

I/A Series[®] Pressure Transmitters

**IAP20 Absolute Pressure and IGP20 Gauge Pressure
with HART Communication**

Installation, Operation, Calibration, Configuration, and Maintenance

Contents

Figures	5
Tables	7
1. Introduction	9
General Description	9
Reference Documents	9
Transmitter Identification.....	10
Standard Specifications.....	12
Product Safety Specifications	18
ATEX and IECEx Warnings.....	19
ATEX Compliance Documents	19
IECEx Compliance Documents	19
2. Installation	21
Transmitter Mounting.....	21
Typical Transmitter Piping.....	22
Positioning the Housing.....	24
Positioning the Display	25
Setting the Write Protect Jumper.....	25
Cover Locks	25
Wiring	25
Accessing Transmitter Field Terminals.....	26
Wiring the Transmitter to a Control Loop.....	27
Multidrop Communication.....	29
Connecting the Transmitter to an I/A Series System.....	30
3. Operation Via Local Display.....	31
Entering Numerical Values.....	32
Reranging.....	33
Viewing the Database.....	33
Viewing the Pressure Range.....	33
Testing the Display.....	33
Error Messages	34
4. Calibration	35

General Calibration Notes.....	35
Calibration Setup.....	37
Setup of Electronic Equipment.....	38
Field Calibration Setup.....	38
Bench Calibration Setup	39
Calibration Using a PC20	40
Calibration Using a PC50	40
Calibration Using a HART Communicator	40
Calibration Using the Optional Local Display.....	40
Zero Adjustment Using External Zero Button	43
Error Messages	45
5. Configuration.....	47
Configurable Parameters	47
Configuration Using a PC20.....	48
Configuration Using a PC50.....	48
Configuration Using a HART Communicator	48
Configuration Using the Optional Local Display	48
Character Lists	56
Error Messages	57
6. Maintenance.....	59
Error Messages	59
Parts Replacement.....	59
Replacing the Terminal Block Assembly	59
Replacing the Electronics Module Assembly.....	60
Removing and Reinstalling a Housing Assembly	61
Adding the Optional Display.....	62
Replacing the Sensor Assembly.....	62
Rotating Process Covers for Venting.....	64

Figures

1	Transmitter Identification.....	10
2	Top Level Structure Diagram	11
3	Minimum Allowable Absolute Pressure vs. Process Temperature with Fluorinert Fill Fluid	14
4	Pipe Mounting.....	21
5	Surface Mounting	22
6	Typical Transmitter Piping.....	23
7	Hot Process Piping.....	24
8	Housing Screw or Clip Location	24
9	Cover Lock Location	25
10	Accessing Field Terminals	26
11	Identification of Field Terminals.....	26
12	Supply Voltage and Loop Load.....	27
13	Loop Wiring Transmitters.....	29
14	Wiring Several Transmitters to a Common Power Supply	29
15	Typical Multidrop Network.....	30
16	Local Display Module	31
17	Top Level Structure Diagram	32
18	Display Test Segment Patterns.....	34
19	4 to 20 mA Output Calibration Setup of Electronic Equipment	38
20	IAP20 and IGP20 Field Calibration Setup.....	39
21	Bench Calibration Setup	40
22	Calibration Structure Diagram (1 of 2)	42
23	Calibration Structure Diagram (2 of 2)	43
24	Configuration Structure Diagram (1 of 3).....	50
25	Configuration Structure Diagram (2 of 3)	51
26	Configuration Structure Diagram (3 of 3)	52
27	Replacing the Electronics Module Assembly and Display	61
28	Replacing the Sensor Assembly.....	63
29	Replacing the Sensor Assembly (pvdF Inserts).....	64
30	Sensor Cavity Venting and Draining	64

Tables

1	Reference Documents	9
2	Minimum Loop Load and Supply Voltage Requirements	16
3	Electrical Safety Specifications	18
4	Operation Error Messages	34
5	Calibration Menu.....	41
6	Calibration Error Messages.....	45
7	Configurable Parameters	47
8	Configuration Menu	49
9	Alphanumeric Character List.....	56
10	Numeric Character List.....	56
11	Configuration Error Messages	57

1. Introduction

General Description

The IAP20-T Intelligent Absolute Pressure and IGP20-T Intelligent Gauge Pressure Transmitters measure pressure by applying the pressure to a silicon strain gauge microsensors within the sensor assembly. This microsensor converts the pressure to a change in resistance, and the resistance change is converted to a 4 to 20 mA or digital signal proportional to the pressure. This measurement signal is transmitted to remote receivers over the same two wires that supply power to the transmitter electronics. These wires also carry two-way data signals between the transmitter and remote communication devices.

The transmitter allows direct analog connection to common receivers while still providing full Intelligent Transmitter Digital Communications using a HART Communicator.

The IAP10, IGP10 can be supplied with direct connected pressure seals; the IAP10, IGP10, IAP20, and IGP20 with remote pressure seals.

For more detailed information on the principle of operation of the transmitter, refer to document TI 037-096.

Reference Documents

Table 1. Reference Documents

Document	Description
Dimensional Prints	
DP 020-342	Dimensional Print – PSFLT Pressure Seals
DP 020-343	Dimensional Print – PSFPS and PSFES Pressure Seals
DP 020-345	Dimensional Print – PSFAR Pressure Seals
DP 020-347	Dimensional Print – PSTAR Pressure Seals
DP 020-349	Dimensional Print – PSISR Pressure Seals
DP 020-351	Dimensional Print – PSSCR Pressure Seals
DP 020-353	Dimensional Print – PSSCT Pressure Seals
DP 020-354	Dimensional Print – PSSSR Pressure Seals
DP 020-355	Dimensional Print – PSSST Pressure Seals
DP 020-447	Dimensional Print – IAP10 and IAP20 Absolute Pressure and IGP10, IGP20, IGP25, and IGP50 Gauge Pressure Transmitters

Table 1. Reference Documents (Continued)

Document	Description
Parts Lists	
PL 009-007	Parts List – IAP20 Absolute and IGP20 Gauge Pressure Transmitters
Instructions	
MI 020-366	Instruction – I/A Series Intelligent Pressure Transmitters Operation, Configuration, and Calibration Using a HART Communicator
MI 020-369	Instruction – Pressure Seals
MI 020-427	Instruction – Intrinsic Safety Connection Diagrams and Nonincendive Circuits
MI 020-495	Instruction – PC20 Intelligent Transmitter Configurator
MI 020-501	Instruction – PC50 Intelligent Field Device Tool (Installation and Parts List)
MI 020-520	Instruction – PC50 Intelligent Field Device Tool with Advanced DTM Library
MI 022-138	Instruction – Bypass Manifolds - Installation and Maintenance
Technical Information	
TI 37-75b	Technical Information – Transmitter Material Selection Guide
TI 037-097	Technical Information – Process Sealing of I/A Series Pressure Transmitters for use in Class 1, Zone 0, 1, and 2 Hazardous Locations

Transmitter Identification

See Figure 1 for transmitter data plate contents. For a complete explanation of the Model Number code, see the parts list. The firmware version is identified on the top line of the display when VIEW DB (View Database) is selected in the top level structure (see Figure 2).

Figure 1. Transmitter Identification

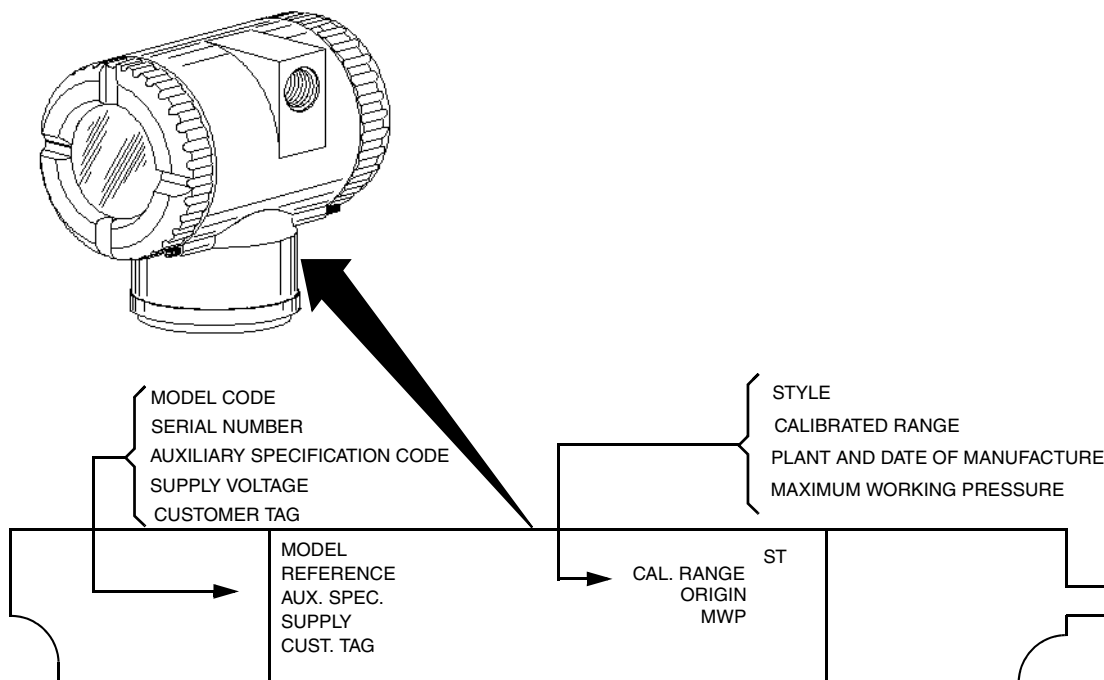
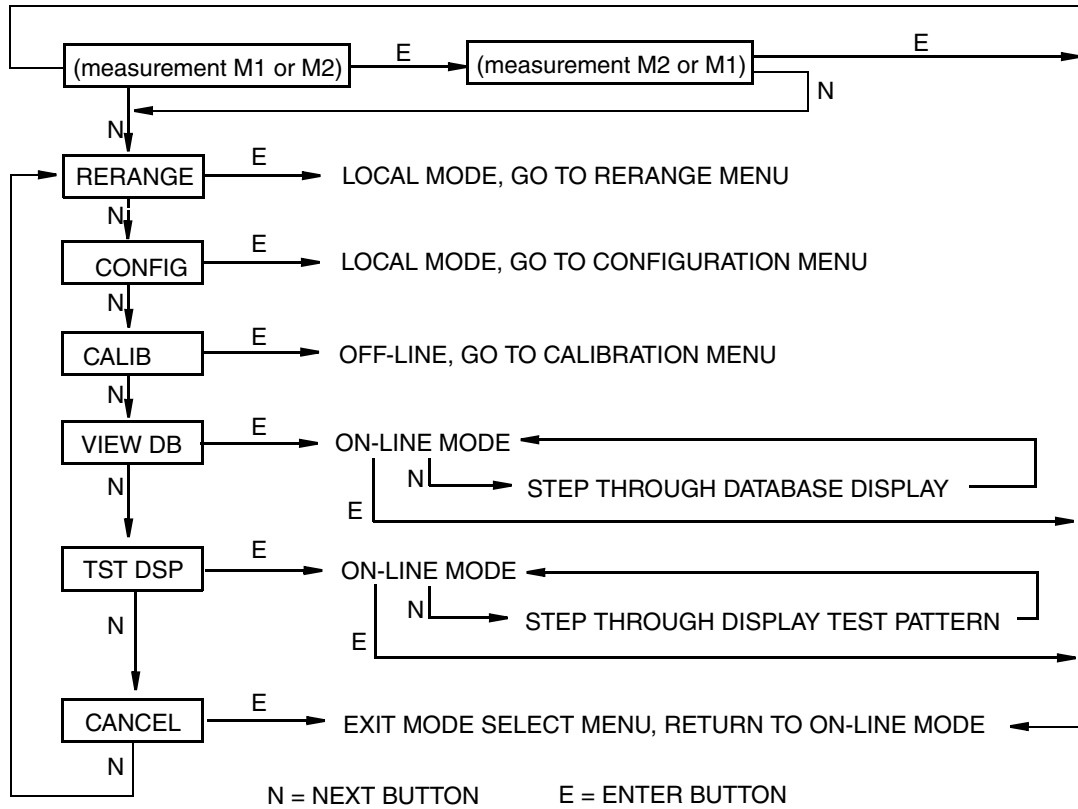


Figure 2. Top Level Structure Diagram



Standard Specifications

Operative Limits

Influence	Operative Limits
Sensor Body Temperature (a) Silicone Fill Fluid Fluorinert Fill Fluid pvdF Inserts	-46 and +121°C (-50 and +250°F) -29 and +121°C (-20 and +250°F) -7 and +82°C (20 and 180°F)
Electronics Temperature With LCD Display	-40 and +85°C (-40 and +185°F) -40 and +85°C (-40 and +185°F) (b)
Relative Humidity	0 and 100%
Supply Voltage	11.5 and 42 V dc
Output Load (c)	0 and 1450 ohms
Mounting Position	No Limit
Vibration	6.3 mm (0.25 in) double amplitude from 5 to 15 Hz with aluminum housing and from 5 to 9 Hz with 316 ss housing. 0 to 30 m/s (0 to 3 "g") from 15 to 500 Hz with aluminum housing and 0 to 10 m/s (0 to 1 "g") from 9 to 500 Hz with 316 ss housing.

- a. Refer to MI 020-369 for temperature limits with pressure seals.
 b. Display updates are slowed and readability decreased at temperatures below -20°C (-4°F).
 c. 250 Ω minimum load is required for communication with a HART Communicator.

Span and Range Limits

Span Limit Code	Span Limits (a)	Range Limits (a)
A (b) (c)	0.12 and 7.5 kPa 0.5 and 30 inH ₂ O 12 and 750 mmH ₂ O	-7.5 and +7.5 kPa -30 and +30 inH ₂ O -750 and +750 mmH ₂ O
B	0.87 and 50 kPa 3.5 and 200 inH ₂ O 87 and 5000 mmH ₂ O	-50 and +50 kPa -200 and +200 inH ₂ O -5000 and +5000 mmH ₂ O
C	0.007 and 0.21 MPa 28 and 840 inH ₂ O	-0.1 and +0.21 MPa -410 and +840 inH ₂ O
D	0.07 and 2.1 MPa 10 and 300 psi 23 and 690 ftH ₂ O	-0.1 and +2.1 MPa -14.7 and +300 psi -34 and +690 ftH ₂ O
E	0.7 and 21 MPa 100 and 3000 psi	-0.1 and +21 MPa -14.7 and +3000 psi
F (b)	1.38 and 34.5 MPa 200 and 5000 psi	-0.1 and 34.5 MPa -14.7 and 5000 psi

- a. Values listed are in absolute or gauge pressure units, as applicable.
 b. Applicable to IGP20 only.
 c. Not available with pressure seals.

Maximum Overage Pressure and Proof Pressure

! CAUTION

1. Exceeding the overrange pressure limit for the transmitter can cause damage to the transmitter, degrading its performance.
2. The transmitter may be nonfunctional after application of the proof pressure.

Span Limit Code	Maximum Overage Pressure (a)	Proof Pressure (a) (b)
A	25 MPa (3625 psi)	100 MPa (14500 psi)
B	25 MPa (3625 psi)	100 MPa (14500 psi)
C	25 MPa (3625 psi)	100 MPa (14500 psi)
D	25 MPa (3625 psi)	100 MPa (14500 psi)
E	31 MPa (4500 psi)	100 MPa (14500 psi)
F	52 MPa (7500 psi)	100 MPa (14500 psi)

- a. Values listed are in absolute or gauge pressure units, as applicable.
- b. Meets ANSI/ISA Standard S82.03-1988.

The maximum overrange pressure and proof pressure may be different depending on the bolting material. Refer to the table below.

Transmitter Configuration (Bolting Material) (a)	Maximum Static and Overage Pressure Rating (b) (c)		Proof Pressure Rating (d)	
	MPa	Psi	MPa	Psi
Option “-B2” (17-4 PH ss), Option “-D3” or “-D7”	25	3625	100	14500
Option “B1” (316 ss) or Option “-D5”	15	2175	60	8700
Option “B3” (B7M)	20	2900	70	11150
Option “-D1”	16	2320	64	9280
Option “-D2”, “-D4”, “-D6”, or “-D8” (e)	10	1500	40	6000
Option “D9” (17-4 PH ss)	40	5800	100	14500

- a. -D1 = DIN Single ended process cover with M10 B7 bolting.
-D2 = DIN Double ended process cover with M10 B7 bolting.
-D3 = DIN Single ended process cover with 7/16 in B7bolting.
-D4 = DIN Double ended process cover with 7/16 in B7bolting.
-D5 = DIN Single ended process cover with 7/16 in 316 ss bolting.
-D6 = DIN Double ended process cover with 7/16 in 316 ss bolting.
-D7 = DIN Single ended process cover with 7/16 in 17-4 ss bolting.
-D8 = DIN Double ended process cover with 7/16 in 17-4 ss bolting.
-D9 = DIN Single ended process cover with 7/16 in 17-4 ss bolting.
- b. Either side can be at higher pressure during overrange.
- c. When Structure Codes 78/79 are used (pvdf insert in the Hi side process cover), the maximum overrange is 2.1 MPa (300 psi) and temperature limits are -7 and +82°C (20 and 180°F).
- d. Meets ANSI/ISA Standard S82.03-1988.
- e. Limited to operating temperatures ranging from 0 to 60°C (32 to 140°F).

Elevated Zero and Suppressed Zero

For applications requiring an elevated or suppressed zero, the maximum span and the upper and lower range limits of the transmitter can not be exceeded.

