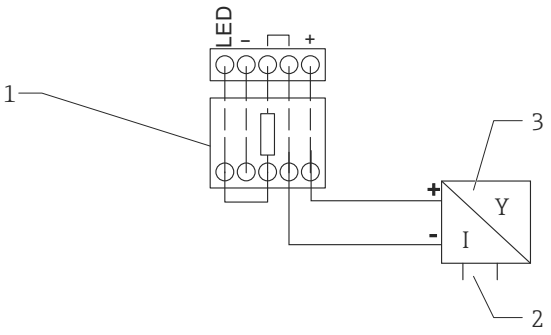
	Circuit diagram / Description
Multidrop 2-wire sensors with process indicator and transmitter power supply, with backlighting	 *1 Sensors* *2 Power supply* *3 HART resistor*
2-wire sensor with process indicator and active barrier (e.g. RN22 from Endress+Hauser) as transmitter power supply	 *1 Sensor* *2 HART primary master* *3 HART resistor* *4 Active barrier*

Optional HART communication resistance module

A HART communication resistance module is available as an accessory; see the "Accessories" section → 🖹 61.

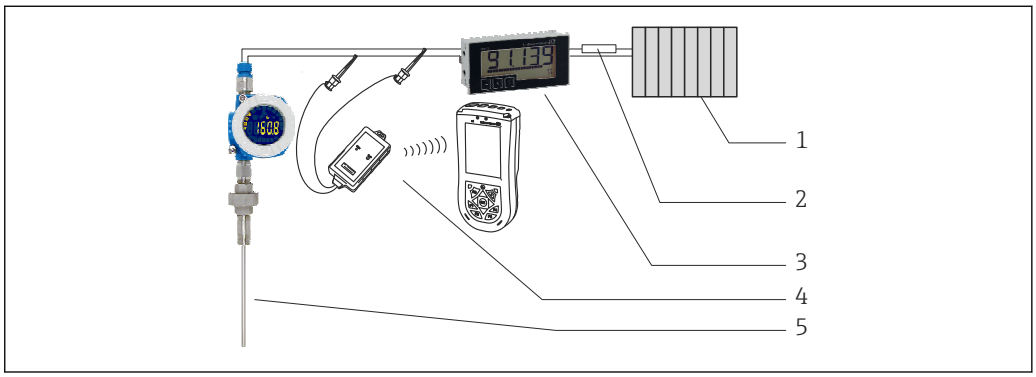
To mount the HART communication resistance module, see the Mounting section → 🖹 22

Wiring

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020839 *1 HART communication resistance module* *2 Sensor* *3 Power supply*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020840 *1 HART communication resistance module* *2 Sensor* *3 Power supply*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020837 *1 HART communication resistance module* *2 Power supply 4-wire device* *3 Sensor*
4-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020838 *1 HART communication resistance module* *2 Power supply 4-wire device* *3 Sensor*

Configuration of HART devices

HART devices are generally not configured via the process indicator. Configuration is done using the Field Xpert SFX100 device configurator, for example. An exception to this is the special options (e.g. RIA15 level & analysis option).



16 *Configuration of HART devices; example iTEMP TMT162*

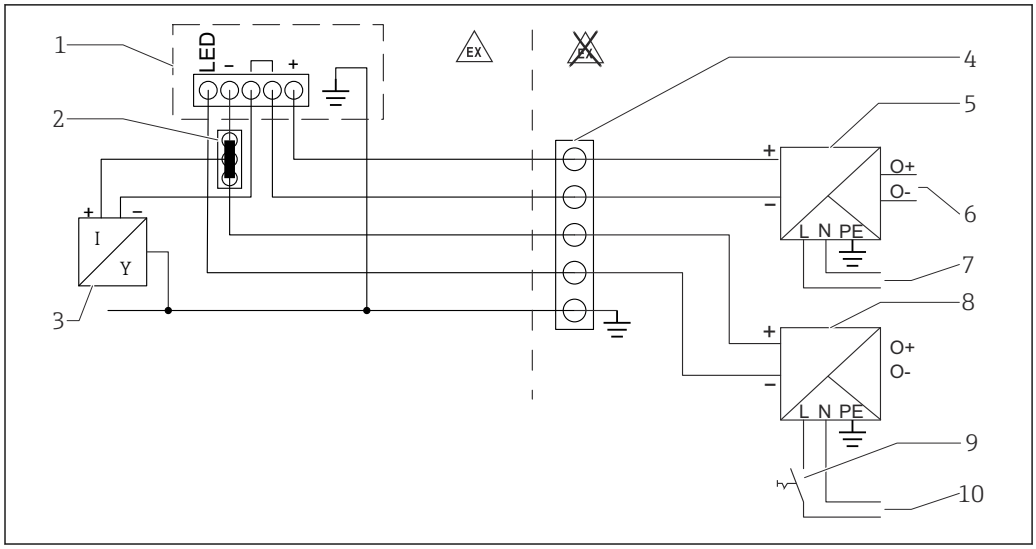
1 *HART primary master (e.g. PLC)*
2 *HART resistor*
3 *RIA15 process indicator*
4 *HART handheld terminal, e.g. Field Xpert SFX100*
5 *Sensor with HART transmitter, e.g. iTEMP TMT162*

6.4 Wiring with switchable backlighting

An additional current-limited power source (e.g. active barrier from the Endress+Hauser RN series) is required to implement switchable backlighting. This power source is used to supply the LED backlighting of up to seven RIA15 process indicators without generating an additional voltage drop in the measuring loop. The backlighting can be switched on and off using an external switch.

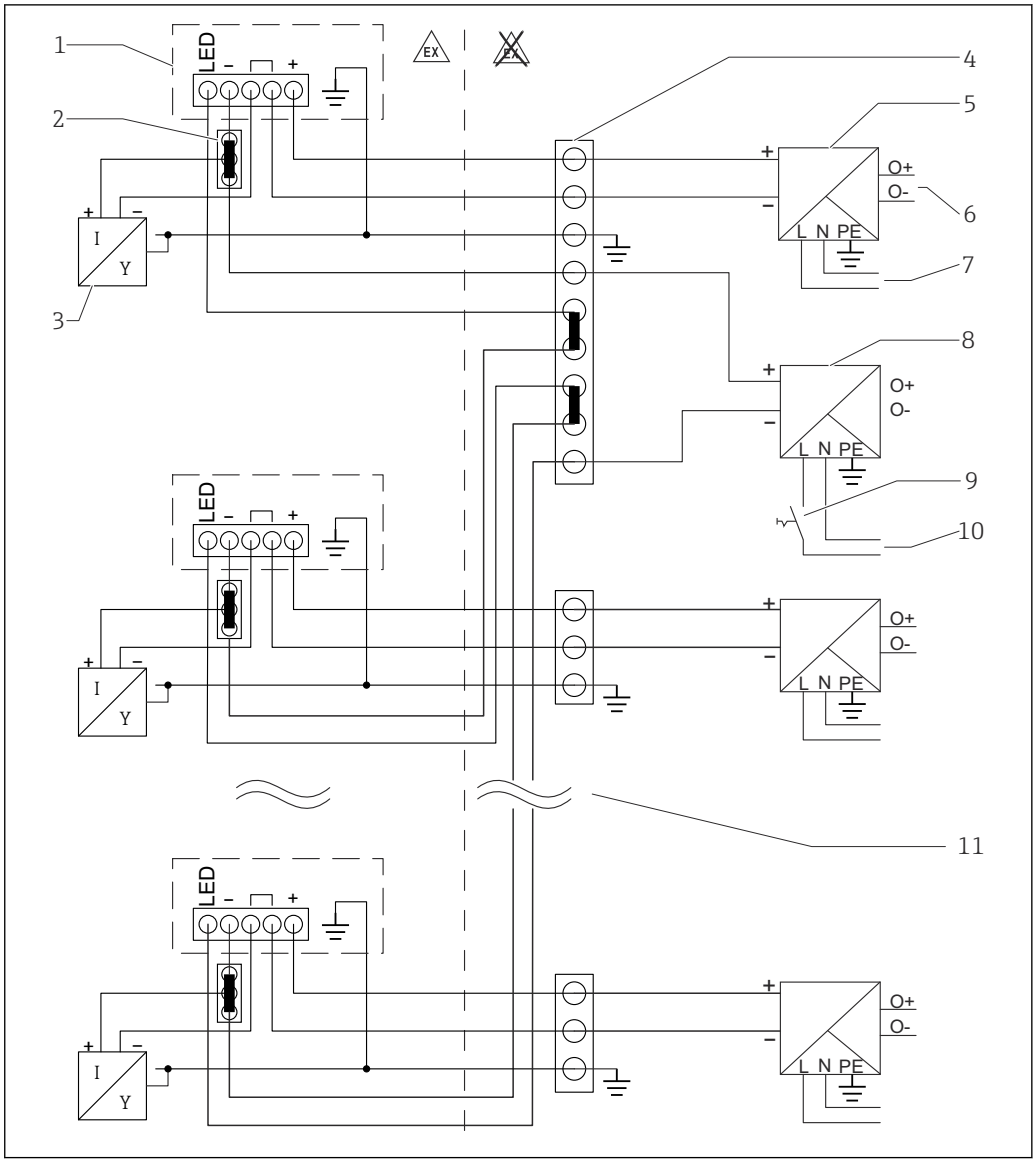
The following shows connection examples for the hazardous area. Wiring is similar for the non-hazardous area; however, it is not necessary to use Ex-certified devices.

6.4.1 Connection diagram for one process indicator



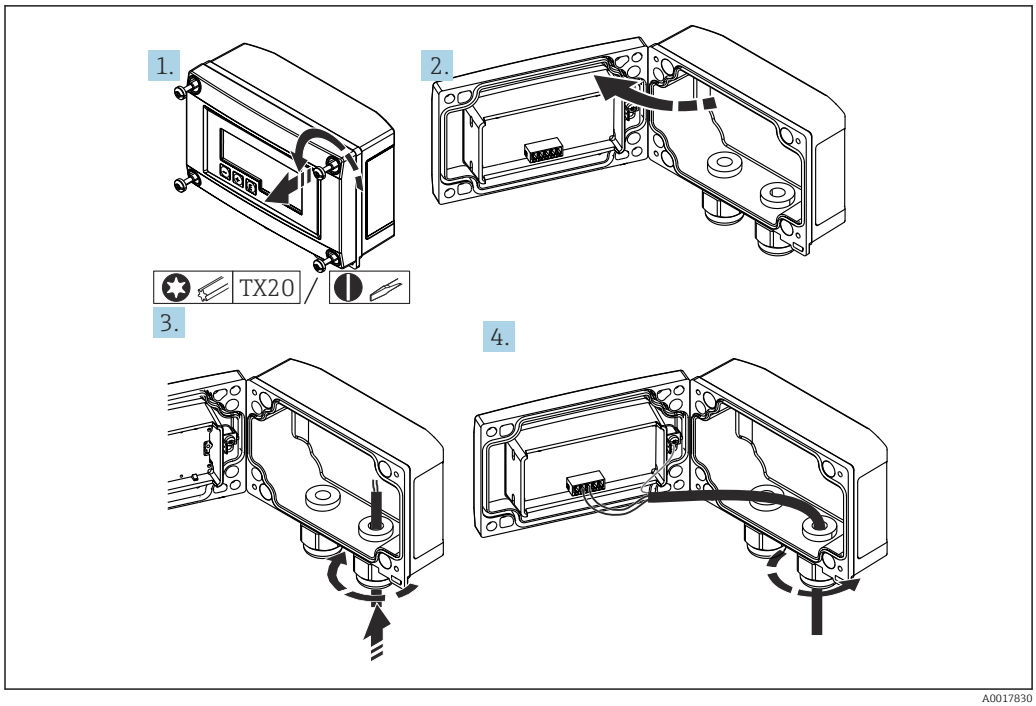
1 RIA15 process indicator
2 3-wire connector, e.g. WAGO 221 series
3 2-wire sensor
4 Terminal block on DIN rail
5 Active barrier (e.g. Endress+Hauser RN series)
6 4 to 20 mA output to the control unit
7 Power supply
8 Power source (e.g. Endress+Hauser RN series)
9 Switch to activate backlighting
10 Power supply

6.4.2 Connection diagram for multiple process indicators



1 RIA15 process indicator
2 3-wire connector, e.g. WAGO 221 series
3 2-wire sensor
4 Terminal block on DIN rail
5 Active barrier (e.g. Endress+Hauser RN series)
6 4 to 20 mA output to the control unit
7 Power supply
8 Power source (e.g. Endress+Hauser RN series)
9 Switch to activate backlighting
10 Power supply
11 Can be extended to 7 devices

6.5 Inserting the cable, field housing



17 *Inserting the cable, field housing*

Inserting the cable, field housing, connection without transmitter power supply (example)

1. Release the housing screws
2. Open the housing
3. Open the cable gland (M16) and insert the cable
4. Connect the cable including the functional grounding and close the cable gland

If using the communication resistance module in the RIA15, the cable of the FMX21 must be inserted into the right gland when connecting the FMX21 so that the integrated pressure compensation tube is not pinched.

6.6 Shielding and grounding

Optimum electromagnetic compatibility (EMC) can only be guaranteed if the system components and, in particular, the lines are shielded and the shield forms as complete a cover as possible. A shield coverage of 90% is ideal.

- To ensure an optimum EMC protective effect when communicating with HART, connect the shield as often as possible to the reference ground.
- For reasons of explosion protection, you should refrain from grounding however.

To comply with both requirements, three different types of shielding are possible when communicating with HART:
- Shielding at both ends
- Shielding at one end on the feed side with capacitance termination at the field device
- Shielding at one end on the feed side

Experience shows that the best results with regard to EMC are achieved in most cases in installations with one-sided shielding on the feed side (without capacitance termination at the field device). Appropriate measures with regard to input wiring must be taken to allow unrestricted operation when EMC interference is present. These measures have been taken into account for this device. Operation in the event of disturbance variables as per

NAMUR NE21 is thus guaranteed. Where applicable, national installation regulations and guidelines must be observed during the installation! Where there are large differences in potential between the individual grounding points, only one point of the shielding is connected directly with the reference ground. In systems without potential equalization, therefore, cable shielding of fieldbus systems should only be grounded on one side, for example at the supply unit or at safety barriers.

NOTICE

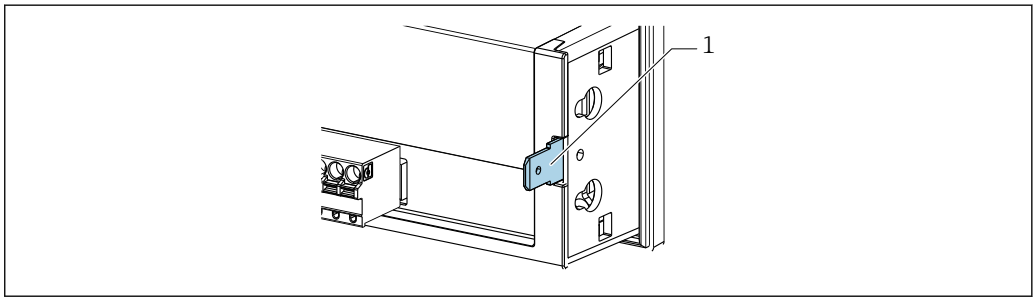
If the shielding of the cable is grounded at more than one point in systems without potential matching, power supply frequency equalizing currents can occur that damage the signal cable or have a serious effect on signal transmission.

- In such cases the shielding of the signal cable should be grounded on one side only, i.e. it must not be connected to the ground terminal of the housing. The shield that is not connected should be insulated!

6.7 Connecting to functional grounding

6.7.1 Panel-mounted device

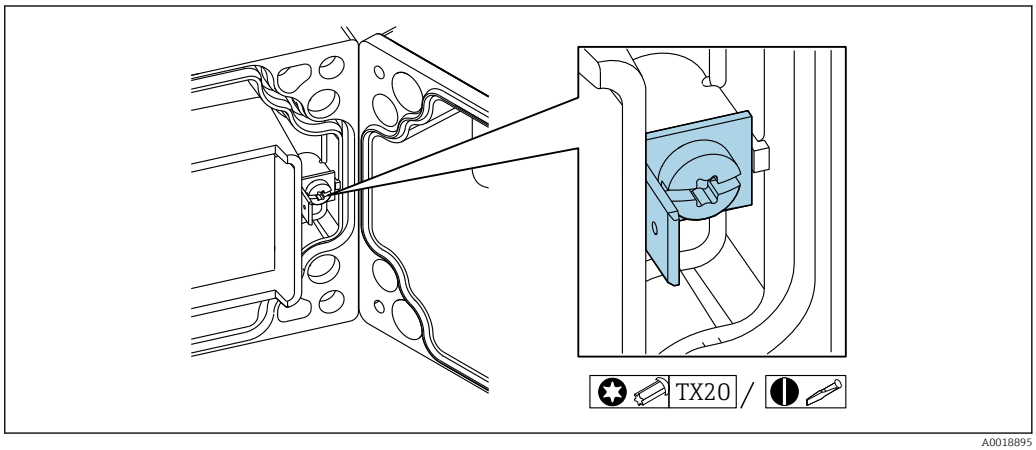
For EMC reasons, the functional grounding should always be connected. When the device is used in the hazardous area (with optional Ex approval) the connection is obligatory.



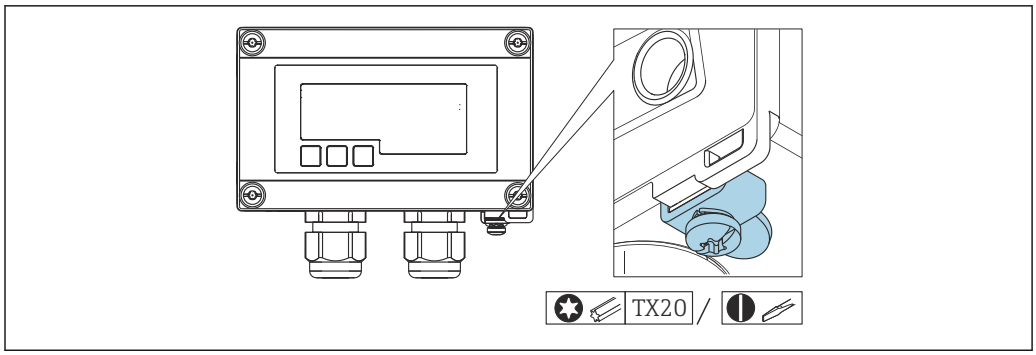
18 *Functional grounding terminal on panel-mounted device*

6.7.2 Field device

For EMC reasons, the functional grounding should always be connected. When used in the hazardous area (with optional Ex approval), the connection is obligatory and the field housing must be grounded via a grounding screw fitted on the outside of the housing.



