A Badger Meter® Brand

Gas Transmitter

F12/D Toxic Gas Transmitter with H10 Smart Sensor

Badger Meter

ATI-UM-04420-EN-02 (February 2025)

User Manual

CONTENTS

SAFETY

Read and understand this manual before installing, operating or maintaining the F12/D gas transmitter. Pay particular attention to the warnings and cautions below. All of the warnings and cautions shown here are repeated in the appropriate sections of the manual.

Protection from hazards may be impaired if used in manners not specified in this manual.

Warnings

- Installation must be in accordance with the recognized standards of the appropriate authority in the country concerned.
- Servicing of this unit must be performed by trained personnel.
- Before servicing, ensure local regulations and site procedures are followed.
- For AC powered units, buildings main circuit breaker to act as instrument disconnect for servicing.
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- Recommended Power Cable 12-22 AWG 300V insulation breakdown voltage or better.
- The transmitter must be earthed/grounded for electrical safety and to limit the effects of radio frequency interference. An Earth ground point is provided inside the unit. To maintain EMI ratings, use shielded cable, connecting the shield/drain to the EARTH terminal in the unit, and the shield/drain to an Earth Ground at the power supply.
- Ground wire to be only Green or Green/Yellow stripe (independent from electrical code references). Green or Green/Yellow stripe may not be used for other purposes.
- Operate only in the specified temperature range.
- Verify transmitter after installation, after service events, and periodically to ensure the safety and integrity of the system.
- Instrument exterior and accessories may be cleaned using a damp cloth. Water Only!
- Any user provided plug or connector, should it be used should conform with the relevant IEC and local electrical code requirements.
- Electrostatic discharge hazard.
    - Take the necessary antistatic precautions if you: handle, install or use the device in potentially explosive atmospheres.
    - Do not install in a location (for example, near to ventilation systems) where the electrostatic charge can increase.
    - Do not clean plastic parts in a hazardous area.
- Use only Panasonic CR2032 batteries.

Hazardous Location Installation

The F12/D gas transmitter is not rated for hazardous locations.

INTRODUCTION

General

F12/D Gas Transmitter

The F12/D gas transmitter is used to monitor for gas leaks near storage cylinders, process piping or gas feed equipment in nearly any type of industrial plant environment. It is housed in a NEMA 4X, polycarbonate enclosure and features an H10 Smart Sensor, a non-intrusive four button user interface with a backlit transflective graphics display, three level alarms with three (optional) alarm relays, a high resolution 4…20 mA current loop output, real-time clock, data-logger and optional HART or Modbus communication interface. In addition, the transmitter offers several optional E18 gas generators for automatic, timed testing of H10 sensors.

H10 Smart Sensor and E18 Gas Generator

H10 Smart Sensors and E18 generators contain non-volatile memory to store information about the target gas they were designed to monitor or generate. They contain general information about the target gas, such as the name, range, units, alarm settings, along with specific calibration information, such as response to gas, mA-Hr of usage and calibration history. Information is transferred into the transmitter at startup and whenever one of the components is inserted into a live transmitter. Because all calibration data is stored in the memory, sensor modules may be calibrated using a spare transmitter in the shop, and subsequently installed into a field transmitter, eliminating the need for field calibration.

Sensors are inserted into the housing at the base of the transmitter. They are easily removed, and installation is simplified by way of an indexing groove that aligns the connector for a perfect fit. Once installed, a threaded port cap secures it in place.

Figure 1: Transmitter with sensor and generator

Sensors are designed for use in ambient air at temperatures of –30…60° C, at a relative humidity between 20…98% RH. (Some sensors are rated to –40 °C. Oxygen sensors are rated to –10 °C.) **Operating sensors in extremely dry air or in condensing gas streams is not recommended.**

Generators are inserted into the optional generator housing attached to the bottom of the sensor housing at the base of the transmitter. Installation of a generator is simplified by way of an indexing groove that aligns the connector for a perfect fit. Once installed apply a little pressure to the top of the generator, and tighten the set screw (using the Badger Meter screwdriver) on the housing to provide a secure fit. An O-ring in the sensor cap provides the mechanism for securing the generator to the transmitter. Simply press the generator into the bottom of the sensor cap until it is secure.

H10 Smart Sensors

Gas	Part No.	Standard Range	Minimum Range	Maximum Range
GENERAL GASES				
Acetylene	00-1057	0…200 PPM	0…50 PPM	0…500 PPM
Alcohol	00-1043	0…200 PPM	0…50 PPM	0…500 PPM
Alcohol	00-1044	0…500 PPM	0…500 PPM	0…2000 PPM
Ammonia	00-1010*	0…100 PPM	0…50 PPM	0…500 PPM
Ammonia	00-1011	0…1000 PPM	0…500 PPM	0…2000 PPM
Carbon Monoxide	00-1012*	0…100 PPM	0…50 PPM	0…1000 PPM
Dimethylamine (DMA)	00-1450	0…100 PPM	0…100 PPM	0…200 PPM
Ethylene Oxide	00-1039*	0…20 PPM	0…20 PPM	0…200 PPM
Formaldehyde	00-1040*	0…20 PPM	0…20 PPM	0…200 PPM
Formaldehyde	00-1349	0…1000 PPM	0…500 PPM	0…2000 PPM
Hydrogen	00-1041	0…2000 PPM	0…500 PPM	0…2000 PPM
Hydrogen	00-1013	0…4 %	0…1%	0…10 %
Nitric Oxide	00-1021	0…100 PPM	0…50 PPM	0…500 PPM
NOx	00-1181	0…200 PPM	0…50 PPM	0…500 PPM
Oxygen	00-1014	0…25%	0…10%	0…25%
Phosgene	00-1015	0…1 PPM	0…1 PPM	0…5 PPM
Phosgene	00-1016	0…100 PPM	0…5 PPM	0…100 PPM
OXIDANT GASES				
Bromine	00-1000*	0…1 PPM	0…1 PPM	0…5 PPM
Bromine	00-1001*	0…10 PPM	0…5 PPM	0…200 PPM
Chlorine	00-1002*	0…1 PPM	0…1 PPM	0…5 PPM
Chlorine	00-1003*	0…10 PPM	0…5 PPM	0…200 PPM
Chlorine Dioxide	00-1004*	0…1 PPM	0…1 PPM	0…5 PPM
Chlorine Dioxide	00-1005*	0…10 PPM	0…5 PPM	0…200 PPM
Chlorine Dioxide	00-1359	0…1000 PPM	0…200 PPM	0…1000 PPM
Chlorine Dioxide	00-1425	0…1 PPM	0…1 PPM	0…5 PPM
Fluorine	00-1006*	0…1 PPM	0…1 PPM	0…5 PPM
Fluorine	00-1007*	0…10 PPM	0…5 PPM	0…200 PPM
Hydrogen Peroxide	00-1042*	0…10 PPM	0…10 PPM	0…200 PPM
Hydrogen Peroxide	00-1169	0…1000 PPM	0…200 PPM	0…2000 PPM
Iodine	00-1036*	0…1 PPM	0…1 PPM	0…5 PPM
Iodine	00-1037*	0…10 PPM	0…5 PPM	0…200 PPM
Ozone	00-1008*	0…1 PPM	0…1 PPM	0…5 PPM
Ozone	00-1009*	0…10 PPM	0…5 PPM	0…200 PPM
Ozone	00-1358	0…1000 PPM	0…200 PPM	0…1000 PPM

*Corresponding E18 gas generator is available for standard range of sensor and lower.

(continued on next page)

ACID GASES				
Hydrogen Bromide	00-1455*	0…20 PPM	0…10 PPM	0…200 PPM
Hydrogen Chloride	00-1017*	0…10 PPM	0…10 PPM	0…200 PPM
Hydrogen Cyanide	00-1018*	0…10 PPM	0…10 PPM	0…200 PPM
Hydrogen Fluoride	00-1019*	0…10 PPM	0…10 PPM	0…200 PPM
Hydrogen Sulfide	00-1020*	0…50 PPM	0…10 PPM	0…500 PPM
Hydrogen Sulfide	00-1469	0…500 PPM	0…200 PPM	0…1000 PPM
Nitrogen Dioxide	00-1022*	0…10 PPM	0…10 PPM	0…200 PPM
Sulfur Dioxide	00-1023*	0…10 PPM	0…10 PPM	0…200 PPM
General Acid Gases	00-1038*	0…10 PPM	0…10 PPM	0…200 PPM
HYDRIDE GASES				
Arsine	00-1024	0…1000 PPB	0…500 PPB	0…2000 PPB
Arsine	00-1025	0…10 PPM	0…10 PPM	0…200 PPM
Diborane	00-1026	0…1000 PPB	0…500 PPB	0…2000 PPB
Diborane	00-1027	0…10 PPM	0…10 PPM	0…200 PPM
Germane	00-1028	0…1000 PPB	0…500 PPB	0…2000 PPB
Germane	00-1029	0…10 PPM	0…10 PPM	0…200 PPM
Hydrogen Selenide	00-1030	0…1000 PPB	0…500 PPB	0…2000 PPB
Hydrogen Selenide	00-1031	0…10 PPM	0…10 PPM	0…200 PPM
Phosphine	00-1032	0…1000 PPB	0…500 PPB	0…2000 PPB
Phosphine	00-1033	0…10 PPM	0…10 PPM	0…200 PPM
Phosphine	00-1034	0…1000 PPM	0…200 PPM	0…2000 PPM
Silane	00-1035	0…10 PPM	0…10 PPM	0…200 PPM
Silane	00-1285	0…1000 PPB	0…500 PPB	0…2000 PPB

*Corresponding E18 gas generator available for standard range of sensor and lower.

Specifications

Sensor Type	Electrochemical cell
Gas Type	Sensor dependent (refer to list of available sensor types)
Range	User adjustable within limits of selected sensor (refer to list of available sensor types)
Response Time	Sensor dependent
Accuracy	Generally, ±10% of value, but limited by available calibration gas accuracy
Repeatability	±1% (Electronic)
Linearity	±0.5% (Electronic)
Zero Drift	Less than 2% full scale per month
Span Drift	Dependent on operating environment but generally less than 3% per month
Analog Output	4…20 mA, 700 Ω max. @24V DC, 100 Ω max. @12V DC
Serial Interface Options	HART® FSK (digital signaling on 4…20 mA loop) Modbus over RS232/485
Alarm Relay Board Options	Three SPST relays (two with N/O contacts, one with N/C contacts) Each relay: 5A @ 230V AC resistive; 5A @ 30V DC resistive Coils are programmable as normally energized or normally de-energized
AC Transmitter Power Requirements	120V AC, 50/60 Hz., 7 W max. 220V AC, 50/60 Hz., 7 W max.
DC Transmitter Power Requirements	Standard or optional HART FSK, 2-wire loop: 25 mA @ 12…30V DC, max. With optional Modbus RS485: additional 50 mA @ 24V DC With Optional Heated Sensor Housing option: additional 93 mA @ 24V DC
Relay Board Power Requirements	AC Alarm Relay Board, 115/230V AC, 4.4 W max. (see above) DC Alarm Relay Board, 12…30V DC, 3.1 W max. (see above)
Enclosure	IP65 (dust protected, water jets), polycarbonate with stainless steel hardware. Weatherproof and corrosion resistant. (Standard H x W x D): 4.9 × 4.9 × 5.5 in. (124 × 124 × 139 mm) Refer to *"Mechanical Installation" on page 10* for dimensions of models with options.
Mounting	(Standard) Wall or pipe mount bracket. U-Bolts suitable for 1.5 in. or 2 in. I.D. (Optional) Panel mount kit available.
Auto-Test Option	Dependent on sensor gas type and full-scale range
Display	Graphics LCD, 96w × 32h, backlit*, transflective *Backlight disabled in 2-wire loop power mode.
Controls	Four, dome-type push buttons. Remote alarm reset input (w/optional alarm relays only).
Operating Environment	–30…60° C (Min. temp. for O_2 sensor is –10° C) 10…95% RH (non-condensing) IP65 (dust protected, water jets)
Weight	1.5 lb. (0.68 kg)

MECHANICAL INSTALLATION

Transmitter Mounting

Threaded inserts in the rear of the enclosure permit the attachment of brackets for securing the transmitter to a wall or pipe. An optional bracket is also available for "flush mounting" the transmitter into a panel, so that only the front cover protrudes. (This option is available for remote AC powered units ONLY.)

Choose a location so the transmitter display is readily visible and the panel buttons and sensor are accessible for calibrations. Consider the remote sensor option to locate the sensor closer to the source of a potential gas leak or closer to the floor for gases heavier than air.

Enclosure Dimensions

Dimensions and the conduit entry locations are detailed in *Figure 2*.

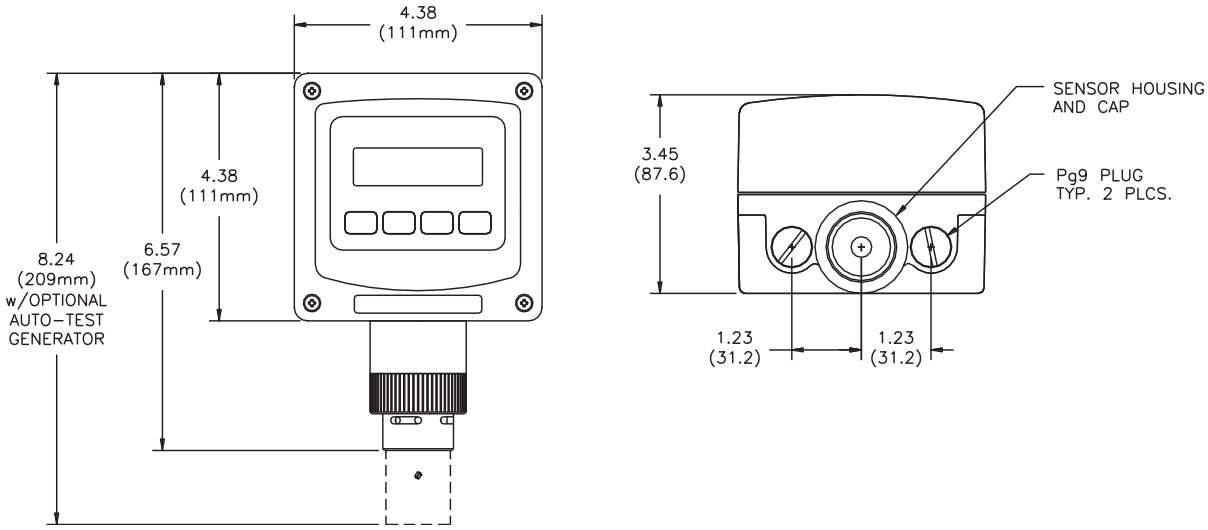


Figure 2: Enclosure dimensions (RS485 no relays)

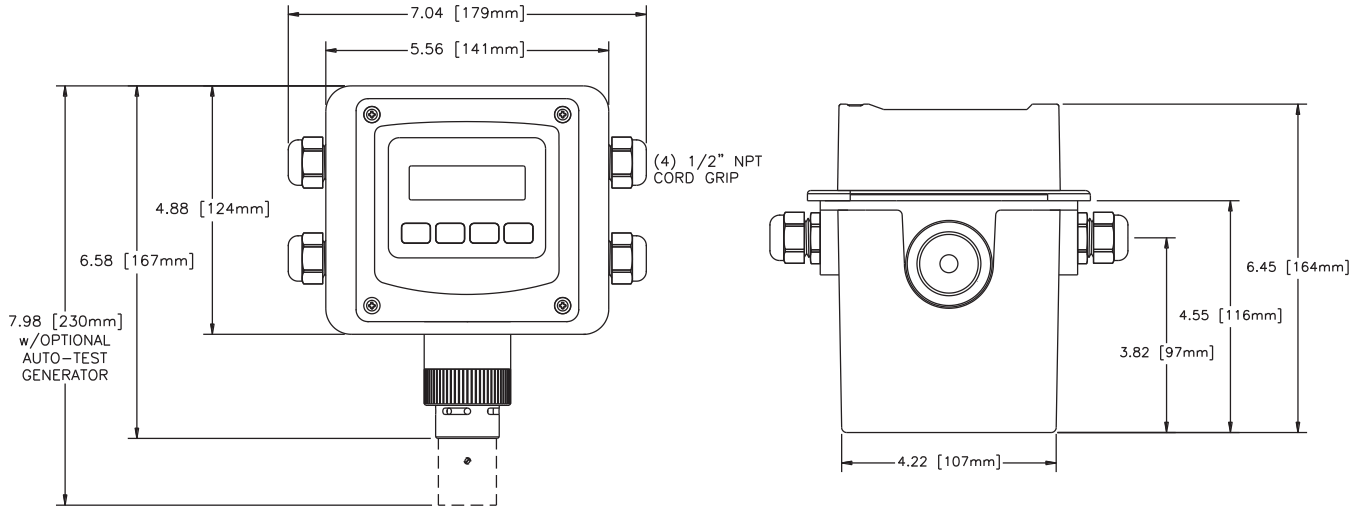


Figure 3: Deep enclosure dimensions

Wall and Pipe Mounting

A PVC mounting bracket with attachment screws is supplied with the transmitter. The transmitter is attached to the bracket using four flat head screws, and the bracket is attached to a wall or pipe by way of the four slots in each corner. The slots accommodate 1/4 inch U-bolts designed for 1-1/2 or 2 inch pipe. For 1-1/2 inch pipe, type 304 stainless steel U-bolts with 2 inch I.D. are available from Badger Meter (p/n 47-0005).