Sensor Fill Fluid

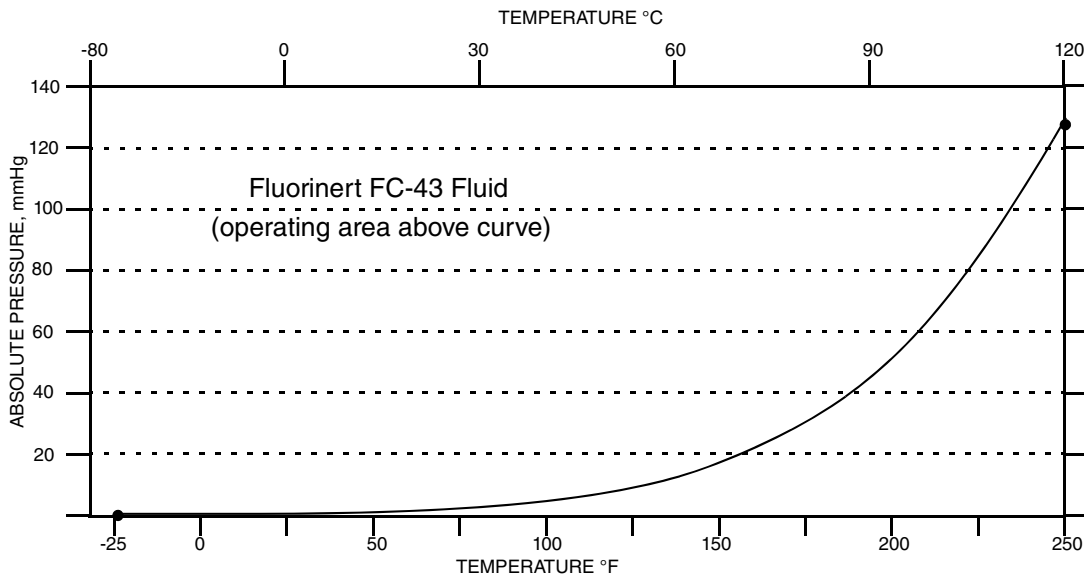
Silicone Oil (DC 200) or Fluorinert (FC-43)
Neobee M-20 (for transmitters with sanitary process connection)

Minimum Allowable Absolute Pressure vs. Process Temperature

With Silicone Fill Fluid: up to 120 °C (250 °F) at full vacuum.

With Fluorinert Fill Fluid: Refer to Figure 3.

Figure 3. Minimum Allowable Absolute Pressure vs. Process Temperature with Fluorinert Fill Fluid



Mounting Position

The transmitter can be mounted in any orientation. It can be directly mounted to the process with either the direct connected or pipe mounted designs. The housing can be rotated up to one full turn to any desired position for access to adjustments, display, or conduit connections. See “Positioning the Housing” on page 24. The display (if present) can also be rotated in the housing to any of four different positions at 90° increments. See “Positioning the Display” on page 25.

— NOTE —

Position effect zero shift for all calibrated spans can be eliminated by readjusting zero output after installation.

Approximate Mass

IAP20, IGP20 (w/o process connector):	3.5 kg (7.8 lb)
IAP20 (with process connector):	3.8 kg (8.5 lb)
IGP20 (with process connector):	4.2 kg (9.2 lb)
With Optional 316 ss Housing:	Add 1.1 kg (2.4 lb)
With Pressure Seals:	Varies with seal used

Process Connections

IAP20 and IGP20 transmitters are connected to the process via a 1/4 NPT thread or any one of a number of optional process connectors.

Process Wetted Materials

Diaphragm:	Co-Ni-Cr, 316L ss, Nickel alloy (a), gold-plated 316L ss, Monel, or tantalum
Covers and Process Connectors:	316 ss, carbon steel, Nickel alloy (a), or Monel, or pvdf inserts
Pressure Seals:	Refer to MI 020-369
Sanitary Process Connections:	316L ss, Nickel alloy (a)
Pulp and Paper Process Connections:	316L ss, Nickel alloy (a)

a. Equivalent to Hastelloy® C. Hastelloy is a registered trademark of Haynes International, Inc.

Process Pressure and Temperature Limits for Pressure Seals

Refer to MI 020-369.

Electrical Connections

Field wires enter through 1/2 NPT, PG 13.5, or M20 threaded entrances on either side of the electronics housing. Leads terminate under screw terminals and washers on the terminal block in the field terminal compartment. To maintain RFI/EMI, environmental, and explosionproof ratings, unused conduit connection must be plugged with metal plug (provided), inserted to five full threads for 1/2 NPT connections; seven full threads for M20 and PG 13.5 connections.

Field Wiring Reversal

Accidental reversal of field wiring will not damage the transmitter, provided the current is limited to 1 A or less by active current limiting or loop resistance. Sustained currents of 1 A will not damage the electronics module or sensor but could damage the terminal block assembly and external instruments in the loop.

Adjustable Damping

The transmitter response time is normally 1.0 second or the electronically adjustable setting of 0.00 (none), 0.25, 0.50, 1, 2, 4, 8, 16, or 32 seconds, whichever is greater, for a 90% recovery from an 80% input step as defined in ANSI/ISA S51.1.

Output Signal

4 to 20 mA dc linear.

Zero and Span Adjustments

Zero and span are adjustable from the HART Communicator. They are also adjustable at the transmitter using the display. An optional external self-contained moisture sealed pushbutton assembly allows local resetting of zero without removing the housing cover.

Power-up Time

Less than 2.0 seconds for output to reach the first valid measurement, then at the electronic damping rate to reach the final measured variable value.

Supply Voltage

Power supply must be capable of providing 22 mA when the transmitter is configured for 4 to 20 mA output. Ripple of up to 2 V pp (50/60/100/120 Hz) is tolerable, but instantaneous voltage must remain within specified range.

The supply voltage and loop load must be within specified limits. This is explained in detail in “Wiring” on page 25. A summary of the minimum requirements is listed in Table 2.

Table 2. Minimum Loop Load and Supply Voltage Requirements

	HART Communication	No HART Communication
Minimum Resistance	250 Ω	0
Minimum Supply Voltage	17 V	11.5 V

Electrical Ground Connections

The transmitter is equipped with an internal ground connection within the field wiring compartment and an external ground connection at the base of the electronics housing. To minimize galvanic corrosion, place the wire lead or contact between the captive washer and loose washer on the external ground screw. If shielded cable is used, earth (ground) the shield at the field enclosure **only**. Do **not** ground the shield at the transmitter.

HART Communicator Connection Points

The HART Communicator can be connected in the loop as shown in “Wiring” on page 25. It can also be connected directly to the transmitter at the two upper banana plug receptacles.

Test Points

The two lower banana plug receptacles (designated CAL) can be used to check transmitter output when configured for 4 to 20 mA. Measurements should be 100-500 mV dc for 0-100% transmitter output.

Remote Communications

The transmitter communicates bidirectionally over the 2-wire field wiring to a HART Communicator. The information that can be continuously displayed is:

- ◆ Process Measurement (expressed in one or two types of units)
- ◆ Transmitter Temperature (sensor and electronics)
- ◆ mA Output (equivalent)

The information that can be remotely displayed and reconfigured includes:

- ◆ Output in Percent Flow (square root) or Pressure Units (linear). Percent Display in Linear mode on local display is also supported.
- ◆ Zero and Span, including reranging
- ◆ Zero Elevation or Suppression
- ◆ Linear Output or Square Root Output (in some models)
- ◆ Pressure or Flow Units (from list provided)
- ◆ Temperature Sensor Failure Strategy
- ◆ Electronic Damping
- ◆ Poll Address (Multidrop mode)
- ◆ External Zero (Enable or Disable)
- ◆ Failsafe Direction
- ◆ Tag, Description, and Message
- ◆ Date of Last Calibration

Communications Format

Communication is based upon the FSK (Frequency Shift Keying) technique. The frequencies are superimposed on the transmitter power/signal leads.

4 to 20 mA Output

The transmitter sends its differential pressure measurement to the loop as a continuous 4 to 20 mA dc signal. It also communicates digitally with the HART Communicator at distances up to 3000 m (10 000 ft). Communication between the remote configurator and the transmitter does not disturb the 4 to 20 mA output signal. Other specifications are:

Data Transmission Rate:	1200 Baud
4 - 20 mA Update Rate:	30 times/second
Output when Fail Low:	3.60 mA
Output when Fail High:	21.00 mA
Output when Underrange:	3.80 mA
Output when Overage:	20.50 mA
Output when Offline:	User configurable between 4 and 20 mA

Product Safety Specifications

DANGER

To prevent possible explosions and to maintain flameproof, explosionproof, and dust-ignitionproof protection, observe applicable wiring practices. Plug unused conduit opening with the provided metal pipe plug. Both plug and conduit must engage a minimum of five full threads for 1/2 NPT connections; seven full threads for M20 and PG 13.5 connections.

WARNING

To maintain IEC IP66 and NEMA Type 4X protection, the unused conduit opening must be plugged with the metal plug provided. Use a suitable thread sealant on both conduit connections. In addition, the threaded housing covers must be installed. Turn covers to seat the O-ring into the housing and then continue to hand tighten until the cover contacts the housing metal-to-metal.

NOTE

1. These transmitters have been designed to meet the electrical safety description listed in Table 3. For detailed information or status of testing laboratory approvals/certifications, contact Global Customer Support.
2. Wiring restrictions required to maintain electrical certification of the transmitter are provided in “Wiring” on page 25.

Table 3. Electrical Safety Specifications

Agency Certification, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
ATEX flameproof: II 2 GD EEx d IIC, Zone 1.	KEMA 00ATEX2019X Temperature Class T6, T85°C, Ta = -40 to +80°C	D
ATEX intrinsically safe: II 1 GD EEx ia IIC, Zone 0.	SIRA 06ATEX2055X Temperature Class T4, Ta = -40 to +80°C	E
ATEX protection n: II 3 GD EEx nL IIC, Zone 2.	SIRA 06ATEX4056X Temperature Class T4, Ta = -40 to +80°C	N
ATEX multiple certifications, ia & ib and n. Refer to Codes E and N for details.	Applies to Codes D, E, and N. (a)	M
CSA intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1. Also, Zone certified intrinsically safe Ex ia IIC and energy limited Ex nA II.	Connect per MI 020-427. Temperature Class T4A at 40°C (104°F) and T3C at 85°C (185°F) maximum ambient. Temperature Class T4 at 40°C (104°F), and T3 at 85°C (185°F) max. ambient.	C
CSA explosionproof for Class I, Division 1, Groups B, C, and D; dust-ignitionproof for Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Maximum Ambient Temperature 85°C (185°F).	
CSA for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Temperature Class T4A at 40°C (104°F) and T3C at 85°C (185°F) maximum ambient.	
CSA field device zone certified flameproof Ex d IIC. Also, all certifications of Code C above.	Maximum Ambient Temperature 85°C (185°F).	B

Table 3. Electrical Safety Specifications (Continued)

Agency Certification, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
FM intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1. Also, Zone certified intrinsically safe AEx ia IIC.	Connect per MI 020-427. Temperature Class T4A at 40°C (104°F) and T4 at 85°C (185°F) maximum ambient. Temperature Class T4 at 85°C (185°F) maximum ambient.	F
FM explosionproof for Class I, Division 1, Groups B, C, and D; dust-ignitionproof for Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Temperature Class T6 at 80°C (176°F) and T5 at 85°C (185°F) maximum ambient.	
FM nonincendive for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Temperature Class T4A at 40°C (104°F) and T4 at 85°C (185°F) maximum ambient.	
FM field device zone certified flameproof AEx d IIC. Also, all certifications of Code F above.	Temperature Class T6 at 75°C (167°F) maximum ambient.	G
IECEx intrinsically safe: Ex ia IIC.	IECEx SIR 06.0010X Temperature Class T4, Ta = -40 to +80°C.	T
IECEx protection n: Ex nL IIC	IECEx SIR 06.0011X Temperature Class T4, Ta = -40 to +80°C.	U
IECEx flameproof: Ex d IIC	IECEx FMG 06.0007X, Ex d IIC T6 Ta=80°C, T5 Ta=85°C Ambient Temperature -20 to +85°C	V

- a. User must permanently mark (check off in rectangular block on data plate) one type of protection only (ia and ib, d, or n). This mark cannot be changed once it is applied.

ATEX and IECEx Warnings

Do not open while circuits are alive.

ATEX Compliance Documents

EN 50014: 1997 (A1 and A2)
 EN 50020: 2002
 EN 50284: 1999
 EN 50281-1-1: 1998
 EN 60079-15: 2004

IECEx Compliance Documents

IEC 60079-0 (Edition 3.1): 2000
 IEC 60079-0 (Edition 4): 2000
 IEC 60079-1 (Edition 5): 2003
 IEC 60079-11 (Edition 4): 1999

2. Installation

! CAUTION

To avoid damage to the transmitter sensor, do not use any impact devices, such as an impact wrench or stamping device, on the transmitter.

NOTE

1. The transmitter should be mounted so that any moisture condensing or draining into the field wiring compartment can exit through one of the two threaded conduit connections.
 2. Use a suitable thread sealant on all connections.
-

Transmitter Mounting

The IAP20 and IGP20 transmitters must be mounted to a vertical or horizontal pipe or a surface using the mounting set. See Figures 4 and 5. For dimensional information, refer to DP 020-447.

NOTE

1. If the transmitter is not installed in the vertical position, readjust the zero output to eliminate the position zero effect. Be aware that an absolute pressure transmitter cannot be zeroed by venting the transmitter to atmosphere.
 2. The lower conduit port can be used as a drain for moisture buildup in terminal compartment.
-

Figure 4. Pipe Mounting

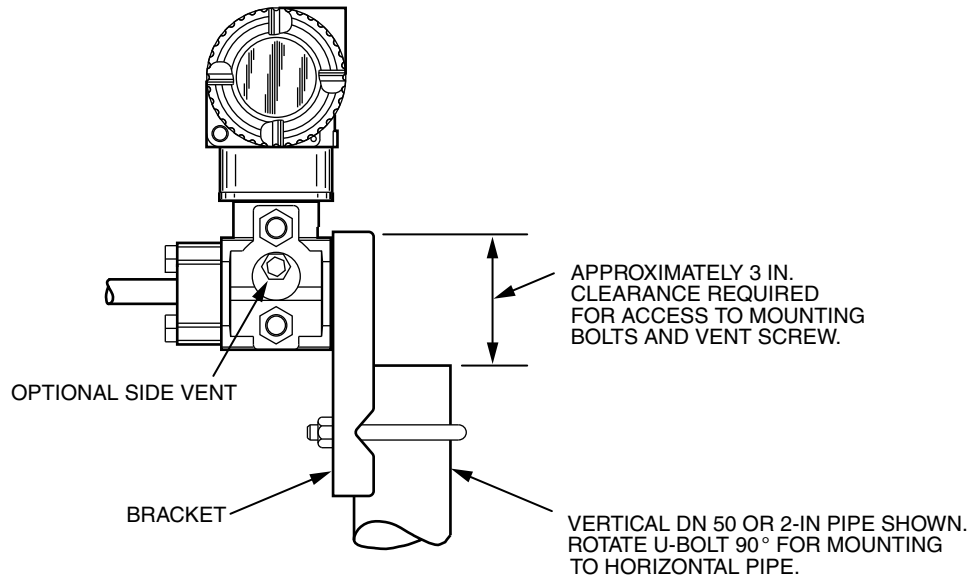
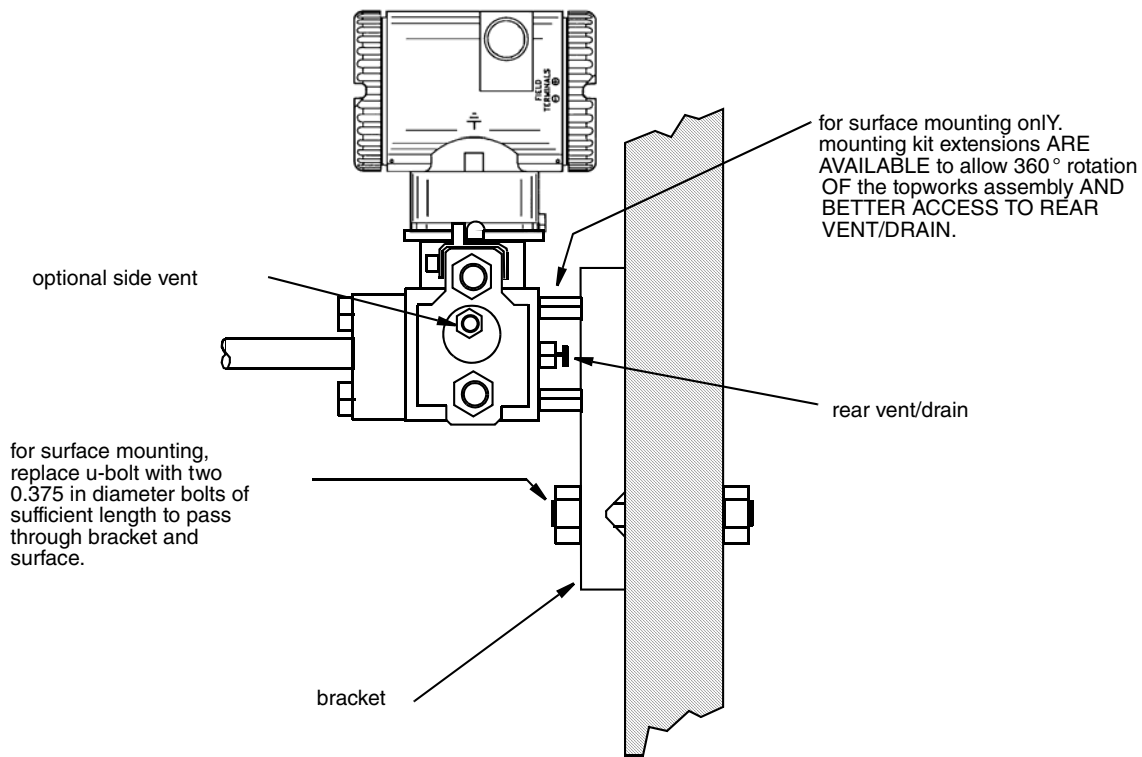


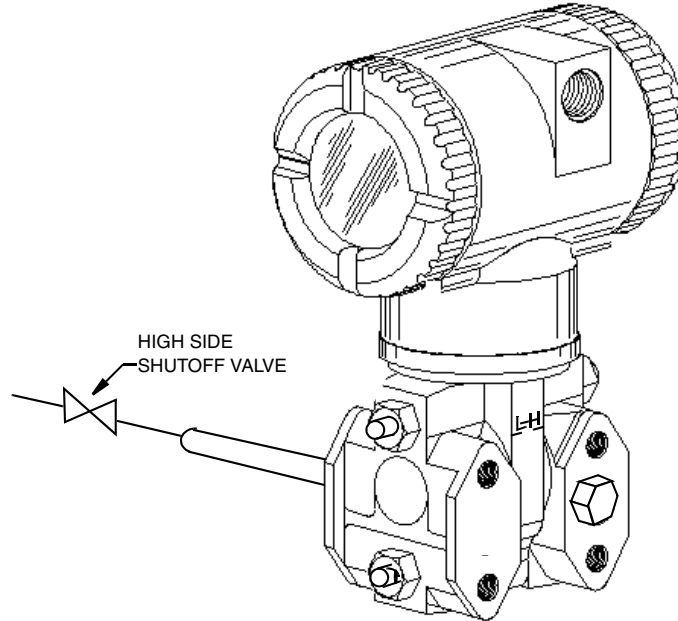
Figure 5. Surface Mounting

Typical Transmitter Piping

Figure 6 shows a typical piping application. Tighten the process connector bolts to a torque of 61 N·m (45 lb·ft) and drain plugs and vent screws to a torque of 20 N·m (15 lb·ft).