19 *Functional grounding terminal in field housing*



20 *Ground terminal on field housing*

6.8 Ensuring the degree of protection

6.8.1 Field housing

The devices meet all the requirements of IP67. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:

- The housing seal must be clean and undamaged when inserted into the groove. The seal must be cleaned, dried or replaced if necessary.
- The cables used for connection must be of the specified outside diameter (e.g. M16 x 1.5, cable diameter 5 to 10 mm (0.2 to 0.39 in)).
- Mount the measuring instrument in such a way that the cable entries point downwards.
- Replace unused cable entries with dummy plugs.
- The housing cover and the cable entries must be firmly tightened.

6.8.2 Panel housing

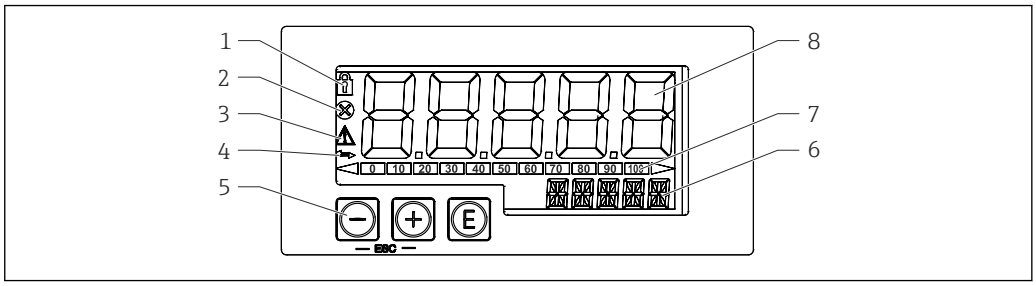
The front of the device meets the requirements of IP65. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:

- The seal between the front of the housing and the panel must be clean and undamaged. The seal must be cleaned, dried or replaced if necessary.
- The threaded rods of the panel mounting clips must be firmly tightened (tightening torque: 0.4 to 0.6 Nm).

6.9 Post-connection check

Device condition and specifications	**Notes**
Are cables or the device damaged?	Visual inspection
Electrical connection	**Notes**
Does the supply current match the specifications on the nameplate?	-
Are the cables, incl. functional grounding, connected correctly and strain-relieved?	-
Field housing: Are the cable glands securely closed?	-

7 Operation



21 *Display and operating elements of the process indicator*

1 *Symbol: operating menu disabled*
2 *Symbol: error*
3 *Symbol: warning*
4 *Symbol: HART communication active (option)*
5 *Operating keys "-", "+", "E"*
6 *14-segment display for unit/TAG*
7 *Bar graph with indicators for under range and over range*
8 *5-digit 7-segment display for measured value, digit height 17 mm (0.67 in)*

The device is operated using three operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

A0017716	Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu
A0017714	Selecting and setting/changing values in the operating menu; pressing the '-' and '+' keys simultaneously takes the user back up a menu level. The configured value is not saved.
A0017715	

7.1 Operating functions

The operating functions of the process indicator are divided into the following menus. The individual parameters and settings are described in the "Commissioning" section.

If the operating menu is disabled by means of a user code, the individual menus and parameters can be displayed but not changed. To change a parameter, the user code must be entered. As the display unit can only display digits in the 7-segment display and not alphanumeric characters, the procedure for number parameters is different to that for text parameters.

If the operating position contains only numbers as parameters, the operating position is displayed in the 14-segment display and the configured parameter is displayed in the 7-segment display. To edit, press the 'E'-button followed by the user code.

If the operating position contains text parameters, only the operating position is initially displayed in the 14-segment display. If the 'E' button is pressed again, the configured parameter is displayed in the 14-segment display. To edit, press the '+' button followed by the user code.

Setup (SETUP)	Basic device settings → 🖹 36
Diagnostics (DIAG)	Device information, display of error messages → 🖹 38
Expert (EXPRT)	Expert settings for the device setup → 🖹 36 The Expert menu is protected from editing by an access code (default 0000).

8 Commissioning

8.1 Post-installation check and switching on the device

Perform the final checks before commissioning the device:
- Checklist for "post-installation check" → 🖹 23.
- Checklist for "post-connection check" → 🖹 34.

The device starts after being connected to the 4 to 20 mA/HART circuit. The firmware version appears on the display during the start-up phase.

When the device is being commissioned for the first time, program the setup in accordance with the descriptions in the Operating Instructions.

If you are commissioning a device that is already configured or preset, the device immediately starts measuring the current or making a HART request as defined in the settings. The values of the currently activated process variables appear in the display.

Remove the protective film from the display as this would otherwise affect the readability of the display.

8.2 Operating matrix

Default settings may differ for RIA15 with the options "Level for FMR20 + FMR20B + FMR30B + FMX21 + FMG50", "Analysis for CM82" and "Level for NMS8x".

Setup menu (SETUP)			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
LEVEL		Level option MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the FMR20/FMR20B/ FMR30B/FMX21 measuring instruments. The individual parameters are described in the "Operating matrix in conjunction with the Micropilot FMR20/FMR20B/FMR30B" → 🖹 41 section and the "Operating matrix in conjunction with the FMX21" → 🖹 42 section.
FMG50		Option FMG50 MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the Gammapilot FMG50. The individual parameters are described in the "Operating matrix in conjunction with the FMG50"→ 🖹 43 section.
OPRAT		Option NMS8x MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the Proservo NMS8x. The individual parameters are described in the "Operating matrix in conjunction with the NMX8x" section → 🖹 47.
CT		Analysis option MODE = HART CM82 connected	This menu contains the parameters for configuring the CM82 analytical measuring instrument. The individual parameters are described in the "Operating matrix in conjunction with the CM82" → 🖹 50section.

Setup menu (SETUP)			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
MODE	**4-20** HART		Use this function to select the operating mode for the indicator. 4-20: The 4 to 20 mA signal of the circuit is displayed. HART: Up to four HART variables (PV, SV, TV, QV) of a sensor/actuator in the loop can be displayed.
DECIM	0 DEC **1 DEC** 2 DEC 3 DEC 4 DEC	MODE = 4-20	Number of decimal places for the 4 to 20 mA display mode.
SC__4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = 4-20	5-digit value (number of decimal places as configured under DECIM) for scaling the measured value at 4 mA Example: SC__4 = 0.0 → 0.0 displayed at measuring current 4 mA The unit selected under UNIT is used to display the value.
SC_20	Numerical value –19 999 to 99 999 Default: **100.0**	MODE = 4-20	5-digit value (number of decimal places as configured under DECIM) for scaling the measured value at 20 mA Example: SC_20 = 100.0 → 100.0 displayed at measuring current 20 mA The unit selected under UNIT is used to display the value.
UNIT	% °C °F K USER	MODE = 4-20	Use this function to select the unit for displaying the value. If "USER" is selected, a user-defined unit can be entered in the TEXT parameter.
TEXT	Customized text, 5-digit	MODE = 4-20	User-defined unit, only visible if the "USER" option has been selected under UNIT.
SCAN	**NO** YES	MODE = HART	Select "YES" to start scanning. All addresses are then automatically scanned once in a HART application until a sensor/actuator is found. Scanning runs from 0 to 63. Only addresses up to 15 are permitted for HART 5. Once the address of the sensor/actuator whose values are to be displayed is found, the address must be confirmed by pressing the 'E' key. This address is adopted and is used even after a device restart. By pressing the '+' or '–' key, it is possible to search for other addresses. Pressing '+'- and '-' simultaneously will cancel scanning. If "NO" is selected, scanning is not active. The address of the sensor/actuator whose values are to be displayed on the process indicator must be configured manually using the operating keys.
ADDR	Numerical value 0 to 63 Default: **0**	MODE = HART	Use this function to enter manually the address of the HART sensor/actuator whose values are to be displayed. If the address of the HART slave is changed, it must also be changed on the process indicator. To do this, either enter the address manually or search using SCAN mode.
MTYPE	PRIM **SEC**	MODE = HART	Use this function to select the HART master type: PRIM = Primary master SEC = Secondary master
HART1-HART4		MODE = HART	Use this function to select which HART value of a sensor/actuator (PV, SV, TV, QV) should be activated and configured: HART1 = PV HART2 = SV HART3 = TV HART4 = QV Press the E key to open the configuration submenu.
DISP1–DISP4	OFF MAN AUTO Default: DISP1: **AUTO** DISP2: **MAN** DISP3: **MAN** DISP4: **MAN**	MODE = HART	Use this function to select how or whether the value should be displayed. OFF: Value is not displayed MAN: You can manually scroll through activated HART values by pressing '+' or '–'. Otherwise the values are not displayed. If all four HART values (HART1 to HART4) are set to "MAN", HART1 (PV) is displayed if you do not scroll manually through the values. AUTO: Activated HART values are displayed alternately (switching time can be configured in the EXPRT menu under "TOGTM"). If one value is set to AUTO, this value is displayed continuously on the device.

Setup menu (SETUP)			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
DEC1 – DEC4	0 DEC **1 DEC** 2 DEC 3 DEC 4 DEC	MODE = HART	Number of decimal places for the values HART1 - HART4.
BGLO1-BGLO4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = HART	5-digit value (number of decimal places as configured under DEC1-DEC4) for scaling the lower range of the bar graph for HART1 - HART4. The bar graph is disabled if BGLOx and BGHIx are set to "0.0".
BGHI1-BGHI4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = HART	5-digit value (number of decimal places as configured under DEC1-DEC4) for scaling the upper range of the bar graph for HART1 - HART4. The bar graph is disabled if BGLOx and BGHIx are set to "0.0".
UNIT1-UNIT4	**HART** % °C °F K USER	MODE = HART	Use this function to select the unit for displaying the HART value. If "HART" is selected, the unit configured on the sensor/actuator is automatically adopted for the relevant HART value. Only units with a maximum of 5 characters can be shown. Longer units are displayed as unit code "UCxxx". The table in the HART communication section at the end of these Operating Instructions provides an overview of the units that can be displayed. If "USER" is selected, a user-defined unit can be entered in the TEXT1-TEXT4 parameter.
TEXT1-TEXT4	Customized text, 5-digit	MODE = HART	User-defined unit. Only visible if the "USER" option has been selected under UNIT

Diagnostics menu (DIAG)		
Parameter	**Values**	**Description**
AERR	Read only	The current diagnostic message appears on the display. If several messages occur simultaneously, the message with the highest priority is shown on the display.
LERR	Read only	The last diagnostic message with the highest priority appears on the display
FWVER	Read only	The firmware version appears on the display
TERR [1)]	Read only	Displays the diagnostic code/error code pending at Endress+Hauser HART transmitters/sensors. Please refer to the Operating Instructions of the relevant Endress+Hauser transmitter/sensor for additional information about the meaning of the diagnostic number and the remedial measures.

1) For Endress+Hauser transmitters/sensors with HART communication, the diagnostic code/error code currently pending can be queried via Endress+Hauser command #231. This command is only supported by Endress+Hauser transmitters/sensors. Therefore, the TERR parameter is not visible if third-party devices are connected to the RIA15.

Expert menu (EXPRT); a code must be entered			
In addition to all the parameters in the Setup menu, the Expert menu also contains the parameters described in this table. If you call up the Expert menu, you will be asked to enter the user code (UCODE, default: 0000).			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
LEVEL		Level option MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the FMR20/FMR20B/FMR30B/FMX21 measuring instruments. The individual parameters are described in the "Operating matrix in conjunction with the Micropilot FMR20/FMR20B/FMR30B" → 🖹 41 section and the "Operating matrix in conjunction with the FMX21" → 🖹 42 section.
FMG50		Option FMG50 MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the Gammapilot FMG50. The individual parameters are described in the "Operating matrix in conjunction with the FMG50"→ 🖹 43 section.

Expert menu (EXPRT); a code must be entered				
In addition to all the parameters in the Setup menu, the Expert menu also contains the parameters described in this table. If you call up the Expert menu, you will be asked to enter the user code (UCODE, default: 0000).				
Parameter		**Values (default in bold)**	**Displayed when**	**Description**
OPRAT			Option NMS8x MODE = HART Measuring instrument connected	This menu contains the parameters for configuring the Proservo NMS8x. The individual parameters are described in the "Operating matrix in conjunction with the NMX8x" section → 🖹 47.
CT			Analysis option MODE = HART CM82 connected	This menu contains the parameters for configuring the CM82 analytical measuring instrument. The CT menu and all of the associated submenus are visible only if the RIA15 was ordered with the "analysis" option and an appropriate device is connected. Using this menu, the basic settings for the analytical measuring instrument can be made via the RIA15. Description of the individual parameters → 🖹 50
SYSTM				
	UCODE	Numerical value 0000 to 9999 Default: **0000**		4-digit user code With the user code it is possible to protect the device setup from unauthorized modifications. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected. The user code is not active with the default setting "0000". This means that setup parameters can be changed without entering the code. The code must always be entered for the Expert menu, even for the default setting.
	FRSET	**NO** YES		Resets the device setup. The values are reset to the preset values for preconfigured devices, and to the default values for all other devices. Select "YES" and press "E" by way of confirmation to reset the device.
	TOGTM	**5** 10 15 20	MODE = HART	Select the switching time in seconds between the HART values if "AUTO" was selected in the DISP1-DISP4 menu.
INPUT				The following parameters are available in addition to the parameters from the Setup menu.
	CURV	**LINAR** SQRT		**Use this to select the calculation function for the process value (for MODE = 4-20)** **LINAR** (scaling with SC__4 and SC_20): Process value = (mA value - 4)/16 * (SC_20 - SC__4) + SC__4 + OFFST **SQRT** (square root extraction and scaling): Process value = Square root((mA value - 4)/16) * (SC_20 - SC__4) + SC__4 + OFFST Negative values when calculating the square root are set to 0. **Use this to select the calculation function for the HART1 value (PV) (for MODE = HART)** **LINAR**: HART1 value (PV) = "exported PV value" * FACT1 + OFFS1 **SQRT** (square root extraction and scaling with BGLO1 and BGHI1): HART1 value (PV) = (square root("exported percentage PV value" / 100) * (BGHI1 - BGLO1) + BGLO1) * FACT1 + OFFS1 Negative values when calculating the square root are set to 0. **Example for SQRT:** ▪ exported percentage PV value = 50 ▪ BGLO1 = 100.0 ▪ BGHI1 = 200.0 ▪ FACT1 = 1 ▪ OFFS1 = 0.0 HART1 value (PV) = (square root(50/100) * (200 - 100) + 100) * 1 + 0 = 170.7
	NAMUR	NO **YES**	MODE = 4-20	Used for determining the maximum permissible errors in accordance with standard NAMUR NE 43 → 🖹 54
	RNGLO	Numerical value	NAMUR = NO	Lower range limit. An error message is displayed if the measured current falls below this limit.

Expert menu (EXPRT); a code must be entered				
In addition to all the parameters in the Setup menu, the Expert menu also contains the parameters described in this table. If you call up the Expert menu, you will be asked to enter the user code (UCODE, default: 0000).				
Parameter		**Values (default in bold)**	**Displayed when**	**Description**
	RNGHI	Numerical value	NAMUR = NO	Upper range limit. An error message is displayed if the measured current exceeds this limit.
	OFFST	Numerical value −19 999 to 99 999	MODE = 4-20	Use this function to enter an offset value to display the measured value.
	FACT1-FACT4	1E-6 1E-5 1E-4 1E-3 1E-2 1E-1 **1** 1E1 1E2 1E3 1E4 1E5 1E6	MODE = HART	As the display is limited to 5 characters, the measured value must be multiplied by a factor if necessary. For example: conductivity 0.00003 S multiplied by factor 1E6 →30.000 µS. If a factor is used, it is recommended to set the unit under UNIT1-4 to "UNIT" and to enter user-defined text because the unit automatically delivered via HART no longer matches the displayed value.
	OFFS1-OFFS4	Numerical value −19 999 to 99 999	MODE = HART	Use this function to enter an offset value to display the HART1-HART4 measured value. If a factor is used, the offset is added to the multiplied value (displayed value = measured value*factor + offset)
	EXP1-EXP4	**YES** NO	MODE = HART	Measured value display for measured values greater than 99999. ▪ YES: If the display overruns, the measured value is displayed in exponential notation. ▪ NO: Values with more than 5 digits are not displayed if the display overruns. Value is displayed with leading zeros. **Example:** Measured value: 130002.4 YES => 1.30E5 NO => 0002.4
DIAG				
	CNTHI	Read only	MODE = HART	Counter for the number of values transmitted via HART, 5 top positions. The counter goes back to 0 after a device restart or scan.
	CNTLO	Read only	MODE = HART	Counter for the number of values transmitted via HART, 5 bottom positions. The counter goes back to 0 after a device restart or scan.
	RETRY	Read only	MODE = HART	Counter for the number of retries to establish HART communication. The counter goes back to 0 after a device restart or scan.
	FAIL	Read only	MODE = HART	Counter for the number of failed attempts to establish HART communication. The counter goes back to 0 after a device restart or scan.
	HLEVL			
	Tx mV	Read only	MODE = HART	Value of the peak-to-peak level of the transmission signal in mV
	Rx mV	Read only	MODE = HART	Value of the peak-to-peak level of the received signal in mV
	NOISE	Read only	MODE = HART	Displays the level of the interference signal LO = low interference signal MED = medium interference signal HI = high interference signal
	Rc Ω	Read only	MODE = HART	Value of the total resistance in the HART loop in Ohm

8.3 Operating matrix in conjunction with the Micropilot FMR20/FMR20B/FMR30B

In the HART mode, the RIA15 with the "level" option can be used for the basic commissioning of the Micropilot radar level sensor.

For additional information on the FMR20/FMR20B/FMR30B, see the associated Operating Instructions → BA01578F/BA02364F/BA02373F.