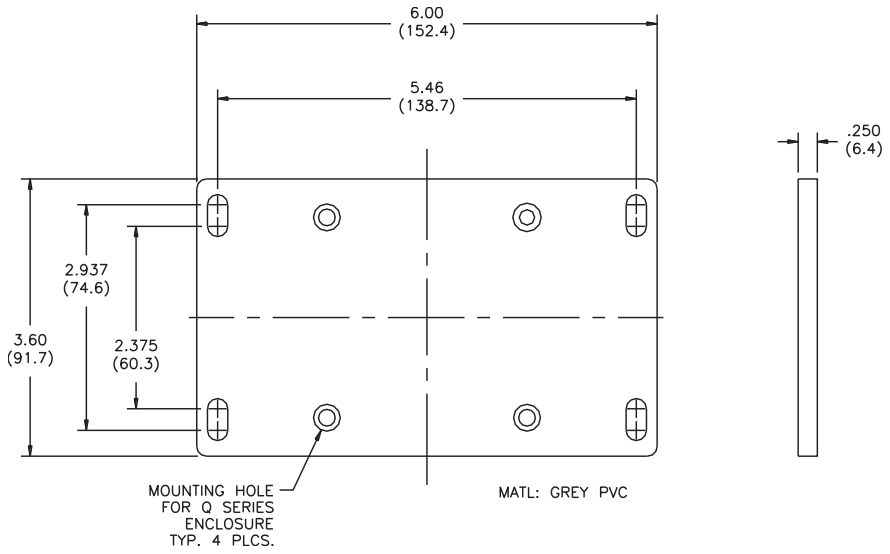


Figure 4: Wall/pipe mounting bracket

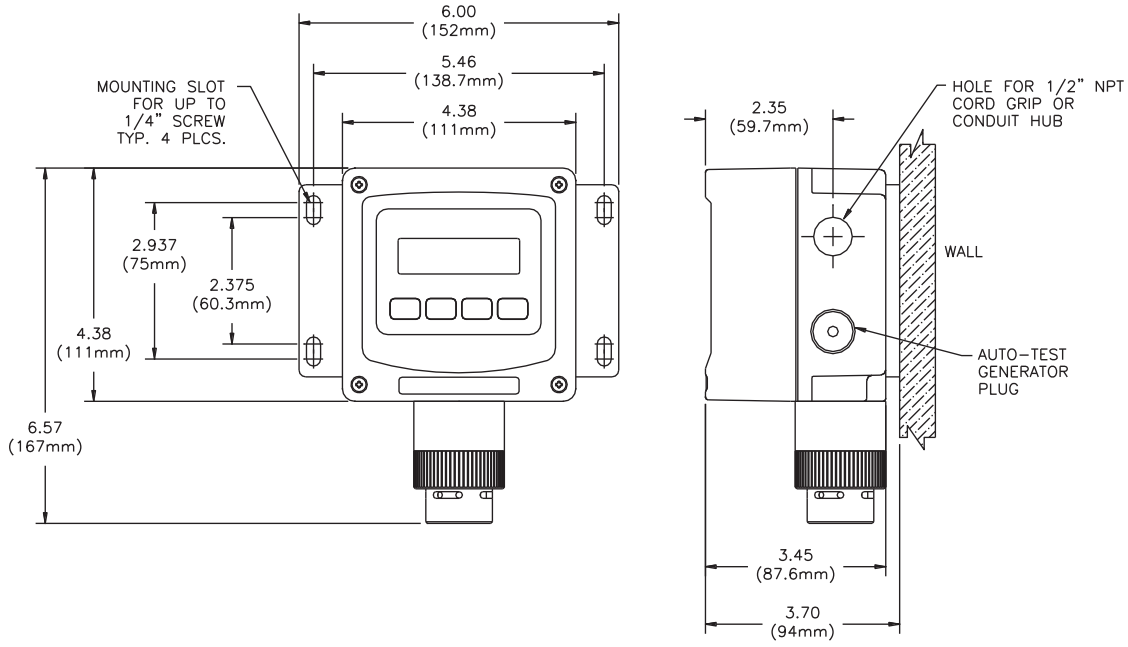


Figure 5: Wall mounting diagram

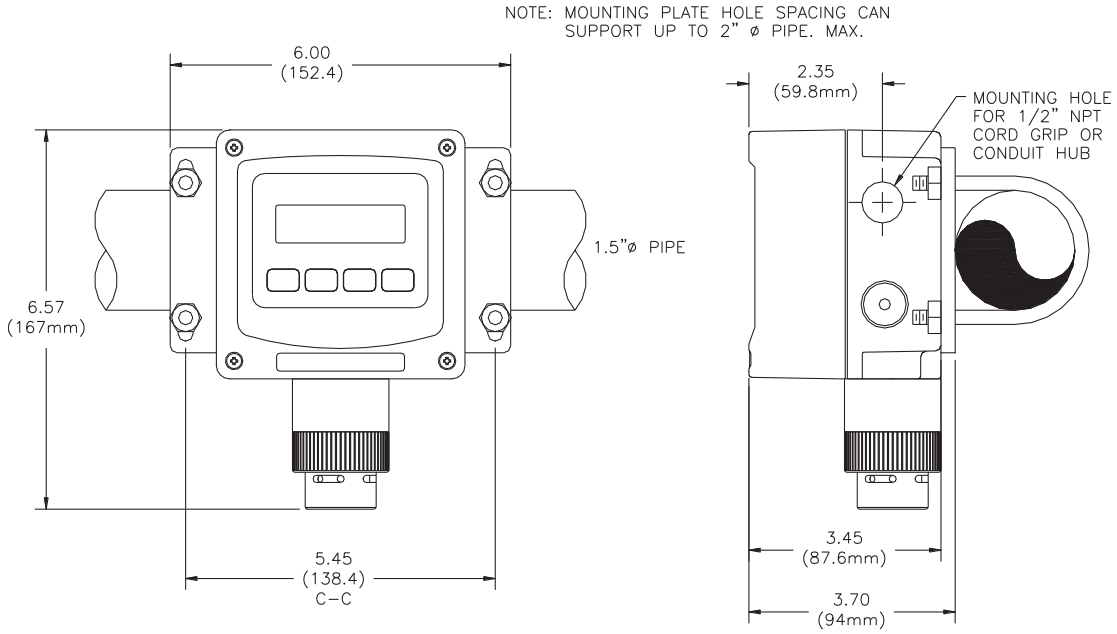


Figure 6: Pipe mounting diagram

Panel Mounting (Remote Sensors Only)

Figure 7 depicts the details for panel mounting the deep case. For this, a bracket attaches to the rear housing, and when adjusted, pulls the transmitter's flange down against the adhesive side of the gasket supplied with the bracket (make certain to remove the protective paper first).

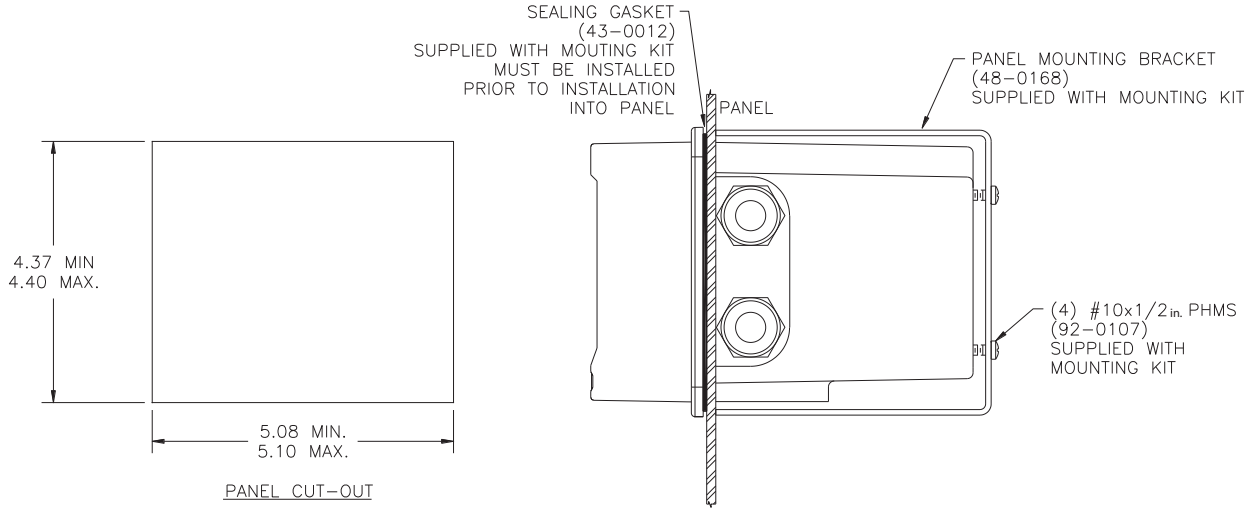


Figure 7: Panel mounting details (deep case)

Duct Sensor Mounting

The H10 sensor duct mount option allows sensors to be installed in a duct or pipe and provides easy access for service.

The assembly is comprised of a special H10 sensor holder that slides into the hollow duct mount adapter. See *Figure 9 on page 13*. The adapter has 1-1/2 inch MNPT threads on the insertion end for securing it to the duct or pipe, and a barb fitting for supplying calibration gas to the sensor. An interface cable is provided to connect the sensor holder to the transmitter.

NOTE: A mating flange for securing the adapter is not provided.

Screw the adapter into the duct or pipe so the barb fitting is accessible to connect gas tubing. Once the adapter is in place, slide in the sensor holder, lock it in place, and connect the interface cable. It is recommended that the sensor not be installed in the holder until you are ready to start the transmitter. This is especially true during construction when excessive dust and dirt may be blowing through the duct system and be deposited on the sensor.

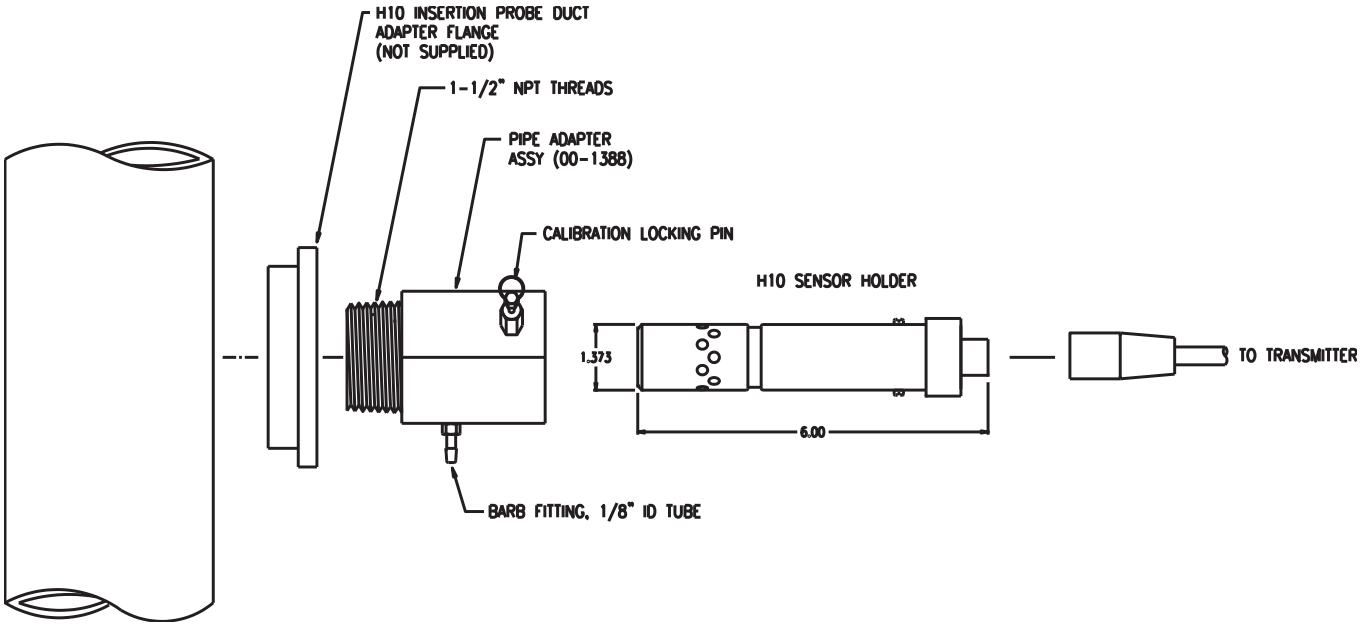


Figure 8: Duct mount sensor exploded view

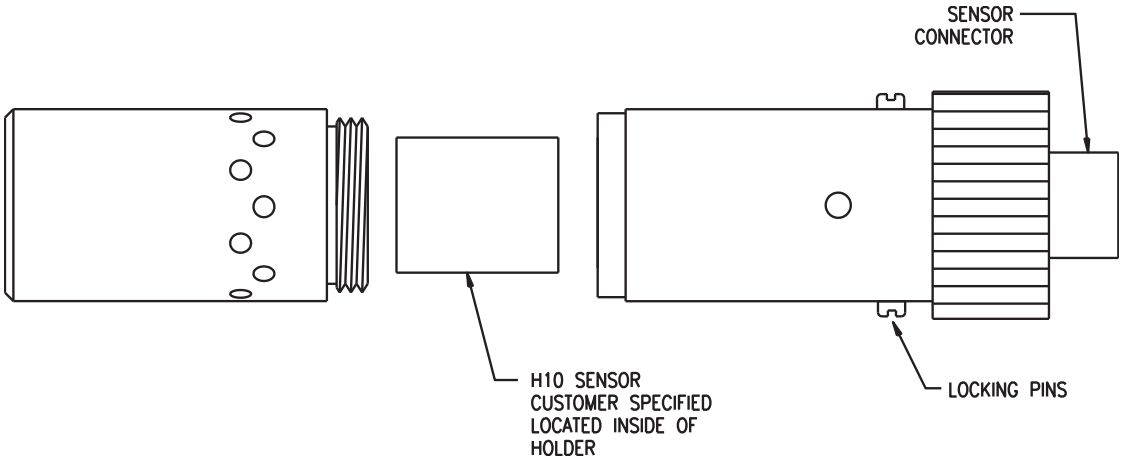


Figure 9: Duct mount assembly

Duct Mount (Integral)

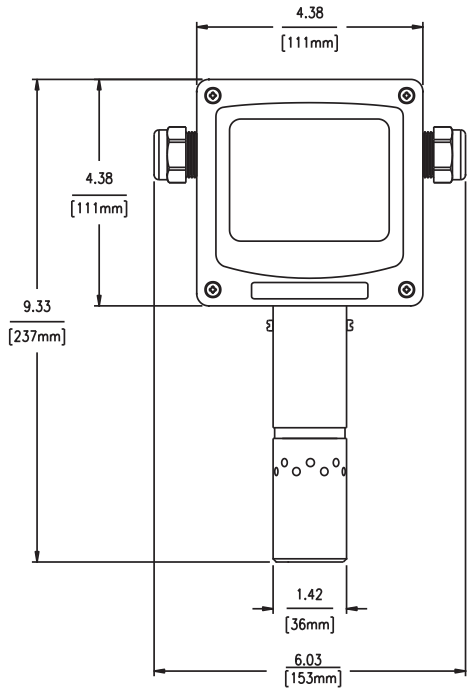


Figure 10: Duct mount (integral) transmitter dimensions

Generator Installation/Removal

Generators are inserted into the optional generator housing attached to the bottom of the sensor housing at the base of the transmitter. Before installing the generator, check to see that the set screw on the side of the holder is loose and does not contact the generator during installation. An indexing groove on the side of the generator aligns the connector for a perfect fit. Once installed, apply a little pressure to the top of the generator and tighten the set screw (using the Badger Meter screwdriver) on the housing to provide a secure fit. If the set screw is not secure, the connector on the generator may disengage causing a "generator missing" error message on the display.

To remove the generator from the holder, loosen the set screw on the side of the holder and pull up on the outlet stem.

An O-ring in the sensor cap provides the mechanism for securing the generator to the transmitter. Simply press the generator into the bottom of the sensor cap until it is secure.

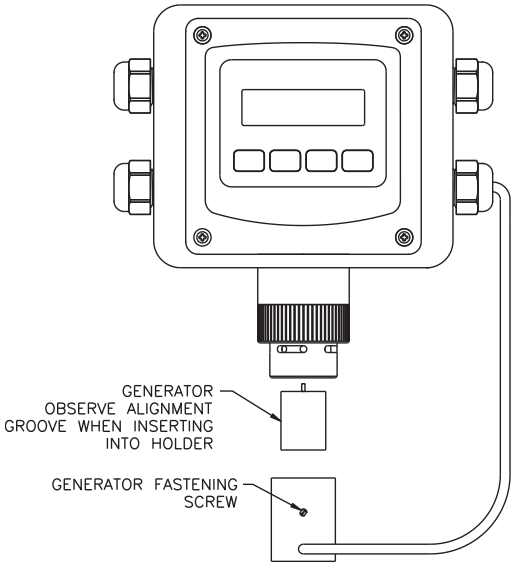


Figure 11: Generator exploded view

ELECTRICAL CONNECTIONS

Transmitter Connections

⚠ WARNING

INSTALLATION MUST BE IN ACCORDANCE WITH THE RECOGNIZED STANDARDS OF THE APPROPRIATE AUTHORITY IN THE COUNTRY CONCERNED.

To access the wiring terminals inside the transmitter, loosen the four screws in each corner of the housing's front cover. The front cover is hinged to the rear cover along its lower edge so it will swing down and stop at approximately 90°. The transmitter has limited space for wire. Use the smallest gauge wire available that is compatible with electrical code and current requirements.

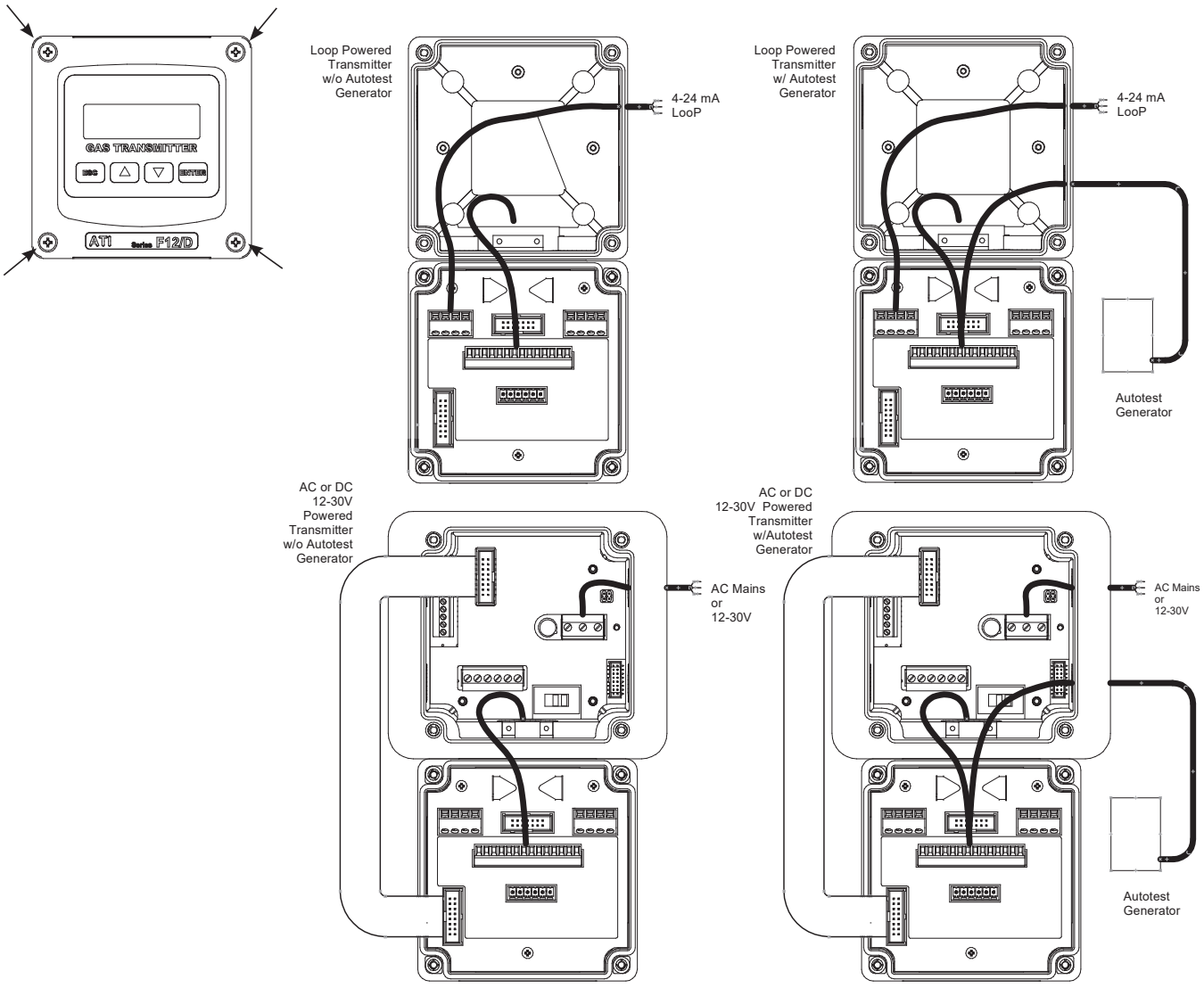
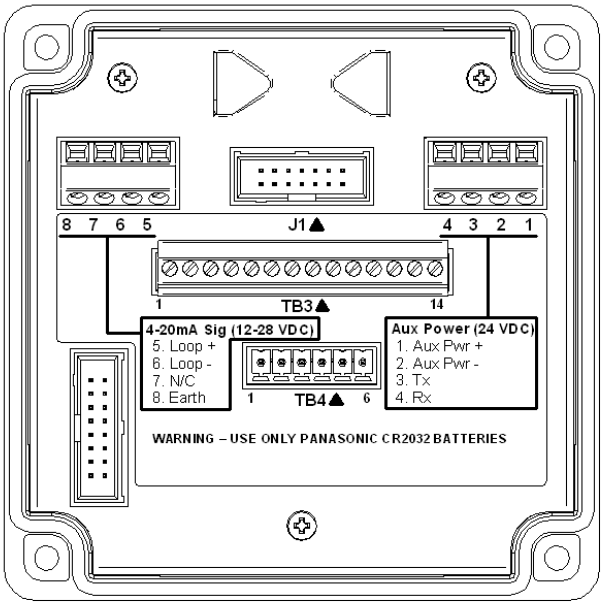


Figure 12: F12/D gas transmitter configurations

Terminal Board Sensor Connections

The terminal board is located just below the metal shield in the front cover. It contains power and communication terminals and provides a header for connecting the sensor housing wires and optional autotest generator wires.