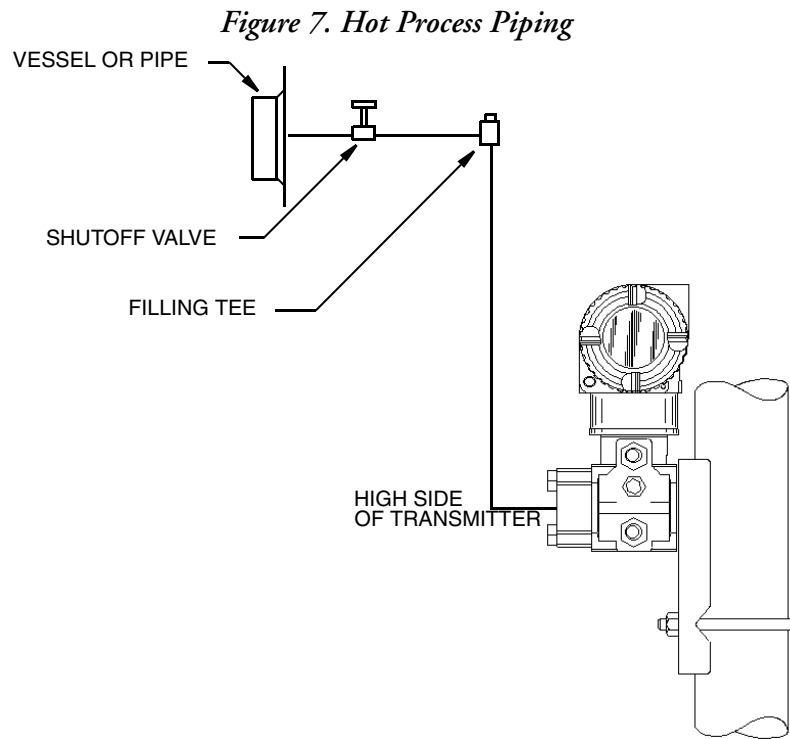
NOTE

1. It is recommended that you use snubbers in installations prone to high levels of fluid pulsations.
 2. When structure codes 78/79 (pvdf insert) are used on an IAP20, the process connection must be made directly to the pvdf insert in the high side process cover.
-

Figure 6. Typical Transmitter Piping

For hot process applications above the operative limits of your transmitter [121°C (250°F) for silicone fill fluid or 82°C (180°F) for fluorinert fill fluid], such as steam, additional piping is required to protect the transmitter from the hot process. See Figure 7. The piping is filled with water or process fluid. Mount the transmitter below the pressure connection at the pipe. Although the transmitter is shown mounted vertically, you can also mount it horizontally. The calibration tee is not required if a calibration screw is used for field calibrations.

If trapped vapor pockets cannot be tolerated in a liquid service and a horizontal process connection is used, install a pipe elbow and vertically position the transmitter with the housing **below** the process connection.



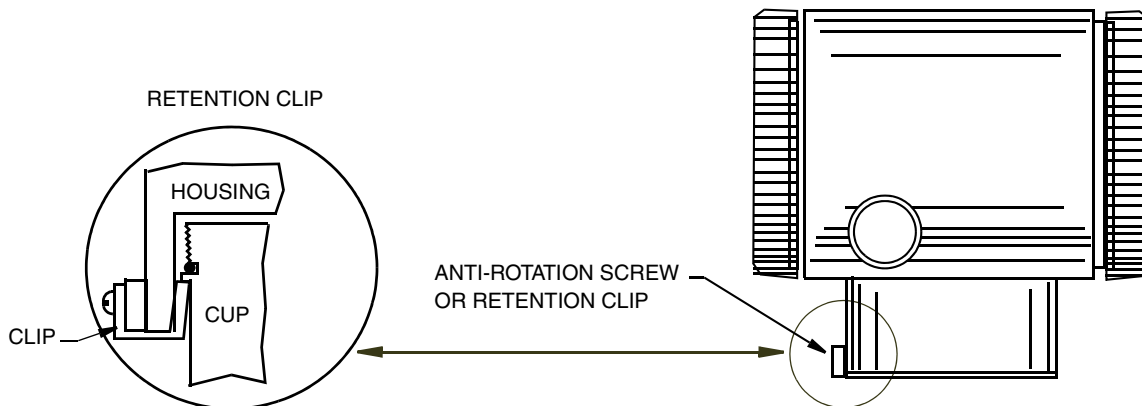
Positioning the Housing

The transmitter housing (topworks) can be rotated up to one full turn in the counterclockwise direction when viewed from above for optimum access to adjustments, display, or conduit connections. Housings have either an anti-rotation screw or a retention clip that prevent the housing from being rotated beyond a safe depth of housing/sensor thread engagement.

! WARNING

If the electronics housing is removed for maintenance, it must be hand tightened to the bottom of the threads, but not over-tightened upon reassembly. See “Removing and Reinstalling a Housing Assembly” on page 61.

Figure 8. Housing Screw or Clip Location



Positioning the Display

The display (optional in some models) can be rotated within the housing to any of four positions at 90° increments. To do this, grasp the two tabs on the display and rotate it about 10° in a counterclockwise direction. Pull out the display. Ensure that the O-ring is fully seated in its groove in the display housing. Turn the display to the desired position, reinsert it in the electronics module, aligning the tabs on the sides of the assembly, and twist it in the clockwise direction.

! CAUTION

Do **not** turn the display more than 180° in any direction. Doing so could damage its connecting cable.

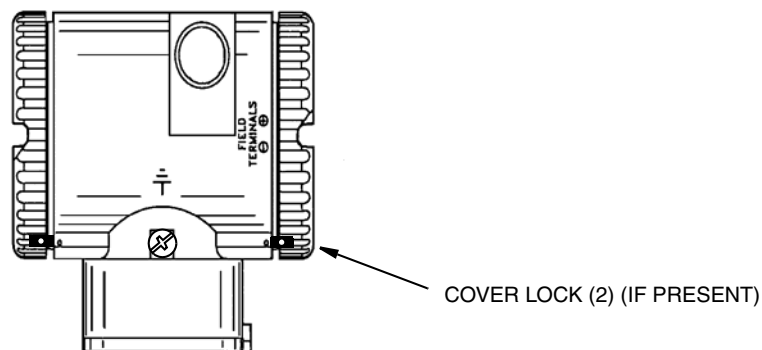
Setting the Write Protect Jumper

Your transmitter has write protection capability. This means that the external zero, local display, and remote communications can be prevented from writing to the electronics. Write protection is set by moving a jumper that is located in the electronics compartment behind the optional display. To activate write protection, remove the display as described in the previous section, then remove the jumper or move it to the lower position as shown on the exposed label. Replace the display.

Cover Locks

Electronic housing cover locks, shown in Figure 9, are provided as standard with certain agency certifications and as part of the Custody Transfer Lock and Seal option. To lock the covers, unscrew the locking pin until approximately 6 mm (0.25 in) shows, lining up the hole in the pin with the hole in the housing. Insert the seal wire through the two holes, slide the seal onto the wire ends and crimp the seal.

Figure 9. Cover Lock Location



Wiring

The installation and wiring of your transmitter must conform to local code requirements.

! WARNING
 ATEX requires that when the equipment is intended to be used in an explosive atmosphere caused by the presence of combustible dust, cable entry devices and blanking elements shall provide a degree of ingress protection of at least IP6X. They shall be suitable for the conditions of use and correctly installed.

NOTE
 It is recommended that you use transient/surge protection in installations prone to high levels of electrical transients and surges.

Accessing Transmitter Field Terminals

For access to the field terminals, thread the cover lock (if present) into the housing to clear the threaded cover and remove the cover from the field terminals compartment as shown in Figure 10. Note that the embossed letters FIELD TERMINALS identify the proper compartment.

Figure 10. Accessing Field Terminals

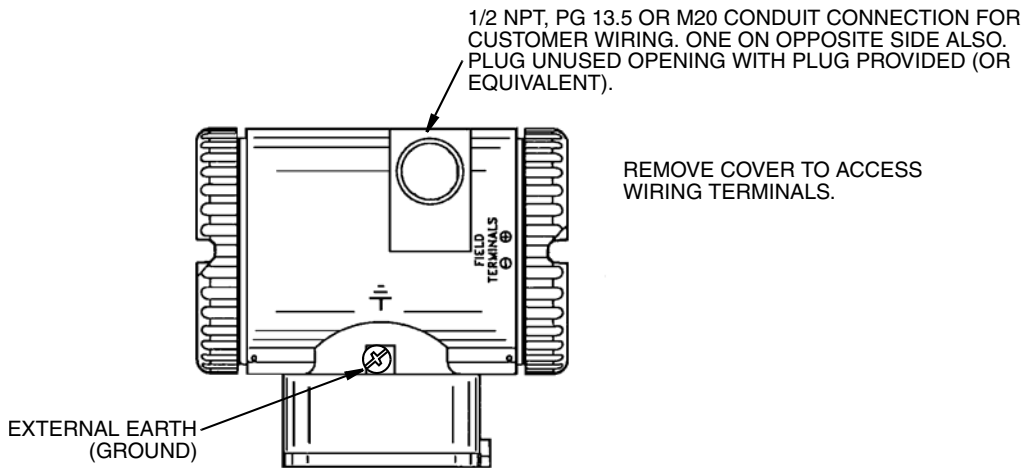
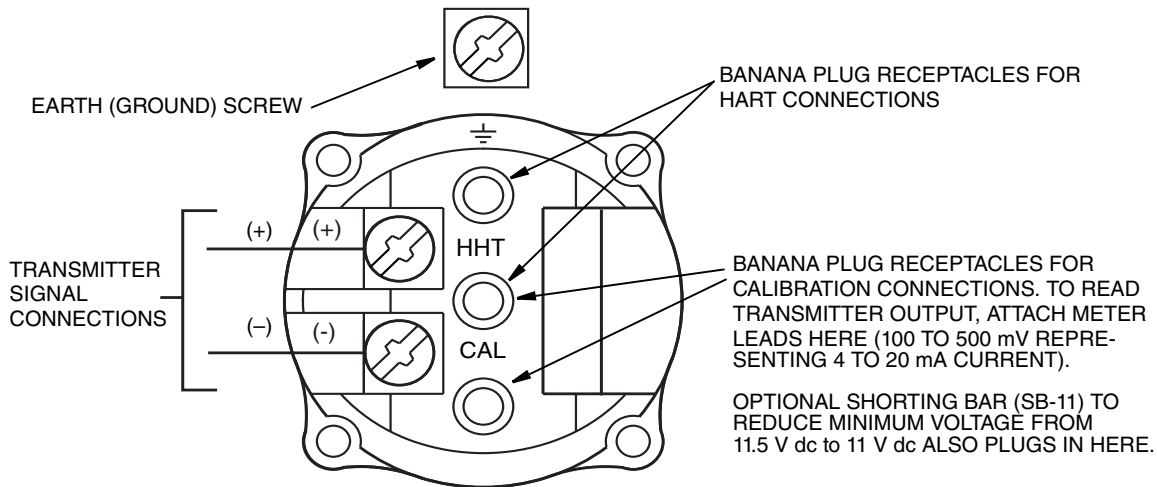


Figure 11. Identification of Field Terminals



Wiring the Transmitter to a Control Loop

When wiring the transmitter, the supply voltage and loop load must be within specified limits. The supply output load vs. voltage relationship is:

$$R_{MAX} = 47.5 (V - 11.5) \text{ and is shown in Figure 12.}$$

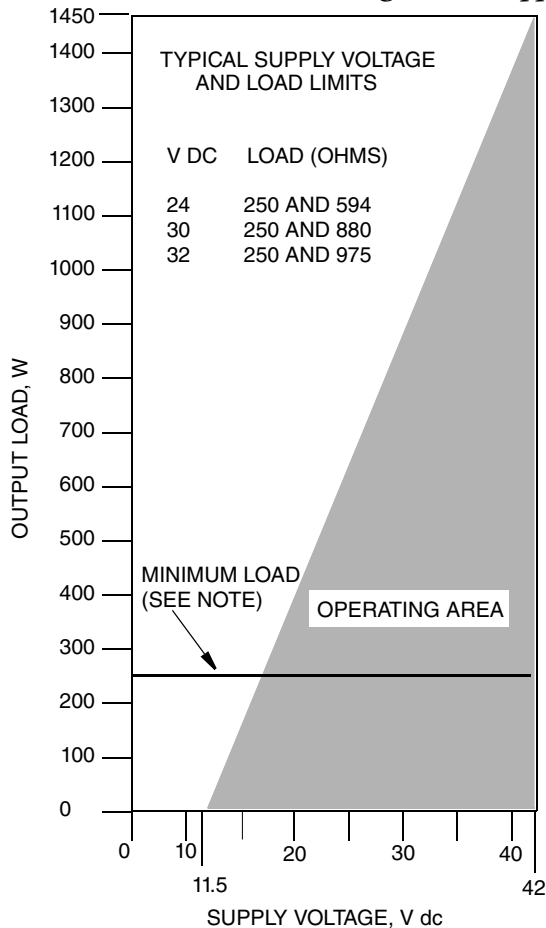
NOTE

The relationship when the optional shorting bar is used is:

$$R_{MAX} = 46.8 (V - 11).$$

Any combination of supply voltage and loop load resistance in the shaded area can be used. To determine the loop load resistance (transmitter output load), add the series resistance of each component in the loop, excluding the transmitter. The power supply must be capable of supplying 22 mA of loop current.

Figure 12. Supply Voltage and Loop Load



NOTES:

1. The minimum load for the HART Communicator is 250 W.
2. The transmitter can function with an output load less than the minimum, provided that a remote configurator is **NOT** connected to it. Connecting a remote configurator while operating in this area could cause output disturbances and/or communication problems.

Examples:

1. For a loop load resistance of 880 Ω , the supply voltage can be any value from 30 to 42 V dc.
2. For a supply voltage of 24 V dc, the loop load resistance can be any value from 250 to 594 Ω (zero to 594 Ω without a HART Communicator or PC-Based Configurator connected to the transmitter).

To wire one or more transmitters to a power supply, proceed with the following steps.

1. Remove the cover from the transmitter field terminals compartment.
2. Run signal wires (0.50 mm² or 20 AWG, typical) through one of the transmitter conduit connections. Use twisted single pair to protect the 4 to 20 mA output and/or remote communications from electrical noise. Maximum recommended length for signal wires is:
 - ◆ 3050 m (10,000 ft) **using single pair cable** and adhering to requirements of HART physical layer implementation defined in HART Document HCF_SPEC-53. Use CN=1 when calculating max. lengths.
 - ◆ 1525 m (5000 ft) in a multidrop (15 devices maximum) mode. Screened (shielded) cable could be required in some locations.

NOTE

Do not run transmitter wires in same conduit as mains (ac power) wires.

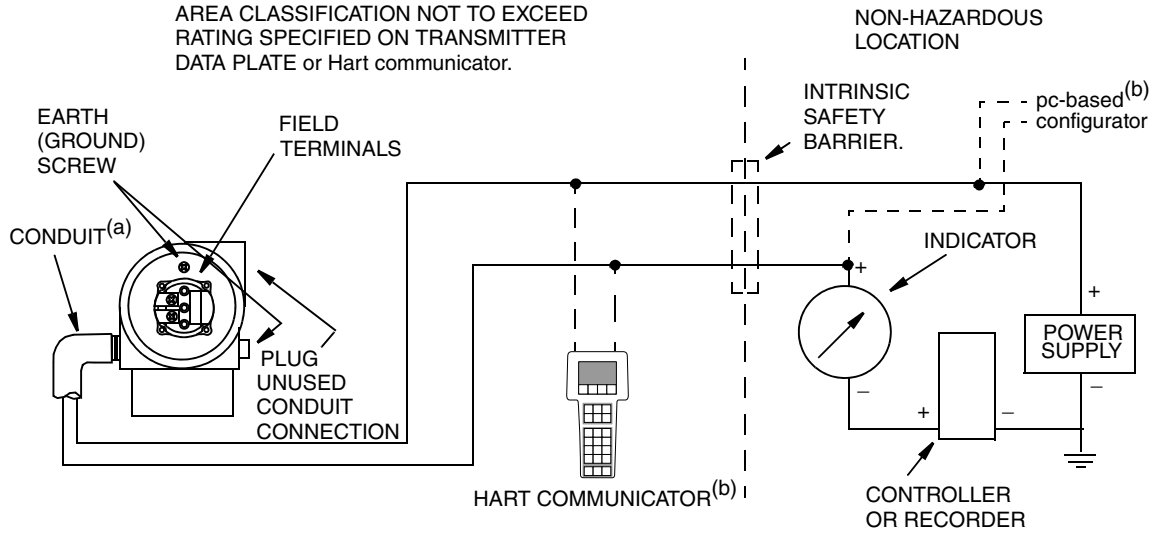
3. If shielded cable is used, earth (ground) the shield at the power supply **only**. Do not ground the shield at the transmitter.
4. Plug unused conduit connection with the 1/2 NPT, PG 13.5 or M20 metal plug provided (or equivalent). To maintain specified explosionproof and dust-ignitionproof protection, plug must engage a **minimum** of five full threads for 1/2 NPT connections; seven full threads for M20 and PG 13.5 connections.
5. Connect an earth (ground) wire to the earth terminal in accordance with local practice.