Basic commissioning of FMR20/FMR20B/FMR30B

The RIA15 must be in the HART mode (MODE = HART) to make the basic settings. The LEVEL menu is not visible in the analog mode (MODE = 4-20).

1. Press the E key.
   ↳ The **Setup** menu opens.
2. Press the E key.
   ↳ The **LEVEL** submenu opens.
3. Set the desired parameters. For parameter descriptions, see the following table.

Setup -> Level (LEVEL) menu		
The LEVEL menu is only visible if the RIA15 has been ordered with the "Level" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Micropilot radar level sensor can be made via the RIA15.		
Parameter	**Values**	**Description**
LEVEL		This menu contains the parameters for configuring the level transmitter. Using this menu, the basic settings for the Micropilot level transmitter can be made via the RIA15.
UNIT [1]	m ft	Use this function to select the displayed unit
DUNIT [2]	mm m in ft	Use this function to select the distance unit at the transmitter
LUNIT [2]	% mm m in ft	Use this function to select the level unit at the transmitter
EMPTY	Numerical value – 199.99 to 999.99	Empty calibration using keys -,+,E. Enter distance from process connection to min. level Valid range of adjustment: 0 to 100 m
FULL	Numerical value – 199.99 to 999.99	Full calibration using keys -,+,E. Enter span from max. level to min. level
DIST	Measured value	Measured value (measured distance)
MAP		
DI OK		To be selected if the distance displayed matches the actual distance. The device then carries out a mapping.
MAN [1]		To be selected if the range of mapping is to be defined manually in the 'MAPDI' parameter. A comparison between the distance displayed and the actual distance is not necessary in this case. Mapping becomes active after approx. 20 s.
DI UN		To be selected if the actual distance is unknown. No mapping is recorded.
FACT [1]		To be selected if the present mapping curve (if one exists) is to be deleted. The device returns to the "Confirm distance" parameter and a new mapping can be recorded.

Setup -> Level (LEVEL) menu			
The LEVEL menu is only visible if the RIA15 has been ordered with the "Level" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Micropilot radar level sensor can be made via the RIA15.			
Parameter		**Values**	**Description**
	EMPTY [2]		To be selected if the tank is empty. The device then carries out a mapping.
	MAPDI [1]		Enter the end of the mapping when the MAN parameter is selected.

1) only for FMR20
2) only for FMR20B and FMR30B

8.4 Operating matrix in conjunction with the Waterpilot FMX21

In the HART mode, the RIA15 with the "level" option can be used for the basic commissioning of the Waterpilot FMX21 level sensor.

For further information on the FMX21, see the associated Operating Instructions → BA00380P and BA01605P.

Basic commissioning of the FMX21

The RIA15 must be in the HART mode (MODE = HART) to make the basic settings. The LEVEL menu is not visible in the analog mode (MODE = 4-20).

1. Press the E key.
   ↳ The **Setup** menu opens.
2. Press the E key.
   ↳ The **LEVEL** submenu opens.
3. Set the desired parameters. For parameter descriptions, see the following table.

Setup -> Level (LEVEL) menu			
The LEVEL menu is only visible if the RIA15 has been ordered with the "level" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Waterpilot FMX21 level sensor can be made via the RIA15.			
Parameters		**Values**	**Description**
LEVEL			This menu contains the parameters for configuring the pressure measuring device for hydrostatic level measurement, FMX21. Using this menu, the basic settings for the FMX21 can be made via the RIA15. Once the LEVEL menu item is opened, the following parameters are automatically adjusted for easier operation: ▪ Operating mode: Level ▪ Calibration mode: Dry ▪ Level selection: In pressure ▪ Lin mode: Linear It is possible to reset these parameters to the factory default settings by performing a reset.
	PUNIT	mbar bar kPa PSI	Use this function to select the unit for pressure
	LUNIT	% m inch feet	Use this function to select the unit for level
	TUNIT	°C °F K	Use this function to select the unit for temperature

Setup -> Level (LEVEL) menu			
The LEVEL menu is only visible if the RIA15 has been ordered with the "level" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Waterpilot FMX21 level sensor can be made via the RIA15.			
Parameters		**Values**	**Description**
	ZERO	NO YES	For performing a position adjustment (gauge pressure sensor). The value 0.0 is assigned to the pressure value present. The current value is also corrected.
	P_LRV	-1999.9 ... 9999.9	Pressure empty calibration using keys -,+,E More in-depth description / valid value range: any value in the range indicated [1)] Number of decimal places depends on the configured pressure unit. Valid ranges of adjustment: 0 to 100 mbar or 0 to 20 bar
	P_URV	-1999.9 ... 9999.9	Pressure full calibration using keys -,+,E More in-depth description / valid value range: any value in the range indicated [1)] Number of decimal places depends on the configured pressure unit. Valid ranges of adjustment: 0 to 100 mbar or 0 to 20 bar
	EMPTY	-1999.9 ... 9999.9	Level empty calibration using keys -,+, E More in-depth description / valid value range: any value in the range indicated [1)] Number of decimal places depends on the configured level unit. For valid ranges of adjustment, see associated Operating Instructions of the FMX21 → BA00380P and BA01605P.
	FULL	-1999.9 ... 9999.9	Level full calibration using keys -,+, E More in-depth description / valid value range: any value in the range indicated [1)] Number of decimal places depends on the configured level unit. For valid ranges of adjustment, see associated Operating Instructions of the FMX21 → BA00380P and BA01605P.
	LEVEL	Measured value	Displays the measured level Number of decimal places depends on the configured level unit.
	RESET	NO YES	Reset the FMX21 to factory defaults

1) The values entered for "Empty calib./Full calib.", "Empty pressure/Full pressure" and "Set LRV/Set URV" must be at least 1% apart. The value will be rejected, and a message displayed, if the values are too close together. Further limit values are not checked, i.e. the values entered must be appropriate for the sensor module and the measuring task for the device to be able to measure correctly.

8.5 Operating matrix in conjunction with the Gammapilot FMG50

In the HART mode, the RIA15 with the "FMG50" option can be used for the basic configuration of the level mode, point level mode or density mode of the Gammapilot FMG50.

For additional information on the FMG50, see the associated Operating Instructions → BA01966F

Basic setup of the Gammapilot FMG50

The RIA15 must be in the HART mode (MODE = HART) to make the basic settings. The **FMG50** menu is not visible in the analog mode (MODE = 4-20).

1. Press the E key.
   ↳ The **SETUP** menu opens.
2. Press the E key.
   ↳ The **FMG50** submenu opens.
3. Set the desired parameters. For parameter descriptions, see the following table.

Menu SETUP -> FMG50 -> OPER (Operating Mode)			
The FMG50 menu is only visible if the RIA15 has been ordered with the "FMG50" option and the display unit is operated in the HART mode (MODE = HART). The basic configuration of the level mode, point level mode or density mode of the Gammapilot FMG50 can be performed via the RIA15 using this menu.			
Parameter		**Values**	**Description**
FMG50			This menu contains the parameters for the basic configuration of the Gammapilot FMG50 for level measurement, point level measurement or density measurement. The basic settings for the Gammapilot FMG50 can be made via the RIA15 using this menu.
	OPER	PLEV LEVEL DENS	Opens the "Operating Mode" menu where the user can select the measuring mode for the device. Users can choose from the following measuring modes: ▪ Point Level (point level measurement) ▪ Continuous Level ▪ Density For a detailed description of the individual operating modes, see the Operating Instructions for the FMG50.

Menu SETUP -> FMG50 -> OPER -> PLEV (Point Level)			
The basic configuration of the Gammapilot FMG50 for point level measurement can be performed via the RIA15 using this menu. **If "PLEV" (Point Level) has been selected as the operating mode, the linearization type is automatically set to "Linear".**			
Parameter		**Values**	**Description**
	LRV		Level value for 4 mA
		Numerical value	0.1 to 9 999.9
	URV		Level value for 20 mA
		Numerical value	0.1 to 9 999.9
	BEAMT		**Beam Type:** Choice of continuous or modulated radiation. Modulated radiation is used to suppress gammagraphy. The FHG65 modulator must be used in order to use modulated radiation.
		MOD	Modulated
		STD	Standard
	ISOTY		Use this function to select the isotope used for the measurement. The type of isotope is critical for correct decay compensation.
		CS137	Caesium 137
		CO60	Cobalt 60
	CTIME		Integration time for the calibration.
		Numerical value	1 to 8 000 s
	BCKCL		Background calibration is necessary for the measurement of natural background radiation.
		START	Starts the measurement of the pulse rate, which is caused by natural background radiation.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	PULSF		Full calibration: calibration of the pulse rate for "Full"
		START	**START** triggers a full calibration. The device determines the pulse rate in the "Full" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	FULL		Use this function to enter a level value for full calibration (for point level measurement = 100 %).
		Numerical value	100.0 to 60.0 %
	PULSE		Empty calibration: calibration of the pulse rate for "Empty"

Menu SETUP -> FMG50 -> OPER -> PLEV (Point Level)			
The basic configuration of the Gammapilot FMG50 for point level measurement can be performed via the RIA15 using this menu. **If "PLEV" (Point Level) has been selected as the operating mode, the linearization type is automatically set to "Linear".**			
Parameter		**Values**	**Description**
		START	**START** triggers an empty calibration. The device determines the pulse rate in the "Empty" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	EMPTY		Use this function to enter a level value for empty calibration (for point level measurement = 0 %).
		Numerical value	0.0 to 40.0 %
	PLSB		Displays the background pulse rate
	PLSF		Displays the full pulse rate
	PLSE		Displays the empty pulse rate

Menu SETUP -> FMG50 -> OPER -> LEVEL (Continuous Level)			
The basic configuration of the Gammapilot FMG50 for continuous level measurement can be performed via the RIA15 using this menu. **If "Continuous Level" has been selected as the operating mode, the linearization type is automatically set to "Standard".**			
Parameter		**Values**	**Description**
	LUNIT		Unit for continuous level measurement (percent only)
		%	Percent
	LRV		Level value for 4 mA
		Numerical value	0.1 to 9 999.9
	URV		Level value for 20 mA
		Numerical value	0.1 to 9 999.9
	BEAMT		**Beam Type:** Choice of continuous or modulated radiation. Modulated radiation is used to suppress gammagraphy. The FHG65 modulator must be used in order to use modulated radiation.
		MOD	Modulated
		STD	Standard
	ISOTY		Use this function to select the isotope used for the measurement. The type of isotope is critical for correct decay compensation.
		CS137	Caesium 137
		CO60	Cobalt 60
	CTIME		Integration time for the calibration.
		Numerical value	1 to 8 000 s
	BCKCL		Background calibration is necessary for the measurement of natural background radiation.
		START	Starts the measurement of the pulse rate, which is caused by natural background radiation.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	PULSF		Full calibration: calibration of the pulse rate for 100 %
		START	**START** triggers a full calibration. The device determines the pulse rate in the "Full" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress

Menu SETUP -> FMG50 -> OPER -> LEVEL (Continuous Level)			
The basic configuration of the Gammapilot FMG50 for continuous level measurement can be performed via the RIA15 using this menu. **If "Continuous Level" has been selected as the operating mode, the linearization type is automatically set to "Standard".**			
Parameter		**Values**	**Description**
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	PULSE		Empty calibration: calibration of the pulse rate for 0 %
		START	**START** triggers an empty calibration. The device determines the pulse rate in the "Empty" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	PLSB		Displays the background pulse rate
	PLSF		Displays the full pulse rate
	PLSE		Displays the empty pulse rate

Menu SETUP -> FMG50 -> OPER -> DENS (Density)			
The basic configuration of the Gammapilot FMG50 for density measurement can be performed via the RIA15 using this menu. **If "Density" has been selected as the operating mode, the linearization type is automatically set to "Multipoint Calibration".**			
Parameter		**Values**	**Description**
	DUNIT		Engineering unit for displaying and transmitting the density value.
		G/CM3 KG/M3 G/L LB/GA LB/IN	g/cm^3 kg/m^3 g/l lb/gal lb/in^3
	LUNIT		Unit of length for entering distances, e.g. length of the beam path
		MM INCH	mm inch
	LRV		Density value for 4 mA
		Numerical value	0.0 to 9 999.9 (the number of decimal places depends on the setting in the DUNIT parameter)
	URV		Density value for 20 mA
		Numerical value	0.0 to 9 999.9 (the number of decimal places depends on the setting in the DUNIT parameter)
	BEAMP		**Beam Path:** The length of the beam path is the distance between the source container and the detector. If this distance is not known, an approximate value or the pipe diameter can be used.
		Numerical value	0 to 99 999 mm (0.1 to 9 999.9 in)
	BEAMT		**Beam Type:** Choice of continuous or modulated radiation. Modulated radiation is used to suppress gammagraphy. The FHG65 modulator must be used in order to use modulated radiation.
		MOD	Modulated
		STD	Standard
	ISOTY		Use this function to select the isotope used for the measurement. The type of isotope is critical for correct decay compensation.
		CS137	Caesium 137
		CO60	Cobalt 60
	CTIME		Integration time for the calibration.
		Numerical value	1 to 8 000 s
	BCKCL		Background calibration is necessary for the measurement of natural background radiation.
		START	Starts the measurement of the pulse rate, which is caused by natural background radiation.

Menu SETUP -> FMG50 -> OPER -> DENS (Density)			
The basic configuration of the Gammapilot FMG50 for density measurement can be performed via the RIA15 using this menu. **If "Density" has been selected as the operating mode, the linearization type is automatically set to "Multipoint Calibration".**			
Parameter		**Values**	**Description**
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	PULS1		Pulse rate of 1st density calibration point The pulse rate that corresponds to the density of the material in the beam path is determined during the calibration. This value and the absorption coefficient are used to calculate the course of the calibration curve for density measurement.
		START	**START** triggers the calibration of the 1st density point. The device determines the pulse rate in the "Density point 1" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	DENS1		Use this function to enter the corresponding density value for the calibration of density point 1.
		Numerical value	0.1 to 999.9
	PULS2		Pulse rate of 2nd density calibration point The pulse rate that corresponds to the density of the material in the beam path is determined during the calibration. This value and the absorption coefficient are used to calculate the course of the calibration curve for density measurement.
		START	**START** triggers the calibration of the 2nd density point. The device determines the pulse rate in the "Density point 2" state.
		STOP	Stop the calibration
		WAIT	Calibration in progress
		DONE	Calibration is finished. The calibration point is activated by pressing the "E" key.
	DENS2		Use this function to enter the corresponding density value for the calibration of density point 2.
		Numerical value	0.1 to 9 999.9
	PLSB		Displays the background pulse rate
	PLSD1		Displays the pulse rate of the 1st density calibration point
	PLSD2		Displays the pulse rate of the 2nd density calibration point

8.6 Operating matrix in conjunction with the Proservo NMS8x

In the HART mode, the RIA15 with the "NMS8x" option can be used for the basic operation of the Proservo NMS8x tank gauging device.

For additional information on the NMS80, see the associated Operating Instructions → BA01456G.

For additional information on the NMS81, see the associated Operating Instructions → BA01459G.

For additional information on the NMS83, see the associated Operating Instructions → BA01462G.

Basic commissioning of the NMS8x

The RIA15 must be in the HART mode (MODE = HART) to make the basic settings. The **OPRAT** menu is not visible in the analog mode (MODE = 4-20).

1. Press the E key.
   ↳ The **OPRAT** menu opens.
2. Press the E key.
   ↳ The **CMD** submenu opens.
3. Set the desired parameters. For parameter descriptions, see the following table.

Menu OPRAT (Operating)		
The OPRAT menu is only visible if the RIA15 has been ordered with the "NMS8x" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Proservo NMS8x tank gauging device can be made via the RIA15.		
Parameters	**Values**	**Description**
OPRAT		This menu contains the parameters for the operation of the Proservo NMS8x and for reading out the current measurement status.
CMD		Command used to select the device measuring mode. The status of the execution of the command is indicated in the **STA** status parameter. For more information on the NMS8x, see the Operating Instructions for the device.
	STOP	Stop
	LEVEL	Level
	UP	Up
	BTM L	Bottom level
	UP IF	Upper I/F level
	LO IF	Lower I/F level
	U DEN	Upper density
	M DEN	Middle density
	L DEN	Lower density
	REPET	Repeatability
	W DIP	Water dip
	R OVR	Release overtension
	T Pro	Tank profile
	IFPro	Interface profile
	M Pro	Manual profile
	STBY	Level standby
	SELF	Self check
BAL		Indicates the validity of the measurement. If it is balanced, the corresponding value (Liquid Level, Upper Interface, Lower Interface, Tank Bottom) is updated.
	No	Level data of the device are not valid.
	Yes	Level data of the device are valid.
STA		Indicates the current measurement status of the device.
	REF	isplacer at reference position
	UP	Displacer hoisting up
	STOP	Displacer stop
	BAL	Level measurement balanced
	UIF B	Upper interface level balanced
	UDErr	Upper density error

Menu OPRAT (Operating)		
The OPRAT menu is only visible if the RIA15 has been ordered with the "NMS8x" option and the indicator is operated in the HART mode (MODE = HART). Using this menu, the basic settings for the Proservo NMS8x tank gauging device can be made via the RIA15.		
Parameters	**Values**	**Description**
	BTm B	Bottom measurement balanced
	UDDon	Upper density done
	MDDon	Middle density done
	LDDon	Lower density done
	REL	Release overtension
	CALIB	Calibration activated
	SEEK	Seek level
	FLW	Follow level
	S UIF	Seek upper interface level
	F UIF	Follow upper interface level
	MDErr	Middle density error
	F LIF	Follow lower interface level
	S BTm	Seek bottom level
	H STP	Stopped at high stop
	L STP	Stopped at low stop
	REPET	Repeatability testing
	S WL	Seek water level
	WLErr	Water level error
	T BAL	Temporary balanced
	LDErr	Lower density error
	SL UP	Slow hoist up
	MAINT	Maintenance
	LIF B	Lower Interface level balanced
	S LIF	Seek lower interface level
	RELSD	Overtension released
	Abv_L	Above liquid
	WDDon	Water dip finished
	P Don	Profile done
	B Don	Bottom done
	L Fnd	Level found
	P Err	Profile error
	WAIT	Wait for level
	S STb	Seek standby position
	MOVE	Move to target
	M DEN	Measure density
	M AIR	Measure in air
	B Err	Bottom error

8.7 Operating matrix in conjunction with the Liquiline CM82

In the HART mode, the RIA15 with the "analysis" option can be used for the basic commissioning of the Liquiline CM82.