The table below lists connections for the sensor housing and autotest generator wires.



Conductor Colors

TB 3 Position	Sensor Wires	Generator Wires
1	WHITE	
2	YELLOW	
3	BLUE	BLUE
4	PURPLE	WHITE
5	GRAY	
6		GREEN
7	BLACK	
8	BROWN	BLACK
9	RED	RED
10	ORANGE	ORANGE
11		WHT / BLK
12	GREEN	
13	PINK or RED	
14	PINK or RED	

Position 13 and 14 are for the heated sensor option. Colors vary depending on heated style ordered.

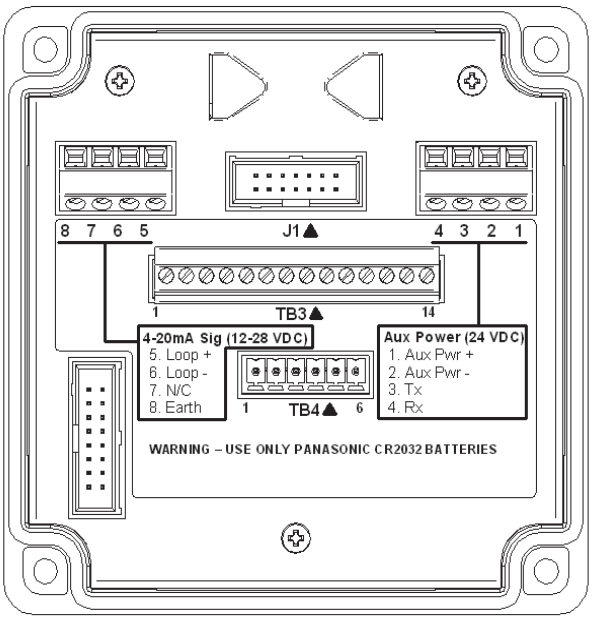
Figure 13: Sensor/generator terminal wiring

Terminal Board – Loop Power Connections

The loop powered transmitter model is powered in using terminals 5 and 6 commonly referred to as "2-wire mode."

Loop powered models with the heated sensor housing and/or Modbus communications option require an additional 24V DC supply to power them. This auxiliary power is connected to terminals 1 and 2.

NOTE: Connections to the communications on the DC powered models are made on the power supply board.



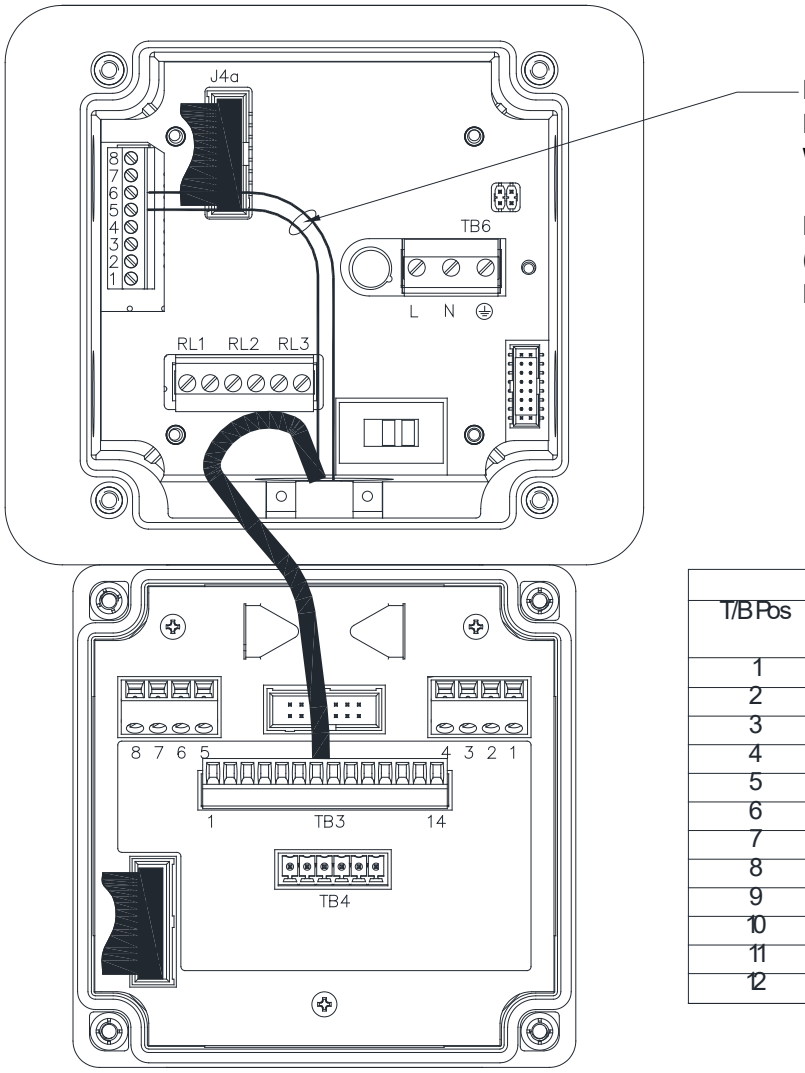
Power Terminals	
1	Auxiliary Power +
2	Auxiliary Power –
3	Comm. Tx
4	Comm Rx
5	Loop +
6	Loop –
7	Comm Common
8	EARTH GROUND

Figure 14: Power and communication terminals

Heated Sensor Housing Wiring

The AC powered and DC powered models contain a power supply to create the power necessary for the optional heated sensor housing.

The heated sensor housing connects to terminals 5 and 6 of the AC or DC power supply PCB. The conductor colors listed below are based on which version of heated sensor is being connected.



Conductor Colors		
T/B Pos	Sensor Wires	Generator Wires
1	WHITE	
2	YELLOW	
3	BLUE	BLUE
4	PURPLE	WHITE
5	GRAY	
6		GREEN
7	BLACK	
8	BROWN	BLACK
9	RED	RED
10	ORANGE	ORANGE
11		WHT / BLK
12	GREEN	

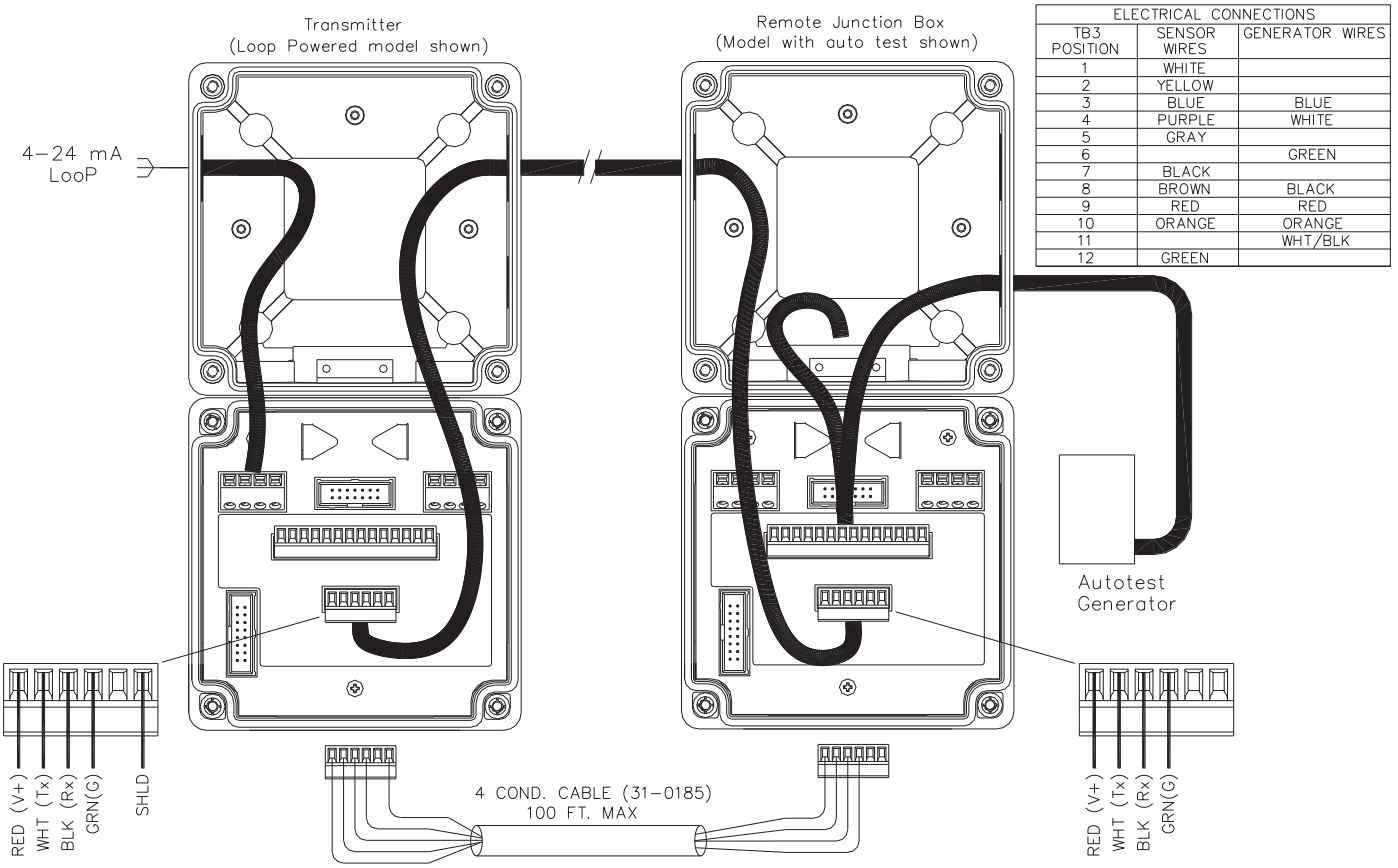
Figure 15: Heated sensor wiring diagram

Remote Sensor Wiring

The remote sensor option permits the sensor to be mounted up to 100 feet from the transmitter. Remote interconnect cable sold separately. The interconnections are shown below.

NOTES:

- The shield must be connected only at one end—preferably at the transmitter end.
- Use shielded 4-conductor (two twisted pairs) cable.
- Loop powered model shown. Interconnections for AC and VDC powered models are similar to the loop powered model.



ELECTRICAL CONNECTIONS		
TB3 POSITION	SENSOR WIRES	GENERATOR WIRES
1	WHITE	
2	YELLOW	
3	BLUE	BLUE
4	PURPLE	WHITE
5	GRAY	
6		GREEN
7	BLACK	
8	BROWN	BLACK
9	RED	RED
10	ORANGE	ORANGE
11		WHT/BLK
12	GREEN	

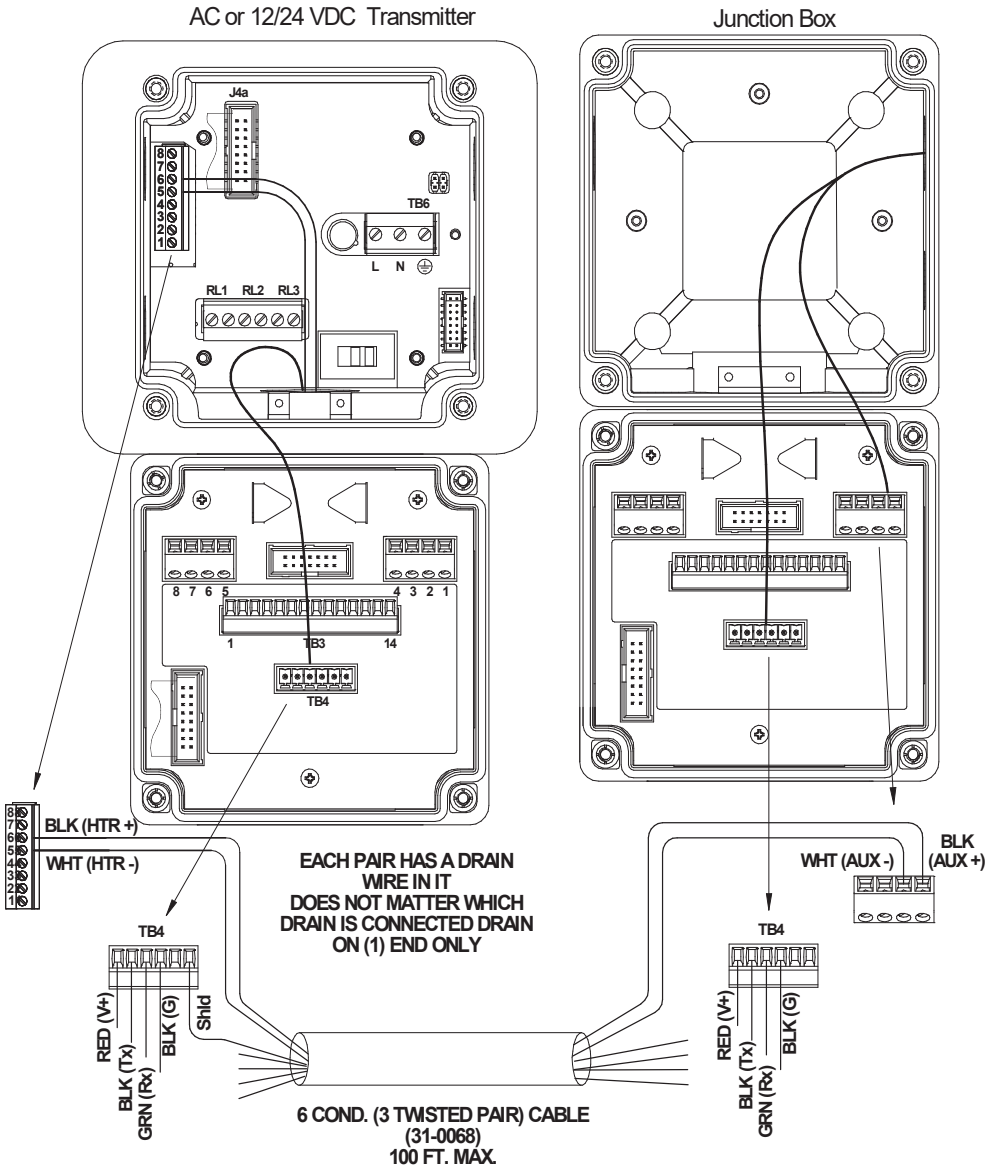
Figure 16: Remote sensor wiring

Heated Sensor Wiring (AC or VDC Powered) - Remote

The heated remote sensor option requires an additional two wires between the transmitter and the remote junction box. The interconnections are shown below.

Notes:

- The shield must be connected only at one end—preferably at the transmitter end.
- Use shielded 6-conductor (three twisted pairs) cable (pairs MUST stay together), or run the lines for the sensor heater separately.



TB3	Sensor Wiring	Generator Wiring
1	WHITE	
2	YELLOW	
3	BLUE	BLUE
4	PURPLE	WHITE
5	GRAY	
6		GREEN
7	BLACK	
8	BROWN	BLACK
9	RED	RED
10	ORANGE	ORANGE
11		WHITE/BLACK
12	GREEN	
13	*PINK	
14	*PINK	

*If using the 6 ft. Heated Sensor (00-1878), Red wires replace the Pink wires listed above.

Figure 17: Remote sensor wiring

Heated Remote Sensor Wiring (2-Wire)

The heated remote sensor option requires an additional two wires between the transmitter and the remote junction box. The interconnections are shown below.

Notes:

- Rx of the transmitter must be connected to Tx of the junction box.
- Tx of the transmitter must be connected to Rx of the junction box.
- The shield must be connected only at one end—preferably at the transmitter end.
- Use shielded 6-conductor (three twisted pairs) cable, or run the lines for the sensor heater separately.