! CAUTION

If the signal circuit must be earthed (grounded), it is preferable to do so at the negative terminal of the dc power supply. To avoid errors resulting from earth loops or the possibility of short-circuiting groups of instruments in a loop, there should be only one earth in a loop.

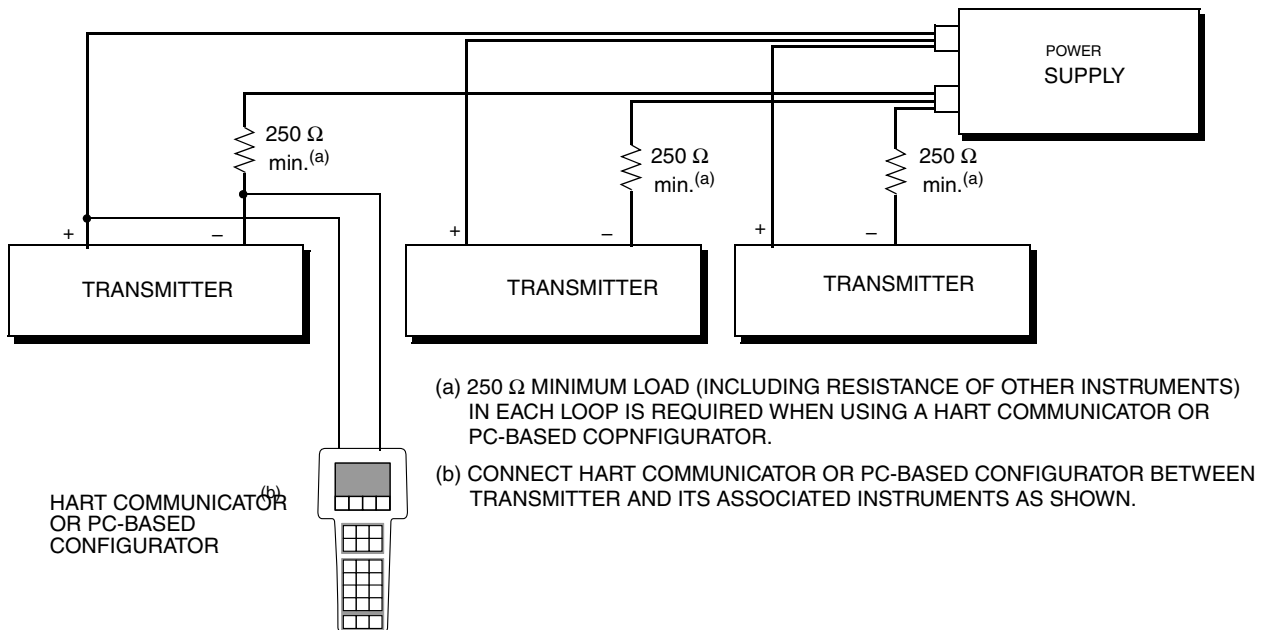
6. Connect the power supply and receiver loop wires to the “+” and “-” terminal connections.
7. Connect receivers (such as controllers, recorders, indicators) in series with power supply and transmitter as shown in Figure 13.
8. Reinstall the cover onto the housing by rotating it clockwise to seat the O-ring into the housing and then continue to hand tighten until the cover contacts the housing metal-to-metal. If cover locks are present, lock the cover per the procedure described in “Cover Locks” on page 25.
9. If wiring additional transmitters to the same power supply, repeat Steps 1 through 8 for each additional transmitter. The setup with multiple transmitters connected to a single power supply is shown in Figure 14.
10. A HART Communicator or PC-Based Configurator can be connected in the loop between the transmitter and the power supply as shown in Figures 13 and 14. Note that a minimum of 250 Ω must separate the power supply from the HART Communicator or PC-Based Configurator.

Figure 13. Loop Wiring Transmitters



- (a) Run conduit down to avoid moisture buildup in terminals compartment.
- (b) There must be at least 250 Ω total resistance between the HART Communicator OR PC-BASED CONFIGURATOR AND the Power Supply.

Figure 14. Wiring Several Transmitters to a Common Power Supply



- (a) 250 Ω MINIMUM LOAD (INCLUDING RESISTANCE OF OTHER INSTRUMENTS) IN EACH LOOP IS REQUIRED WHEN USING A HART COMMUNICATOR OR PC-BASED COPNFIGURATOR.
- (b) CONNECT HART COMMUNICATOR OR PC-BASED CONFIGURATOR BETWEEN TRANSMITTER AND ITS ASSOCIATED INSTRUMENTS AS SHOWN.

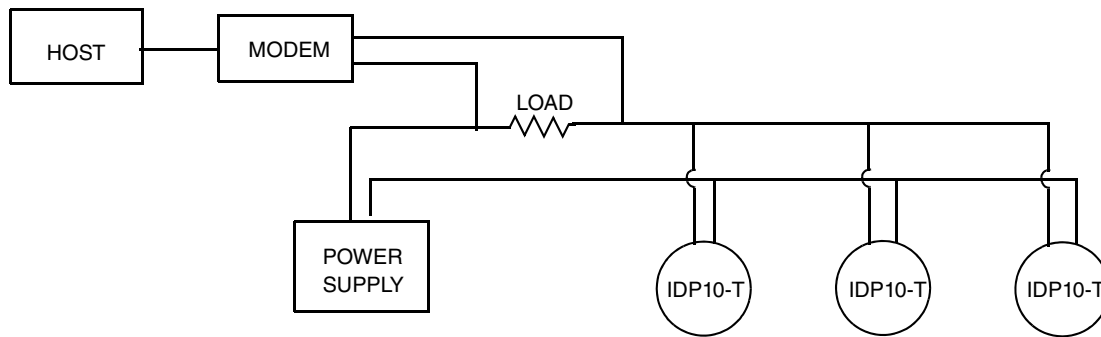
Multidrop Communication

“Multidropping” refers to the connection of several transmitters to a single communications transmission line. Communications between the host computer and the transmitters takes place digitally with the analog output of the transmitter deactivated. With the HART communications protocol, up to 15 transmitters can be connected on a single twisted pair of wires or over leased telephone lines.

The application of a multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Multidrop installations are not recommended where Intrinsic Safety is a requirement. Communication with the transmitters can be accomplished with any HART compatible modem and a host implementing the HART protocol. Each transmitter is identified by a unique address (1-15) and responds to the commands defined in the HART protocol.

Figure 15 shows a typical multidrop network. Do not use this figure as an installation diagram. Contact the HART Communications Foundation, (512) 794-0369, with specific requirements for multidrop applications.

Figure 15. Typical Multidrop Network



The HART Communicator can operate, configure, and calibrate IASPT transmitters with HART communication protocol in the same way as it can in a standard point-to-point installation.

NOTE

IASPT transmitters with HART communication protocol are set to poll address 0 (POLLADR 0) at the factory, allowing them to operate in the standard point-to-point manner with a 4 to 20 mA output signal. To activate multidrop communication, the transmitter address must be changed to a number from 1 to 15. Each transmitter must be assigned a unique number on each multidrop network. This change deactivates the 4 to 20 mA analog output.

Connecting the Transmitter to an I/A Series System

The transmitter can also send its measurement to an I/A Series system as a digital signal via an FBM214/215. Wiring terminations at the transmitter are the same as described above. For other system wiring details, refer to the installation instructions provided with the I/A Series system.

3. Operation Via Local Display

A local display, as shown in Figure 16, has two lines of information. The upper line is a 5-digit numeric display (4-digit when a minus sign is needed); the lower line is a 7-digit alphanumeric display. The display provides local indication of measurement information.

The display can be configured to meet your specific needs. If configured **Show 1**, M1 is displayed. If configured **Show 2**, M2 is displayed. To temporarily view the alternate measurement, press the **Enter** button. After showing this measurement for a brief period, the display reverts to the configured display. If configured **Toggle**, the display toggles between M1 and M2. When M2 is displayed, an M2 message blinks in the lower right of the display.

The display also provides a means for performing calibration and configuration, viewing the database, testing the display, and reranging the transmitter via the 2-button keypad. You can access these operations by means of a multi-level menu system. Entry to the Mode Select menu is made (from normal operating mode) by pressing the **Next** button. You can exit this menu, restore your prior calibration or configuration, and return to the normal operating mode at any time by going to **Cancel** and pressing the **Enter** button.

The top level structure diagram is shown in Figure 17.

Figure 16. Local Display Module

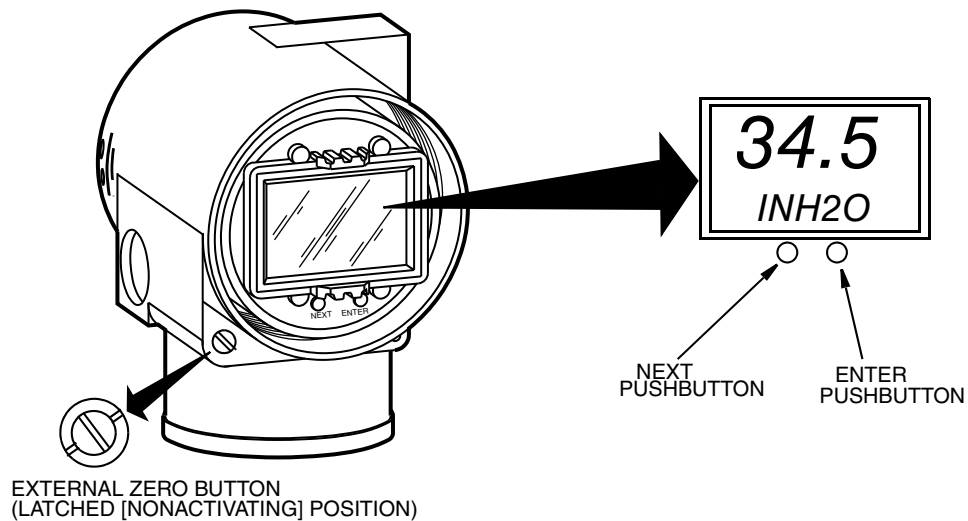
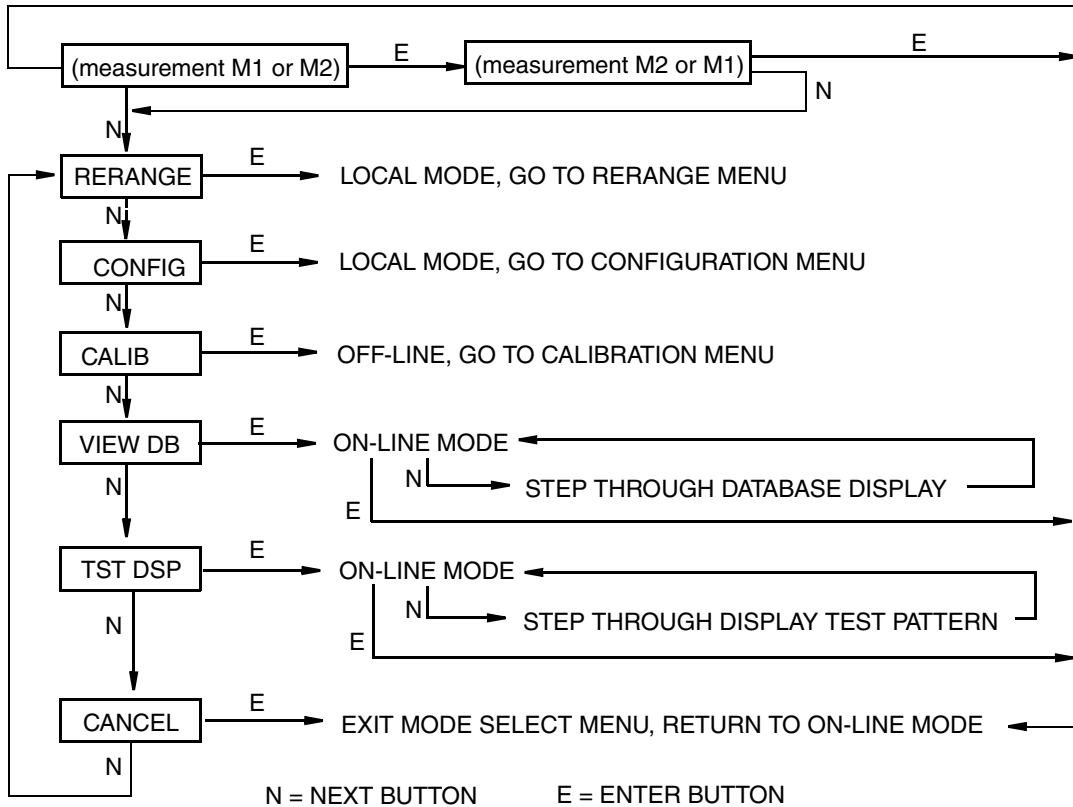


Figure 17. Top Level Structure Diagram



Entering Numerical Values

The general procedure for entering numerical values in Calibration and Configuration is as follows:

1. At the appropriate prompt, press the Enter button. The display shows the last (or default) value with the first digit flashing.
2. Use the Next button to select the desired first digit, then press the Enter button. Your selection is entered and the second digit flashes.
3. Repeat Step 2 until you have created your new value. If the number has less than five characters, use leading or trailing zeros for the remaining spaces. When you have configured the fifth space, the display prompts you to place the decimal point.
4. Move the decimal point with the Next button until it is where you want it and press the Enter button.

NOTE

The decimal point may not be placed directly after the first digit. For example, you can not enter a value as 1.2300; you must enter it as 01.230.

The decimal position is identified by flashing except at the position after the fifth digit. At that position (representing a whole number), the decimal point is assumed.

5. The display advances to the next menu item.

Reranging

You can access the Rerange mode in the top level menu (see Figure 17). Entry to the Mode Select menu is made (from normal operating mode) by pressing the **Next** button. The display reads **RERANGE**. You can then adjust **M1 URV** and/or **M1 LRV** in the following two submenus.

M1 URV:

To edit the upper range value, press **Enter** at the prompt **M1 URV**. Use the procedure “Entering Numerical Values” on page 32 section to edit this parameter.

M1 LRV:

Similar to **M1URV** immediately above.

Viewing the Database

You can access the View Database mode by the multi-level menu system described above. Entry to the Mode Select menu is made (from normal operating mode) by pressing the **Next** button. The display reads **RERANGE**. Use the **Next** button to get to **VIEW DB**. Acknowledge your choice of this selection by pressing the **Enter** button. The display shows the first item in the database. You can step through the database display by repeated use of the **Next** button. You can abort this procedure at any time by pressing the **Enter** button.

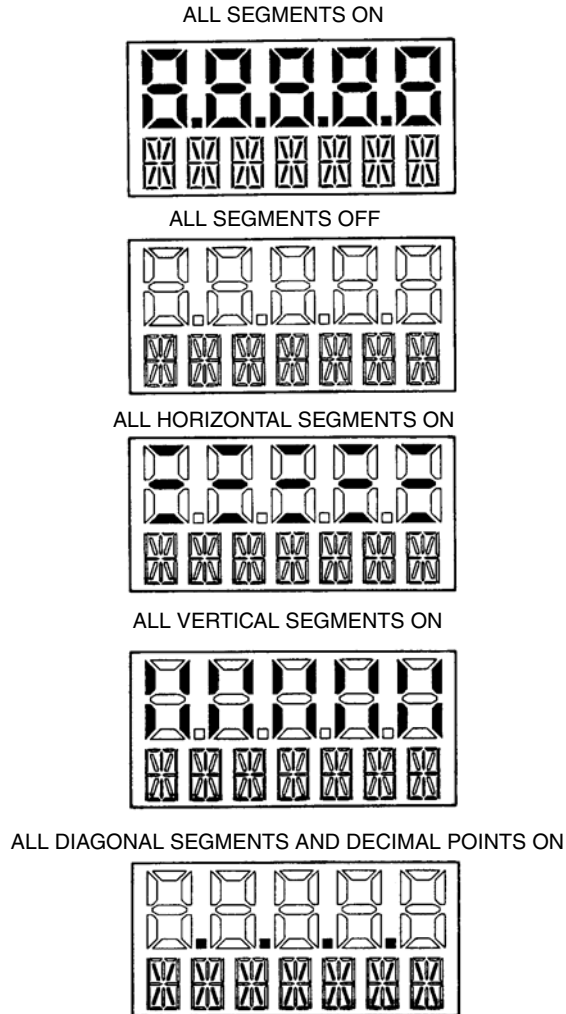
Viewing the Pressure Range

The values of **M1LRV** and **M1 URV** can be viewed in **VIEW DB** as described above.

Testing the Display

You can access the Test Display mode by the same multi-level menu system that was used to enter Reranging, Calibration, Configuration, and View Database mode. Entry to the Mode Select menu is made (from normal operating mode) by pressing the **Next** button. The display reads **RERANGE**. Use the **Next** button to get to **TST DSP**. Acknowledge your choice of this selection by pressing the **Enter** button. The display shows the first test segment pattern. You can step through the five patterns by repeated use of the **Next** button. You can abort the test at any time by pressing the **Enter** button. The five patterns are shown in Figure 18.

Figure 18. Display Test Segment Patterns



Error Messages

Table 4. Operation Error Messages

Parameter	Condition Tested	Error Message	Action
Normal Operation	Write Protection Enabled	WR PROT	Displays periodically to notify user that unit is in Write Protect.
	Any non-On-line Condition	OFFLINE	Notifies user of a non-On-line condition.
Startup	Database OK or corrupted	INITERR	User should perform SET GDB procedure.