For further information on the CM82, see the associated Operating Instructions → BA01845C

Basic commissioning of the CM82

The RIA15 must be in the HART mode (MODE = HART) to make the basic settings. The ANALYSIS menu is not visible in analog mode (MODE = 4-20).

1. Press the E key.
   ↳ The **Setup** menu opens.
2. Press the E key.
   ↳ The **CT** submenu opens.
3. Set the desired parameters. For parameter descriptions, see the following table.

Setup -> ANALYSIS menu			
The CT menu and all of the associated submenus are visible only if the RIA15 was ordered with the "analysis" option, the HART option has been configured and a CM82 has been detected by the RIA15. Using this menu, the basic settings for the CM82 can be made via the RIA15.			
Parameters		**Values**	**Description**
CT			This menu contains the parameters for configuring the CM82 compact transmitter.
CSET			Access the "CM82 setup" submenu
	TUNIT	°C °F °K	Select the unit for temperature on the CM82.
	OUTS		Access the "CM82 - Output Setting" submenu to change the setting on the CM82. The primary value (CMAIN) of the CM82 is assigned here and the measuring range (4-20mA) configured. Depending on the sensor type connected, only certain measured values can be configured/displayed.
		pH glass sensors	
		CMAIN	pH mV_PH IMPGL TEMP	pH: pH measured value in pH mV_PH: pH raw value in mV IMPGL: Glass impedance in MOhm [1)] TEMP: Temperature in °C/°F/K (unit as per setting in TUNIT)
		pH-ISFET sensors	
		CMAIN	pH mV_PH LEAKC TEMP	PH: pH measured value in pH mV_PH: pH raw value in mV LEAKC: ISFET leak current in "nA" [1)] TEMP: Temperature in °C/°F/K (unit as per setting in TUNIT)
		pH ORP sensors	
		CMAIN	mVORP %_ORP TEMP	mVORP: ORP measured value in mV %_ORP: Percentage ORP value as % TEMP: Temperature in °C/°F/K (unit as per setting in TUNIT)
		pH/ORP combination sensors	

Setup -> ANALYSIS menu			
The CT menu and all of the associated submenus are visible only if the RIA15 was ordered with the "analysis" option, the HART option has been configured and a CM82 has been detected by the RIA15. Using this menu, the basic settings for the CM82 can be made via the RIA15.			
Parameters		**Values**	**Description**
	CMAIN	pH mV_PH IMPGL IMPRE mVORP %_ORP RH TEMP	PH: pH measured value in pH mV_PH: pH raw value in mV IMPGL: Glass impedance in MOhm [1)] IMPRE: Reference impedance in Ohm mVORP: ORP measured value in mV %_ORP: Percentage ORP value as % RH: rH value in rH TEMP: Temperature in °C/°F/K (unit as per setting in TUNIT)
	Oxygen sensors		
	CMAIN	PAR_P %SAT C_LIQ C_GAS CURR RTIME TEMP	PAR_P: Partial pressure of oxygen in hPa %SAT: Percentage saturation as % C_LIQ: Liquid concentration (unit as per setting in UCLIQ) C_GAS: Gas concentration (unit as per setting in UCGAS) CURR: Raw value, measuring current of sensor in nA [1)] (visible only in the case of amperometric oxygen sensors) RTIME: Decay time, raw value in µs (visible only in the case of optical oxygen sensors) TEMP: Temperature in °C/°F/K (unit as per setting in TUNIT)
	UCLIQ	 mG_L uG_L PPM PPB	Unit of upper and lower turndown setting if the primary value (CMAIN) is set to C_LIQ mG_L: milligram/liter [1)] uG_L: microgram/liter PPM: parts per million PPB: parts per billion
	UCGAS	 %_VOL PPM_V	Unit of upper and lower turndown setting if the primary value (CMAIN) is set to C_GAS %_VOL: percent by volume PPM_V: parts per million
	Conductivity sensors		
	CMAIN	COND RESIS RAWC TEMP	COND: specific conductivity (unit as per setting in UCOND) RESIS: resistivity (unit as per setting in URES) RAWC: uncompensated conductivity (unit as per setting in UCOND) TEMP: temperature (unit as per setting in TUNIT)
	URES	 KO*CM MO*CM KO*M	Unit of upper and lower turndown setting if the primary value (CMAIN) is set to RESIS KO*CM: kOhm*cm MO*CM: MOhm*cm KO*M: kOhm*m
	UCOND	 uS/cm mS/cm S/cm uS/m mS/m S/m	Unit of upper and lower turndown setting if the primary value (CMAIN) is set to COND or RESIS uS/cm: microsiemens/cm mS/cm: millisiemens/cm S/cm: siemens/cm uS/m: microsiemens/m mS/m: millisiemens/m S/m: siemens/m
	for all sensors		

Setup -> ANALYSIS menu			
The CT menu and all of the associated submenus are visible only if the RIA15 was ordered with the "analysis" option, the HART option has been configured and a CM82 has been detected by the RIA15. Using this menu, the basic settings for the CM82 can be made via the RIA15.			
Parameters		**Values**	**Description**
	LOW	-19,999 ... 99,999	Configure turndown of current output. The measured value that corresponds to 4 mA is set here. The limits of adjustment vary depending on the sensor type and measured value. The position of the decimal point is permanently preset depending on the primary value (CMAIN) configured. **Valid ranges of adjustment:** **pH sensor:** PH: -2.00 to 16.00 pH mV_PH: -2000 to 2000 mV LEAKC: -4000.0 to 4000.0 nA IMPGL: 0 to 99999 MOhm IMPRE: 0 to 99999 Ohm mVORP: -2000 to 2000 mV %_ORP: -3000.0 to 3000.0 % RH: 0.0 to 70.0 rH TEMP: -50.0 to 150.0 °C (depending on the unit configured under TEMP) -58.0 to 302.0°F 223.1 to 423.1 K **dissolved oxygen sensor:** PAR_P: 0.0 to 2500.0 hPa %SAT: 0.02 to 200.00 % saturation C_LIQ: -0.02 to 120.00 mg/l -20.00 to 999.99 ug/l -0.02 to 120.00 ppm -20.00 to 999.99 ppb (depending on the unit configured in UCLIQ) C_GAS: -0.02 to 200 .00 % Vol -0.02 to 200 .00 % Vol -200.00 to 999.99 ppm Vol (depending on the unit configured under UCGAS) CURR: 0.0 to 9999.9 nA RTIME: 0.0 to 100.0 µs TEMP: -10.0 to 140.0 °C 14.0 to 284 °F 263.1 to 413.1 K (depending on the unit configured under TEMP) **Conductivity sensor:** COND: 0.000 to 99.999 uS/cm 0.000 to 99.999 mS/cm 0.000 to 2.000 S/cm 0.000 to 99.999 uS/m 0.000 to 99.999 mS/m 0.000 to 99.999 S/m (depending on the unit configured in UCOND) RESIS: 0.00 to 999.99 kOhm*cm 0.00 to 200.00 MOhm*cm 0.00 to 999.99 kOhm*m (depending on the unit configured in URES) RAWC: 0.000 to 99.999 uS/cm 0.000 to 99.999 mS/cm 0.000 to 2.000 S/cm 0.000 to 99.999 uS/m 0.000 to 99.999 mS/m 0.000 to 99.999 S/m (depending on the unit configured in UCOND)

Setup -> ANALYSIS menu				
The CT menu and all of the associated submenus are visible only if the RIA15 was ordered with the "analysis" option, the HART option has been configured and a CM82 has been detected by the RIA15. Using this menu, the basic settings for the CM82 can be made via the RIA15.				
Parameters			**Values**	**Description**
				TEMP: -50.0 to 250.0 °C -58.0 to 482.0 °F 223.1 to 523.1 K (depending on the unit configured under TEMP)
		HIGH	-19,999 ... 99,999	Configure turndown of current output. The measured value that corresponds to 20 mA is set here. The limits of adjustment vary depending on the sensor type and measured value. The position of the decimal point is permanently preset depending on the primary value (CMAIN) and the set units (UCLIQ, UCGAS, URES, UCOND) configured. For valid ranges of adjustment, see LOW (setting for 4 mA)
		ERRC	3.6 to 23.0	Configure the error current on the CM82 in mA
CDIAC				Access the "CM82 - Device diagnostics" submenu
	FCSM		Error category as per NAMUR and error number	Display the error message with the highest priority on the CM82
	DTAG		Device tag	Display the device tag of the CM82 (use +/- keys to scroll through text)
	DSER		Device serial number	Display the serial number of the CM82 (use +/- keys to scroll through text)
	SENOC		Sensor order code	Display the oder code of the sensor (use +/- keys to scroll through text)
	SENSN		Sensor serial number	Display the serial number of the sensor (use +/- keys to scroll through text)
CTRES				Access the "CM82 -Reset" submenu
	RBOOT		No YES	Trigger a restart of the CM82
	FDEF		No YES	Reset the CM82 to factory settings
CTSIM				Access the "CM82 -Simulation" submenu
	SIMUL		OFF ON	Switch on simulation for current output value on CM82
	VALUE		3.6 to 23.0	Configure current output value on CM82 for simulation in mA

1) If this parameter is selected, "UC170" appears in display mode for the unit. To display the unit, this must be individually configured in the "TEXT1" menu item. (SETUP => HART => HART1 => UNIT1 => TEXT1) → 🖹 54

9 Troubleshooting

9.1 Maximum permissible errors as per NAMUR NE 43

In Mode=4-20, the device can be set to maximum permissible errors as per NAMUR NE 43→ 38.

The device displays an error message if a value is outside these limits.

Current value	Error	Diagnostic code
≤ 3.6 mA	Under range	F100
3.6 mA < x ≤ 3.8 mA	Unpermitted measured value	S901
20.5 mA ≤ x < 21.0 mA	Unpermitted measured value	S902
> 21.0 mA	Over range	F100

9.2 Diagnostic messages

If several errors are pending simultaneously, the device always displays the error with the highest priority.

1 = Highest priority

Diagnostic number	Event text	Remedial action	Status signal	Diagnostic behavior	Priority
Diagnostics for the sensor					
F100	Sensor error	▪ Check electrical wiring ▪ Check sensor ▪ Check sensor settings	F	Alarm	6
S901	Input signal too small	▪ Check transmitter output for defect and conformity error ▪ Check transmitter for incorrect configuration	S	Warning	4
S902	Input signal too large		S	Warning	5
Diagnostics for the electronics					
F261	Electronics module	Replace electronics	F	Alarm	1
F283	Memory content	▪ Restart device ▪ Reset device ▪ Replace electronics	F	Alarm	2
F431	Factory calibration	Replace electronics	F	Alarm	3
Diagnostics for the configuration					
M561	Display overshoot	Check scaling	M	Warning	7

9.2.1 Display "UCxxx" instead of HART unit

By default, the unit of the transmitted measured value is automatically read out and displayed using a HART command. If the transmitted "unit code" cannot be uniquely assigned by the RIA15, the unit code (UCxxx) is displayed instead of the unit.

To remedy this, the unit must be set manually. (SETUP => HART => HART1-4 => UNIT1-4 => TEXT1-4).

For the affected units, see → 68

CM82 special case:

The unit codes 170 to 219 are assigned multiple times as per the HART specification. As the UC170 is also used with the CM82, the unit must be assigned manually. This applies to the following measured values/units:

PV (TEXT1):

Transmitter parameter	Primary value (CMAIN)	Unit
pH	Leak current (LEAKC)	nA
pH	Glass impedance (IMPGL)	MOhm
Dissolved oxygen	Liquid concentration (C_LIQ)	mg/l
Dissolved oxygen	Raw value of sensor (CURR)	nA

QV (TEXT4):

Transmitter parameter	Sensor type	Unit
pH	Glass	MOhm
pH	IsFET	nA

9.2.2 HART diagnostic messages

If several errors are pending simultaneously, the device always displays the error with the highest priority.

1 = Highest priority

Diagnostic number	Event text	Remedial action	Status signal	Diagnostic behavior	Priority
F960	HART communication (slave not responding)	▪ Verify HART slave address ▪ Check electrical wiring (HART) ▪ Check HART function sensor/actuator	F	Alarm	8
C970	Multi-master collision	▪ Check additional master in HART network (e.g. handheld) ▪ Check master setting (secondary/primary)	C	Check	9
F911	HART-HART slave device error (HART Field Device Status)	Check sensor/actuator configuration or check for defects	F	Alarm	10
S913	HART slave current output saturated (HART Field Device Status)	▪ Commissioning: Check sensor/actuator for incorrect configuration, check sensor/actuator configuration ▪ Operation: Process parameter outside valid range	S	Warning	11
S915	HART slave variable outside limits of range (HART Field Device Status)		S	Warning	12

9.2.3 Other diagnostics in the HART mode

The process indicator has an integrated HART diagnostics function. This function can be used to estimate the HART signal level, the applicable communication resistance, and the noise of the network.

The indicator can measure and display the following values:

Parameter	Description	Display	
Tx mV	Process indicator signal level	mV	Peak-to-peak level of the transmission signal
Rx mV	Slave signal level	mV	Peak-to-peak level of the received signal
NOISE	Weighting of the interference signal	LO / MED / HI	Categorization of the interference into low, medium or high
Rc Ω	Effective communication resistance	Ω	Resistance in Ohm

The values can be called up in the EXPRT – DIAG – HLEVL menu.

Measuring the transmission signal level "Tx":

The Tx measurement can be used to assess the signal level of the transmission signal.

Ideally this should vary between 200 mV and 800 mV . The following values are displayed:

Tx	< 120 mV	120 to 200 mV	200 to 800 mV	800 to 850 mV	> 850 mV
Display	LO	Level in mV			HI
Bargraph	<	<	0 to 100 %	>	>

Measuring the received signal level "Rx":

The Rx measurement can be used to assess the signal level of the received signal. Ideally this should vary between 200 mV and 800 mV .

The Rx signal measured value that is displayed is a filtered signal level as assessed by the process indicator. In this way, the value measured externally and the displayed value can differ from one another, for example in the case of a trapezoidal received signal.

The following values are displayed:

Rx	< 120 mV	120 to 200 mV	200 to 800 mV	800 to 850 mV	> 850 mV
Display	LO	Level in mV			HI
Bargraph	<	<	0 to 100 %	>	>

Measuring the "NOISE" interference signal:

When the interference signal level is measured, the interference signal determined is divided into three categories:

LO = low

MED = medium

HIGH = high

The noise measurement is also a filtered signal level as assessed by the process indicator. The value measured externally and the displayed value can therefore differ from one another, depending on the frequency and the form of the signal.

With low wanted signal levels (Rx, Tx), transmission errors can occur even if the interference signal level is low ("LO" displayed).

Measuring the communication resistance "Rc":

The "Rc" measurement can be used to determine the network resistance of the HART network. Ideally this should vary between 230 Ω and 600 Ω .

The network resistance is the sum of the HART communication resistance, the device's input resistance, the transmission line resistance and line capacitance.

The following values are displayed:

Rc	< 100 Ω	100 to 230 Ω	230 to 600 Ω	600 to 1000 Ω	> 1000 Ω
Display	LO	Resistance in Ω			HI
Bargraph	<	< .-	0 to 100 %	>	>

9.2.4 Error messages during basic configuration of connected transmitters

While configuring connected transmitters, it may happen that the transmitter responds with a response code not equal to 0. In this case, the response code is displayed briefly on the process indicator ("RC XX"). The current setting on the transmitter is then retrieved again and displayed on the process indicator.

The meaning of the response codes is explained in the following table.

Code	Description	Remedy
RC 02	Invalid selection	Check HART setting and firmware in the connected transmitter
RC 03	Value too large	Check basic settings for the connected transmitter → 🖹 41
RC 04	Value too small	Check basic settings for the connected transmitter → 🖹 41
RC 05	Not enough data bytes received	Check HART setting and firmware in the connected transmitter
RC 06	Device-specific command error	Check HART setting and firmware in the connected transmitter
RC 07	In the write-protected mode	Check write protection in the connected transmitter
RC 14	Span too small	Check basic settings for the connected transmitter → 🖹 41
RC 16	Access restricted	Check HART setting and firmware in the connected transmitter
RC 29	Invalid span	Check basic settings for the connected transmitter → 🖹 41
RC 32	Busy	Try to establish communication again

9.2.5 Other error messages that may occur during configuration

Code	Description	Remedy
F960	HART communication error	Check HART communication: ▪ Communication resistance ▪ Signal level ▪ Faults ▪ Sensor version
F013	CM82 transmitter/sensor type is not supported by the RIA15	Connect a supported transmitter/sensor type

9.3 Firmware history

Release

The firmware version on the nameplate and in the Operating Instructions indicates the device release: XX.YY.ZZ (example 1.02.01).

XX	Change to main version. No longer compatible. The device and Operating Instructions change.
YY	Change to functions and operation. Compatible. The Operating Instructions change.
ZZ	Fixes and internal changes. No changes to the Operating Instructions.

Date	Firmware version	Software changes	Documentation
03/2013	ISU00XA: 1.01.00	HART option	BA01170K/09/EN/02.13
07/2013	ISU00XA: 1.02.00	HART level measurement	BA01170K/09/EN/03.13
11/2014	ISU00XA: 1.03.00	New EXP1-EXP4 parameter for HART option	BA01170K/09/EN/04.14
05/2016	ISU00XA: 1.04.00	New menus and parameters in "FMR20 basic commissioning"	BA01170K/09/EN/05.15
04/2018	ISU00XA (standard): 1.05.01 ISU01XA (CM82): 1.05.01	New menus and parameters "FMX21 / CM82 basic commissioning"	BA01170K/09/EN/06.18
07/2019	ISU00XA (standard +FMG50): 1.06.xx ISU01XA (CM82): 1.05.01 ISU03XA (NMS8x): 1.06.xx	▪ Configuration for FMG50 (ISU00XA) ▪ Configuration for NMS8X (ISU03XA) ▪ Display of the mA value in 4-20 mA mode via + or - key held down	BA01170K/09/EN/07.19
06/2023	ISU00XA (standard +FMG50): 1.06.xx ISU01XA (CM82): 1.05.01 ISU03XA (NMS8x): 1.06.xx	-	BA01170K/09/EN/08.23
11/2024	ISU00XA (standard +FMG50): 1.07.xx	FMR20B and FMR30B configuration	BA01170K/09/EN/09.24

10 Maintenance

No special maintenance work is required for the device.