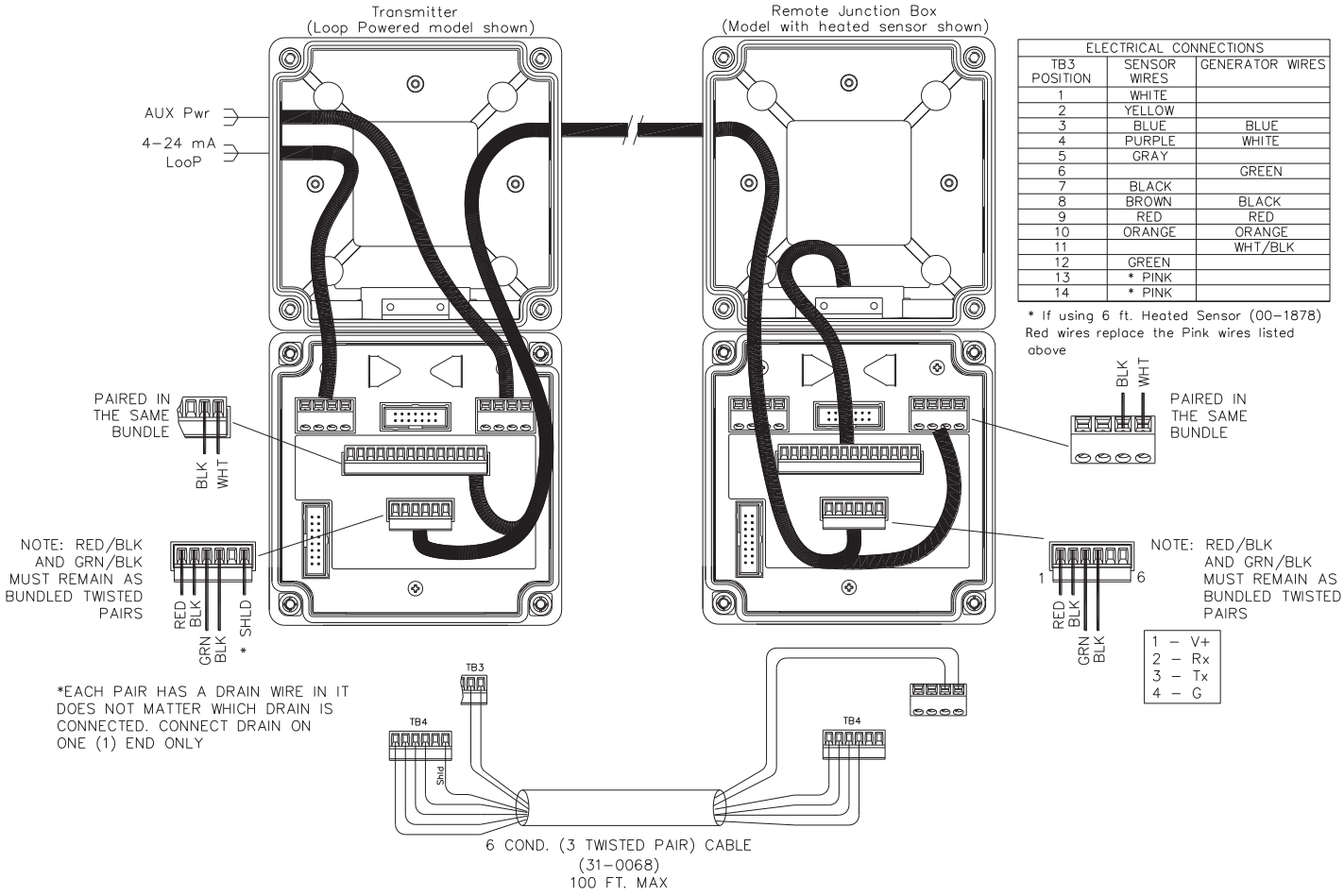
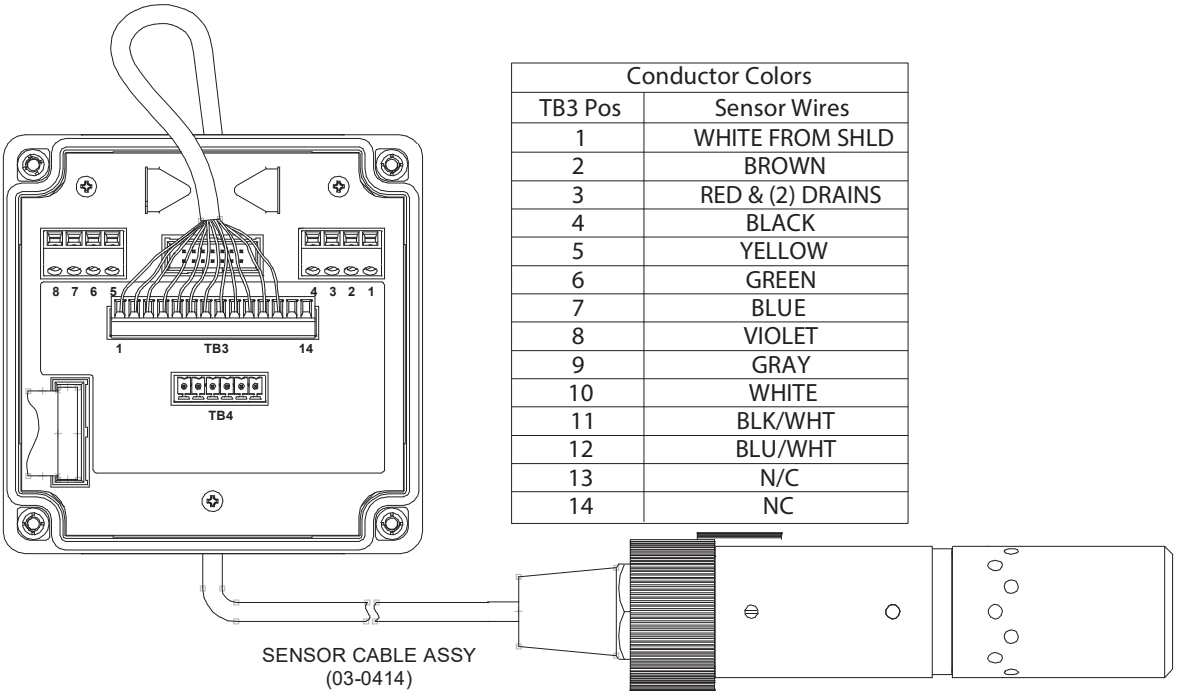


Figure 18: Heated remote sensor wiring

Duct Mount Sensor Wiring

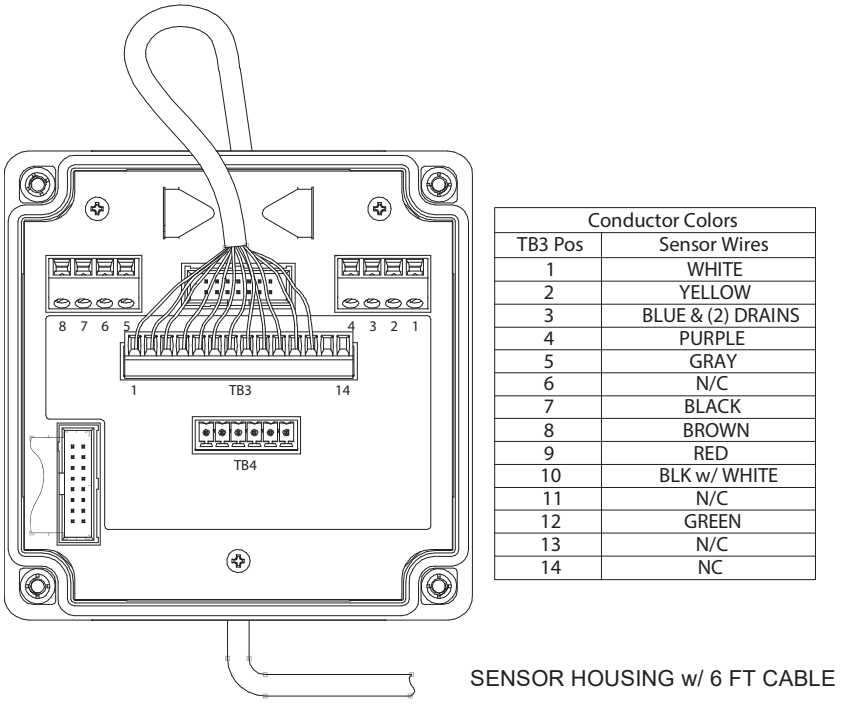
The duct mount sensor option permits the sensor to be mounted into a process flow stream.



Conductor Colors	
TB3 Pos	Sensor Wires
1	WHITE FROM SHLD
2	BROWN
3	RED & (2) DRAINS
4	BLACK
5	YELLOW
6	GREEN
7	BLUE
8	VIOLET
9	GRAY
10	WHITE
11	BLK/WHT
12	BLU/WHT
13	N/C
14	NC

Figure 19: Duct mount sensor wiring

Sensor Connections with 6 Foot Cable



Conductor Colors	
TB3 Pos	Sensor Wires
1	WHITE
2	YELLOW
3	BLUE & (2) DRAINS
4	PURPLE
5	GRAY
6	N/C
7	BLACK
8	BROWN
9	RED
10	BLK w/ WHITE
11	N/C
12	GREEN
13	N/C
14	NC

Figure 20: Wiring connections - 6 ft sensor cable

Alarm Relay Boards (Option)

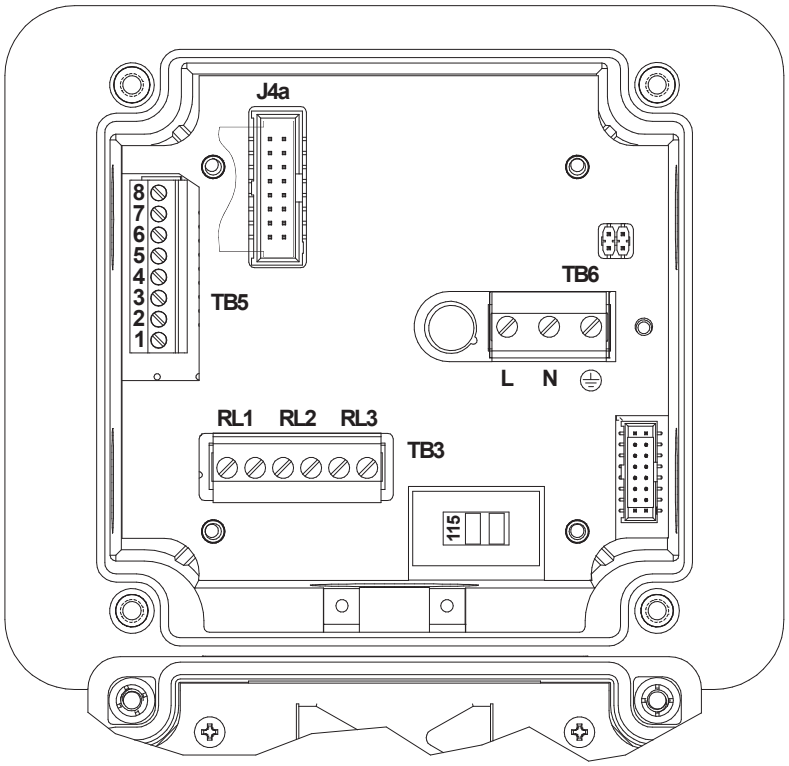
The alarm relay board is available in both an AC powered and DC powered version. Each version features three SPST relays, an external remote alarm reset, and provides power to the transmitter and communication interface. A 20-conductor ribbon cable connects control signals and power between the transmitter and the relay board. Relay operation must be enabled through the operator interface.

Signaling on the 20 mA current loop, including HART FSK, is still possible by connecting a separate power supply and current loop receiver to terminals 5 and 6 on the P/S board.

AC or 12-30V DC Powered

The AC powered version requires 115 or 230V AC at 50…60 Hz applied to TB6. DC powered units require 12…30 V between terminals 1 and 2 of TB6.

NOTE: The Voltage selector switch is factory set to proper voltage as ordered by the customer. **DO NOT ADJUST as instrument damage may occur if the switch is moved.**



J4a
CONNECTS TO (AUX)
ON FRONT LID

TB3
1 - RL1 Contact NO
2 - RL1 Contact C
3 - RL2 Contact NO
4 - RL2 Contact C
5 - RL3 Contact NC
6 - RL3 Contact C

TB5
8 - Loop Power (-)
7 - Loop Power (+)
6 - Heater Power (+)
5 - Heater Power (-)
4 - Pwr -
3 - Pwr -
2 - Remote Reset
1 - Pwr +

TB6 for AC operation
1 (L) - 115 or 230 VAC, 50/60 Hz
2 (N) - Neutral
3 (⏚) - Ground

TB6 for DC operation
(+) - V+
(-) - V-
(⏚) - Ground

Figure 21: Powered alarm relay contacts

Relay Configuration

By default, RL1 and RL2 are under the control of the transmitter's gas concentration alarms. The C (common) and NO (normally open) contacts of relays RL1 and RL2 are jumpered to TB3 and are open when their respective coils are de-energized (no gas alarm or no power). In contrast, RL3 is under the control of the transmitter's fault alarm, which is programmed to keep the relay coil energized until a fault is detected (or power fails). The C and NC (normally closed) contacts of relay RL3 are jumpered to TB3 so it is closed when the coil is de-energized. The default configuration may be modified by cutting and reconnecting jumpers on the alarm relay board, and by changing variables via the operator interface.

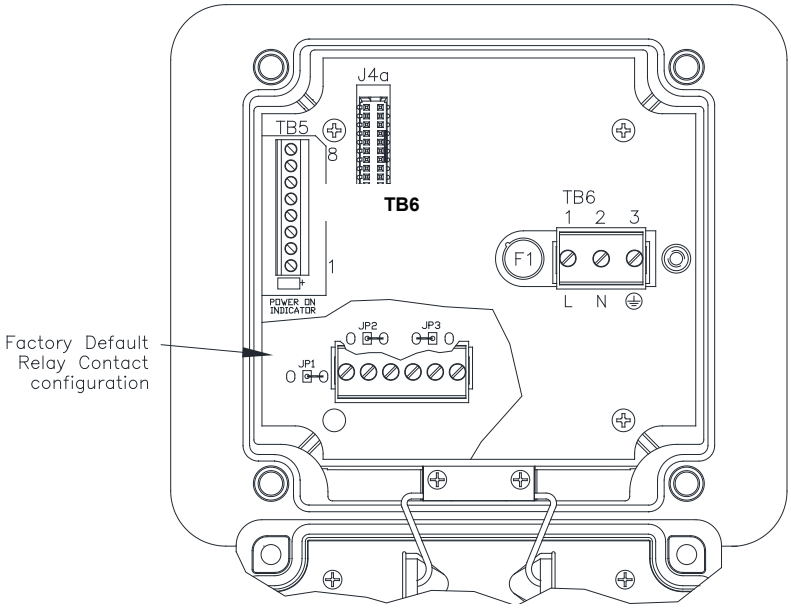


Figure 22: Relay configuration jumper location

Relays are best used as pilot relays if heavy load switching is desired. Use suitable arc suppression devices across loads switched through internal relays. In addition, relays may toggle rapidly if manually reset before an alarm condition has cleared. See Remote Reset Input (below), or if gas persists at the alarm set level without proper set delay when configured for automatic reset, see *"Alarm Setting Menus" on page 52*.

Remote Reset Input

The remote reset inputs on pins 2 and 3 of TB5 are used to clear alarms requiring manual reset. The function is activated when the two contacts are momentarily shorted together.

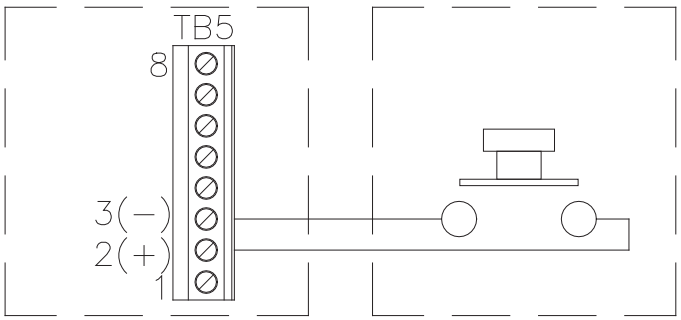


Figure 23: Remote reset input

Wiring Examples

A17/B14 Receiver(s)

Up to two transmitter/receivers may be connected to a single A17 power supply.

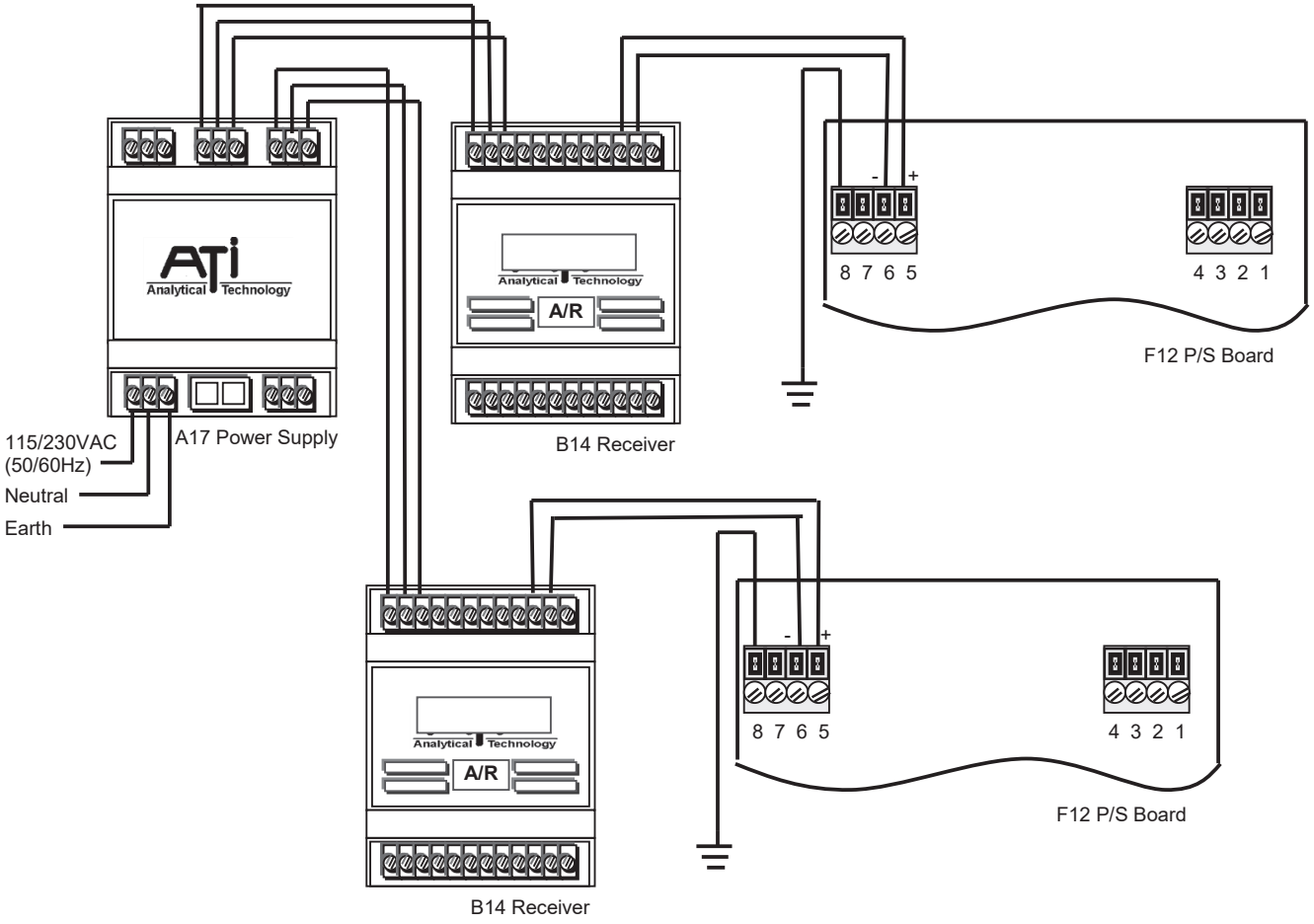


Figure 24: A17/B14 receiver modules

RS485 Transmitter with 4…20 mA Signaling to A17/B14 Receiver

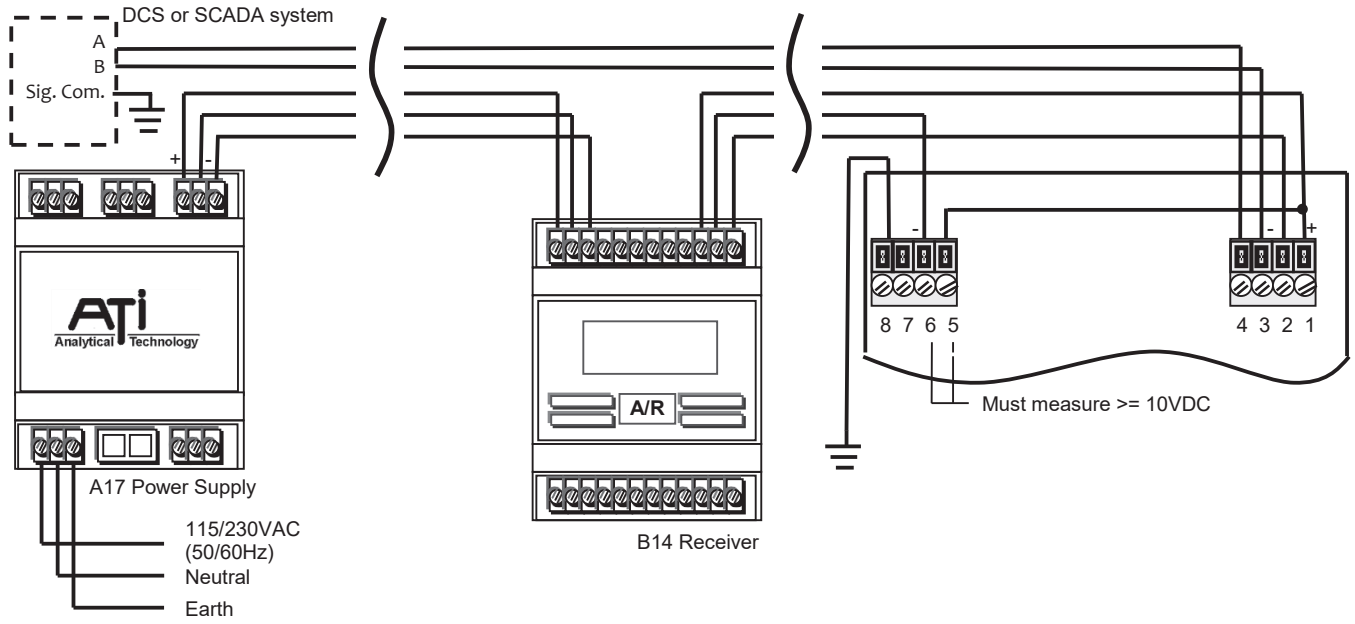


Figure 25: RS485 multidrop with 4…20 mA signaling

RS485 Multidrop Network without 4…20 mA Signaling

The A17 power supply module may be used to power up to four F12/D gas transmitters connected in an RS485 network. Use an appropriate gauge wire to minimize supply voltage drops (must not drop below 10V at any transmitter).