4. Calibration

NOTE

1. For best results in applications where high accuracy is required, rezero the transmitter output once it has stabilized at the final operating temperature.
 2. Zero shifts resulting from position effects and/or static pressure effects can be eliminated by rezeroing the transmitter output.
 3. After calibrating transmitters operating with a 4 to 20 mA (or 1 to 5 V dc) output signal, check the underrange and overrange output values to ensure that they extend beyond 4 and 20 mA (or 1 and 5 V dc) respectively.
-

General Calibration Notes

1. Each transmitter is factory characterized over its full rated pressure range. One benefit of this process is that every transmitter can measure any applied pressure within its range limits regardless of the calibrated range. The applied pressure is measured and converted into an internal digital value of pressure. This digital value of pressure is always available whether the transmitter is calibrated or not. Calibration assures that the transmitter rated accuracy is achieved over the calibrated range.
2. The internal digital value of pressure can be displayed on the optional local display, transmitted digitally, and converted to a 4 to 20 mA analog output signal.
3. Each transmitter is factory calibrated to either a specified or a default calibrated range. This calibration optimizes the accuracy of the internal digital value of pressure over that range. If no range is specified, the default range is zero to the sensor upper range limit (URL).
4. The transmitter database has configurable values for both lower range value (LRV) and upper range value (URV). These values are used for two functions.
 - a. Defining the Calibrated Range When Using Local Pushbuttons for Calibration:
 - ◆ When either CAL LRV or CAL URV is initiated from the local pushbuttons, the transmitter expects that the pressure applied at the time the button is pressed is equal to the LRV or URV value respectively.
 - ◆ This function trims the internal digital value of pressure; that is, it performs a calibration based on the application of accurate pressures equal to the values entered for LRV and URV in the transmitter database.
 - ◆ This function also sets the 4 and 20 mA output points; that is, the 4 and 20 mA points correspond to the values of LRV and URV in the database.
 - ◆ The value of LRV can be larger than the value of URV.

- b. Reranging Without the Application of Pressure:
- ◆ Since the transmitter continually determines an internal digital value of the measured pressure from the lower range limit (LRL) to the upper range limit (URL), the 4 and 20 mA output points can be assigned to any pressure values (within the span and range limits) without application of pressure.
 - ◆ The reranging function is accomplished by entering new database values for LRV and URV.
 - ◆ Reranging does not affect the calibration of the transmitter; that is, it does not affect the optimization of the internal digital value of pressure over a specific calibrated range.
 - ◆ If the reranged LRV and URV are not within the calibrated range, the measured values may not be as accurate as when they are within the calibrated range.
5. When the optional local display is used, the internal digital value of pressure is sent directly to the indicator.
- ◆ The display can show any measured pressure in selected units regardless of the calibrated range and the values of LRV and URV (within the limits of the transmitter and display).
 - ◆ If the measured pressure is outside the range established by the LRV and URV values in the database, the display shows the measurement but also continually blinks to indicate that the measurement is out of range. The mA current signal is saturated at either the low or high overrange limit respectively but the display continually shows the pressure.
6. When configured for 4 to 20 mA output, the internal digital value of pressure is converted to an analog current signal.
- ◆ The transmitter sets the output at 4 mA for the LRV and 20 mA for the URV.
 - ◆ There is an independent trim on the digital-to-analog conversion stage. This trim allows for slight adjustment of the 4 and 20 mA outputs. This compensates for any slight difference that exists between the transmitter mA output and an external reference device which is measuring the current.
 - ◆ The mA trim does not affect the calibration or the reranging of the transmitter and does not affect the internal digital value of pressure or the transmission or display of measured pressure.
 - ◆ The mA trim can be done with or without pressure applied to the transmitter.
7. Zeroing from the local display does not affect the span.

When the transmitter is zeroed to compensate for installed position effect, the transmitter can have either LRV pressure applied (CAL LRV) or zero pressure applied (CAL AT0). If the range is zero-based, either method produces the same result. However, if the range is not zero-based, it is advantageous to have both methods available.

For example, consider a pressure transmitter having a range of 50 to 100 psig. If it is not feasible to vent the transmitter to atmosphere for zeroing, it can be zeroed while the LRV pressure of 50 psi is applied by using the CAL LRV function. On the other hand, if the transmitter has been installed but there is no pressure in the process line yet, it can be zeroed while open to atmosphere by using the CAL AT0 function.

a. Zeroing with LRV Pressure Applied (CAL LRV):

- ◆ Before using this zeroing function, apply a pressure to the transmitter equal to the value of LRV stored in the transmitter database.
- ◆ When you zero the transmitter, the internal digital value of the pressure is trimmed to be equal to the value of LRV stored in the database and the mA output set to 4 mA.
- ◆ If zeroing is done when the applied pressure is different from the LRV pressure value in the database, the internal digital value of pressure is biased by the difference in the values but the output is still set at 4 mA.
- ◆ The CAL LRV and CAL URV function should be used when calibrating a transmitter for a specific range with known input pressures applied for the LRV and URV.

b. Zeroing a Gauge Pressure Transmitter with Zero Pressure Applied (CAL AT0):

— **NOTE**

Do **not** use the CAL AT0 function with an absolute pressure transmitter. If an absolute pressure transmitter is vented to atmosphere, it does **not** have zero pressure applied but instead has the barometric pressure (approximately 14.7 psia) applied.

- ◆ Make sure that the applied pressure is at zero. This means venting the transmitter to atmosphere.
- ◆ When you zero the transmitter, the internal digital value of the pressure is trimmed to be equal to zero and the mA output set to an appropriate value such that the mA output is a normal 4 mA when the LRV pressure is applied later.

c. Zeroing an Absolute Pressure Transmitter

To zero an absolute pressure transmitter, the LRV can be temporarily set to the barometric pressure and a CAL LRV function performed with the transmitter vented to atmosphere. Then, the LRV can be set back to the proper value.

Calibration Setup

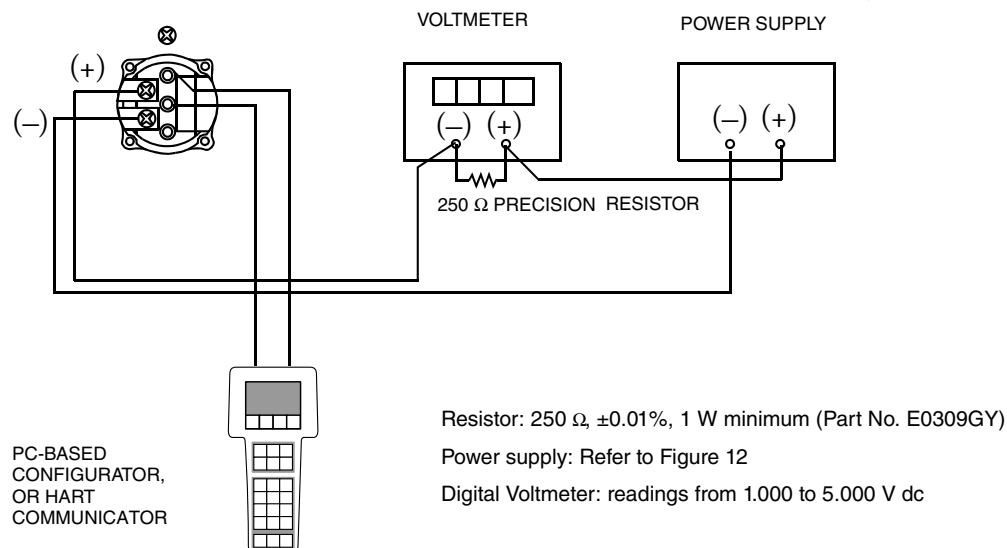
The following sections show setups for field or bench calibration. Use test equipment that is at least three times as accurate as the desired accuracy of the transmitter.

— **NOTE**

It is not necessary to set up calibration equipment to rerange the transmitter to a different range. The transmitter can be accurately reranged by simply changing the lower range value and the upper range value, which are stored in the transmitter database.

Setup of Electronic Equipment

Figure 19. 4 to 20 mA Output Calibration Setup of Electronic Equipment



Field Calibration Setup

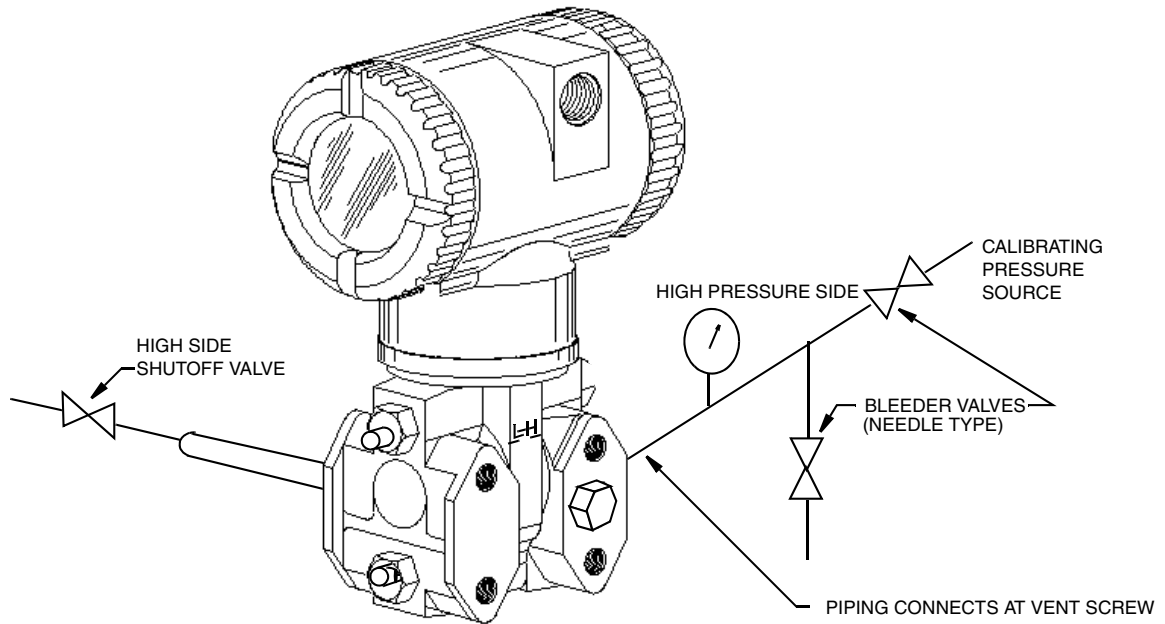
Field calibration is performed without disconnecting the process piping. This is only possible if you have a shutoff valve between the process and the transmitter and the process covers vent screw option (-V1).

If the transmitter is to be removed from the process for calibration, refer to “Bench Calibration Setup” on page 39.

An adjustable air supply and a pressure measuring device are required. For example, a dead weight tester or an adjustable clean air supply and pressure gauge can be used. The pressure source can be connected to the transmitter with pipe fittings or it can be connected to the vent screw assembly using a calibration screw. The calibration screw has a Polyflo fitting and can be used for pressures up to 700 kPa (100 psi). It is available as Foxboro Part Number F0101ES.

To set up the equipment, refer to Figure 20 and then use the following procedure:

1. Close the shutoff valve between the process and the transmitter.
2. If a calibration screw **is** being used, remove the vent screw and replace it with the calibration screw. Connect the pressure source to the calibration screw using 6 x 1 mm or 0.250 inch tubing.
 If a calibration screw **is not** being used, remove the drain plug or the entire vent screw assembly (as applicable) from the high pressure side of the transmitter. Connect calibration tubing using a suitable thread sealant.
3. If calibrating the output signal, also connect equipment as shown in “Setup of Electronic Equipment” on page 38.

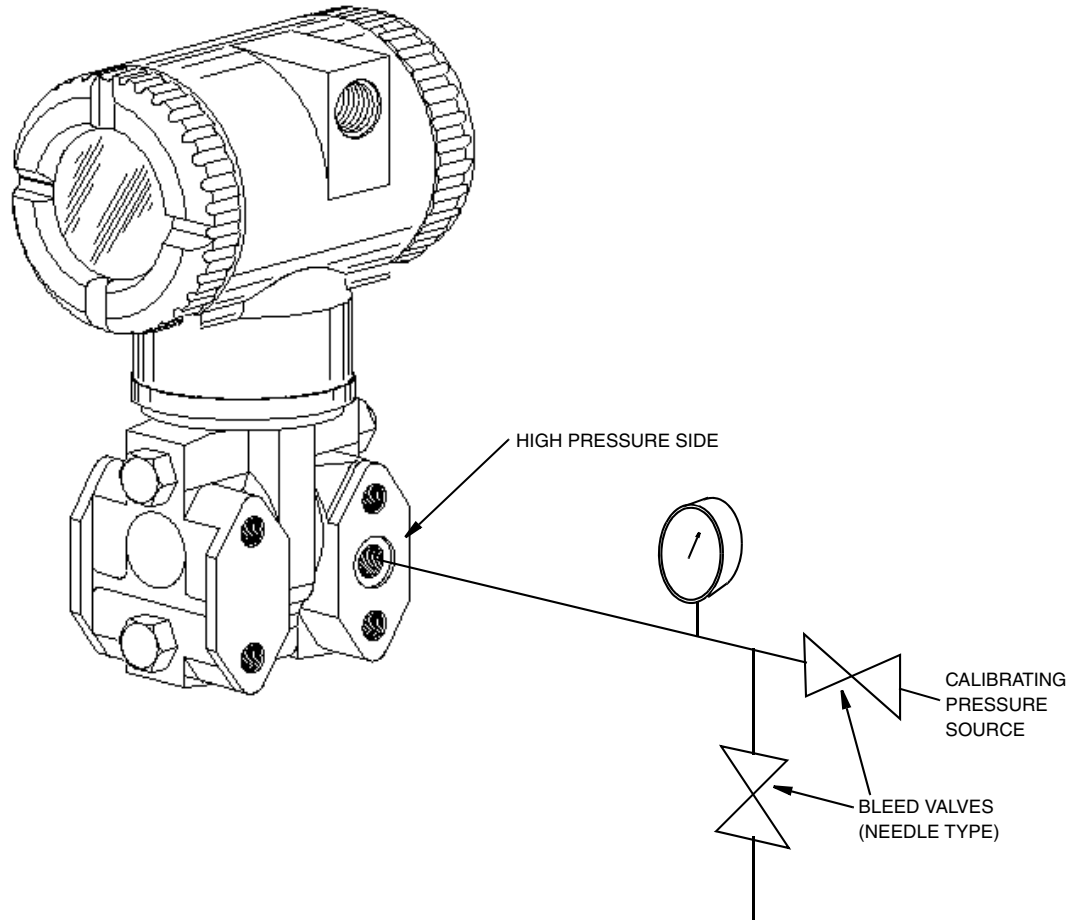
Figure 20. IAP20 and IGP20 Field Calibration Setup

Bench Calibration Setup

The bench calibration setup requires disconnecting the process piping. For calibration setup without disconnecting the process piping, refer to “Field Calibration Setup” on page 38.

The bench calibration setup is shown in Figure 21. Connect the input piping to the high pressure side of the transmitter as shown. Vent the low pressure side of the transmitter.

If calibrating the output signal, also connect equipment as shown in “Setup of Electronic Equipment” on page 38.”

Figure 21. Bench Calibration Setup

Calibration Using a PC20

To calibrate the transmitter using a PC20 Configurator, follow the procedure in MI 020-495.

Calibration Using a PC50

To calibrate the transmitter using a PC50 Configurator, follow the procedure in MI 020-501 and MI 020-520.

Calibration Using a HART Communicator

To calibrate the transmitter using a HART Communicator, follow the procedure in MI 020-366.

Calibration Using the Optional Local Display

To access the Calibration mode (from normal operating mode), press the **Next** button. The display reads **CALIB**, the first item on the menu. Acknowledge your choice of this selection by pressing the **Enter** button. The display shows the first item in the Calibration menu.

-
- NOTE**
1. During calibration, a single change could affect several parameters. For this reason, if an entry is entered in error, re-examine the entire database or use the **Cancel** feature to restore the transmitter to its starting configuration and begin again.
 2. During adjustment of 4 and 20 mA in the Calibration menu, the milliampere output does not reflect live measurement values.
-

Table 5. Calibration Menu

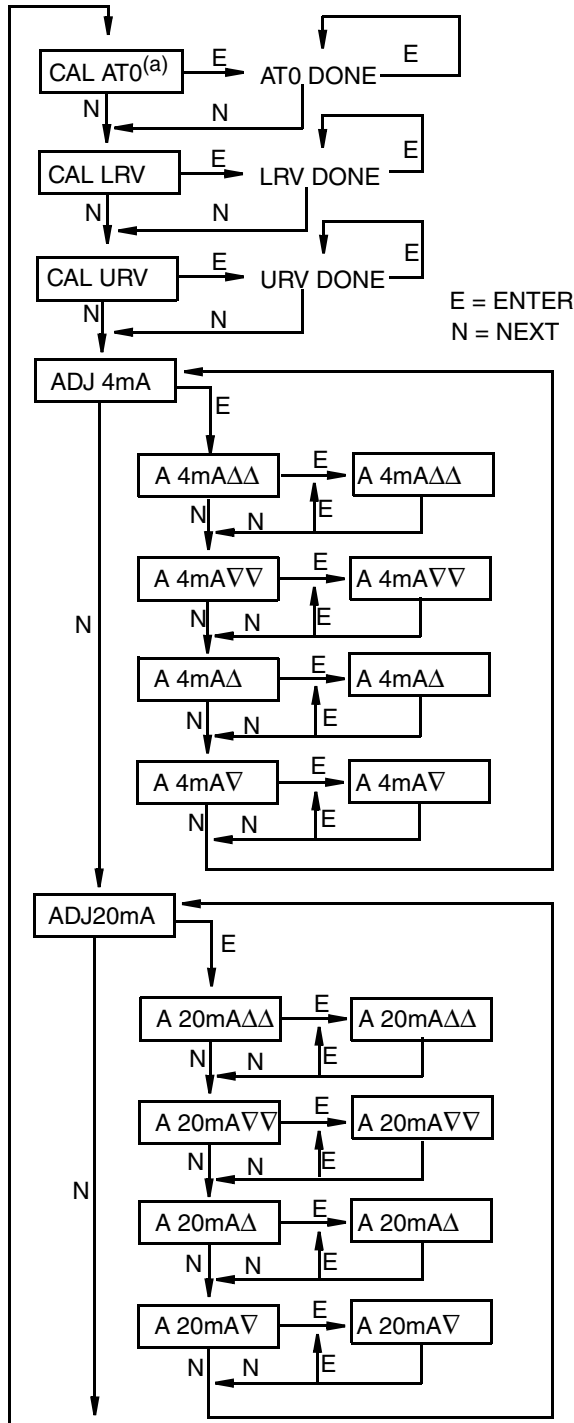
Item	Description
CAL AT0 (a)	Calibrate at zero pressure.
CAL LRV	Calibrate with pressure at 0% of transmitter range (LRV).
CAL URV	Calibrate with pressure at 100% of transmitter range (URV).
ADJ 4mA	Adjust nominal 4 mA output.
ADJ20mA	Adjust nominal 20 mA output.
CALDATE	Enter the calibration date.
ADJ 4mA causes the following four submenus.	
A 4mA $\Delta\Delta$	Increase 4 mA output by large step.
A 4mA $\nabla\nabla$	Decrease 4 mA output by large step.
A 4mA Δ	Increase 4 mA output by small step.
A 4mA ∇	Decrease 4 mA output by small step.
ADJ 20mA causes the following four submenus.	
A 20mA $\Delta\Delta$	Increase 20 mA output by large step.
A 20mA $\nabla\nabla$	Decrease 20 mA output by large step.
A 20mA Δ	Increase 20 mA output by small step.
A 20mA ∇	Decrease 20 mA output by small step.

a. Function not applicable to absolute pressure transmitters.