10.1 Cleaning

A clean, dry cloth can be used to clean the device.

11 Repair

11.1 General information

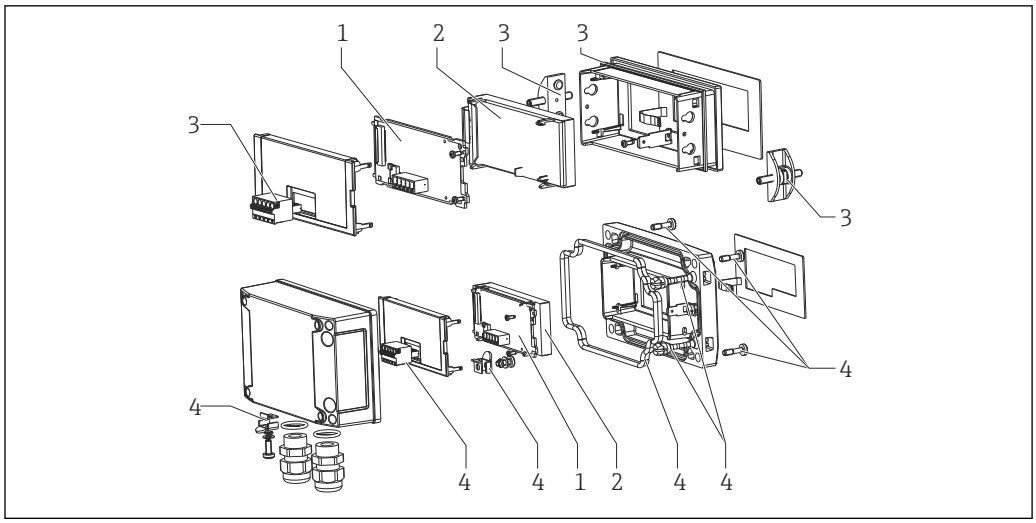
The device has a modular design and repairs can be carried out by the customer's electrotechnical personnel. For more information on service and spare parts, contact the supplier.

11.1.1 Repair of Ex-certified devices

- Only specialist personnel or the manufacturer may undertake repairs on Ex-certified devices.
- The prevailing standards, national hazardous area regulations, safety instructions and certificates must be observed.
- Only use original spare parts from the manufacturer.
- When ordering spare parts, check the device designation on the nameplate. Parts may only be replaced by identical parts.
- Carry out repairs according to the instructions. On completion of the repair, carry out the routine test specified for the device.
- A certified device may only be converted to another certified device version by the manufacturer only.
- Document all repairs and modifications.

11.2 Spare parts

Spare parts currently available for the device can be found online at: http://www.products.endress.com/spareparts_consumables. Always quote the serial number of the device when ordering spare parts!



22 *Spare parts of the process indicator*

Item no.	Name	Order number
1	Mainboard HART Mainboard HART with Level option (FMX21, FMR20 etc.) Mainboard HART with Analysis option (CM82)	XPR0005-ABA XPR0005-ACA XPR0005-ADA
2	LCD module	XPR0006-A1
3	Small parts set for panel-mount housing (5-pin plug-in terminal, seal on front frame, 2x fastening clip)	XPR0006-A2
4	Small parts set for field housing (5-pin plug-in terminal, seal on cover, 2x cover hinge, grounding connection on bottom, cover screws, grounding lug)	XPR0006-A3
4	Cable gland with integrated pressure compensation membrane (for FMX21)	RK01-BD
	Plastic field housing W18 RAL5012, conductive	XPR0006-A4

11.3 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the web page for information:
   https://www.endress.com/support/return-material
   ↳ Select the region.
2. If returning the device, pack the device in such a way that it is reliably protected against impact and external influences. The original packaging offers the best protection.

11.4 Disposal

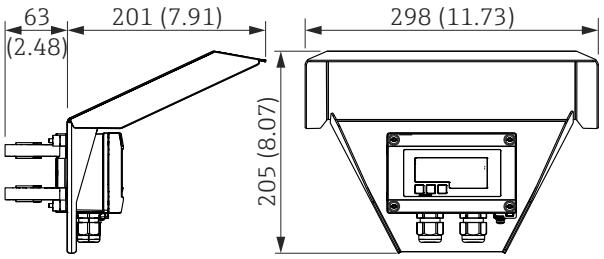
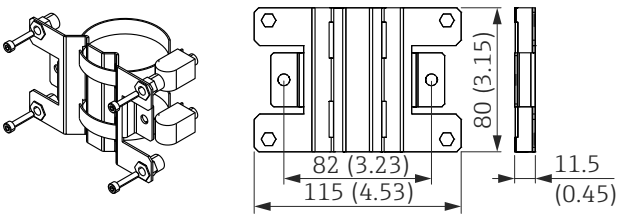
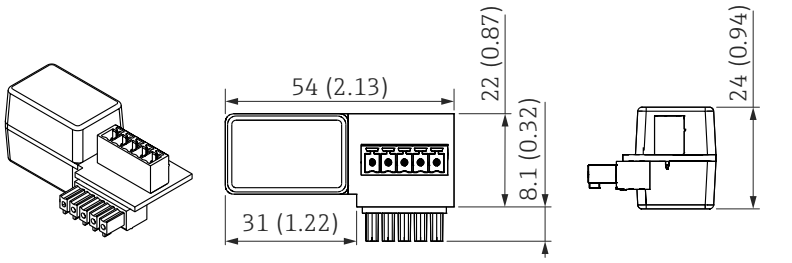
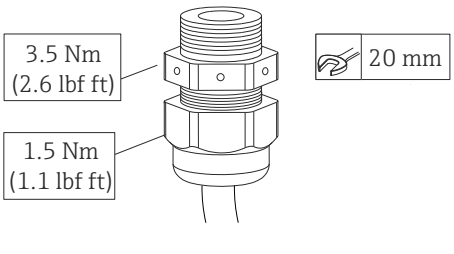
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

12 Accessories

The accessories currently available for the product can be selected at www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Spare parts & Accessories**.

12.1 Device-specific accessories

Weather protection cover	 23 Dimensions of protective cover, engineering unit mm (in)
Mounting kit for wall/ pipe mounting Material: SS 316L	 24 Dimensions of mounting bracket, engineering unit mm (in)
HART® communication resistance module	 25 Dimensions of communication resistance module, engineering unit mm (in)
M16 cable gland with integrated pressure compensation membrane	

12.2 Online tools

Product information over the entire life cycle of the device: www.endress.com/onlinetools

12.3 System components

RN series active barrier

Single- or two-channel active barrier for safe separation of 0/4 to 20 mA standard signal circuits with bidirectional HART transmission. In the signal duplicator option, the input signal is transmitted to two galvanically isolated outputs. The device has one active and one passive current input; the outputs can be operated actively or passively.

For more information, please refer to: www.endress.com

13 Technical data

13.1 Input

Voltage drop	
Standard device with 4 to 20 mA communication	≤ 1.0 V
Device with HART communication	≤ 1.9 V
Display lighting	Additional 2.9 V

HART input impedance
Rx = 40 kΩ
Cx = 2.3 nF

Measured variable

The 4 to 20 mA current signal or the HART signal is the input variable.

HART signals are not affected.

Measuring range

4 to 20 mA (scalable, reverse polarity protection)

Max. input current 200 mA

13.2 Power supply

Supply voltage

NOTICE

SELV/Class 2 device

- The device may be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1 Paragraph 9.4 or Class 2 as per UL 1310: 'SELV or Class 2 circuit'.

The process indicator is loop-powered and does not require any external power supply. The voltage drop is ≤1 V in the standard version with 4 to 20 mA communication, ≤1.9 V with HART communication and an additional 2.9 V if display lighting is used.

13.3 Performance characteristics

Reference operating conditions

Reference temperature 25 °C ±5 °C (77 °F ±9 °F)

Humidity 20 to 60 % relative humidity

Maximum measured error

Input	Range	Measured error of measuring range
Current	4 to 20 mA Over range up to 22 mA	±0.1 %

Resolution

Signal resolution > 13 bit

Influence of ambient temperature

< 0.02 %/K (0.01 %/°F) of measuring range

Warm-up period

10 minutes

13.4 Installation

Mounting location

Panel housing

The device is designed for use in a panel.

Required panel cutout 45x92 mm (1.77x3.62 in)

Field housing

The field housing version is designed for use in the field. The unit is mounted directly on a wall, or on a pipe with a diameter of up to 2 " with the aid of an optional mounting bracket. An optional weather protection cover protects the device from the effects of weather conditions.

Orientation

Panel housing

The orientation is horizontal.

Field housing

The device must be mounted in such a way that the cable entries point downwards.

13.5 Environment

Ambient temperature range

−40 to 60 °C (−40 to 140 °F)

At temperatures below −25 °C (−13 °F) the readability of the display can no longer be guaranteed.

Storage temperature

−40 to 85 °C (−40 to 185 °F)

Climate class

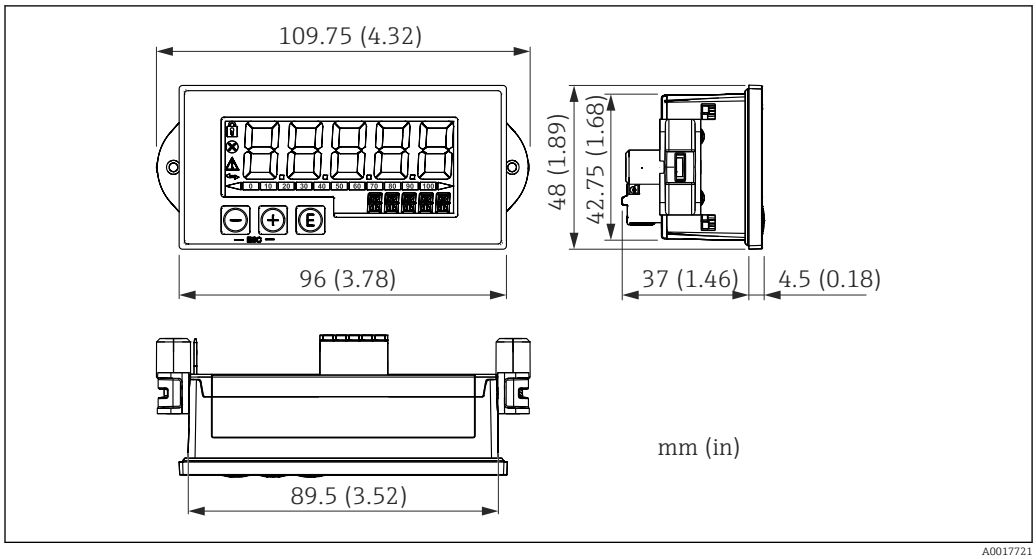
IEC 60654-1, Class B2

Operating altitude	Up to 5 000 m (16 400 ft) above MSL in accordance with IEC61010-1
Degree of protection	**Panel housing** IP65 at front, IP20 at rear **Field housing** Aluminum housing: degree of protection IP66/67, NEMA 4x Plastic housing: degree of protection IP66/67
Electromagnetic compatibility	▪ Interference immunity: As per IEC61326 (Industrial Environments) / NAMUR NE 21 Maximum measured error < 1 % o. MR ▪ Interference emission: As per IEC61326, Class B
Electrical safety	Class III, overvoltage protection category II, pollution degree 2

13.6 Mechanical construction

Design, dimensions

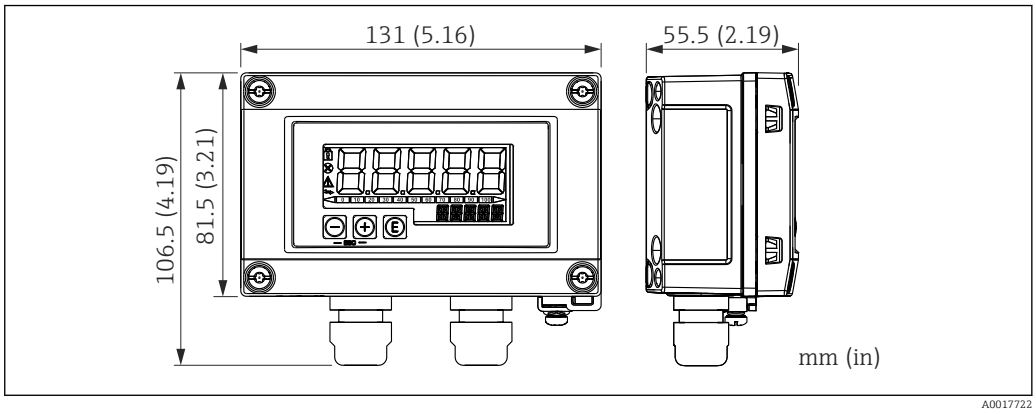
Panel-mount housing



26 Dimensions of the panel housing

Required panel cutout 45x92 mm (1.77x3.62 in), max. panel thickness 13 mm (0.51 in).

Field housing



27 *Dimensions of the field housing incl. cable entries (M16)*

Weight

Panel-mount housing

115 g (0.25 lb.)

Field housing

- Aluminum: 520 g (1.15 lb)
- Plastic: 300 g (0.66 lb)

Materials

Panel-mount housing

Front: aluminum

Rear panel: polycarbonate PC

Field housing

Aluminum or plastic (PBT with steel fibers, antistatic)

13.7 Operability

On-site operation

The device is operated with the 3 operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

A0017716	Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu
A0017714	Selecting and setting values in the operating menu; pressing the - and + keys simultaneously takes the user back up a menu level. The configured value is not saved (ESC)
A0017715	

13.8 Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

14 HART communication

HART (Highway Addressable Remote Transducer) is an established global industry standard, which has been tried and tested in the field and has an installed base of over 14 million devices.

HART is a "smart" technology which enables 4 to 20 mA analog transmission and digital communication to occur simultaneously along the same wire pair. With HART, transmission is based on the Bell 202 Frequency-shift keying (FSK). A high-frequency wave (±0.5 mA) is superimposed on the low-frequency analog signal (4 to 20 mA). Maximum transmission distances depend on the network structure and ambient conditions.

In many applications, the HART signal is used only for configuration purposes. However, with the appropriate tools, HART can be used for device monitoring, device diagnosis and for recording multivariable process information.

The HART protocol is based on the master/slave principle. This means that during normal operation, all communication is initiated by the master. Unlike other master-slave communication types, HART permits two masters in one loop/network: a primary master, e.g. the distributed control system, and a secondary master, e.g. a handheld terminal. However, two masters of the same type are not permitted simultaneously. Secondary master devices can be used without affecting communication to and from the primary master. The field devices are generally the HART slaves and respond to HART commands from the master that are addressed directly to them or to all devices.

The HART specification stipulates that the masters transmit a voltage signal, while the sensors/actuators (slaves) convey their messages using load-independent currents. The current signals are converted to voltage signals at the internal resistor of the receiver (load).

To ensure reliable signal reception, the HART protocol specifies that the total load of the current loop - including cable resistance - must be between a minimum of 230 Ω and a maximum of 600 Ω. If the resistance is less than 230 Ω, the digital signal is greatly attenuated or short-circuited. Therefore, a HART communication resistor is always required in the 4 to 20 mA cable in the case of a low-impedance power supply.

14.1 HART protocol command classes

Each command is assigned to one of the following three classes:
- Universal commands
  are supported by all devices using the HART protocol (e.g. device tag, firmware no. etc.).)
- Common practice commands
  offer functions that are supported by many but not by all HART instruments (e.g. read out value, set parameter etc.)
- Device-specific commands
  provide access to device data that are not HART standard but are unique to a particular device model (e.g. linearization, advanced diagnostic functions)

Since the HART protocol is an open communication protocol between the control device and the field device, it can be implemented by any manufacturer and freely applied by the user. The necessary technical support is provided by the HART Communication Foundation (HCF).

14.2 HART commands used

The process indicator uses the following HART universal commands:

Universal command number	Response data used
0 Unique device identifier	The device identifier provides information on the device and manufacturer; it cannot be changed. The response comprises a 12-byte device ID. The following bytes are used by the process indicator: ▪ Byte 0: fixed value 254 ▪ Byte 2: device type ID, for slave addressing with long address format ▪ Byte 3: number of preambles ▪ Byte 9-11: device identification, for slave addressing with long address format
2 Read the primary process variable as current in mA and the percentage value based on the current range	The response comprises 8 bytes: ▪ Byte 0-3: current in mA ▪ Byte 4-7: percentage value
3 Read the primary process variable as current in mA and four dynamic process variables	The response comprises 24 bytes: The following bytes are used by the process indicator: ▪ Byte 4: HART unit code of the primary process variable ▪ Byte 5-8: primary process variable ▪ Byte 9: HART unit code of the secondary process variable ▪ Byte 10-13: secondary process variable ▪ Byte 14: HART unit code of the third process variable ▪ Byte 15-18: third process variable ▪ Byte 19: HART unit code of the fourth process variable ▪ Byte 20-23: fourth process variable

The universal commands used by the process indicator must be supported by the slaves to guarantee proper communication.

14.3 Field device status

The field device status is contained in the second data byte of a slave/actuator response.

The following bits are analyzed by the process indicator and displayed as a diagnostic message:

Bit mask	Definition	Used in the process indicator
0x80	Device error function – The device has detected a serious error or an error function which affects the operation of the device.	Diagnostic F911
0x40	Configuration changed – A function was executed which has changed the device configuration.	No
0x20	Cold start – The supply voltage has failed or a device reset has occurred.	No
0x10	Additional status available – Additional status information is available via command #48.	No
0x08	Loop current fixed – The loop current is maintained at a fixed value and does not react to changes in the process.	No

Bit mask	Definition	Used in the process indicator
0x04	Loop current saturated – The loop current has reached its upper (or lower) limit point and cannot increase (decrease) further.	Diagnostic S913
0x02	Non-primary variable out of limits.	Diagnostic S915
0x01	Primary variable out of limits.	Diagnostic S915

14.4 Supported units

If "HART" is configured in the UNIT1-4 parameter, the units are automatically read out and displayed by the transmitter.