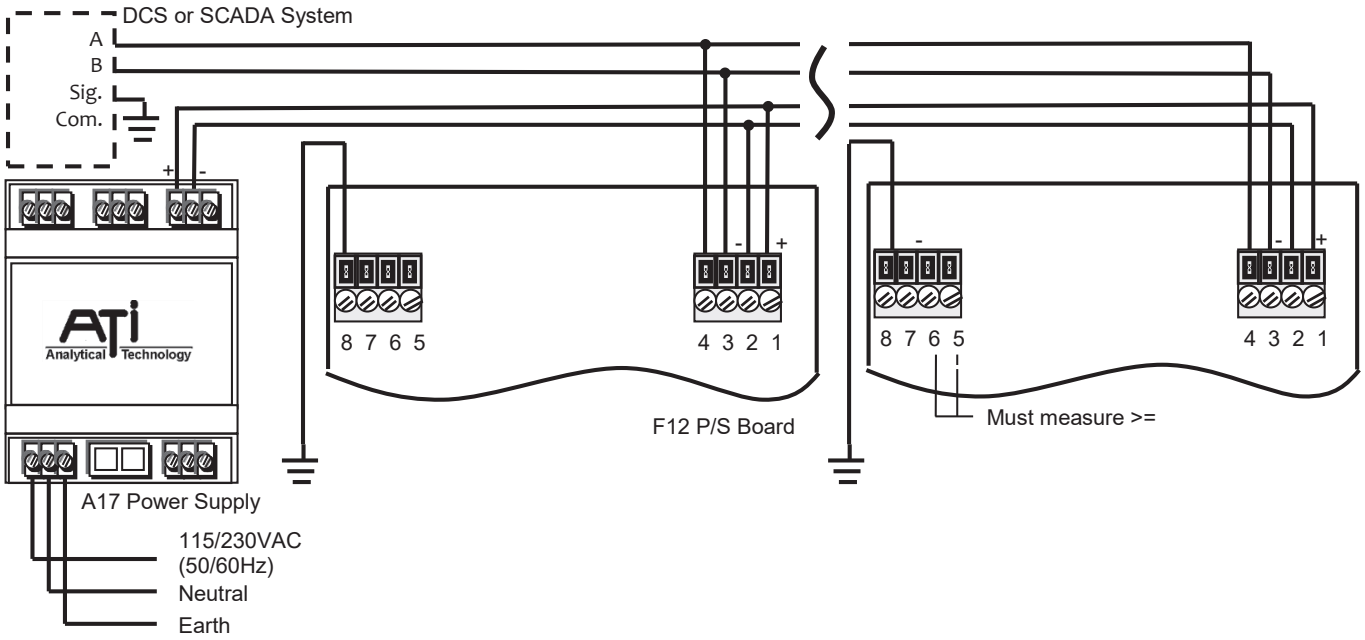


Figure 26: RS485 multidrop without 4…20 mA signaling

Powered 4…20 mA Output

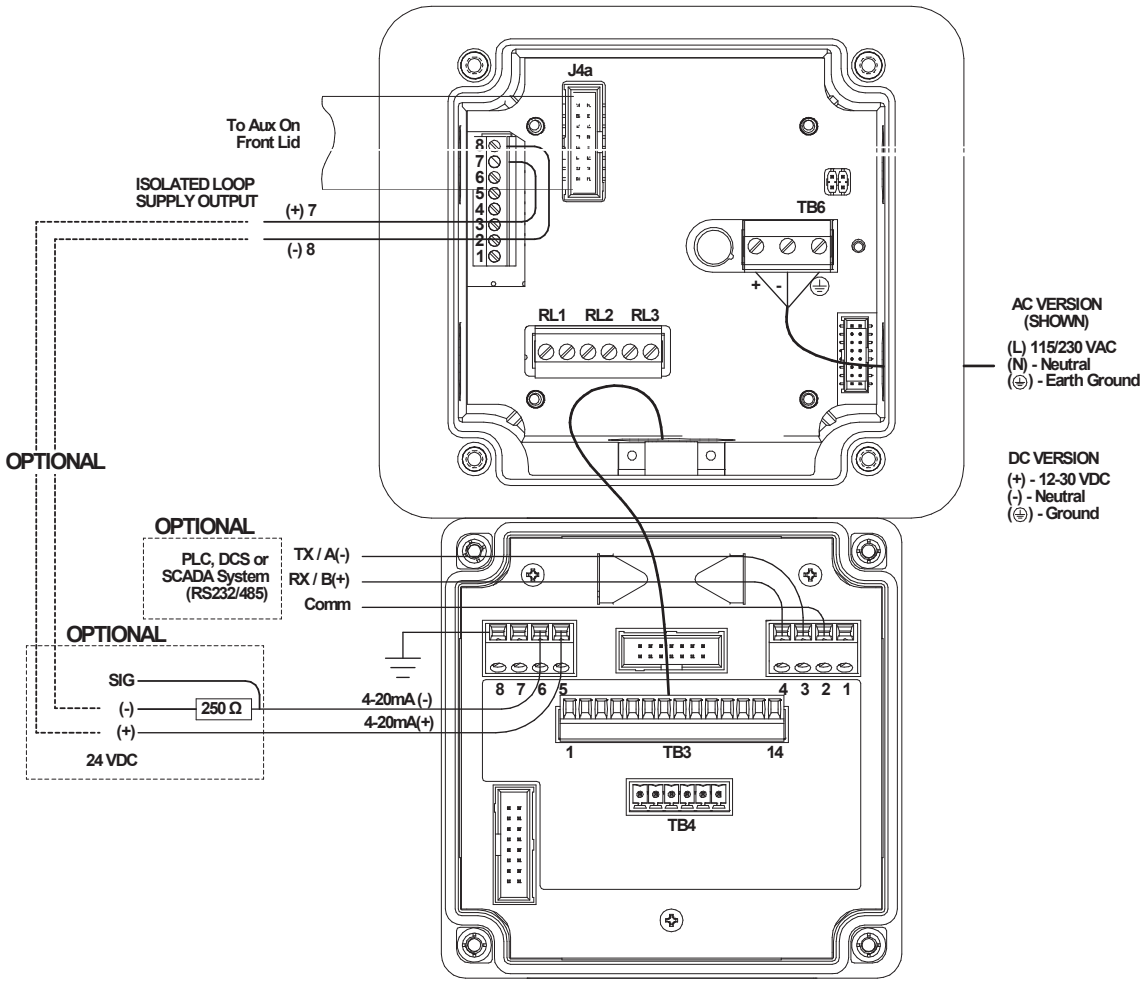


Figure 27: AC or 12…30V DC powered relay board wiring

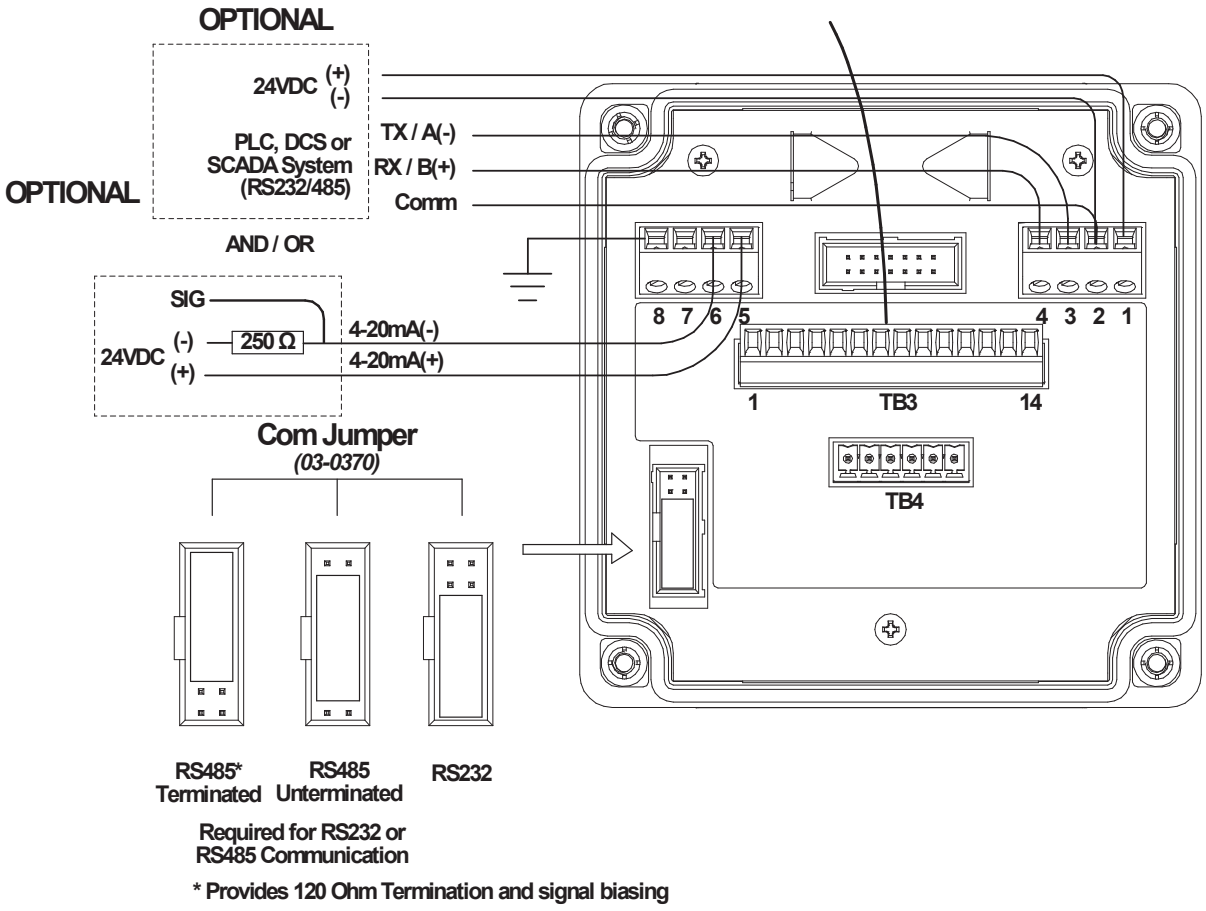


Figure 28: Communication with 4…20 loop output

HART Point-to-Point (2-Wire)

The HART point-to-point connection permits the transmitter to communicate digitally, while retaining the functionality of its 4…20 mA current loop. Setting the transmitter's polling address to 0 (zero) permits the current loop to function normally. According to HART specifications, the current loop must be terminated with a load resistor between 230…1100 ohms. However, transmitter specifications restrict the maximum analog output resistance to a lower value. See *"Specifications" on page 9*. The term "active source" refers to a transmitter that is not loop powered and sources current from power applied to it on separate terminals. Size the power supply according to the number of transmitters, the current demand of each transmitter (see specifications), and wire resistance. Wire resistance must not be allowed to drop the primary supply voltage below 10V at the terminals of any transmitter.

NOTE: Use at least 14 AWG wire on supply connections (shown in bold).

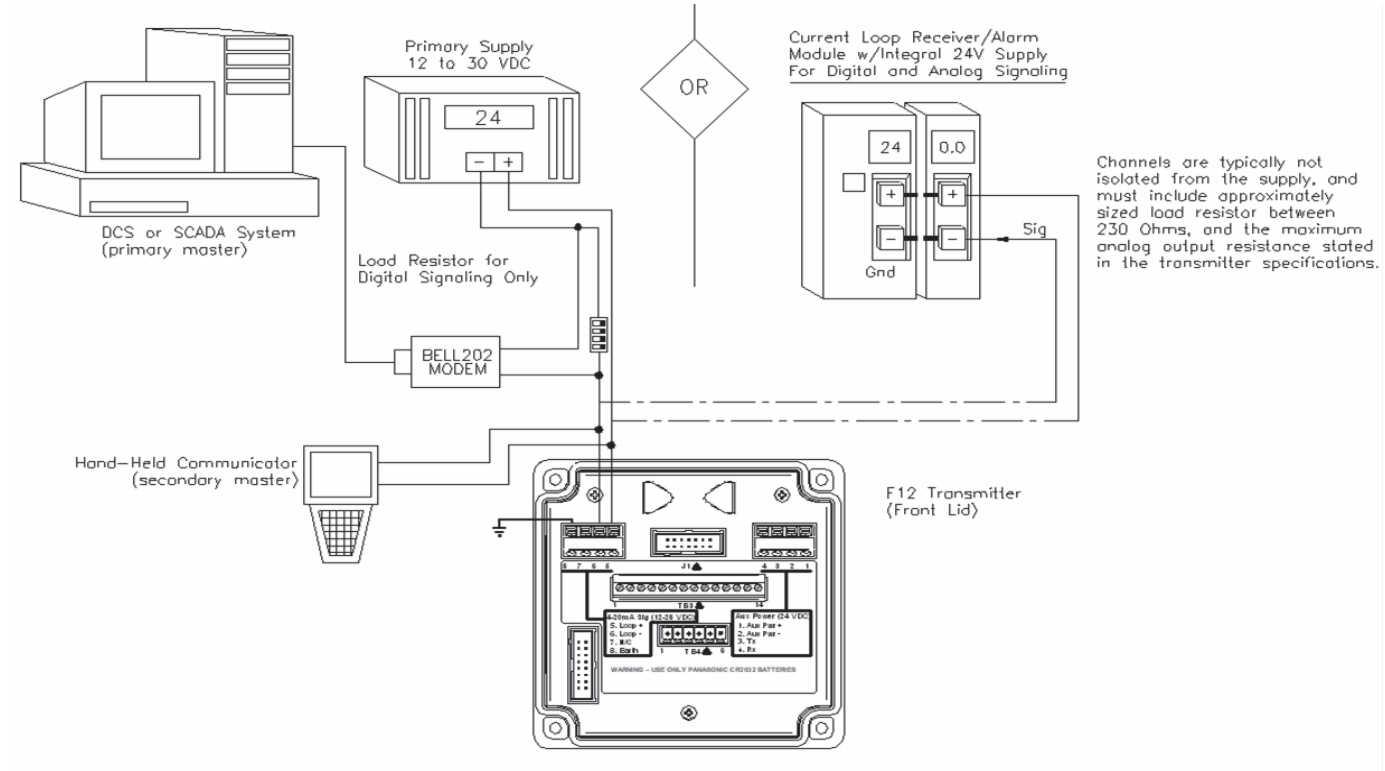


Figure 29: HART point-to-point (2-wire)

Communications Jumper Setting

Units with an optional communications interface use a jumper to select between RS-232, RS-485 and RS-485 with termination. The desired physical interface is set by positioning jumper JP5 as shown below. Orientation does not matter, only its position.

Protocol	Alignment
RS-232	Top (toward JP5 label)
RS-485 Unterminated	Middle
RS-485 With termination	Bottom (away from JP5 label)

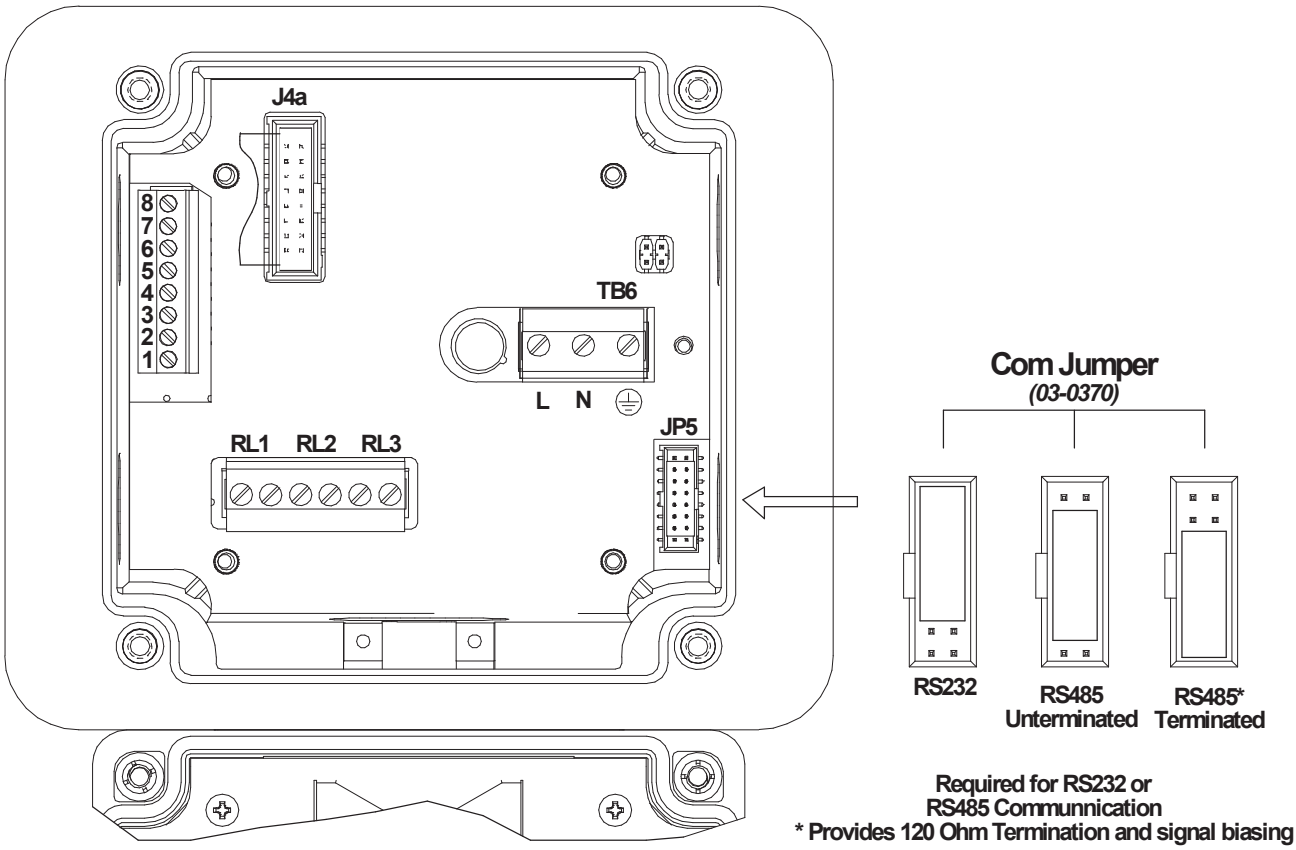


Figure 30: Comm interface jumper

OPERATION

Operator Interface Panel

The Model F12/D gas transmitter operator interface is non-intrusive, so you do not have to remove the housing cover to view the display, configure the transmitter or calibrate the sensor. It features a backlit transflective 96 × 32 dot LCD display and four panel keys.