-
- NOTE**
- It is not necessary to use the ADJ4mA or ADJ20mA menu selections (commonly known as mA Trim) unless there is a plant requirement to make the 4 and 20 mA output values exactly match readings on certain plant calibration equipment and the calibration operations done result in a small but unacceptable difference between the transmitter mA output and the test equipment mA readout values.
-

Proceed to calibrate your transmitter by using the **Next** key to select your item and the **Enter** key to specify your selection per Figures 22 and 23. At any point in the calibration you can **Cancel**, restore your prior calibration and return to the on-line mode or **Save** your new calibration.

Figure 22. Calibration Structure Diagram (1 of 2)



E = ENTER
N = NEXT

CAL AT0: To set or reset the zero point at zero pressure, apply zero differential pressure to the transmitter and, at display of CAL AT0, press Enter. This can be done whether LRV is zero or not. Completion is indicated by the display AT0 Done.

CAL LRV: To set or reset 0% of range input, apply differential pressure to the transmitter equal to the lower range value (LRV) in the transmitter database and, at display of CAL LRV, press Enter. Completion is indicated by the display LRV Done.

CAL URV: To set or reset 100% of range input, apply differential pressure to the transmitter equal to the upper range value (URV) in the transmitter database and, at display of CAL URV, press Enter. Completion is indicated by the display URV Done.

ADJ4mA: If you configured your transmitter operating mode as 4 to 20 mA, you can adjust the 4 mA output by going to ADJ4mA using the Next button and press Enter. This menu item is bypassed if you configured your transmitter for multidrop mode (poll address other than zero).

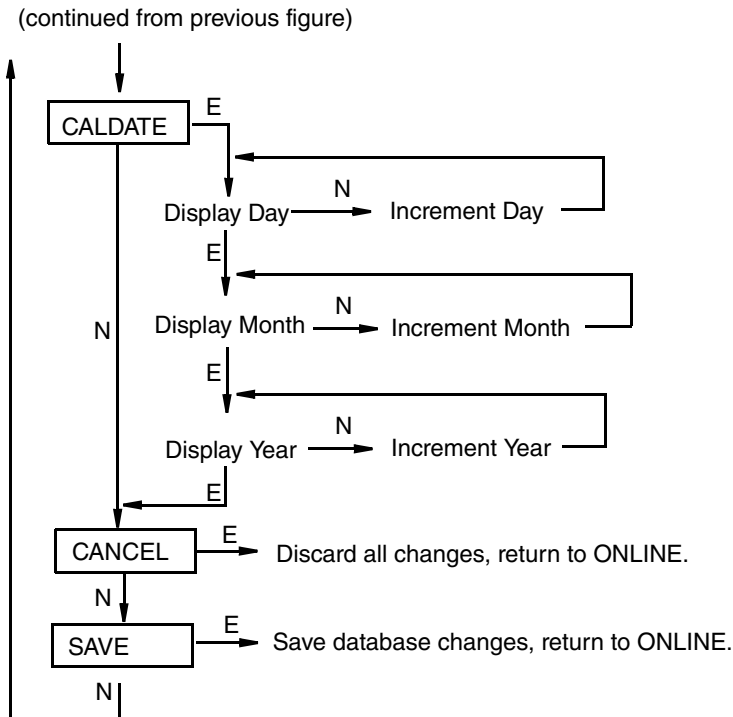
To increase the 4 mA output by a large (0.025 mA) step, press Enter at the display A 4mAΔΔ. To decrease it by a large step, go to the display A 4mA∇∇ by pressing the Next button

CALDATE

Notes:
(a) Not applicable to Absolute Pressure Transmitters.

(continued on next figure)

Figure 23. Calibration Structure Diagram (2 of 2)



*If character is not the last position on the display line, advances to next character.
 **If character is the last position on the display line, advances to next menu item.

NOTE: Commentary about this diagram immediately follows.

Commentary on Figure 23

CALDATE:

This is not a required entry but can be used for recordkeeping or plant maintenance purposes. To edit the calibration date, go to CALDATE with the **Next** button and press **Enter**. You then can change the day, month, and year. The display shows the last date with the day flashing. Use the **Next** button to step through the menu of digits to select the desired day, then press **Enter**. Repeat this process for the month and year.

Zero Adjustment Using External Zero Button

An optional external zero adjustment mechanism in the electronics housing allows calibration at zero differential pressure (the CAL AT0 function) or at the lower range value differential pressure (the CAL LRV function) without removing the electronics compartment cover. The mechanism is magnetically activated through the housing wall to prevent moisture from entering the enclosure.

To use this feature:

1. Unlatch the external zero button by turning it 90° in a counterclockwise direction so that the screwdriver slot lines up with the two holes in the face of the adjacent part. **Do not** push the button in with the screwdriver while doing this.
2. To set or reset the zero point at zero pressure, apply zero pressure to the transmitter and press the external zero button until the display reads CAL AT0. Release the button. The display reads CAL WAIT and then RESET (calibration is complete).

To set or reset the 0% of range input, apply the lower range value (LRV) pressure to the transmitter and press and hold the external zero button until the display reads CAL LRV (it reads CAL AT0 first). Release the button. The display reads CAL WAIT and then RESET (calibration is complete).

NOTE

If the optional display is not present, the same functions can be accomplished by depending on the length of time the external zero button is depressed. Press and hold the button for 1 to 3 seconds for CAL AT0 or for 5 or more seconds for CAL LRV. Therefore, if your LRV is zero, just depress the button for a few seconds. However, if your LRV is not zero, use **caution** when using the external zero button without the optional display because you must rely strictly on the length of time the button is depressed to differentiate between CAL AT0 and CAL LRV.

Other possible messages are:

DISABLD if EX ZERO is configured EXZ DIS

IGNORED if the transmitter is not in the on-line mode.

WP ENAB if write protection jumper is in write protect position.

If additional rezeroing is required after Steps 1 and 2 have been accomplished, repeat Step 2.

3. Relatch the external zero button by turning it 90° in a clockwise direction to prevent accidental pressing of the button. Do **not** push the button in with the screwdriver while doing this.

Error Messages

Table 6. Calibration Error Messages

Parameter	Condition Tested	Error Message	User Action
Password Protection	Password	BAD PWD	Bad password entered, use another.
Write Protection	Write protection enabled	REJECT	Displays when user attempts an action that is write protected.
ZERO	Internal offset too large	BADZERO	Check applied pressure, configured M1 LRV and configured M1 EOFF.
SPAN	Slope too large or too small	BADSPAN	Check applied pressure, configured M1 LRV and configured M1 EFAC.
M1 URV	M1URV > max pressure in EGU	URV>FMX	Entered pressure is greater than maximum rated pressure of transmitter. Check entry. Verify EGUs.
	M1URV < min pressure in EGU	URV<FMN	Entered pressure is less than minimum rated pressure of transmitter. Check entry. Verify EGUs.
	M1 URV = M1 LRV	LRV=URV	Cannot set span to 0. Check entry. Check M1 LRV.
	M1 turndown exceeds limit	BADTDWN	Check entry. Check M1 LRV.
M1 LRV	M1LRV > max pressure in EGU	LRV>FMX	Entered pressure is greater than maximum rated pressure of transmitter. Check entry. Verify EGUs.
	M1LRV < min pressure in EGU	LRV<FMN	Entered pressure is less than minimum rated pressure of transmitter. Check entry. Verify EGUs.
	M1 URV = M1 LRV	LRV=URV	Cannot set span to 0. check entry. Check M1 URV.
	M1 turndown exceeds limit	BADTDWN	Check entry. Check M1 URV.

5. Configuration

Configurable Parameters

The following table lists all the configurable parameters and the factory default for the IAP20-T and IGP20-T Transmitters. The factory default values have been customized if the transmitter was ordered with optional feature -C2. The table also shows which parameters are configurable with the integral vs. remote configurators.

Table 7. Configurable Parameters

Parameter	Capability	Factory Default	Configurable with		Application Requirement
			Integ. Indic.	Remote Config.	
Descriptors					
Tag Number	8 characters max	Tag Number	No	Yes	
Descriptor	16 characters max	Tag Name	No	Yes	
Message	32 characters max	Inst Location	No	Yes	
Input					
Calibrated Range	LRV to URV in units listed in (a) below	See (b) below when not specified per S.O.	Yes	Yes	
Output					
Meas. #1 Output	4 to 20 mA or Fixed Current. Specify Poll Address (1-15) for Fixed Current.	4 to 20 mA	Yes	Yes	
Meas. #1 Mode	Linear	Linear	Yes	Yes	
Meas #1 EGUs	Select from units listed in (a) below.	Same as Calibrated Range	Yes	Yes	
Meas. #2 Mode	Linear	Linear	Yes	Yes	
Meas #2 EGUs	If linear, select from units listed in (a) below	Same as Calibrated Range	Yes	Yes	
Temp. Sensor Fail Strategy	Normal oper or fail-safe	Fail-safe	Yes		
Fail-safe	High or Low	High	Yes	Yes	
External Zero	Enabled or Disabled	Enabled	Yes	Yes	
Damping	0 to 32 seconds	None	Yes	Yes	
Poll Address	0 - 15	0	Yes	Yes	
LCD Indicator (c)	Meas #1 EGU or % Lin	Meas #1 EGU	Yes	No	

a. psi, inHg, ftH₂O, inH₂O, atm, bar, mbar, MPa, Pa, kPa, kg/cm², g/cm², mmHg, torr, mmH₂O.

b. Span Code A: 0 to 30 inH₂O; Span Code B: 0 to 200 inH₂O; Span Code C: 0 to 30 psi; Span Code D: 0 to 300 psi; Span Code E: 0 to 3000 psi; Span Code F: 0 to 5000 psi.

c. Measurement #2 can be displayed at any time by pressing the Enter button regardless of the local display configuration. This reverts to Measurement #1 or % Lin (as configured) when power is cycled off and on.

Configuration Using a PC20

To configure the transmitter using a PC20 Configurator, follow the procedure in MI 020-495.

Configuration Using a PC50

To configure the transmitter using a PC50 Configurator, follow the procedure in MI 020-501 and MI 020-520.

Configuration Using a HART Communicator

To configure the transmitter using a HART Communicator, follow the procedure in MI 020-366.

Configuration Using the Optional Local Display

You can access the Configuration mode by the same multi-level menu system that was used to enter Calibration mode. Entry to the Mode Select menu is made (from normal operating mode) by pressing the **Next** button. The display reads **CALIB**, the first item on the menu. Press the **Next** button again to get to the second item on the menu, **CONFIG**. Acknowledge your choice of this selection by pressing the **Enter** button. The display shows the first item in the Configuration menu. You can then configure items shown in the following table. The standard factory default configuration is also given in this table.

The standard factory default configuration is not used if custom configuration option -C2 has been specified. Option -C2 is a full factory configuration of all parameters to the user's specifications.

NOTE

1. You can configure most parameters using the local display. However, for more complete configuration capability, use a HART Communicator or PC-Based configurator.
 2. During configuration, a single change can affect several parameters. For this reason, if an entry is entered in error, re-examine the entire database or use the **Cancel** feature to restore the transmitter to its starting configuration and begin again.
-

Table 8. Configuration Menu

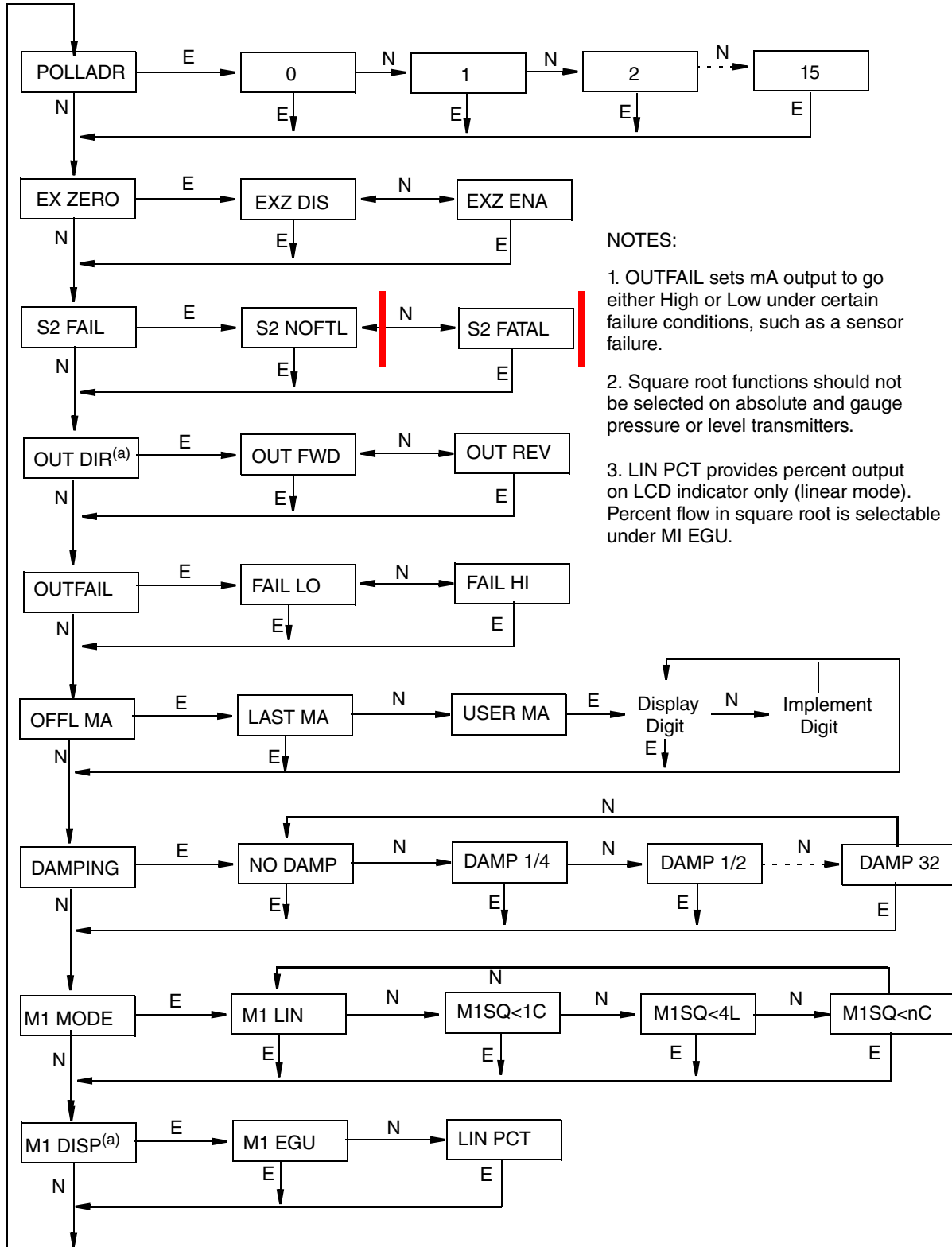
Item	Description	Initial Factory Configuration
POLLADR	Poll Address: 0 - 15	0
EX ZERO (a)	External Zero: enable or disable	Enable
S2 FAIL	Temperature Sensor Failure Strategy: S2FATAL or S2NOFTL	S2NOFTL
OUT DIR	4 to 20 mA Output: forward or reverse	Forward
OUTFAIL	4 to 20 mA Output: fail mode output - low or high	High
OFFL MA	4 to 20 mA Output in offline mode - last or user set	USER MA
DAMPING	Damping: none, 1/4, 1/2, 1, 2, 4, 8, 16, or 32 seconds	None
M1 MODE	Output: linear or type of square root (b)	Linear
M1DISP	Local Indicator Display in linear mode: in percent or engineering units	M1EGU
M1 EGU	User-Defined Engineering Units	inH ₂ O or psi
M1EOFF	Offset applied to the Primary Value	0
M1 URV	Primary Upper Range Value	URL
M1 LRV	Primary Lower Range Value	0
M2 MODE	Output: linear or type of square root	Linear
M2 EGU	User-Defined Engineering Units	Same as M1 EGU
DISPLAY	Display M1, M2, or Toggle between M1 and M2	M1
CALDATE	Calibration Date	- - -
ENA PWD	Enable password; no password, configuration only, or configuration and calibration	NO PWD
CFG PWD	User set configuration password (six characters)	- - -
CAL PWD	User set calibration password (six characters)	- - -
SET GDB	Rewrite all calibration and configuration values with default values	- - -

a. Applies only if transmitter contains External Zero option.

b. Square root is not applicable to absolute pressure, gauge pressure, and flange level measurement.