However, if the transmitted unit cannot be clearly displayed, the HART-UnitCode "UCxxx" is displayed instead, with xxx standing for the unit code number.

In this case, a self-defined text can be specified for the unit via the TEXT1-4 parameter.

Unit code	Description	Display text
1	Inches of water at 68 °F	inH2O
2	Inches of mercury at 0 °C	inHG
3	Feet of water at 68 °F	FTH2O
4	Millimeters of water at 68 °F	mmH2O
5	Millimeters of mercury at 0 °C	mmHG
6	Pounds per square inch	PSI
7	Bar	BAR
8	Millibars	mBAR
9	Grams per square centimeter	g/cm2
10	Kilograms per square centimeter	UC010
11	Pascal	Pa
12	Kilopascals	kPa
13	Torr	TORR
14	Atmospheres	ATM
15	Cubic feet per minute	FT3/m
16	Gallons per minute	gal/m
17	Liters per minute	l/min
18	Imperial gallons per minute	UC018
19	Cubic meters per hour	m3/h
20	Feet per second	FT/S
21	Meters per second	m/S
22	Gallons per second	gal/S
23	Million gallons per day	MGD
24	Liters per second	l/S
25	Million liters per day	Ml/d
26	Cubic feet per second	FT3/S
27	Cubic feet per day	FT3/d
28	Cubic meters per second	m3/S
29	Cubic meters per day	m3/d
30	Imperial gallons per hour	UC030

Unit code	Description	Display text
31	Imperial gallons per day	UC031
32	Degrees Celsius	°C
33	Degrees Fahrenheit	°F
34	Degrees Rankine	°R
35	Kelvin	K
36	Millivolts	mV
37	Ohm	Ohm
38	Hertz	HZ
39	Milliamperes	mA
40	Gallons	gal
41	Liters	LITERS
42	Imperial gallons	Igal
43	Cubic meters	m3
44	Feet	FEET
45	Meters	METER
46	Barrels	bbl
47	Inches	inch
48	Centimeters	cm
49	Millimeters	mm
50	Minutes	min
51	Seconds	SEC
52	Hours	HOUR
53	Days	DAY
54	Centistokes	cST
55	Centipoises	cP
56	Microsiemens	uS
57	Percent	%
58	Volts	VOLT
59	pH	PH
60	Grams	g
61	Kilograms	Kg
62	Metric tons	T
63	Pounds	lb
64	American tons	TN SH
65	British tons	TN L
66	Millisiemens per centimeter	mS/cm
67	Microsiemens per centimeter	uS/cm
68	Newton	N
69	Newton meters	Nm
70	Grams per second	g/S
71	Grams per minute	g/min
72	Grams per hour	g/h
73	Kilograms per second	Kg/S

Unit code	Description	Display text
74	Kilograms per minute	Kg/mi
75	Kilograms per hour	Kg/h
76	Kilograms per day	Kg/d
77	Metric tons per minute	T/min
78	Metric tons per hour	T/h
79	Metric tons per day	T/d
80	Pounds per second	lb/S
81	Pounds per minute	lb/mi
82	Pounds per hour	lb/h
83	Pounds per day	lb/d
84	American tons per minute	TnS/m
85	American tons per hour	TnS/h
86	American tons per day	TnS/d
87	British tons per hour	Tnl/h
88	British tons per day	Tnl/d
89	Deka therm	dTh
90	Specific gravity units	UC090
91	Grams per cubic centimeter	g/cm3
92	Kilograms per cubic meter	Kg/m3
93	Pounds per gallon	lb/ga
94	Pounds per cubic feet	lb/F3
95	Grams per milliliter	g/ml
96	Kilograms per liter	Kg/l
97	Grams per liter	g/l
98	Pounds per cubic inch	lb/ci
99	American tons per cubic yard	UC099
100	Degrees Twaddell	°Tw
101	Degrees Brix	°BX
102	Degrees Baumé heavy	UC102
103	Degrees Baumé light	UC103
104	Degrees API	°API
105	Percent solids per weight	%wT
106	Volume percent	%VOL
107	Degrees Balling	°bal
108	Proof per volume	P/VOL
109	Proof per mass	P/MAS
110	Bushels	bSh
111	Cubic yards	YARD3
112	Cubic feet	FEET3
113	Cubic inches	inch3
114	Inches per second	in/S
115	Inches per minute	in/mi
116	Feet per minute	F/min

Unit code	Description	Display text
117	Degrees per second	DEG/S
118	Revolutions per second	RPS
119	Revolutions per minute	RPM
120	Meters per hour	m/h
121	Normal cubic meters per hour	Nm3/h
122	Normal liters per hour	Nl/h
123	Normal cubic feet per minute	F3/mi
124	Fluid barrel (1 barrel = 31.5 U.S. gallons)	UC124
125	Ounce	Oz
126	Foot Pound Force	FTLBF
127	Kilowatts	kW
128	Kilowatt hours	kWh
129	Horse power	HP
130	Cubic feet per hour	FT3/h
131	Cubic meters per minute	m3/mi
132	Barrels per second	bbl/S
133	Barrels per minute	bbl/m
134	Barrels per hour	bbl/h
135	Barrels per day	bbl/d
136	Gallons per hour	gal/h
137	Imperial gallons per second	UC137
138	Liters per hour	l/h
139	Parts per million	PPm
140	Mega calories per hour	UC140
141	Mega joules per hour	mJ/h
142	British Thermal Units per hour	BTU/h
143	Degrees	DEG
144	Radian	rad
145	Millimeters of water at 60 °F	inH2O
146	Micrograms per liter	ug/l
147	Micrograms per cubic meter	ug/m3
148	Percent consistency	%con
149	Volume percent	VOL%
150	Percent steam quality	%SQ
151	Feet inch sixteenths	UC151
152	Cubic feet per pound	F3/lb
153	Picofarads	PF
154	Milliliters per liter	ml/l
155	Microliters per liter	ul/l
156-159	Unit Code Expansion Tables	UC156 - UC159
160	Percent Plato	%P
161	Percent lower explosion level	%LEL

Unit code	Description	Display text
162	Mega calories	Mcal
163	Kilo ohms	KOHM
164	Mega joules	MJ
165	British Thermal Unit	BTU
166	Standard cubic meters	Nm3
167	Normal liters	Nl
168	Normal cubic feet	SCF
169	Parts per billion	PPb
170 - 219	Unit Code Expansion Tables See Operating Instructions of connected transmitter/sensor. For CM82: see Section "Troubleshooting"	UC170 - UC219
220 - 234	not defined	UC220 - UC234
235	Gallons per day	gal/d
236	Hectoliters	hl
237	Megapascals	MPa
238	Inches of water at 4 °C	inH2O
239	Millimeters of water at 4 °C	mmH2O
240 - 249	Manufacturer-specific	UC240 - UC249
250	Not used	-----
251	None	
252	Unknown	UC252
253	Special	UC253

14.5 HART® protocol connection types

The HART protocol can be used for point-to-point and Multidrop connections:

Point to point (TYPICAL)

In a point-to-point connection, the HART® master communicates with precisely one HART® slave.

A point-to-point connection should always be the preferred option where possible.

Multidrop (measurement not by current, slower)

In Multidrop mode, several HART® devices are incorporated in a single current loop. Analog signal transmission is disabled in this case and the data and measured values are exchanged exclusively via the HART® protocol. The current output of each connected device is set to a fixed value of 4 mA and is used only to supply power to the two-wire devices.

Using Multidrop, several sensors/actuators can be connected in parallel to one wire pair. The master then differentiates between devices based on the configured addresses. Each device must have a different address. When more than seven sensors/actuators are connected in parallel, an increased voltage drop occurs.

The loop must not include a mixture of devices with an active current output (e.g. four-wire devices) and devices with a passive current output (e.g. two-wire devices).

The HART® protocol is a form of communication that is not susceptible to interference. This means that, during operation, communication devices can be connected or removed without putting components of the other devices at risk or interrupting their communication.

14.6 Device variables for multivariable measuring instruments

Multivariable measuring instruments can transmit up to four device variables via HART®: the primary variable (PV), the secondary variable (SV), the tertiary variable (TV) and the quarternary variable (QV).

Below you will find some examples of what default values can be set for these variables for various sensors/actuators:

Flowmeter, e.g. Promass:

- Primary process variable (PV) → Mass flow
- Secondary process variable (SV) → Totalizer 1
- Third process variable (TV) → Density
- Fourth process variable (QV) → Temperature

Temperature transmitter, e.g. TMT82:

- Primary process variable (PV) → Sensor 1
- Secondary process variable (SV) → Device temperature
- Third process variable (TV) → Sensor 1
- Fourth process variable (QV) → Sensor 1

For a level measuring instrument such as the Levelflex FMP5x, these four values can be as follows:

Level measurement:
- Primary process variable (PV) → Level linearized
- Secondary process variable (SV) → Distance
- Third process variable (TV) → Absolute echo amplitude
- Fourth process variable (QV) → Relative echo amplitude

Interface measurement:
- Primary process variable (PV) → Interface
- Secondary process variable (SV) → Level linearized
- Third process variable (TV) → Upper interface thickness
- Fourth process variable (QV) → Relative interface amplitude

HART® actuator, e.g. positioner:

- Primary process variable (PV) → Actuating value
- Secondary process variable (SV) → Valve set point
- Third process variable (TV) → Target position
- Fourth process variable (QV) → Valve position

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www.addresses.endress.com

Endress+Hauser

People for Process Automation

Certificate of Compliance

Certificate: 2622950 (200600) **Master Contract:** 200600

Project: 70046586 **Date Issued:** 2015-11-12

Issued to: **Endress + Hauser Wetzer GmbH Co. KG**
Obere Wank 1
Nesselwang, 87484
GERMANY

Attention: Michael Pfanzelt

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Issued by: *Eshwar Kashyap*
Eshwar Kashyap

PRODUCTS

CLASS 2258 04	-	PROCESS CONTROL EQUIPMENT - Intrinsically Safe Entity - For Hazardous Locations
CLASS 2258 84	-	PROCESS CONTROL EQUIPMENT - Intrinsically Safe Entity - For Hazardous Locations- Certified to U.S. Standards

Ex ia IIC T6 Ga:
AEx ia IIC T6 Ga:
Class I, Division 1, Groups A, B, C & D:

• Digital Field Display, Types RIA15 and ORIA15, rated 30Vdc, loop powered 4-20mA, with supply entity parameters U_i = 30Vdc, I_i = 200mA, P_i = 900mW, C_i = 0, L_i = 35.1µH, Intrinsically Safe when connected according to Installation Drawing XA01056K or XA010368K. Temperature codes, T6, Ta = -40 °C to + 60 °C. Field housing is Enclosure Type 4X (Aluminium enclosure only) and IP66/67. Panel mount front is IP65 when mounted in suitable enclosure acceptable to the local authority having jurisdiction

Special condition of safe use:

The equipment must be installed such that even in the event of rare accidents, an ignition source due to impact or friction is excluded.

CLASS 2258 03	-	PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non-Incendive Systems - For Hazardous Locations
CLASS 2258 83	-	PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non-Incendive Systems - For Hazardous Locations- Certified to U.S. Standards

Class I, Division 2, Groups A, B, C and D:

• Digital Field Display, Types RIA15 and ORIA15, rated 30Vdc, loop powered 4-20mA. Non-Incendive when installed with Certified non-incendive associated apparatus meeting entity U_i / Vmax = 30Vdc; Ii / Imax = 200mA, C_i = 0, L_i = 35.1µH according to Installation Drawing XA01368K. Temperature codes, T6, Ta = -40 °C to + 60 °C. Field housing is Enclosure Type 4X (Aluminium enclosure only) and IP66/67.

Certificate: 2622950 **Master Contract:** 200600
Project: 70046586 **Date Issued:** 2015-11-12

APPLICABLE REQUIREMENTS

CAN/CSA-C22.2 No. 0-M91	General Requirements - Canadian Electrical Code, Part II
C22.2 NO. 142-M1987	Process Control Equipment
CAN/CSA-C22.2 NO. 157-92	Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations
C22.2 NO. 213-M1987	Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
CAN/CSA-C22.2 NO. 60079-0:11	Explosive atmospheres - Part 0: Equipment - General requirements
CAN/CSA-C22.2 NO. 60079-11:11	Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"
CAN/CSA-C22.2 No. 60529:05	Degrees of protection provided by enclosures (IP Code)
UL 916:2007	Energy Management Equipment
ANSI/ISA-12.12.01-2013	Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III Divisions 1 and 2 Hazardous (Classified) Locations
ANSI/UL 60079-0:2013	Explosive atmospheres - Part 0: Equipment - General requirements
ANSI/UL 60079-11:2013	Explosive Atmospheres - Part 11: Equipment Protection by Intrinsic Safety 'i'
ANSI/IEC 60529:2004	Degrees of Protection Provided by Enclosures (IP Code)

Supplement to Certificate of Compliance

Certificate: 2622950 (200600) **Master Contract:** 200600

The products listed, including the latest revision described below, are eligible to be marked in accordance with the referenced Certificate.

Product Certification History

Project	Date	Description
70046586	2015-11-12	Update to include IP67 markings, revisions to the non-incendive listing and the inclusion of US standards.
70021867	2015-01-29	Update to include a new non-metallic enclosure and new circuitry based on the assessment conducted within IECEx PTB 12.0048X Issue 1.
2622950	2013-09-30	Model RIA15 and ORIA15 loop powered current display modules; Intrinsically safe for Class I, Groups A, B, C and D and Ex ia IIC.

PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C92TIT0201	Wall-Mount Room Air Temperature Monitoring System	Moore Industries	T2X/PT10/4-20MA/ 8-42DC [DWB]	Section 40 91 00	09-I-009
002							
003							
004							
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MOORE INDUSTRIES WORLDWIDE

T2X-DWB

Wall-Mount Room Air Temperature Monitoring System

October 2022

Description

The T2X-DWB Wall-Mount Room Air Temperature Monitoring System delivers the long-term stability of Moore Industries' T2X transmitter while being enclosed in a durable wall-mounted box. It can be used in a wide range of indoor temperature sensing applications.

The PC-programmable T2X-DWB has an internal 1000 ohm RTD for room temperature sensing. It provides a proportional 4-20mA output that is linear with temperature, and ready for direct interface with a monitoring and/or control system.

The T2X-DWB mounts directly to a wall for quick and easy installation..

Figure 1. Installation Dimensions

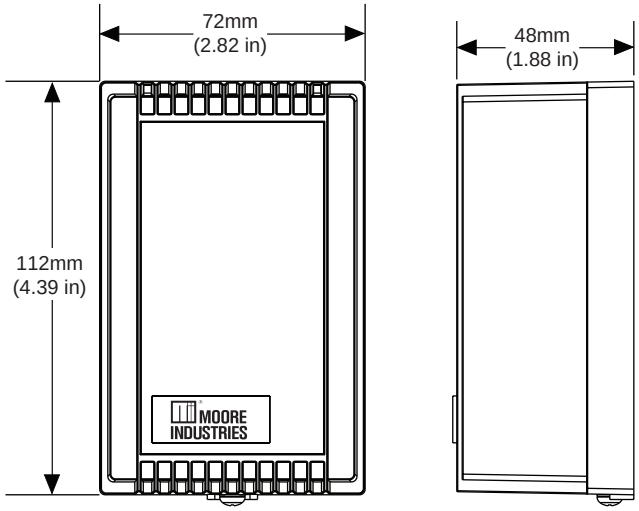
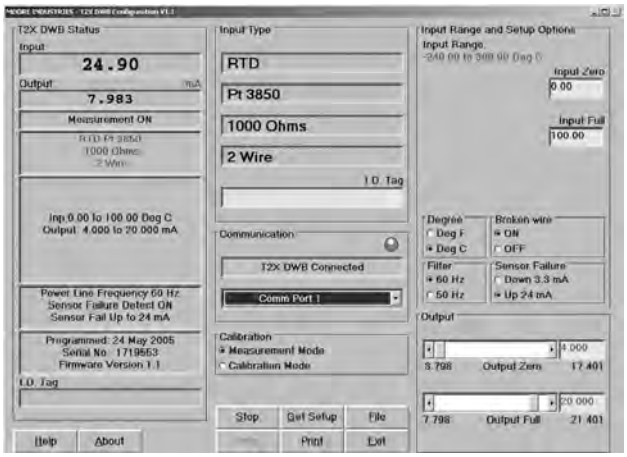


Figure 2. In less than a minute, you can set up the T2X-DWB using our single window Intelligent PC Configuration Software.



Features

- **Easy Mounting.** Mounts easily to a wall for simple installation.
- **Maximum Air Flow.** Sensor placement and vented housing design allow for maximum air flow.
- **Easy Setup With Free Software.** Sets up in a minute or less with single window Intelligent PC Configuration Software.
- **Proportional 4-20mA Output.** Provides a proportional 4-20mA output that is ready for direct interface with a monitoring/control system.
- **Independent Output.** Independent input and output scaling capabilities.
- **Warranty.** Full 3-year warranty.