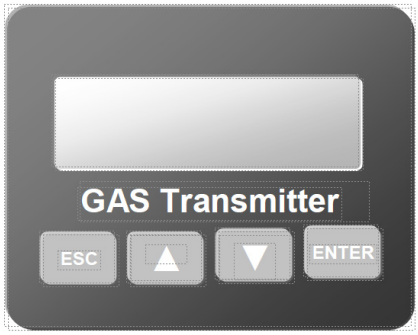


Figure 31: Operator interface panel

Menus and Settings

Items appearing on the display are usually text labels that identify the name of a menu or a setting. Menus are typically a single text label (for example, "Menu") while settings are typically composed of a text label and a value field separated by an equal sign (for example, Range = 50.0).

Moving the Cursor and Selecting

The up▲and down▼keys are used to move the selection cursor ➡between displayed items. The down key typically moves the cursor down, or to the right, while the up key moves the cursor up, or to the left. Pressing the **Enter** key when the cursor is pointing at a menu label (to the left of the label) causes the transmitter to display the new menu and position the cursor at the first item. Pressing the **Esc** key at any item on the selected menu causes the transmitter to return to the previous display.

Editing Settings

A setting is selected for editing by moving the cursor to the left of the label and pressing the **Enter** key, which causes the up-down edit cursor to appear in front of the value. Pressing the up▲ key causes the value to increase or present the next list item, while pressing the down▼ key causes the value to decrease or present the previous list item. Once the setting has been adjusted to the desired value, pressing the **Enter** key stores the new value and exits edit mode. Pressing the **Esc** key restores the original value and exits edit mode.

While editing, the edit cursor changes its shape to provide feedback on which key is active.

Edit Active Increasing Decreasing Saving Value

1	➡Range = 50.0	Move the selection cursor in front of the setting's label, and swipe the **Enter** key.
2	Range◆50.0	The up-down edit cursor appears.
3	Range▲ 50.1	Pressing the ▲ key increases the value.
4	Range▼ 49.9	Pressing the ▼ key decreases the value.
5	Range⧗ 100.0	Pressing the **Enter** key saves the new value and exits edit mode.
6	➡Range = 50.0	Pressing the **ESC** key restores the old value and exits edit mode.

Figure 32: Example edit

Startup

Transmitter Review

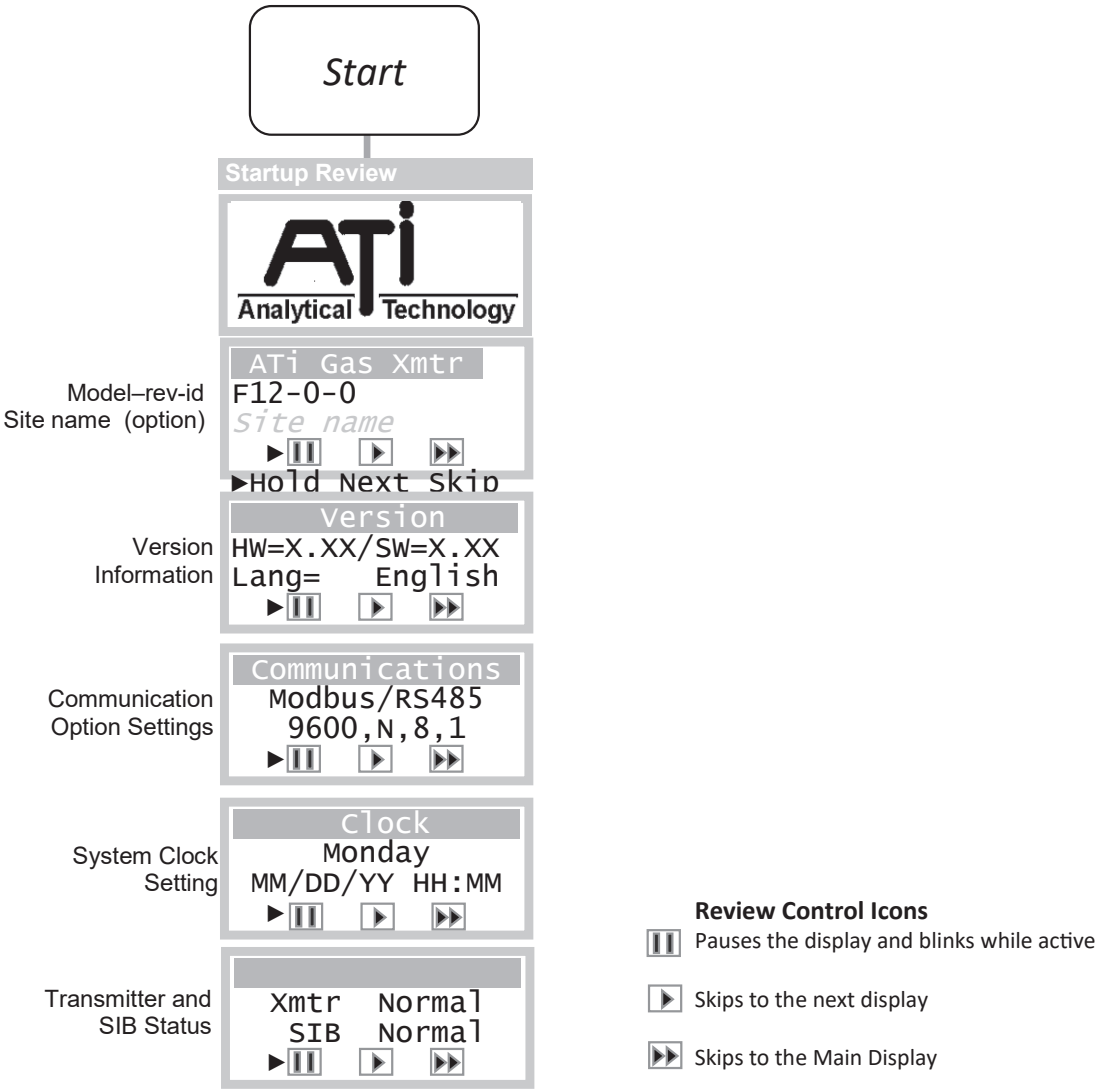
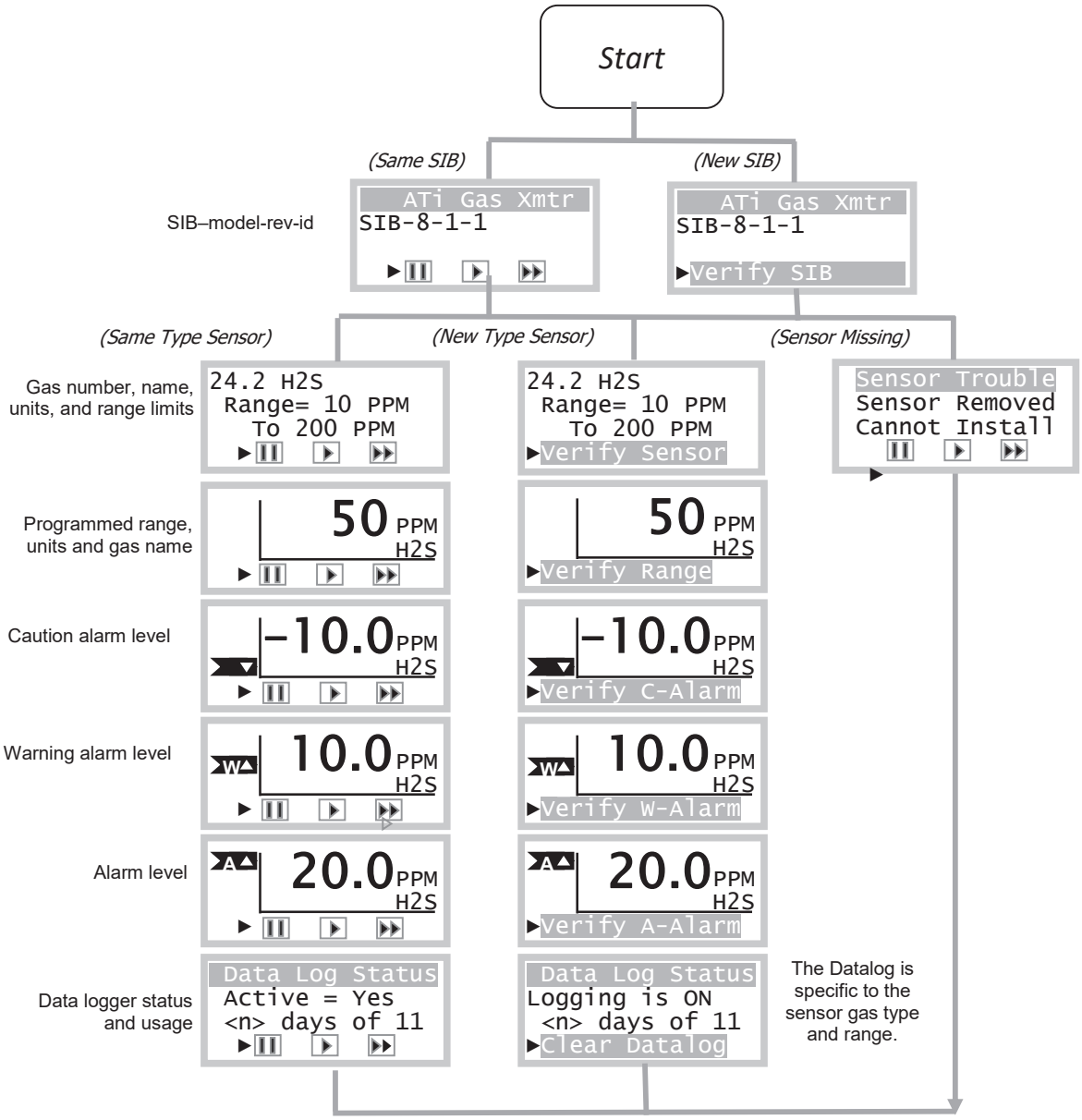


Figure 33: Transmitter review displays

Sensor Review



Review Control Icons

- Pauses the display
- Skips to the next display
- Skips to the Main Display

Operator Verify

Review pauses indefinitely at: Verify SIB, Verify Sensor, Verify Range, Verify C-Alarm, Verify W-Alarm, Verify A-Alarm, and Clear Datalog, The Trouble alarm is activated after 5 minutes of no keypad activity.

Figure 34: Sensor review display

Generator Review

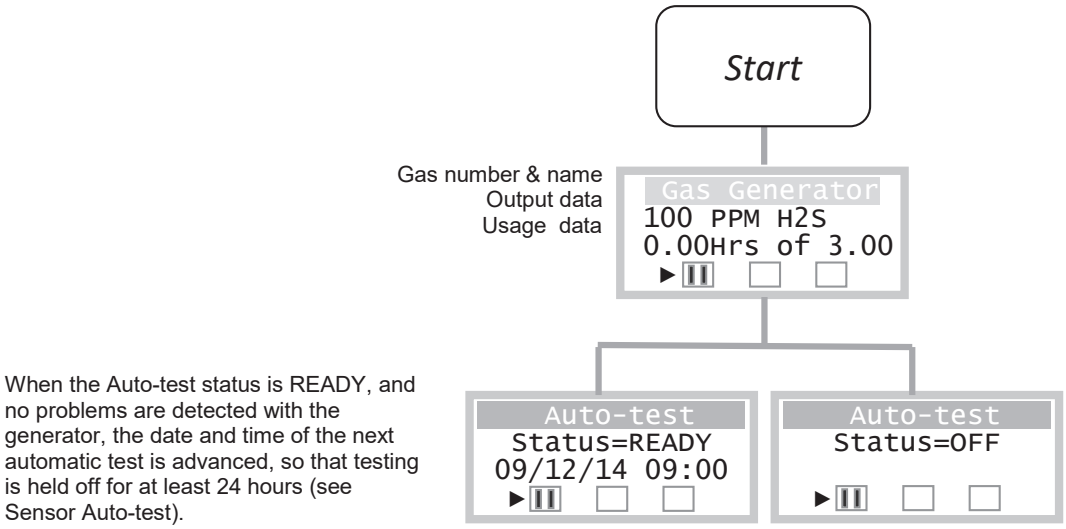


Figure 35: Generator normal review

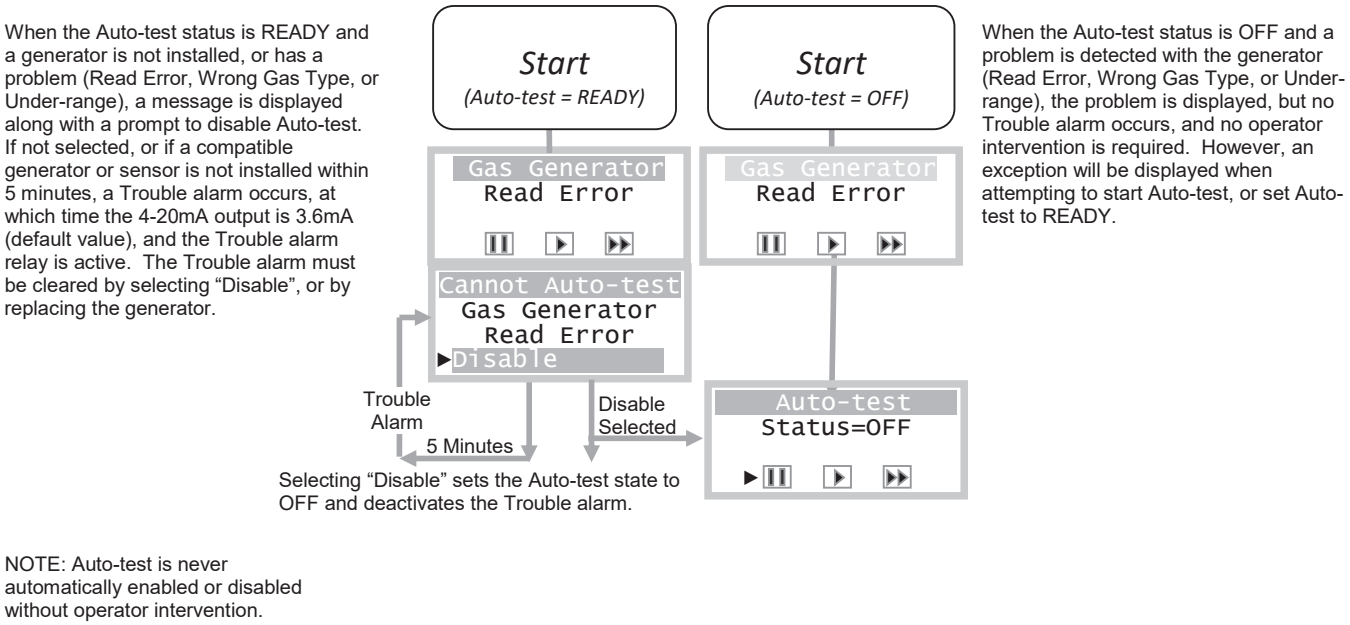


Figure 36: Generator trouble review

Main Display

The Main display page shows the name and concentration of the target gas and units of measurement (for example, PPM, PPB, %). Indicators on the left and below show alarm and operating status.

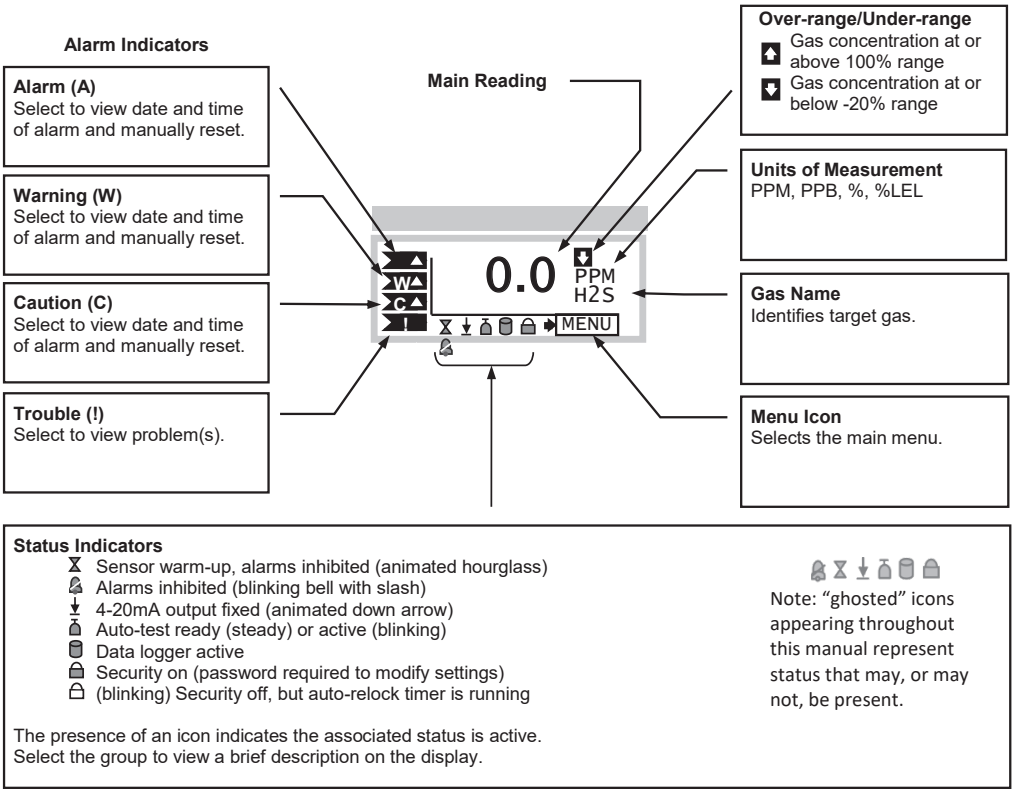


Figure 37: Main display

Main Reading

The main reading represents the gas concentration value and appears on the Main display, along with the gas name and units of concentration, and is reported on the 4…20 mA output. [1,2] By default, it is blanked to suppress the display of negative values. That is, the reading is reported as zero if the concentration drifts below zero, which can occur over time as a result of sensor aging. If the concentration falls to –20% of the full-scale range, a trouble alarm is generated. Blanking is typically extended slightly above zero, as a means of stabilizing the reading in the presence of excessive external noise or other environmental factors. See *"Sensor Settings Menu" on page 39*. During zero and span calibration, the un-blanked gas concentration value is displayed, primarily to assess the amount of positive or negative drift.

[1] The 4…20 mA may not match the reading when the status indicator ↓ is visible on the Main display or when the output is in a physical limit.
[2] Throughout this manual, ghosted status icons may be used to indicate status that may be present or not present.

Trouble Indication

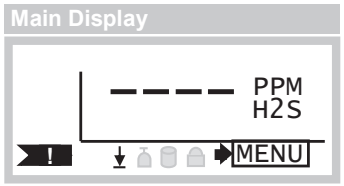


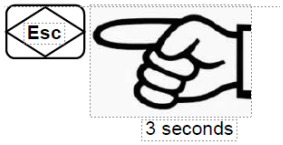
Figure 38: Main display trouble indication

The Trouble alarm is indicated by four dashes appearing on the Main display, along with the (!) flag in the lower left corner and the 4…20 mA status icon indicating that the 4…20 mA output is fixed (default = 3.6 mA).

Timed Return to Main Display

Menus and other pages used for configuring the transmitter and sensor return to the Main display after five minutes of no key activity. Exceptions to this behavior include the zero and span calibration pages.

Inhibiting Alarms from the Main Display



Pressing the **Esc** key for three seconds, then releasing, toggles the alarm inhibit mode. If alarm inhibit was off, it is turned on for 15 minutes (default value). If alarm inhibit was on, it is turned off and in addition, the sensor warm up period is expired immediately. See Status Indicators in *"Figure 37: Main display" on page 35*.