Proceed to configure your transmitter by using the **Next** button to select your item and the **Enter** button to specify your selection per the following three figures. At any point in the configuration you can **Cancel** your changes and return to the on-line mode, or **Save** your changes.

Figure 24. Configuration Structure Diagram (1 of 3)



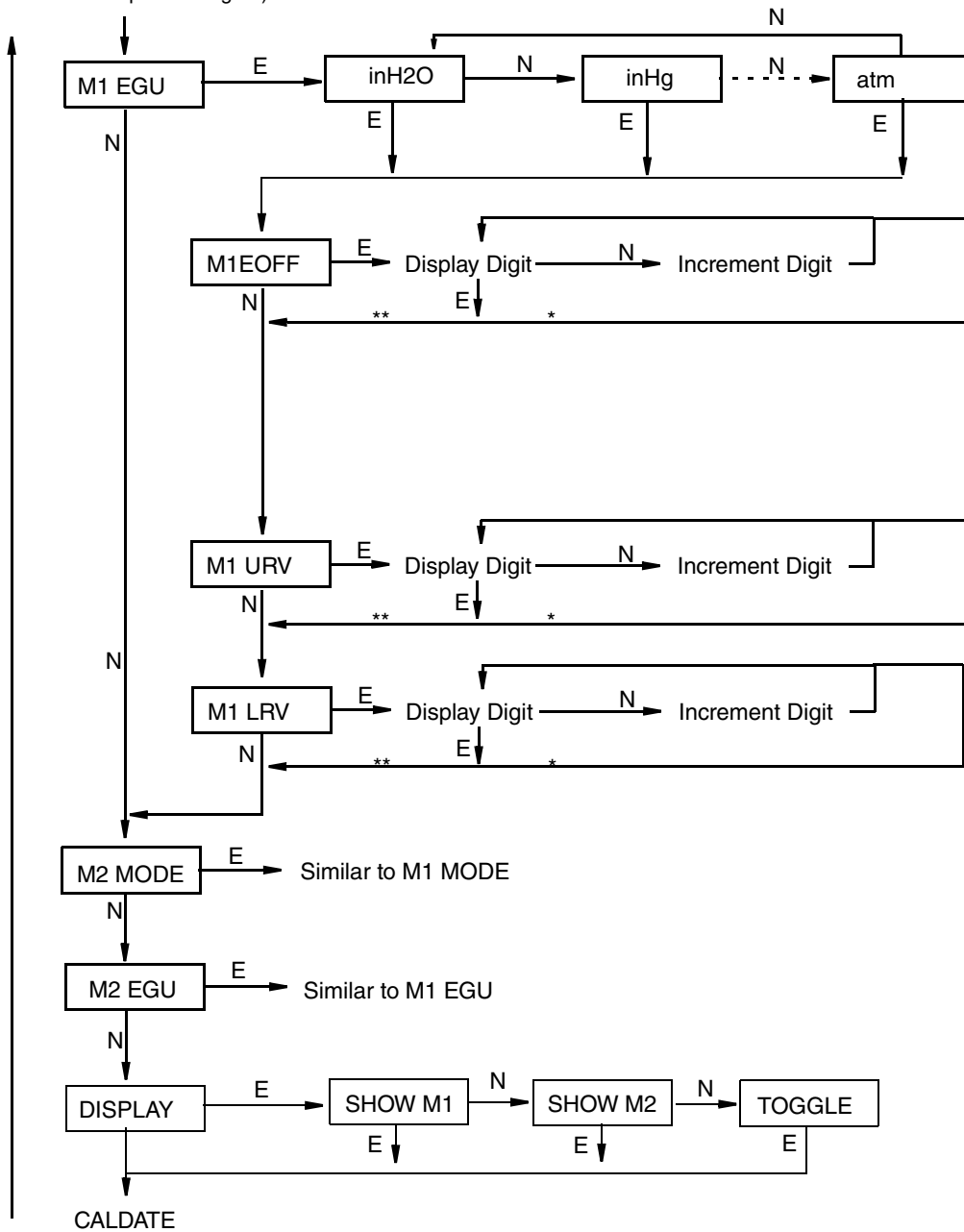
- NOTES:
1. OUTFAIL sets mA output to go either High or Low under certain failure conditions, such as a sensor failure.
 2. Square root functions should not be selected on absolute and gauge pressure or level transmitters.
 3. LIN PCT provides percent output on LCD indicator only (linear mode). Percent flow in square root is selectable under MI EGU.

(continued on next figure)

(a) Linear Mode only.

Figure 25. Configuration Structure Diagram (2 of 3)

(continued from previous figure)



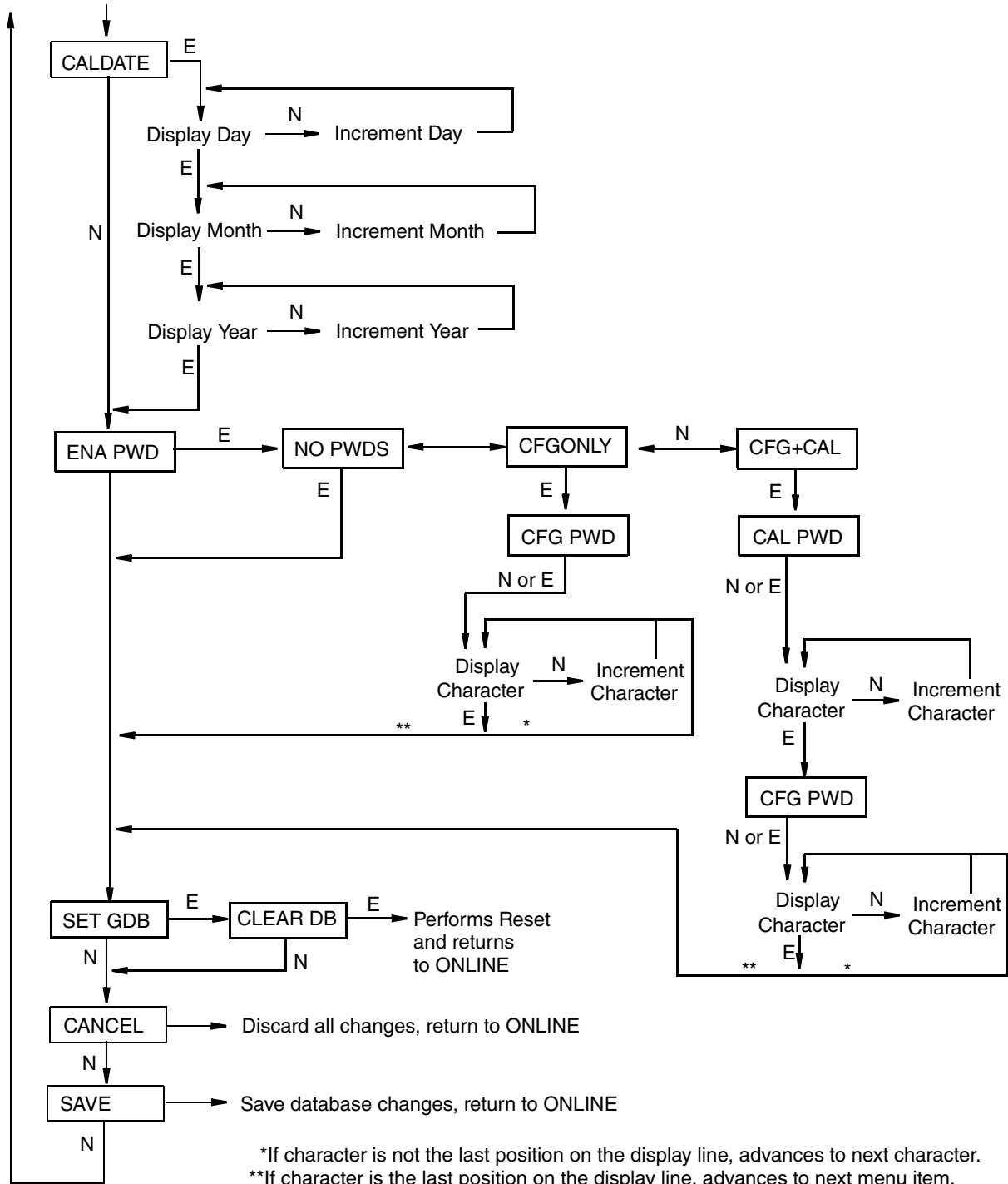
(continued on next figure)

*If character is not the last position on the display line, advances to next character.

**If character is the last position on the display line, advances to next menu item.

Figure 26. Configuration Structure Diagram (3 of 3)

(continued from previous figure)



Commentary on Configuration Structure Diagram

In general, use the **Next** button to select your item and the **Enter** button to specify your selection.

POLLADR:

To configure the transmitter poll address, press **Enter**. Use the **Next** button to select an address of 0 through 15, then press **Enter**. An address of 1 through 15 is used for multidrop mode with a fixed mA output.

EX ZERO:

The External Zero feature allows the optional external zero pushbutton to be disabled for additional security. To configure this feature, go to **EX ZERO** with the **Next** button and press **Enter**. Use the **Next** button to select **EXZ DIS** or **EXZ ENA** and press **Enter**.

S2 FAIL:

The temperature sensor compensates for changes in temperature in the transmitter electronics. Failure of this sensor can cause a 4 to 20 mA accuracy change of up to 0.25%. The **S2 FAIL** feature allows you to specify action (or no action) if such a failure occurs. To configure this feature, go to **S2 FAIL** with the **Next** button and press **Enter**. Use the **Next** button to select **S2 FATAL** (to have the output go to that configured in **OUTFAIL**) or **S2 NOFTL** (to continue operation with a temperature sensor failure) and press **Enter**. This parameter has no effect if **POLLADR** is configured to any number from 1 through 15.

OUT DIR:

To configure the Output Direction, go to **OUT DIR** with the **Next** button and press **Enter**. Use the **Next** button to select **OUT FWD** (4 - 20 mA) or **OUT REV** (20 - 4 mA) and press **Enter**. This parameter has no effect if **POLLADR** is configured to any number from 1 through 15.

OUTFAIL:

The Outfail feature provides high or low output with certain malfunctions. To configure the fail mode output, go to **OUTFAIL** with the **Next** button and press **Enter**. Use the **Next** button to select **FAIL LO** or **FAIL HI** and press **Enter**. This parameter has no effect if **POLLADR** is configured to any number from 1 through 15.

OFFL MA:

The Off-line mA feature enables you to set the output to a specified value or to the last value if the transmitter goes off-line. To configure the off-line output, go to **OFFL MA** with the **Next** button and press **Enter**. Use the **Next** button to select **LAST MA** or **USER MA** and press **Enter**. If you selected **USER MA**, press **Enter** again at the display of digits. Then use the **Next** button to step through the library of digits to select the desired first digit, then press **Enter**. Your selection is entered and the second character flashes. Repeat this procedure until you have entered the last digit. Then use the **Next** button to move the decimal point to its desired location and press **Enter**. The display advances to the next menu item.

DAMPING:

To configure additional damping, go to **DAMPING** with the **Next** button and press **Enter**. Use the **Next** button to select **NO DAMP**, **DAMP 1/4**, **DAMP 1/2**, **DAMP 1**, **DAMP 2**, **DAMP 4**, **DAMP 8**, **DAMP 16**, or **DAMP 32** and press **Enter**.

M1 MODE:

To configure the mode of the primary output, go to **M1 MODE** with the **Next** button and press **Enter**. Use the **Next** button to select **M1 LIN** and press **Enter**. **M1SQ<1C** (square root with cutoff below 1% of calibrated pressure range), **M1SQ<4L** (square root with linear below 4% of calibrated pressure range), or **M1SQ<nC** (square root with user configured cutoff specified between 0 and 20% of the flow range) is not applicable to absolute or gauge pressure measurement.

M1 DISP:

To configure the optional local indicator to show engineering units or percent, go to **M1 DISP** with the **Next** button and press **Enter**. Use the **Next** button to select **M1 EGU** or **LIN PCT** and press **Enter**. **LIN PCT** only provides percent readings on the local display. The **M1** engineering unit is used for remote communication of Measurement #1, even if **LIN PCT** is selected.

M1 EGU:

To configure pressure or flow engineering units for your display and transmission, go to **M1 EGU** with the **Next** button and press **Enter**. Because **M1 MODE** is configured as **M1 LIN**, you are asked to specify one of the following pressure labels: **psi**, **inHg**, **ftH₂O**, **inH₂O**, **atm**, **bar**, **mbar**, **MPa**, **Pa**, **kPa**, **kg/cm²**, **g/cm²**, **mmHg**, **torr**, or **mmH₂O**. Your transmitter then automatically adjusts **M1EFAC** (engineering factor), **M1 URV** (upper range value), and **M1 LRV** (lower range value). **M1EOFF** is set to zero.

M1EOFF:

You can introduce an offset by entering a nonzero value for **M1EOFF**. The offset affects the value of **PV** that is transmitted in engineering units, transmitted as an analog **mA** signal, and displayed in the (optional) local display. This feature can be used in such applications as an elevated water storage tank where the transmitter is at grade level but the output is to correspond to the level of the tank. It can also be used for a grade level water storage tank where the transmitter is installed above the bottom of the tank and the output is to correspond to the level in the tank.

M1 URV:

To edit the upper range value, press **Enter** at the prompt **M1 URV**. Use the procedure “Entering Numerical Values” on page 32 to edit this parameter.

M1 LRV:

Similar to **M1URV** immediately above.

M2 MODE:

M2 is a secondary measurement that is read by the Model 275 HART Communicator and can be displayed on the optional display. You might use this feature to display **M1** in your primary pressure units and **M2** in a different set of pressure units. To configure this parameter, go to **M2 MODE** with the **Next** button and press **Enter**. Use the next button to select **M2 LIN** and press **Enter**.

M2 EGU:

Similar to **M1 EGU**.

DISPLAY:

To display M1, M2, or to toggle between M1 and M2, go to **DISPLAY** with the **Next** button and press **Enter**. Use the **Next** button to select **SHOW M1**, **SHOW M2**, or **TOGGLE** and press **Enter**.

CALDATE:

This is not a required entry but can be used for record-keeping or plant maintenance purposes. To edit the calibration date, go to **CALDATE** with the **Next** button and press **Enter**. You then can change the day, month, and year. The display shows the last date with the day flashing. Use the **Next** button to step through the library of digits to select the desired day, then press **Enter**. Repeat this process for the month and year.

ENA PWD:

To enable or disable the password feature, go to **ENA PWD** with the **Next** button and press **Enter**. Use the **Next** button to select **NO PWDS** (password not required for either calibration or configuration), **CFGONLY** (password required to configure but not to calibrate), or **CFG+CAL** (passwords required to both configure and calibrate) and press **Enter**.

If you selected **CFG ONLY**, the display changes to **CFG PWD**. Press either the **Next** or **Enter** button. Use the **Next** button to step through the library of characters to select the desired first character, then press **Enter**. Your selection is entered and the second character flashes. Repeat this procedure until you have created your password. If the password has less than six characters, use blanks for the remaining spaces. When you have configured the sixth space, the display advances to the next menu item.

If you selected **CFG+CAL**, the display changes to **CAL PWD**. To create the Calibration password, press either the **Next** or **Enter** button. Use the **Next** button to step through the library of characters to select the desired first character, then press **Enter**. Your selection is entered and the second character flashes. Repeat this procedure until you have created your password. If the password has less than six characters, use blanks for the remaining spaces. When you have configured the sixth space, the display advances to **CFG PWD**. Use the same procedure to create the configuration password.

— NOTE —

In normal operation, the **CAL PWD** allows access to only calibration mode. The **CFG PWD** allows access to both configuration and calibration.

— ! CAUTION —

Record your new password before saving changes to the database.

SET GDB:

If your transmitter database becomes corrupted and you receive an **INITERR** message upon startup, this function enables you to rewrite all calibration and configuration values with default values.

— ! CAUTION —

Any calibration and configuration values that you have entered will be lost. Therefore, **SET GDB** should **not** be selected if your transmitter is functioning normally.

Character Lists

Table 9. Alphanumeric Character List

Character List (a)	
@	'
, (comma)	(
A-Z (uppercase))
[*
\	+
]	-
^	.
_ (underscore)	/
space	0-9
!	:
"	;
#	<
\$	>
%	=
&	?

- a. List only applies to a HART Communicator not to the optional local display.

Table 10. Numeric Character List

Character List
-
. (decimal point)
0 through 9

Error Messages

Table 11. Configuration Error Messages

Parameter	Condition Tested	Error Message	User Action
Password Protection	Password	BAD PWD	Bad password entered, use another.
Write Protection	Write Protection Enabled	REJECT	Displays when user attempts an action that is write protected.
M1EFAC	M1EFAC < 0	-M1EFAC	Negative M1 EFAC is not valid. Change M1 EFAC to positive value.
	M1EFAC = 0	0M1EFAC	M1 EFAC = 0 is not valid. Change M1 EFAC to positive value.
M1 URV	M1URV > max pressure in EGU	URV>FMX	Entered pressure is greater than maximum rated pressure of transmitter. Check entry. Verify EGUs.
	M1URV < min pressure in EGU	URV<FMN	Entered pressure is less than minimum rated pressure of transmitter. Check entry. Verify EGUs.
	M1 URV = M1 LRV	LRV=URV	Cannot set span to 0. Check entry. Check M1 LRV.
	M1 turndown exceeds limit	BADTDWN	Check entry. Check M1 LRV.
M1 LRV	M1LRV > max pressure in EGU	LRV>FMX	Entered pressure is greater than maximum rated pressure of transmitter. Check entry. Verify EGUs.
	M1LRV < min pressure in EGU	LRV<FMN	Entered pressure is less than minimum rated pressure of transmitter. Check entry. Verify EGUs.
	M1 URV = M1 LRV	LRV=URV	Cannot set span to 0. Check entry. Check M1 URV.
	M1 turndown exceeds limit	BADTDWN	Check entry. Check M1 URV.
M2EFAC	M2EFAC < 0	-M2EFAC	Negative M2 EFAC is not valid. Change M2 EFAC to positive value.
	M2EFAC = 0	0M2EFAC	M2 EFAC = 0 is not valid. Change M2 EFAC to positive value.