Certifications

CE EMC Directive 2014/30/EU
EN 61326

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T2X-DWB

Wall-Mount Room Air
Temperature Monitoring System

Specifications

Performance

Input Accuracy: Platinum RTD, ±0.4°C (±0.7°F)
Output Accuracy: Input Accuracy + 0.1% of output span
NOTE: Overall accuracy is determined by combining input and output accuracy. It includes the combined effects of linearity, hysteresis, repeatability and adjustment resolution. It does not include ambient temperature effect.
Calibration: Set at factory; sensor cannot be removed
Minimum Span:
10°C (18°F)
Stability (maximum span):
1 year = ±0.12%
3 years = ±0.21%
5 years = ±0.27%
Measurement Cycle: Output updates at least 8 times per second
Output Response Time: 256msec typical, 360msec maximum, for the output to change from 10% to 90% for an input step change of 0% to 100%

Performance (Continued)

Over-Voltage Protection: Output, 48Vdc, maximum; Reverse Polarity, 48Vdc, maximum
Digital Input Filter: User-selectable, 50/60Hz
Power Requirement: 8-42Vdc
Power Supply and Load Effects: Negligible within specified power limits Load Capability: 700 ohms@24V

$$\frac{\text{Supply Voltage} - 8\text{V}}{0.024\text{A}} = \text{Ohms}$$

Burnout Protection: User-programmable, Upscale to 23.6mA; Downscale to 3.3mA
RTD Lead Wire RTD Excitation: 250 microamps, ±10%

Ambient Conditions

Operating Range: -40°C to +85°C (-40°F to +185°F)
Storage Range: -55°C to +105°C (-67°F to +221°F)
Relative Humidity: 0-95%, non-condensing

Ambient Conditions (Continued)

Ambient Temperature Effect: ±0.015% of span/°C change

RFI/EMI Immunity: 10V/m@80-1000MHz, 1kHz AM when tested according to IEC 61326 with an error of 0.5% of span or less

Noise Rejection: Common mode: 100dB@ 50/60Hz; Normal Mode: 70dB typical at 200mVp-p@50/60Hz

Set Up
All settings are made using Moore Industries' T2X-DWB PC Configuration Software, and then stored in nonvolatile memory

Weight
113 grams (4 oz.)

Ordering Information

Unit	Input	Output	Power	Options	Housing
T2X Wall-Mount Room Air Temperature Monitoring System	**PT10** Pt 3850 RTD, fixed 1000 ohm	**Current** Any range between 4-20mA	**8-42DC** ±10%	**-VTD** Standard Factory Calibration	**DWB** Decorative Wall Box

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: T2X / PT10 / 2-40MA / 8-42DC [DWB]

Accessories

Each T2X-DWB order comes with one copy of our Configuration Software (Windows® compatible) on CD.
To order additional software or cables, refer to the chart.

Part Number	Part
750-75E05-01	T2X-DWB PC Configuration Software Program
803-039-26	Isolated Serial Configuration Cable
803-040-26	Non-Isolated Serial Configuration Cable
804-030-26	Fuse Protected, Non-Isolated USB Communication Cable

Specifications and information subject to change without notice. Printed in the U.S.A.

MOORE INDUSTRIES WORLDWIDE

Demand Moore Reliability

No. 237-705-00E
April 2018

Wall-Mount Room Air Temperature Monitoring System

T2X DWB

User's Manual

All product names are registered trademarks of their respective companies.

MOORE INDUSTRIES WORLDWIDE

Demand Moore Reliability

Customer Support

Moore Industries is recognized as the industry leader in delivering top quality to its customers in products and services. We perform a sequence of stringent quality assurance checks on every unit we ship. If any Moore Industries product fails to perform up to rated specifications, call us for help. Our highly skilled staff of trained technicians and engineers pride themselves on their ability to provide timely, accurate, and practical answers to your process instrumentation questions. Our headquarters and other facilities phone numbers are listed below.

There are several pieces of information that can be gathered before you call the factory that will help our staff get the answers you need in the shortest time possible. For fastest service, gather the complete model and serial number(s) of the problem unit(s) and the job number of the original sale.

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T2X DWB

Wall-Mount Room Air Temperature Monitoring System

April 2018

The T2X DWB

The T2X-DWB Wall-Mount Air Temperature Monitoring System delivers the long-term stability of Moore Industries T2X transmitter but is also enclosed in a durable wall-mounted box. It can be used in a wide range of indoor temperature sensing applications.

The PC-programmable T2X-DWB has an internal 1000 ohm RTD for room temperature sensing. It provides a proportional 4-20mA output that is linear with temperature, and ready for direct interface with a monitoring/control system.

Setting up the T2X-DWB

Configuring and programming the T2X-DWB is simple. Begin by gathering all of the necessary equipment (listed in Table 1), installing the T2X-DWB PC Configuration Program onto your computer, then connecting the instrument as shown in Figure 1. It is necessary to connect the T2X-DWB to the PC before creating a configuration file.

Figure 1. *Connecting the T2X-DWB to the PC for Configuration*

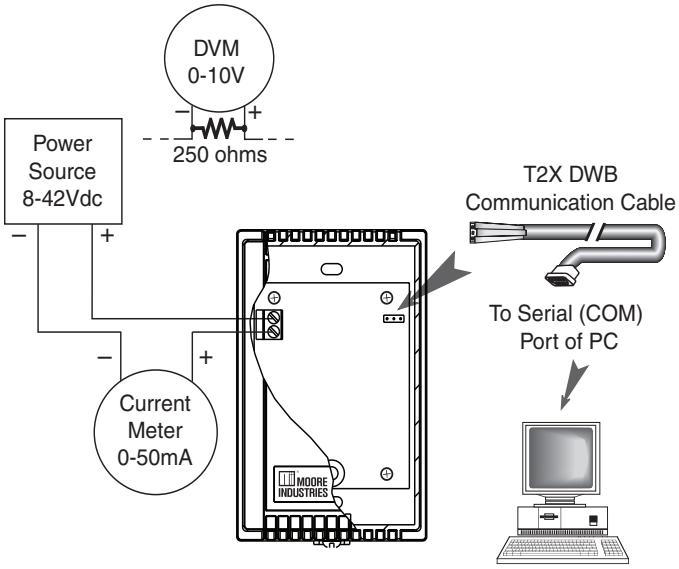

Table 1. *Equipment Needed for Setting Up the T2X DWB*

Device	Specifications
Power Supply	24-42Vdc, ±10%
Multimeter	Accurate to ±0.025%, e.g. Fluke Model 87
Personal Computer	Microsoft Windows based PC; 16Mb free RAM; 20MB free disk space on hard drive Microsoft Windows XP, 7, or 10 1 (one) serial port or one available USB port (with optional USB cable)
Moore Industries' T2X DWB Configuration Program	Version 1.0, or greater, successfully installed on the hard drive of the specified PC
Moore Industries' Communication Cable	Non-Isolated Serial Cable: 803-040-26 Isolated Serial Cable: 803-039-26 Fuse Protected, Non-Isolated USB Communication Cable: 804-030-26

Installing the Configuration Software

Refer to Table 1 for the equipment needed.

1. Insert the *Moore Industries Interface Solution PC Configuration Software* CD into the CD drive of the PC. Access the CD and open the "T2X DWB PC Configuration Software" folder.
2. Double-click the installation program located in the folder. Follow the prompts to correctly install the program.

Once the configuration software is installed on the PC, the T2X- DWB can be connected to equipment to simulate input and monitor output. You can then change the transmitter's operating parameters.

Configuring the T2X-DWB

One of the benefits of the T2X-DWB is that there are no internal or external controls to adjust or settings to change. All operating parameters are set using a PC and Moore Industries' T2X-DWB PC Configuration Software Program.

The software settings are downloaded to the transmitter in the form of a configuration file and stored in the instrument's memory. You can save a backup copy of the file on your PC hard drive or other media.

Default Configuration Settings
Input: RTD 2W Pt3850 1000Ohms 0-100degF

Filter: 60Hz

Broken Wire: ON

Filter: 60Hz

Output: 4-20mA

Sensor Failure: Up 24mA

Note:
The new settings will not take effect until you have programmed the T2X-DWB with the new configuration file. To program the transmitter, (with the T2X-DWB attached) click Stop, then Prog.

Managing Configuration Files

Once all of the parameters for a transmitter are set, they can be saved using the *File* menus and fields.

Saving a Configuration File to your PC – To save a configuration file to your PC, click the *File* button. Enter the name of the file you wish to save in the *Selected File Name* box. Select the location for the file to be saved and click *Save*. Follow the prompts accordingly to finish saving the file.

Retrieving a Configuration File from your PC – To retrieve a file, click the *File* button. Use the display on the left to locate and click on the file to be retrieved. Click on the *Quit File* button. Follow the prompts accordingly to finish loading the file. The file can now be downloaded to a T2X-DWB.

Retrieving a Configuration File from a Connected T2X DWB – To retrieve the configuration file from a connected T2X-DWB, simply click *Stop*, then *Get Setup*. The screen will reflect any changes. This file can now be saved or downloaded to a different T2X-DWB.

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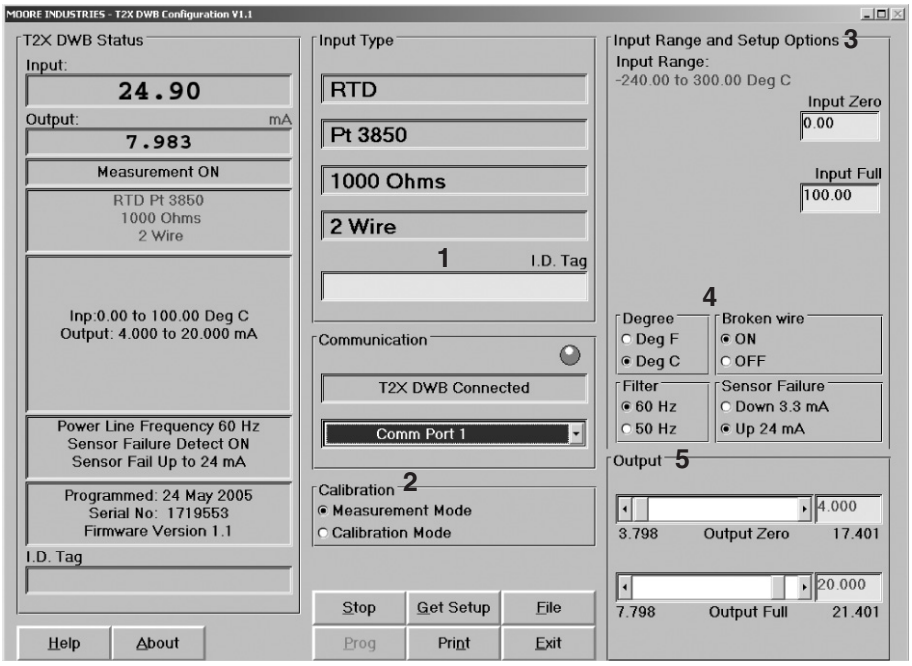
Figure 2. *T2X-DWB PC Configuration Software Screen*



To apply selections from the following list to your transmitter, click the *Stop/Start* button at the bottom of the screen and then click the *Program* button. This will download the settings from the configuration software tot he memory of the connected transmitter.

1. I.D. Tag
Use this parameter to place an identifying descriptor for your instrument.

2. Calibration
Calibration Mode is intended for ***factory use only***.

For normal measurement operations, the instrument must be placed in *Measurement Mode*.

3. Input Range and Setup Options
Scaling the input allows you to set the T2X-DWB to scale its output to the desired temperature range. In a reverse output application, the T2X-DWB output drops in proportion to a rise in input, and conversely rises in proportion to a drop in the input.

To scale the input– Enter the desired zero input value for your application in the *Input Zero* box. Next, enter the desired full input value into the *Input Full* box.

To set reverse output– Follow the instructions to scale the input, but enter a value in the *Input Zero* box that is greater than the *Input Full*, and a value in the *Input Full* box that is less than the *Input Zero*.

4. Setting Degree, Broken Wire, Filter and Sensor Failure Functions:

Degree– Select how you choose to view temperature readings (Fahrenheit or Celsius).

Broken Wire– Select whether to enable/disable the Broken Sensor Wire feature.

During operation, the T2X-DWB sends random microamp pulses through the internal sensor to check for an inoperative sensor. To disable this feature, select *OFF*.

Filter– This setting is used to configure the input filter. Use this filter to reduce the effects of mains-induced noise. The input filter value should be set to the frequency of the local AC supply–50Hz or 60Hz.

Sensor Failure– This button configures the transmitter to drive its output, up to 24.0mA or down to 3.3mA, if the internal sensor fails.

5. Scaling the Output and Setting Damping
The T2X-DWB can be configured to scale its 4-20mA output to offset the performance or calibration of other instruments in the process loop.

You can also introduce a delay (0-5sec) into the response of your unit in order to stop short-lived spikes from indicating a failure.

To scale the output– Enter the desired zero output value in the *Output Zero* box, or use the slide bar to adjust the value. Next, select the *Output Full* box and enter the desired full output value.

Specifications

Performance

Input Accuracy: Platinum RTD, ±0.4°C (±0.7°F)
Output Accuracy: Input Accuracy + 0.1% of output span
NOTE: Overall accuracy is determined by combining input and output accuracy. It includes the combined effects of linearity, hysteresis, repeatability and adjustment resolution. It does not include ambient temperature effect.
Calibration Accuracy: Set at factory; sensor cannot be removed
Minimum Span: 10oC (18°F)
Stability (maximum span):
1 year = ±0.12%
3 years = ±0.21%
5 years = ±0.27%
Measurement Cycle: Output updates at least 8 times per second

Performance (continued)

Output Response Time: 256msec typical, 360msec maximum, for the output to change from 10% to 90% for an input step change of 0% to 100%
Over-Voltage Protection: Input, 4Vdc peak, maximum; Output, 48Vdc, maximum; Reverse Polarity, 48Vdc, maximum
Digital Input Filter: User-selectable, 50/60Hz
Power Requirement: 8-42Vdc
Power Supply and Load Effects: Negligible within specified power limits
Load Capability: 700 ohms@24V

$$\frac{\text{Supply Voltage - 8V}}{0.024\text{A}} = \text{Ohms}$$

Burnout Protection: User-programmable, Upscale to 23.6mA; Downscale to 3.3mA
RTD Lead Wire
RTD Excitation: 250 microamps, ±10%

Ambient Conditions

Operating Range: -40°C to + 85°C (-40°F to + 185°F)
Storage Range: -55°C to +105°C (-67°F to +221°F)
Relative Humidity: 0-95%, non-condensing
Ambient Temperature Effect: ±0.015% of span/°C change
RFI/EMI Immunity: 10V/m@80-1000MHz, 1kHz AM when tested according to IEC 61326 with an error of 0.5% of span or less
Noise Rejection: Common mode: 100dB@ 50/60Hz; Normal Mode: 70dB typical at 200mVp-p@50/60Hz

Set Up All settings are made using Moore Industries' T2X-DWB PC Configuration Software, and then stored in nonvolatile memory

Weight 113 g (4 oz)

Accessories

Each T2X-DWB order comes with one copy of our Configuration Software (Windows® compatible) on CD.

To order additional software or cables:

Part Number	Part
750-75E05-01	T2X-DWB PC Configuration Software Program
803-039-26	Isolated Serial Configuration Cable
803-040-26	Non-Isolated Serial Configuration Cable
804-030-26	Fuse Protected, Non-Isolated USB Communication Cable

Specifications and information subject to change without notice. Printed in U.S.A.

T2X DWB

Wall-Mount Room Air Temperature Monitoring System

Installation

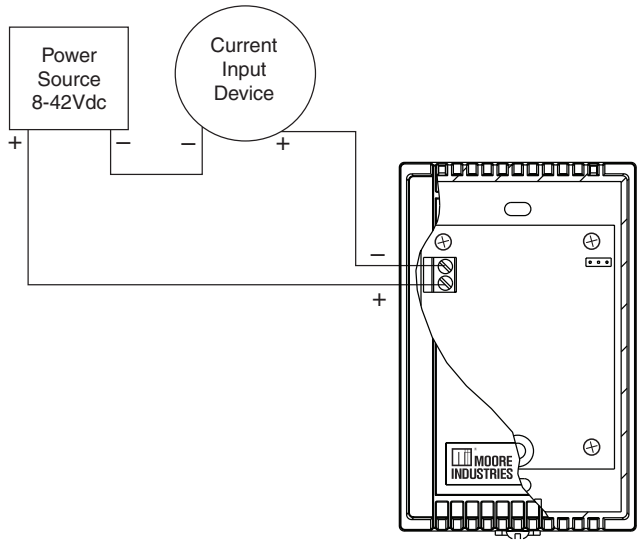
Installation consists of physically mounting the unit and completing the electrical connections. Moore Industries suggests installing the T2X-DWB by first mounting the unit in its intended application, then making the electrical connections to output and power. Before any installation, make sure that the unit has been bench checked to ensure that it is configured and calibrated properly for its intended application.

Mounting

Mounting the T2X-DWB simply consists of mounting it to a wall.

Connecting the T2X DWB

Figure 3. *Connecting the T2X-DWB into the loop*



Recommended Ground Wiring Practices

The following ground wiring practices must be followed to ensure proper performance of the T2X-DWB in any application. Moore Industries recommends the following ground wiring practices:

- Any Moore Industries product in a metal case or housing must be grounded.
- The protective earth conductor must be connected to a system safety earth ground before making other connections.
- All input signals to, and output signals from, Moore Industries' products should be wired using a shielded, twisted pair wiring technique. Shields should be connected to an earth or safety ground.
- For the best shielding, the shield should be run all the way from the signal source to the receiving device. (see Note below)
- The maximum length of unshielded input and output signal wiring should be 2 inches.

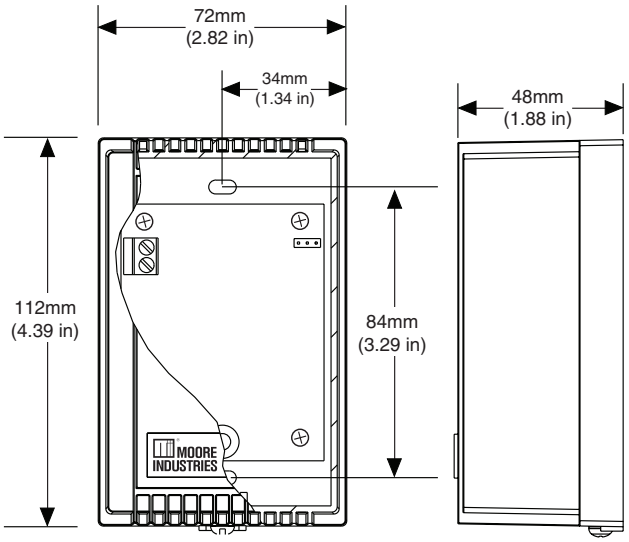
Note:

Some of Moore Industries' instruments can be classified as receivers (IPT2, IPX2, etc.) and some can be classified as transmitters (TRX, TRY, etc.) while some are both a receiver and a transmitter (SPA2, HIM, etc). Hence, your shield ground connections should be appropriate for the type of signal line being shielded. The shield should be grounded at the receiver and not at the signal source.