Pop-up Displays

Sensor Removed Display

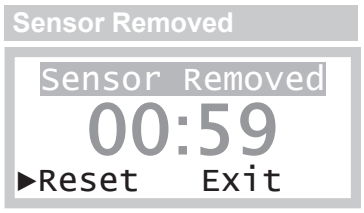


Figure 39: Sensor Removed display

Removing the gas sensor causes the transmitter to "pop-up" the Sensor Removed display, which displays a count-down timer. During this time, alarms are inhibited and the current loop output is fixed at 4.0 mA (17.4 mA for oxygen sensors). A trouble alarm occurs if a sensor is not installed before the timer expires. This 60 second period is usually long enough to reinstall the sensor or install a replacement, but if more time is needed, the count may be extended to 5 minutes by selecting **Reset**. Selecting **Exit** forces expiration of the timer and exits to the Main display, which indicates the Trouble alarm is active. See *Figure 38*.

Sensor Installed

When a sensor is installed, the transmitter compares the type to the previously installed sensor. If they match, the previous sensor's settings are copied to the new sensor, if necessary. [3] The transmitter then starts the sensor review as shown in *"Sensor Review" on page 33* . If the types did not match, the review halts and waits for the operator to verify the new sensor's full-scale range and alarm settings. After verifying the sensor, the transmitter copies the sensor settings to its local memory.

[3] The transmitter sets the new sensor's range, blanking, damping, and alarms to match the previously installed sensor, which might cause confusion when transferring sensors from field transmitters to shop transmitters for calibration. During review, the shop transmitter displays the settings of the previously installed sensor, which might not match the field transmitter. Fortunately, this is not a real problem. The sensor may be calibrated as normal and when it is eventually returned to the field, the field transmitter restores its original settings. **Always verify settings of field transmitters.**

Sensor Install Effects on the Data Log

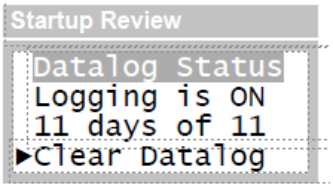


Figure 40: Clear Datalog

When the sensor is replaced with one of a different gas type, such as a different part number, you are also prompted to clear the data log during review.

Once the sensor is installed, the transmitter executes a 5-minute (typical value) warm-up period during which alarms are inhibited, the 4…20 mA output is held at 4 mA (17.4 mA for oxygen sensors) and zero, span and auto-test are not permitted.

NOTE: Changing the sensor gas type clears the data log. Electrochemical sensors may take up to 12 hours to stabilize if not stored in the sensor keeper.

Generator Removed

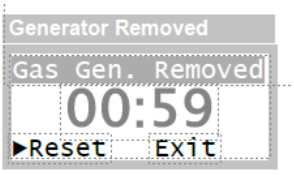


Figure 41: Generator Removed

Removing the gas generator causes the transmitter to "pop-up" the Generator Removed display, but only if the auto-test control is set to "READY." Otherwise, the transmitter displays the generator review shown in *Figure 35 on page 34* without causing a trouble alarm and pausing for the operator to disable auto-test. The 4…20 mA operates normally and no operator intervention is required at the panel.

At the conclusion of the Generator Removed display (**Exit** selected or timeout), the transmitter displays the generator review shown in *Figure 38*, which pauses 5 minutes for the operator to select **Disable**. Selecting **Disable** forces the auto-test control to "OFF" permanently and prevents a trouble alarm. The auto-test control must be changed back to "READY" when a new generator is eventually installed. If "Disable" is not selected in time, the transmitter activates the trouble alarm and continues to wait for "Disable" to be selected or for a compatible generator or sensor to be installed. See *"Sensor Auto-test" on page 45* for more details.

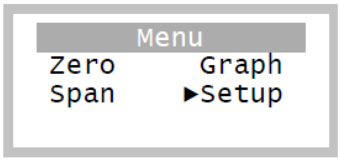
Generator Installed

When a generator is installed and no problems are detected, the transmitter starts the generator review as depicted in *Figure 35 on page 34*. If problems are detected, the transmitter starts the generator review as depicted in *Figure 36 on page 34* . The following table lists the types of problems that can occur with an installed gas generator.

Problem	Description
Wrong Gas Type	The generator is not compatible with the installed sensor.
Under Range	The generator cannot produce a gas concentration high enough for the currently programmed sensor range.
Read Error	The generator has an internal memory error.

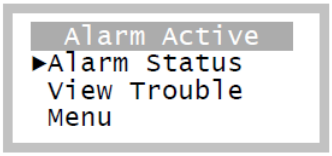
Main Menu

The Main menu provides direct access to the sensor calibration methods, data logger graph and transmitter settings.

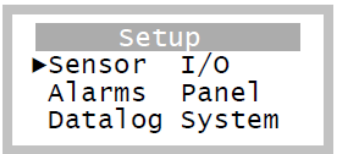
Display	Item	Select to …
 *Figure 42: Main menu*	Zero	Calibrate the gas sensor zero reading. See *"Sensor Zero Calibration" on page 42*.
	Span	Calibrate the gas sensor sensitivity. See *"Sensor Span Calibration" on page 43*.
	Graph	View the contents of the logged data as a graph. See *"Data Log Graph View" on page 61*.
	Setup	View and configure transmitter settings (below).

Alarm Active Menu

When a gas or trouble alarm is active, the following menu appears in place of the main menu.

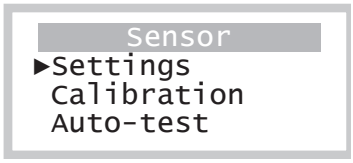
Display	Item	Select to …
 *Figure 43: Alarm Active menu*	Alarm Status	View the Alarm Status menu and clear manual reset alarms. This item appears only if a gas alarm is active. See *"Alarm Status Menu" on page 51*.
	View Trouble	View the Trouble Status display. This item appears only if the trouble alarm is active. *"Trouble Status Display" on page 53*.
	Menu	View the Main menu (above).

Setup Menu

Display	Item	Select to …
 *Figure 44: Setup menu*	Sensor	Configure sensor settings, auto-test and calibration methods. See *"Sensor Menus, Methods and Settings" on page 39*.
	Alarms	Configure the three gas alarms. See *"Alarm Menus, Methods and Settings" on page 49*.
	Datalog	View the data log graph. *"Data-log Menus, Methods, and Settings" on page 59*.
	I/O	Configure the 4…20 mA output, serial communications, and relay operation (see *Figure 87 on page 64*).
	Panel	Configure the display contrast and backlighting and panel security (see *"Relay Coil Norm Setting Table" on page 70*).
	System	Set the real-time-clock, site name and view version information. See *"System Menu" on page 76*.

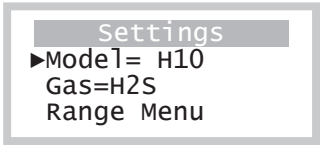
Sensor Menus, Methods and Settings

Sensor Menu

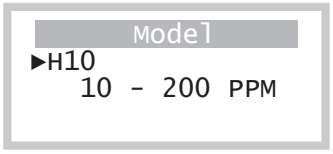
Display	Item	Select to …
 *Figure 45: Sensor menu*	Settings	Configure the sensor range, damping and blanking (see Sensor Settings, below).
	Calibration	Maintain the accuracy of the gas sensor (see *"Sensor Calibration" on page 41*).
	Auto-test	Configure automatic gas sensor tests or perform manual tests (see *"Sensor Auto-test" on page 45*).

Sensor Settings Menu

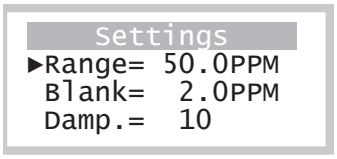
The transmitter accommodates a variety of sensors that automatically configure the transmitter with the gas name, range, units and other settings, and contain calibration data to convert the sensor analog output to a gas concentration reading. Some of these settings can be changed by the transmitter and it is important to make sure they are configured properly for the site.

Display	Item	Description …
 *Figure 46: Sensor Settings menu*	Model	Displays the model name. Select to view sensor specific settings or information about the installed sensor (below).
	Gas	Displays the name of the target gas (read only).
	Range Menu	Select to view and adjust the sensor's upper range, blanking, and damping settings (below).

Sensor Model Menu

Display	Item	Description …
 *Figure 47: Sensor Model menu*	Line 1	Sensor model name (read only)
	Line 2	Sensor upper range limits (read only)

Sensor Range Menu

Display	Item	Select to …
 *Figure 48: Sensor Range menu*	Range	Set the gas concentration value corresponding to the 20 mA output value. Changing this value also changes the Blank (blanking) value, which is maintained as a fraction of the range. Setting limits vary among sensors. Changing this setting invalidates data stored in the data logger (see below) and may result in an auto-test exception message (also below).
	Blank (Blanking)	Force the main reading to zero whenever the gas concentration is below this setting. The limits vary from sensor to sensor but are typically 0…5% of Range. **NOTE:** The transmitter always reports negative readings as 0 (except on calibration displays) without regard to this setting. The setting is recomputed when the *Range* setting changes, so that the same fraction of range is maintained. Doubling, or halving the *Range* setting, doubles or halves the *Blanking* setting, respectively.
	Damp. (Damping)	Helps to stabilize the gas sensor readings. It is a unit-less value from 1…100 that controls a s/w lag filter. The setting has an approximate effect on the T90[4] response time, as shown. **Damping** / **T90 Time**: 1 / 6 s; 10 / 10 s; 100 / 50 s

Effect of the Range Setting on the Data Logger

The data logger records readings as a fraction of the sensor range. If data logging is turned on (as indicated on the Main display), changing the *Range* setting causes a warning message to appear prior to saving the value. Select **Save** to save the new *Range* setting, or **Abort** to leave it unchanged.

NOTE: Changing this parameter clears the data log.

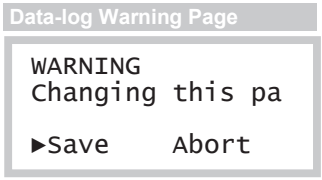


Figure 49: Data log warning message

Effect of Range on Auto-test

Gas generators used for auto-test may not be compatible on all sensor ranges. If the auto-test Status is READY, scrolling to a higher *Range* may result in the following exception message, "Gas generator incompatible on sensor's range." To overcome this exception, change the auto-test Status to OFF, then set the desired range.

[4] T90 is the approximate time required for the transmitter to reach 90% of its final value after a step change. The values given in the table do not include gas flow time or the actual response time of the sensor.

Sensor Calibration

Calibration Frequency

While the transmitter itself requires no periodic calibration, H10 sensors should be zero and span calibrated every 3…6 months, based upon environmental factors. Sensors frequently exposed to dirt, oil mist, vapors or very dry air may require more frequent calibration.

Zero Calibration

As the name implies, zero calibration corrects the transmitter offset reading in the absence of any reactive gas. During zero calibration, the offset error is stored in the sensor, and subsequently subtracted from future readings. We recommend bottled zero gas as a source, which should be selected based on the type of sensor. For example, bottled Zero Air may be used to zero chlorine sensors, but oxygen sensors require bottled nitrogen gas.

Span Calibration

Span calibration corrects the transmitter sensitivity to a known concentration of target gas (the gas for which the sensor was designed to monitor). Sensors for most gases, such as ammonia, require a bottled "span gas" source. This applies even to Oxygen sensors, where the span gas source is bottled zero air.

Calibration Terminology

The zero calibration is referred to as "zero," "zeroing" and "zeroed." Likewise for the span calibration, which appears as "span," "spanning" and "spanned." As with most instruments, perform zero calibration before span calibration.

Calibration Kits

Calibration kits containing zero and span bottle gas sources are available from Badger Meter for many toxic gases. Contact Badger Meter or your local Badger Meter representative if you have questions about calibration gas kits or gas sources.

Indications During Calibration

The un-blanked gas concentration value is displayed during zero and span calibration, primarily to observe any slight amount of positive or negative drift. Alarms are cleared and inhibited, and the 4…20 mA output is locked at 4.0 mA (transmitters equipped with oxygen sensors are locked at 17.4 mA, representing normal, 20.9% atmospheric oxygen). The 4…20 mA output will not change when gas is applied and removed, and for 15 minutes thereafter (the default value). While viewing the calibration pages, the LCD display will indicate the changing gas concentration.

Calibration Exceptions

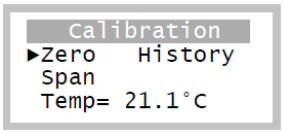
Zero and span calibration are not allowed during the following conditions:

- Sensor removed, or in 5-minute[5] warm-up period
- Trouble alarm active
- Auto-test active (status indicator appears on Main display page)

To help prevent errors, zero and span are not allowed if the sensor output or span value entered is too high or too low. If detected, memory errors are reported while updating the sensor or transmitter memory.

[5] Typical value, may vary by sensor gas type.

Sensor Calibration Menu

Display	Item	Select to …
 *Figure 50: Sensor Calibration menu*	Zero	Calibrate the gas sensor zero reading (below). **NOTE:** This item also appears in the Main menu. See *"Main menu" on page 38*.
	Span	Calibrate the gas sensor sensitivity (below). **NOTE:** This item also appears in the Main menu. See *"Main menu" on page 38*.
	Temp	Adjust the gas sensor's temperature reading offset. Note: this reading may be slightly higher than ambient temperature due to self-heating. Contact the factory before adjusting.
	History	View the transmitter calibration records.

Sensor Zero Calibration

Performing a zero calibration requires a bottled Zero-gas with a 500 cc/min regulator, calibration adapter and a convenient length of 1/4 inch tubing. The gas used depends on the type of sensor installed. For example, an H_2S sensor may be zeroed with Zero-air, however, **oxygen sensors must be zeroed with nitrogen.** In some cases, a sensor may be zeroed directly to the atmosphere, but only when it is known to be free of reactive gasses. Check with the factory if you are uncertain about which gas to use. Referring to *Figure 51*, push the calibration adapter onto the exposed end of the sensor and connect one end of the tubing (1), connect the other end of tubing to the cylinder's regulator (2). Do not open the gas valve until instructed below.

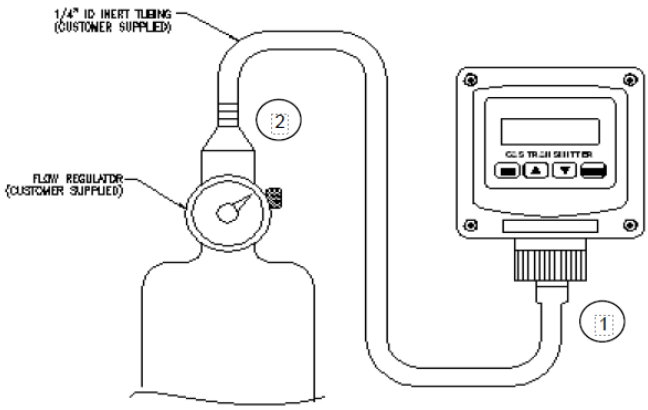


Figure 51: Sensor zero cal setup

Select the Zero method from the Sensor Calibration menu,[6] as shown in *Figure 52*. This will clear and inhibit alarms at the transmitter and hold the current loop output at 4 mA (17.4 mA for oxygen sensors) for up to 30 minutes of no key activity.

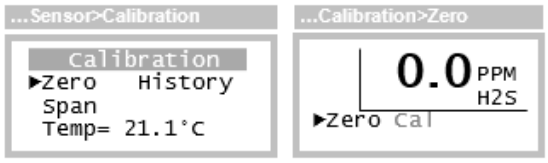


Figure 52: Sensor Zero Calibration menus

Open the regulator to flow gas to the sensor. After approximately four minutes, select **Zero**. "Cal" appears briefly at the bottom of the page and the reading is forced to 0, 0.0, or 0.00. Since the reading is not blanked, it may show a negative sign, like -0.0, which is normal. Press the **Esc** key twice to return to the Main page. Alarms remain inhibited, and the current loop will be fixed for 30 minutes after calibration.

[6] The zero method is also directly accessible from the main menu.

Sensor Span Calibration

Span calibration* requires a bottled "span-gas" with a 500 cc/min regulator, calibration adapter, and a convenient length of ¼" tubing. The gas type and concentration used depends on the type of sensor installed. Check with the factory if you are uncertain about which gas to use.

Referring to *Figure 53*, slip the calibration adapter onto the exposed end of the sensor and connect one end of the tubing (1), connect the other end of tubing to the cylinder's regulator (2). Do not open the gas valve until instructed below.

* Perform the Zero calibration prior to the Span calibration.

Select the **Span** method from the Sensor Calibration menu, as shown in *Figure 54*.[7] This will clear and inhibit alarms at the transmitter and hold the current loop output at 4 mA (17.4 mA for oxygen sensors) for up to 30 minutes of no key activity.

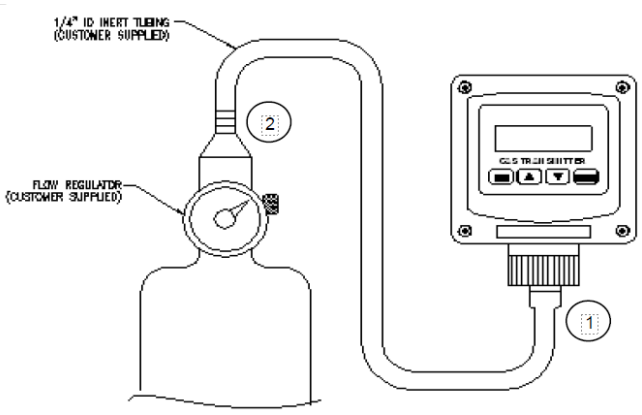


Figure 53: Sensor span cal setup

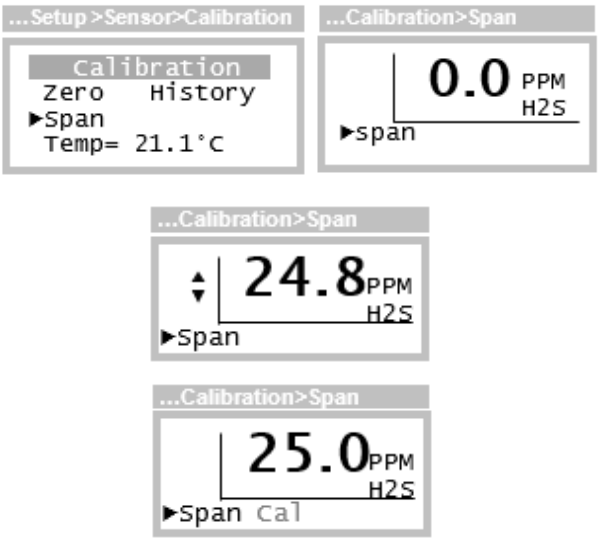


Figure 54: Sensor Span Cal. menus

Open the regulator and allow gas to flow to the sensor. The displayed reading should begin to increase and stabilize after 5…10 minutes, depending on the gas type and range of the sensor.

Select **Span**. the concentration reading will become fixed, and the blinking Up/Dn edit cursor appears just to the left of the reading. Press the up▲ or down▼ key to correct the reading to match the known concentration of gas.

Press the **Enter** key to perform the calibration. "Cal" appears briefly at the bottom of the page.

Press the **Esc** key twice to return to the Main page. Disconnect the calibration adapter from the sensor and permit the readings to return to zero. Alarms remain inhibited and the current loop is fixed for 30 minutes after calibration. Once the reading is below any of the alarm set levels, you may terminate the alarm inhibit (and fixed loop output) using the **Esc** key on the Main display. See *"Inhibiting Alarms from the Main Display" on page 36*.