6. Maintenance

 **DANGER**

For nonintrinsically safe installations, to prevent a potential explosion in a Division 1 hazardous area, de-energize transmitters before you remove threaded housing covers. Failure to comply with this warning could result in an explosion resulting in severe injury or death.

Error Messages

For error messages displayed on the HART Communicator refer to MI 020-366.

Parts Replacement

Parts replacement is generally limited to the electronics module assembly, housing assembly, sensor assembly, terminal block assembly, cover O-rings, and optional display. For part numbers relating to the transmitter and its options, see PL 009=007.

Replacing the Terminal Block Assembly

1. Turn off transmitter power source.
2. Remove the Field Terminals and the Electronics compartment covers by rotating them counterclockwise. Screw in cover lock if applicable.
3. Remove the digital display (if applicable) as follows: grasp the two tabs on the display and rotate it about 10° in a counterclockwise direction.
4. Remove the electronics module from the housing by loosening the two captive screws that secure it to the housing. Then pull the module out of the housing far enough to gain access to the cable connectors on the rear of the module.
5. Remove the four socket head screws securing the terminal block.
6. Disconnect the terminal block cable connector from the electronics module.
7. Remove the terminal block and the gasket under it.
8. Connect the new terminal block cable connector to the electronics module.
9. Install the new terminal block and new gasket and reinstall the four screws to 0.67 N·m (6 in·lb) in several even increments.
10. Reinstall the electronics module (and digital display if applicable).

11. Reinstall the covers onto the housing by rotating them clockwise to seat the O-ring into the housing and then continue to hand tighten until the each cover contacts the housing metal-to-metal. If cover locks are present, lock the cover per the procedure described in “Cover Locks” on page 25.
12. Turn on transmitter power source.

Replacing the Electronics Module Assembly

To replace the electronics module assembly, refer to Figure 27 and proceed as follows:

1. Turn off transmitter power source.
2. Remove the electronics compartment cover by rotating it counterclockwise. Screw in cover lock if applicable.
3. Remove the digital display (if applicable) as follows: grasp the two tabs on the display and rotate it about 10° in a counterclockwise direction. Pull out the display and disconnect its cable.
4. Remove the electronics module from the housing by loosening the two captive screws that secure it to the housing. Then pull the module out of the housing far enough to gain access to the cable connectors on the rear of the module.

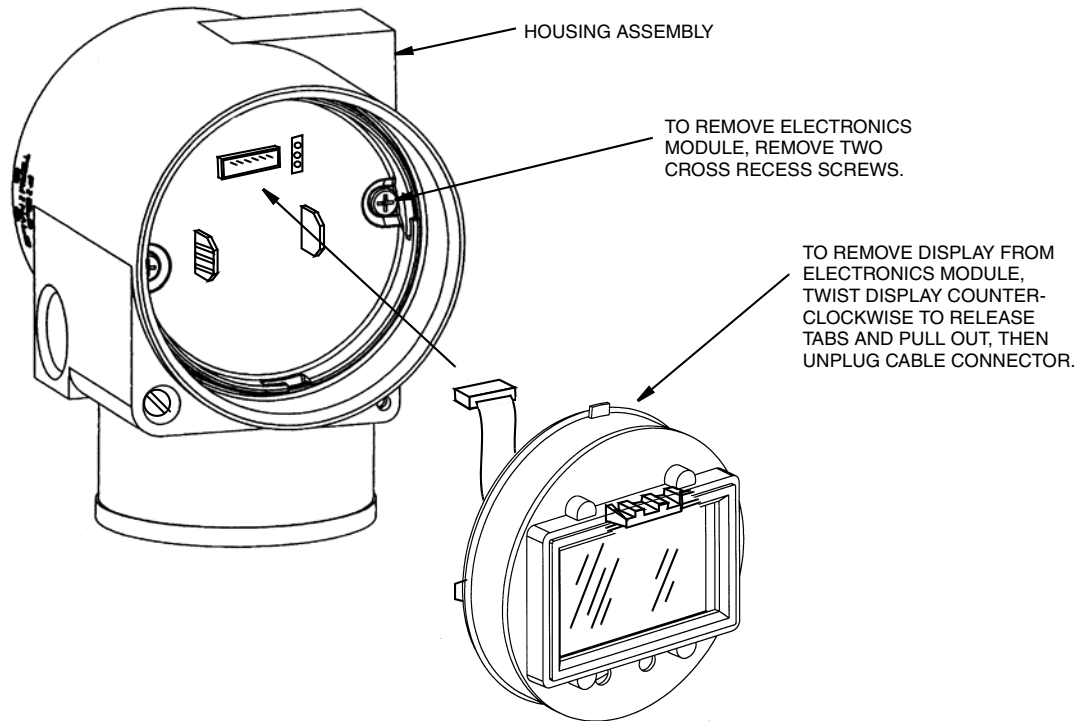
CAUTION

The electronics module is “one assembly” at this point and is electrically and mechanically connected to topworks with a flexible ribbon signal cable, a 2-wire power cable, and in some cases, a cable for an external zero pushbutton. Do **not** exceed the slack available in these cables when removing the assembled module.

5. Unplug all cable connectors from the rear of the electronics module and place the module on a clean surface.
6. Predetermine connector orientation, then insert the cable connectors into the replacement module. Replace the module in the housing using care not to pinch the cables between the module and the housing. Tighten the two screws that secure the module to the housing.
7. Connect the cable from the digital display to the electronics module. Ensure that the O-ring is fully seated in the display housing. Then, holding the digital display by the tabs at the sides of the display, insert it into the housing. Secure the display to the housing by aligning the tabs on the sides of the assembly and rotating it about 10° in a clockwise direction.
8. Reinstall the cover onto the housing by rotating it clockwise to seat the O-ring into the housing and then continue to hand tighten until the cover contacts the housing metal-to-metal. If cover locks are present, lock the cover per the procedure described in “Cover Locks” on page 25.
9. Turn on transmitter power source.

The module replacement procedure is now complete.

Figure 27. Replacing the Electronics Module Assembly and Display



Removing and Reinstalling a Housing Assembly

To remove and reinstall a housing assembly, refer to Figure 27 and proceed as follows:

1. Remove the electronics module per Steps 1 through 5 in the previous procedure.
2. If your housing has an anti-rotation screw, remove the red lacquer from the screw recess. Turn the screw three full turns counterclockwise.
3. If your housing has a retention clip, remove the red lacquer from the screw recess. Remove the screw completely, and slide the clip off the housing. Save the clip and screw for future use,
4. Remove the housing by rotating it counterclockwise (when viewed from the top). Use caution to avoid damaging the sensor cable.
5. Inspect the sensor O-ring for damage. If the O-ring is damaged, replace it with the appropriate O-ring. (See parts list for your transmitter). Lubricate the O-ring with silicone lubricant (Foxboro Part Number 0048130 or equivalent). Verify that the O-ring is situated in the groove of the neck.

! WARNING

Failure to reuse or install the proper O-ring for a CSA labeled product violates ANSI / ISA 12.27.01.

6. Feed the sensor cable through the housing neck into the electronics compartment.
7. Screw the housing onto the sensor neck until it bottoms. Do not over tighten. Be careful not to damage the sensor cable or dislodge the neck O-ring.

8. If your housing has an anti-rotation screw, engage the screw until it touches the sensor neck and back it off 1/8th turn. It is important that the screw is not touching the sensor. Fill the screw recess with red lacquer (Foxboro Part Number X0180GS or equivalent). The housing may then be rotated up to one full turn counterclockwise for optimum access.
9. If your housing has a retention clip, insert the clip over the boss in the housing neck so that the hole in the clip is aligned with the hole in the boss. Install the screw but do not tighten. Rotate the housing up to one full turn counterclockwise for optimum access. Tighten the retention clip screw and fill the screw recess with red lacquer (Foxboro Part Number X0180GS or equivalent). The housing can still be rotated for optimum access.
10. Reinstall the electronics module per Steps 6 through 9 in the previous procedure.

Adding the Optional Display

To add the optional display, refer to Figure 27 and proceed as follows:

1. Turn off transmitter power source.
2. Remove the electronics compartment cover by rotating it counterclockwise. Screw in cover lock if applicable.
3. Plug the display into the receptacle at the top of the electronics assembly.
4. Ensure that the O-ring is seated in its groove in the display housing. Then insert the display into the electronics compartment by grasping the two tabs on the display and rotating it about 10° in a clockwise direction.
5. Install the new cover (with a window) onto the housing by rotating it clockwise to seat the O-ring into the housing and then continue to hand tighten until the cover contacts the housing metal-to-metal. If cover locks are present, lock the cover per the procedure described in “Cover Locks” on page 25.
6. Turn on transmitter power source.

Replacing the Sensor Assembly

To replace the sensor assembly, refer to Figures 28 and 29 and proceed as follows:

1. Remove the electronics module as described above.
2. Remove the housing as described above.
3. Remove the process covers from sensor by removing two hex head bolts.
4. Replace the gaskets in the process covers.
5. Install the process covers and housing on the new sensor. Torque cover bolts to 100 N·m (75 lb-ft) in several even increments. Torque values are 68 N·m (50 lb-ft) when 316 ss bolts are specified; 75 N·m (55 lb-ft) when B7M bolts are specified.
6. Reinstall electronics module.

7. Pressure test the sensor and process cover assembly by applying a hydrostatic pressure of 150% of the maximum static and overrange pressure rating to both sides of the process cover/sensor assembly simultaneously through the process connections. Hold pressure for one minute. There should be no leakage of the test fluid through the gaskets. If leakage occurs, retighten the cover bolts per Step 5 (or replace the gaskets) and retest.

! CAUTION
Perform hydrostatic test with a liquid and follow proper hydrostatic test procedures.

Figure 28. Replacing the Sensor Assembly

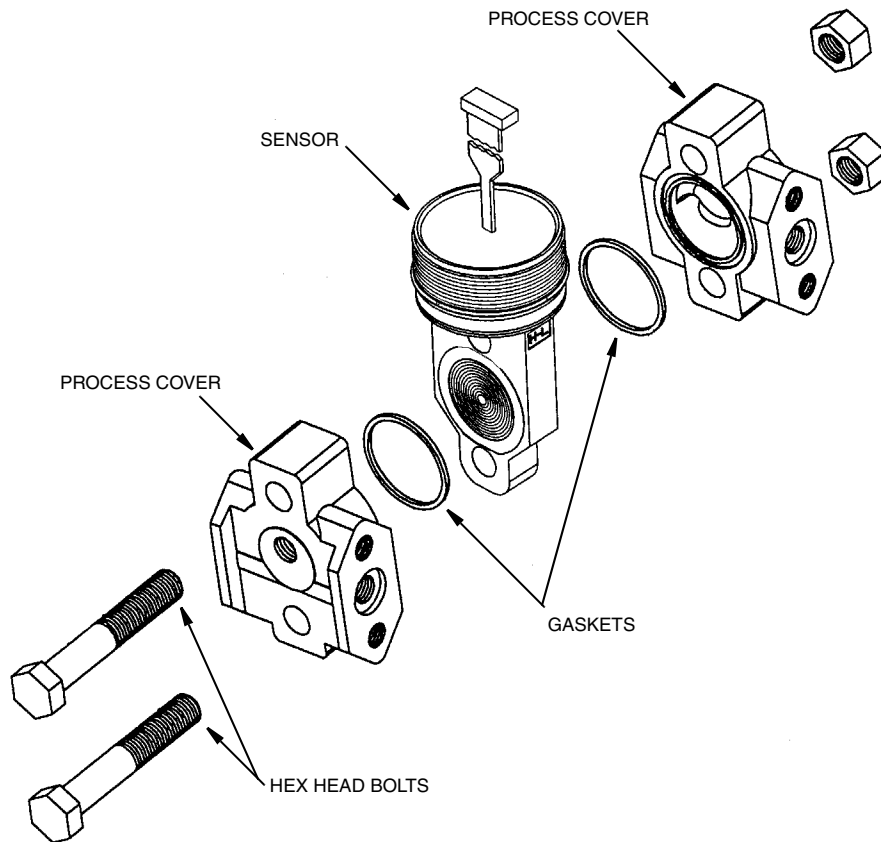
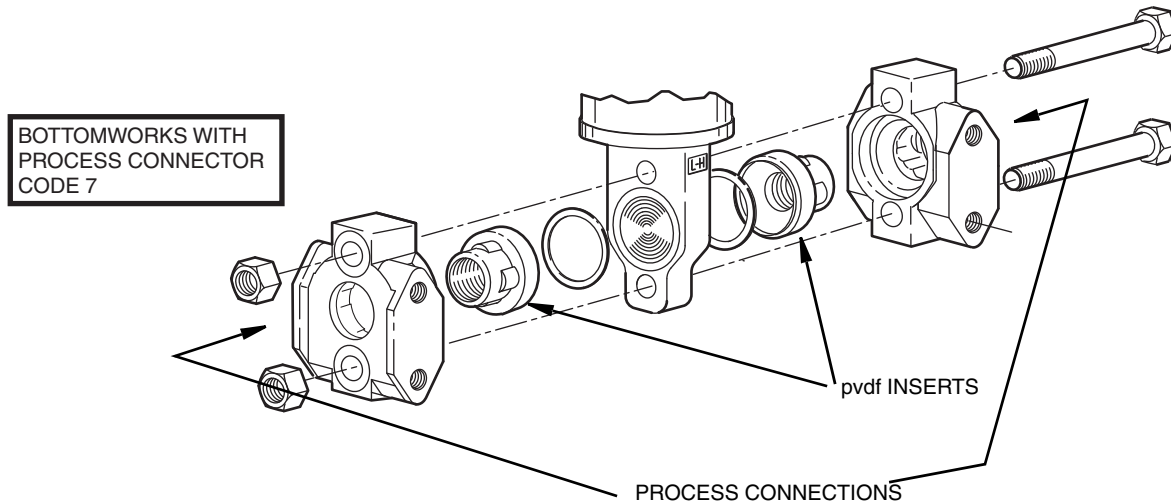
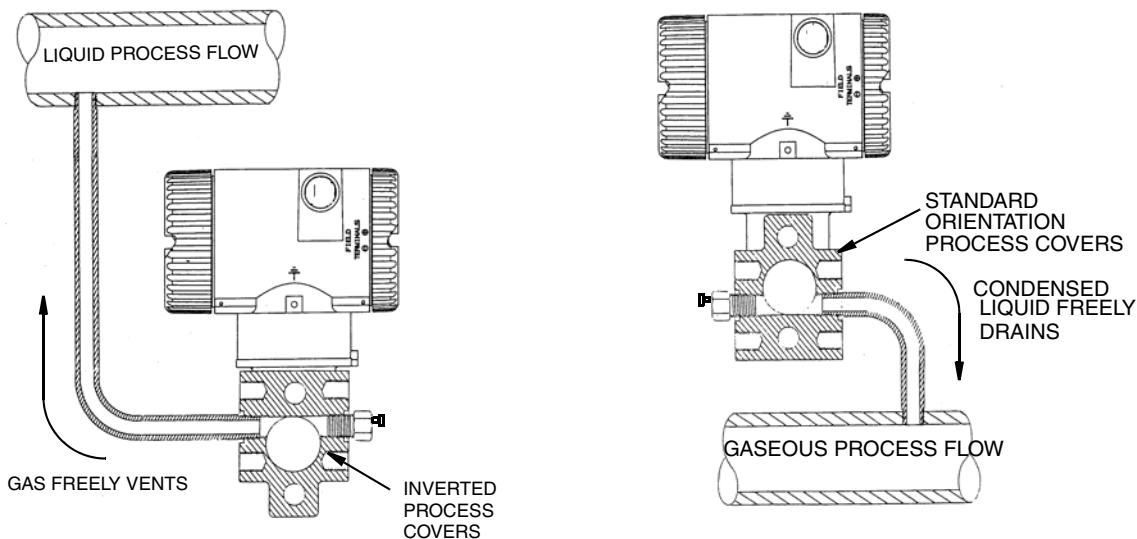


Figure 29. Replacing the Sensor Assembly (pvdf Inserts)

Rotating Process Covers for Venting

As received, your IASPT Transmitter provides sensor cavity draining without the need for side drain connections, regardless of whether the transmitter is mounted vertically or horizontally. Sensor cavity venting is provided by mounting the transmitter horizontally or with the optional vent screw (-V). However, if you did not specify this option, you can still achieve venting (instead of draining) with vertical mounting by rotating the process covers.

Figure 30. Sensor Cavity Venting and Draining

To rotate the process covers, refer to Figure 28 and proceed as follows:

1. Turn off the transmitter power source and remove the transmitter from the process.
2. Remove the process covers from sensor by removing two hex head bolts.
3. Replace gaskets in process covers.
4. Rotate the process covers so that the longer tab is at the bottom.

5. Reinstall process covers and bolts. Torque cover bolts to 100 N·m (75 lb·ft) in several even increments. Torque values are 68 N·m (50 lb·ft) when 316 ss bolts are specified; 75 N·m (55 lb·ft) when B7M bolts are specified.
6. Pressure test the sensor and process cover assembly by applying a hydrostatic pressure of 150% of the maximum static and overrange pressure (see “Standard Specifications” on page 12) to both sides of the process cover/sensor assembly simultaneously through the process connections. Hold pressure for one minute. There should be no leakage of the test fluid through the gaskets. If leakage occurs, retighten the cover bolts per Step 4 or replace the gaskets and retest.

 **CAUTION** —————
Perform hydrostatic test with a liquid and follow proper hydrostatic test procedures.

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