Maintenance

Moore Industries suggests a quick check for terminal tightness and general unit condition every 6-8 months, depending upon the severity of conditions. Things such as ambient vibration, corrosive atmospheres, extreme heat or cold, etc., can play a role in shortening the service life of any piece of electronic equipment. Always adhere to any site requirements for programmed maintenance.

Figure 4. *T2X-DWB Dimensions*



CE Conformity

Installation of any Moore Industries products that carry the CE certification (Commission Electrotechnique) ***must*** adhere to guidelines set forth in the applicable EMC (Electromagnetic Compatibility) directive EN 61326.

Warranty Disclaimer

Moore Industries ("The Company") makes no express, implied or statutory warranties (including any warranty of merchantability or of fitness for a particular purpose) with respect to any goods or services sold by the company. The company disclaims all warranties arising from any course of dealing or trade usage, and any buyer of goods or services from the company acknowledges that there are no warranties implied by custom or usage in the trade of the buyer and of the company, and that any prior dealings of the buyer with the company do not imply that the company warrants the goods or services in any way.

Any buyer of goods or services from the company agrees with the company that the sole and exclusive remedies for breach of any warranty concerning the goods or services shall be for the company, at its option, to repair or replace the goods or services or refund the purchase price. The company shall in no event be liable for any consequential or incidental damages even if the company fails in any attempt to remedy defects in the goods or services , but in such case the buyer shall be entitled to no more than a refund of all monies paid to the company by the buyer for purchase of the goods or services.

Any cause of action for breach of any warranty by the company shall be barred unless the company receives from the buyer a written notice of the alleged defect or breach within ten days from the earliest date on which the buyer could reasonably have discovered the alleged defect or breach, and no action for the breach of any warranty shall be commenced by the buyer any later than twelve months from the earliest date on which the buyer could reasonably have discovered the alleged defect or breach.

Return Policy

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –

   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –

   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:

   a) A note listing the symptoms that indicate the unit needs repair

   b) Complete shipping information for return of the equipment after repair

   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

MOORE INDUSTRIES

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816

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Tel: (02) 8536-7200 • FAX: (02) 9525-7296

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PLACEHOLDER

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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PLACEHOLDER

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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PLACEHOLDER

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	C40PIT1201	Sunshade, CUBESHADE SD165	Intertec	KEOB	Section 40 91 00	4091-265
002	2	"	Mounting Bracket Type RS 100	Intertec	KCBA-100S	Section 40 91 00	4091-265
003	4	"	Cross Rail Type MS	Intertec	KBAB-Q	Section 40 91 00	4091-265
004	2	"	Cross Rail Type MS RV	Intertec	KBAB-QS	Section 40 91 00	4091-265
005							
006							
007							
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Unit Process Company

Line No	Product Details	Qty			
1	Part Number INTERTEC:KEOB Sun Shade in G.R.P Type CUBESHADE SD165 *with reduced surface resistance "GO"* *For ex area \ Without holes*	1			
2	Part Number INTERTEC:KCBA-100S Mounting Bracket Type RS 100 *galvanized steel for sunshade SD100*	2			
3	Part Number INTERTEC:KBAB-Q Cross Rail Type MS 100 Q *incl.2 T-Bolts* *Steel, hot dip galvanized*	4			
4	Part Number INTERTEC:KBAB-QS Cross Rail Type MS 100 QS, Reverse *incl.2 T-Bolts* *Steel, hot dip galvanized*	2			

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Shade – CUBESHADE SD165

Material: hot-pressed, glassfibre reinforced polyester
Color: light gray, UV-resistant
Low flammability and self-extinguishing

Design

☐ GO antistatic to avoid electrostatic charges according to DIN EN IEC 60079-0

1 Application

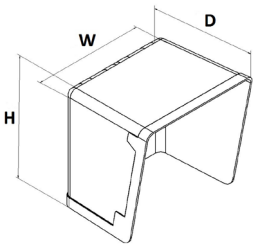
Simple shielding of instruments and fittings designed to ensure protection from:

- Sun light (overheating)
- Dirt accumulation
- Exposure to atmospheric conditions
- Mechanical damage

2 Features

- The drip lip all around and cone shaped design allow rain and melt water to run off easily.
- Large lateral surfaces provide excellent protection from the sun, especially in case of low sun angles.
- Heat-insulating material preventing the heat generated by solar radiation to be transferred.
- Stackable for space-saving transport and storage due to tapered side walls.
- Increased stability by reinforced ribs in the back wall.

3 Available Types and Dimensions



CUBESHADE SD165
H x W x D **600 x 550 x 500**

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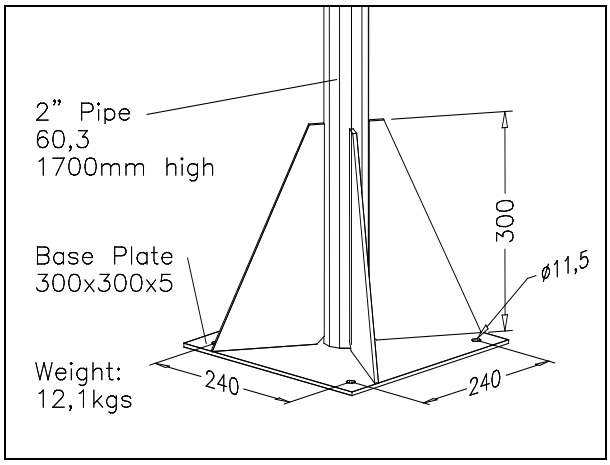
Shade – CUBESHADE SD165

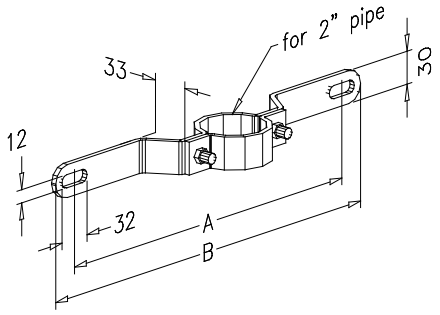
4 Mounting Accessories

4.1 Pipe Stands

Pipe Stands ST17-2, 1700 mm high



4.2 Pipe Mounting Brackets RS..

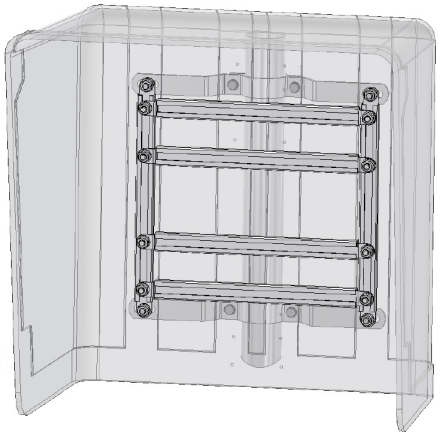


For CUBESHADE	RS Type	A	B	Weight
	KCBA-100S (set)	340	390	0,75

4.3 Mounting Rails

Form A

Form B



For Cubeshade	Form A	Form B
	4x MS 100 Q	4x MS 100 Q
	2x MS 100 QS	2x MS 100 QS

For further Mounting Rails see data sheet KDS10398

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Installation, Operation & Maintenance Manual (IOM) – Enclosures and Shades

1 Important Safety Information

1.1 To ensure safe operation

The proper and safe operation of the enclosure/shades and its components requires that it is properly handled and stored, installed and commissioned, and operated as intended with maintenance as required.

1.2 Qualification of personnel

Only qualified and trained personnel should install and commission the enclosures/shades and be responsible for maintenance of the components.

1.3 Important Instructions and guidelines to be observed:

- Review the content of this manual and operating instructions for the individual components,
- Review the enclosure and the various component safety instructions which are attached.
- Review Safety precautions for the construction and operation of electrical equipment
- Review Safety precautions for handling gases, dust and condensate.

1.4 National rules

All National, State/Provincial and local regulations, codes and standards shall be followed in regards to the installation of this equipment.

1.5 Safety of the enclosure and safe operation

The enclosure has been constructed, tested and shipped in accordance to the relevant safety authorities. To maintain these guidelines and ensure safe operation, the enclosed instructions shall be followed.

1.6 Notes on explosion protection

INTERTEC enclosures/shades are optionally designed for use in hazardous/classified areas. They have been built and tested to meet these guidelines.

Ensure that installation is per the relevant ATEX directives/standards, National Electrical Code (NEC), Canadian Electrical Code (CEC) and all other State/Provinicial and Local regulations.

2 Delivery/Transportation

- INTERTEC Enclosures may be supplied completely assembled or as loose components.
- The goods shall be properly packed and/or protected as appropriate to the goods supplied and the method of transportation and provided with braces/stays to ensure adequate protection during transport.

3 On site requirements for installation and operation

Prior to installing the protective enclosures/shades, the surrounding conditions should be examined by qualified personnel to ensure that adjacent walls or floors are suitable for mounting. The wall/floor has to be constructed to provide the necessary structural capability. Floor must be level, if not balance shims have to be used.

INTERTEC assumes no responsibility if assembly or installation area does not meet requirements.

4 Mounting

It is generally recommended to mount INTERTEC enclosures/shades using INTERTEC standard mounting accessories.

4.1 Before mounting

- Check the enclosure/shade for mechanical damage.
- Check whether the installation area is free of wires, cables, pipes, etc.

4.2 Mounting

- Ensure a horizontally and vertically leveled installation, to avoid impact to degree of protection (IP)
- Ensure that additional installed equipment does not impact the function or the degree of protection (IP)
- Check the enclosure/shade after installation for mechanical damage and performance impairment

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Installation, Operation & Maintenance Manual (IOM) – Enclosures and Shades

4.3 General accessories

For further information about:

Product	Data sheet
ISOPASS– Insulation Adapter	KDS10414
WDD – Grommet	KDS10385
ISS – Shrink Sleeve	KDS11282
Vents and Drains	KDS10429
MULTIBOX	KDS10409
DIABOX	KDS10491; KDS10499
MINIBOX	KDS10522
SHADE	RDS10422
DIASHADE	RDS10562

5 Safety and Grounding

If a ground is provided, all electrically conductive parts should be grounded inside enclosure.

6 Maintenance and Care Instructions

We recommend that you regularly perform maintenance on the enclosure.
All services should be performed by qualified and trained personnel.

- Mechanical parts (hinges, clasps) should be treated with silicone spray
- Clean windows with glass cleaner, for coarse dirt use abrasive cleanser
- Clean exterior with all-purpose cleaner
- Remove graffiti with INTERTEC graffiti cleaner
- Maintain locking cylinder /padlock - with Graphite powder, no oil!
- Spray gasket seal with silicone spray
- Check and verify operation of Latch pins
- Check the sealing gasket for damage
- Check for leaks inside enclosure
- Clean vents exhausts for debris
- Check for pipe and fitting leaks
- General visual inspection of all sides of the enclosure both inside and outside

7 Vendor Information

All INTERTEC warranties and guarantees are null and void in cases of fire, burglary or attempted burglary. If tampering with the design or function of the enclosure occur or damage to the surface of the enclosure, especially the GO low surface resistance according to DIN EN 60079-0 all regulations and codes are no longer valid.

All materials that were used in the manufacture of the enclosure, do not fall under the REACH registration (Registration, Evaluation and Authorization of Chemicals)

8 Further Information and Service

Please contact your local sales representative, distributor or INTERTEC directly at:

INTERTEC-Hess GmbH
Raffineriestr. 8
93333 Neustadt / Do.
Tel.: +49-9445-9532-0
Fax: +49-9445-9532-32
Email:info@intertec-hess.com

INTERTEC Instrumentation Ltd.
255 Henry Drive
Sarnia, Ontario N7T 7H5
Canada
Tel.: +1-888-875-8756
Fax: +1-519-337-1522
Email: info@intertec-inst.com

INTERTEC Instrumentation Inc.
11050 W. Little York Bldg M
Houston, TX 77041
USA
Tel.: +1-866-381-8350
Fax: +1-832-243-0791
Email: info@intertec-inst.com

This operating and maintenance guide does not claim to cover all items, options or changes to be considered in the installation, operation or maintenance and is a guide only. INTERTEC will not take responsibility for any field changes without written consent or approval.

Konformitätserklärung
Declaration of Conformity
декларация соответствия

CE

INTERTEC Hess GmbH
Raffineriestraße 8
93 333 Neustadt / Donau

Wir | We | Мы

INTERTEC Hess GmbH,

erklären in alleiniger Verantwortung, dass das Produkt

declare under our sole responsibility that the product

заявляем под свою исключительную ответственность, что продукция

Schutzkästen, Schutzdächer oder Schutzschränke in der Ausführung „GO“

Enclosures, Shades or Cabinets / Shelters with Option ‘GO’

защитные кожухи, защитные козырьки, защитные шкафы в исполнении «GO»

auf das sich diese Erklärung bezieht den Bestimmungen der folgenden Richtlinien entspricht

to which this declaration relates is in accordance with the provision of the following directives

на которую распространяется данное заявление, соответствует следующим директивам

2014/34/EU (ATEX) | **2014/34/EC (ATEX)** | **2014/34/EU (ATEX)**

und mit folgenden Normen oder normativen Dokumenten übereinstimmt

and is in conformity with the following standards or other normative documents

и соответствует следующим стандартам или другим нормативным документам

DIN EN IEC 60079-0:2019 DIN EN 60529:2014 IEC 60216:2013

- **Antistatisch zur Vermeidung von elektrostatischen Aufladungen (acc. DIN EN IEC 60079-0 / 7.4 und 26.13)**
- **Schlagfest (acc. DIN EN IEC 60079-0 / 6.2 und 26.4.2)**
- **IP Schutzgrad nach Datenblatt (acc. DIN EN 60529)**
- **Thermische Beständigkeit -60°C bis +100°C**
- **TI: +100°C (acc. IEC 60216-1 und -2)**

- **Antistatic to avoid electrostatic charges (acc. DIN EN IEC 60079-0 / 7.4 and 26.13)**
- **Resistant to impact (acc. DIN EN IEC 60079-0 / 6.2 and 26.4.2)**
- **IP Degree of Protection acc. to data sheet (acc. DIN EN 60529)**
- **thermal resistance -60°C to +100°C**
- **TI: +100°C (acc. IEC 60216-1 and -2)**

- **Антистатическое для предотвращения электростатического заряда (в соотв. DIN EN IEC 60079-0 / 7.4 и 26.13)**
- **Ударостойкая (в соотв. DIN EN IEC 60079-0 /6.2 и26.4.2)**
- **IP степень защиты в соответствии с техническими данными (в соотв. DIN EN 60529)**
- **Термостойкая от -60°C до +100°C**
- **TI: +100°C (в соотв. IEC 60216-1 и -2)**

Hinweis:
Auf Potentialausgleich/Erdung ist zu achten!

Note:
Pay attention to equipotential bonding/grounding!

Указание:
Обратить внимание на выравнивание потенциалов / заземление

Kennzeichnung | Marking | Маркировка

CE 0102

Neustadt, den 12.03.2020

Dipl.-Ing. Martin Hess, President

INTERTEC-Hess GmbH · Raffineriestr. 8 · 93333 Neustadt/Donau · Germany · ☎ +49 9445 9532-0 · ✉ info@intertec.info

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Service Policy Declaration

We at

INTERTEC-Hess GmbH,

warrant a spare parts availability for our product groups

Enclosures,
Shades,
Cabinets and Shelters,
Heaters, Thermostats and Controllers

of ten (10) years

after the date of shipment.

It is expressly understood that INTERTEC-Hess GmbH assumes no obligation for repair, replacment, damages or any other costs.

Neustadt, den 20.02.2020

President/CEO Martin Hess

INTERTEC-Hess GmbH · Raffineriestr. 8 · 93333 Neustadt/Donau · Germany · ☎ +49 9445 9532-0 · ✉ info@intertec.info

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Bill of Materials

Project: Coos Bay Wastewater Treatment Plant 1 Phase 1A Improvements
Specification Section(s): Section 40 90 00 – Instrumentation and Control for Process Systems
Date: September 2025

Item No.	Qty.	Control Panel or Instrument	Description	Manufacturer	Manufacturer Part Number	Specification Section	Drawing
001	1	SPARE PARTS	13-Slot ControlLogix Chassis	Allen-Bradley	1756-A13	Section 40 91 00	—
002	1	SPARE PARTS	ControlLogix Redundant Power Supply	Allen-Bradley	1756-PA75R	Section 40 91 00	—
003	1	SPARE PARTS	ControlLogix 5570 Controller	Allen-Bradley	1756-L72	Section 40 91 00	—
004	1	SPARE PARTS	Analog Input Module, 8 Isolated Points	Allen-Bradley	1756-IF8I	Section 40 91 00	—
005	1	SPARE PARTS	Analog Output Module, 8 Isolated Points	Allen-Bradley	1756-OF8I	Section 40 91 00	—
006	1	SPARE PARTS	Discrete Input Module, Isolated 16 Points	Allen-Bradley	1756-IA16I	Section 40 91 00	—
007	1	SPARE PARTS	Discrete Output Module, Isolated 16 Points	Allen-Bradley	1756-OA16I	Section 40 91 00	—
008	1	SPARE PARTS	Dual-Port EtherNet/IP Communication Module	Allen-Bradley	1756-EN2TR	Section 40 91 00	—
009	1	SPARE PARTS	Performance Power Supply, 240 W	Allen-Bradley	1606-XLS240E	Section 40 91 00	—
010	1	SPARE PARTS	Performance Redundancy Module, 480 W	Allen-Bradley	1606-XLSRED	Section 40 91 00	—
011	3	SPARE PARTS	General Purpose Plug-In Relay	TE Connectivity	KUP-14A45-120	Section 40 91 00	—
012	10	SPARE PARTS	Fuse Holder Terminal Block, Type ML 10/13.SFL	Entrelec	1SNA199168R0000	Section 40 91 00	—
013	10	SPARE PARTS	Fuse Holder Terminal Block, Type ML 10/13.SFD	Entrelec	1SNA199166R2600	Section 40 91 00	—
014	10	SPARE PARTS	Fast-Acting Glass Body Fuse, 312 Series, 1 Amp	Littelfuse	312.500P	Section 40 91 00	—
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