[7] The Span method is also directly accessible from the main menu.

Sensor Calibration History

A calibration record is written into the sensor memory each time a zero or span calibration is performed. Enough memory is reserved for 63 zero calibrations and 63 span calibrations. Zero and span calibration records are accessed on the Sensor Calibration History page.

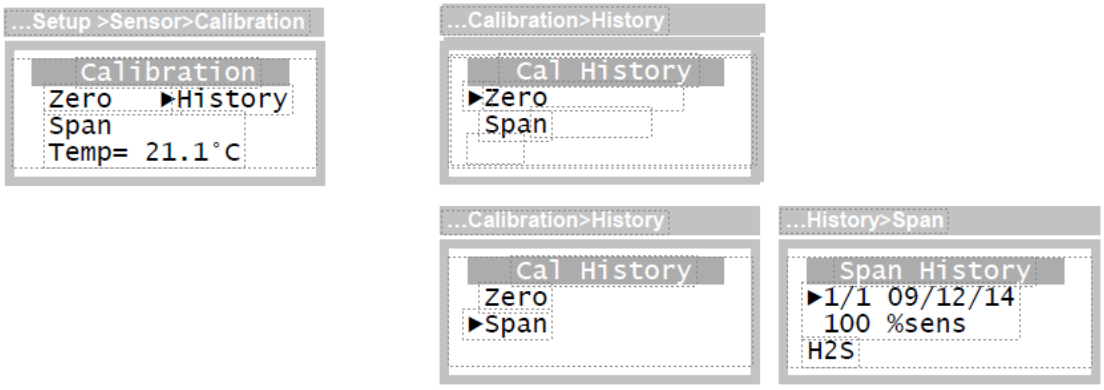


Figure 55: Sensor calibration history menus

Zero calibration records are composed of an index field (record no/total records), date, concentration reading and gas name. The reading is recorded just before applying the correction and can be thought of as "drift" from the previous zero calibration. Upon entry, the index number is set to the most recent calibration and may be scrolled down to view earlier calibration records.

Span calibration records are composed of an index field, date and the relative sensitivity of the sensor. Like the zero records, the index number is set to index the most recent calibration and may be scrolled down to view earlier calibration records. Span calibrations record the deviation from the reference sensitivity and display it in units of percent. Sensitivity is a measure of the sensor output for a given exposure to gas. More specifically, it is defined as the ratio of the signal output to the gas concentration and is often measured in µA/PPM. During manufacture, the sensitivity of the sensor is recorded and used as a reference. A value of 100% signifies that the sensitivity has not changed from the reference (for example, the sensor calibration is the same at it was when the sensor was calibrated at the factory). Lower values indicate a decreased sensitivity and, although not typical, higher values indicate increased sensitivity.

When sensitivity drops to 10% it is time to replace the sensor.

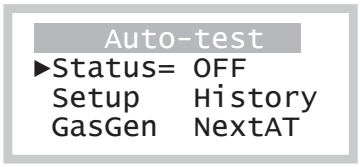
Sensor Auto-test

Auto-test verifies the serviceability of the sensor on a prescribed schedule by exposing it to a small amount of gas and verifying a minimum response. Three attempts per test are made, and if the sensor does not respond on the third attempt, a temporary trouble alarm is triggered (may be optionally disabled). A summary of pass, fail and retry counts are maintained in the sensor memory and may be viewed on the Auto-test History page.

The test is performed at a specific time of day and may be scheduled to repeat every 1…14 days. The date and time of the next test is available for editing, and the test may be triggered manually at any time without affecting the preset schedule.

The Auto-test option requires an optional gas generator that is compatible with the installed sensor's gas type and full-scale range. For more information, see *"H10 Sensor Modules" on page 81* and *"E18 Gas Generators" on page 82*.

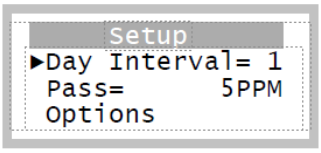
Auto-test Menu

Display	Item	Select to …
 *Figure 56: Auto-test menu*	Status	Change the Auto-test state: OFF – Auto-test will not start automatically. READY – Updates NextAT and arms Auto-test to start automatically on a scheduled basis. The transmitter will not permit this selection if a compatible gas generator is not installed. START – Runs Auto-test once and returns to the original state. Does not affect the date of the next Auto-test (see NextAT below). The transmitter may not always permit this selection (see below). STOP – Ends an Auto-test in progress, updates NextAT and returns to READY or OFF. When Status = START, a test will occur upon return to the Main display, either manually by pressing **Esc** or after a Timer Return on Display. See *page 36*. If Auto-test is already in progress, selecting **Status** presents the Auto-test Status display. See *"Auto-test Status Display sequence" on page 48*.
	Setup	Configure the interval, pass value and options.
	GasGen	View the gas generator information.
	History	View the pass, fail and retry counts of previous Auto-test attempts.
	NextAT	View and change the date and time of the next Auto-test.

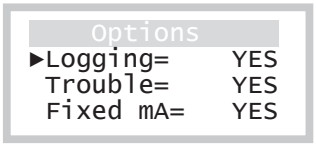
Conditions Preventing Selection of Ready or Start

You may not set Status to READY or START if a generator is not installed, has a fault or is not compatible with the sensor gas type or range. Furthermore, Auto-test will not START when an alarm or transmitter fault is detected or any other conditions described in *"Auto-test Exceptions" on page 47* are present. When attempted, the transmitter displays an exception message.

Auto-test Setup Menu

Display	Item	Select to …
 *Figure 57: Auto-test Setup menu*	Day Interval	Configure the number of days between automatic tests. The default is 1, and the limit is 1…14 (the exact time of day for testing may be set on the NextAT menu, see below).
	Pass	Configure the amount by which the gas concentration must increase, in order to pass. Prior to starting the test, this mount is added to the "un-blanked" gas concentration reading to compute the pass value. This value is limited between 5% (default value), and 10% of the sensor range (see *Range* in *"Sensor Settings Menu" on page 39*).
	Options	View the Auto-test Setup Options menu (below).

Auto-test Setup Options Menu

Display	Item	Select to …
 *Figure 58: Auto-test Setup Options menu*	Logging	Control values logged during Auto-test. When set to YES (default), the gas concentration (main reading) is logged as usual, including any increase caused by the gas generator. When set to NO, a code is logged that displays as TEST on graphic and tabular report pages, and printouts.
	Trouble	Determine if Auto-test failures cause trouble alarms. When set to YES (default), a failure to pass Auto-test after the third attempt causes a trouble alarm and force the 4…20 mA output to the Trouble mA value. When set to NO, Auto-test failures do not cause Trouble alarms (not recommended).
	Fixed mA	Control the 4…20 mA output during Auto-test. When set to YES (default), the 4…20 mA output is fixed at the Auto-test mA value to prevent receiver alarms (see *Figure 89 on page 65*). When set to NO, the output will increase as the gas concentration rises and may cause receiver alarms (not recommended).

Auto-test NextAT Menu

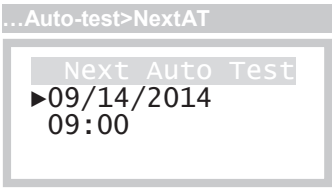


Figure 59: Auto-test Next AT Menu

The date and time of the Next Auto-Test appears on the NextAT menu. After each test, the date is incremented by the Day Interval setting on the Auto-test Setup menu (above). The time establishes the time of day that tests are performed. Setting Auto-test to occur in the past when the Status is READY will change the Status to START.

NextAT Date After Startup

During startup, the transmitter examines the date of the Next Auto-Test and advances it by the Day Interval to provide a minimum of 24 hours before the next test is performed. Therefore, it is important to keep the transmitter powered to maintain the desired test Auto-test schedule.

Auto-test History Menu

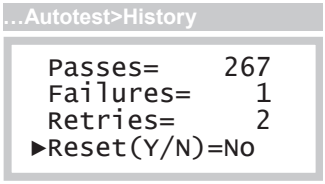
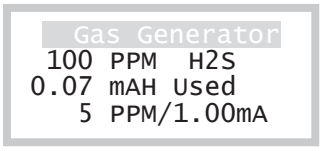


Figure 60: Auto-test History menu

The Auto-test History menu provides a summary of passes, failures and retries, which are maintained in the sensor memory. Three attempts are made before a failure is recorded. The total number of tests is the sum of the passes and failures, and the number of gas generations is the sum of all three counts. Setting Reset to YES clears all counts to zero, which is not normally recommended.

Gas Generator Display

Display	Item	Select to …
 *Figure 61: Gas Generator display*	(line 2)	Name of gas generated and maximum (compatible) sensor range.
	(line 3)	Generator use in units of mAH (milliamp-hours).
	(line 4)	Change in concentration required to pass Auto-test (same as *Pass* value in *"Auto-test Setup Menu" on page 46*, and current applied to generator (or if problem detected: Wrong Gas Type, Under-range).

Auto-test Exceptions

Auto-test does not start if any of the following conditions are present. Furthermore, Auto-test is immediately aborted when any of the critical exceptions are detected.

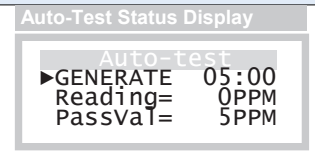
Non-critical Exceptions

- The sensor is warming up (animated hour glass visible on Main display).
- The gas concentration is greater than 10% of the sensor range.
- Auto-test has already been started (manually).

Critical Exceptions

- Gas generator is missing or is not compatible with the sensor type or range.
- Gas alarm is active or being tested.
- The Trouble alarm is active or a fault is detected.

Auto-test Status Display

Display	Item	Select to …
 *Figure 62: Auto-test Status display*	(line 1)	Change the Auto-test state to STOP, READY, OFF. See *Status* in *"Auto-test Menu" on page 45*.

When Auto-test starts, the Auto-test Status Display Sequence appears. This happens automatically from the Main display or by setting Status = START on the *"Auto-test Menu"* (see *page 45*). *Figure 63* illustrates the appearance of the Auto-test Status Display Sequence as Auto-test sequences. During Auto-test, alarms are inhibited, and the 4…20 mA output is fixed (usually at 4mA, however, see Auto-test Setup Options Menu and *Figure 89*). This condition continues for up to 10 minutes after the gas generation ends during the recovery period. If a significant gas leak occurs during this time (50% or more of the sensor range), Auto-test is aborted, alarm inhibit is cleared and the 4…20 mA operation reverts to normal.

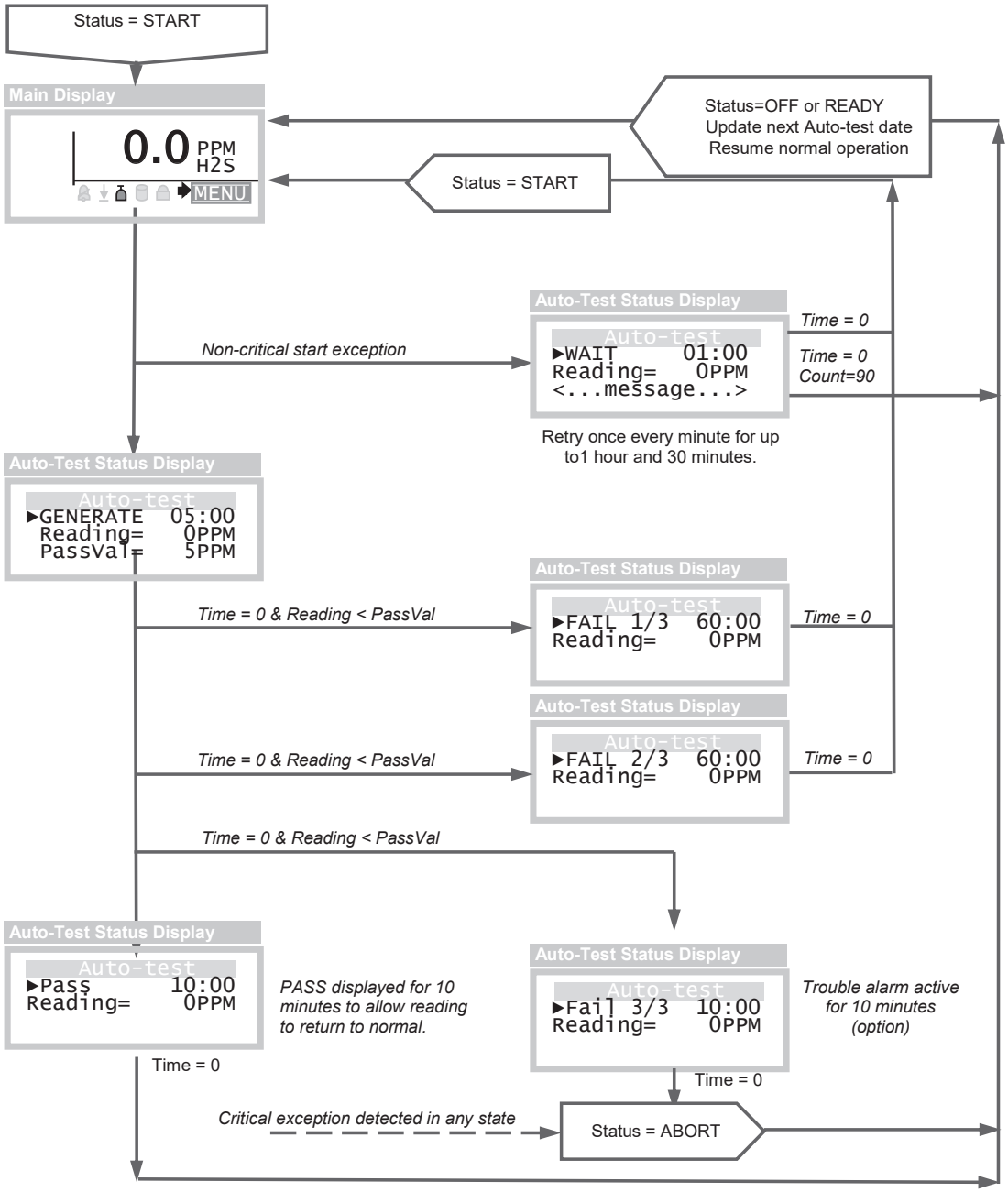


Figure 63: Auto-test Status Display sequence

Alarm Menus, Methods and Settings

The transmitter features three gas level alarms - Alarm, Warning, and Caution, and a Trouble alarm. Gas level alarms are automatically configured when a gas sensor is installed and are retained between same type sensors. Alarm status appears on the Main display, is available over the optional serial interface and is used to activate the three optional relays. See *"Relay Operation, Menus and Settings" on page 70*.

Alarms Menu

The Alarms menu is the main entry point for configuring gas level alarms, and for inhibiting and testing configured alarms.

Display	Item	Select to …
Alarms ▶Alarm Inhibit Warning Test Caution	Alarm	Configure the Alarm settings to indicate a dangerous condition (see *"Alarm Setting Menus" on page 52*).
	Warning	Configure the Warning settings to indicate an unsafe condition (see *"Alarm Setting Menus" on page 52*).
	Caution	Configure the Caution settings (normally used to indicate excessive sensor drift (see *"Alarm Setting Menus" on page 52*).
	Inhibit	Configure or activate the manual alarm inhibit period (see *"Alarm Inhibit" on page 57*).
	Test	Test operation of the alarm indicators and relays (see *"Alarm Test Menu" on page 58*).

Figure 64: Alarms menu

Gas Level Alarms

For toxic gas sensors, Alarm is a high-high alarm and the default setting for Alarm is normally 2 or 3 times higher than the TLV (threshold limit value) of the target gas. The Warning alarm is a high alarm and normally set to the TLV. Caution is a low alarm and set to activate on negative drift of –10% of the sensor range (a Trouble alarm occurs if the reading drifts to –20% of the sensor range). *Figure 65* depicts the relationships of these alarms.

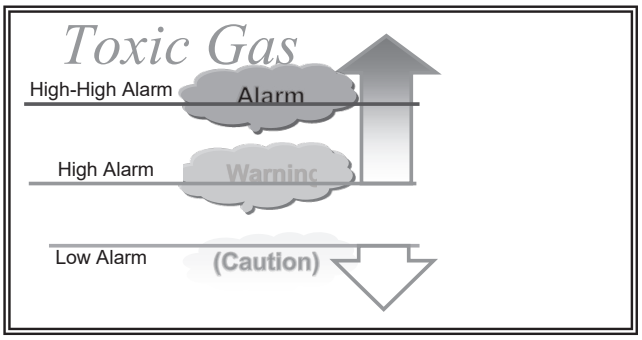


Figure 65: Toxic gas alarms

For oxygen sensors, Alarm is a low-low alarm set to 16%, Warning is a low alarm set to 19.5%, and Caution is a high alarm set to 23%. *Figure 66* depicts the relationships of these alarms.

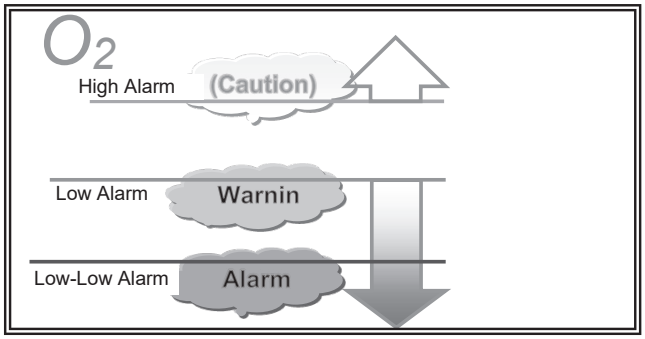


Figure 66: Oxygen deficiency alarms

Gas Alarm Operation

Figure 67 illustrates the operation of a high (rising) gas level alarm.

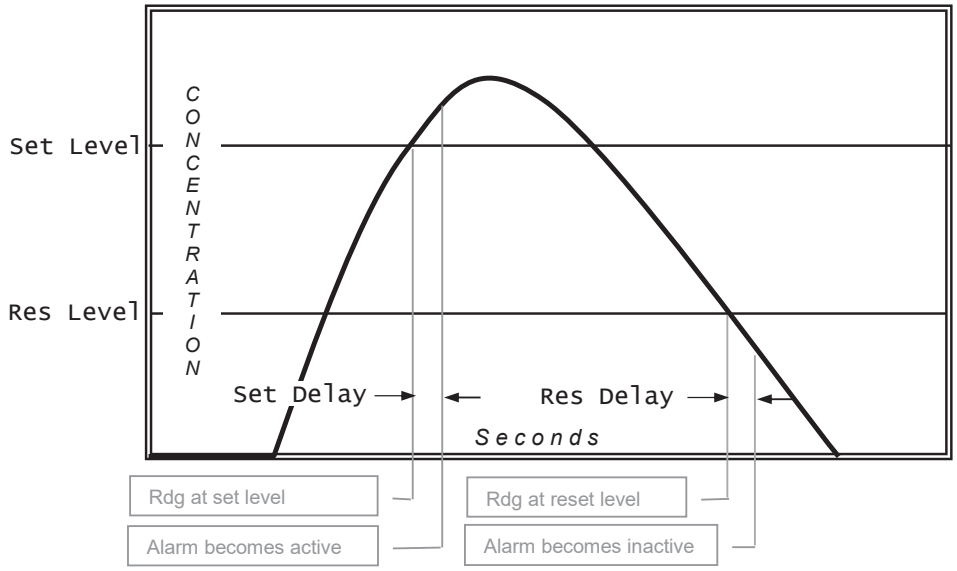


Figure 67: High alarm operation

Figure 68 illustrates the operation of a low (falling) gas level alarm (such as for oxygen deficiency).

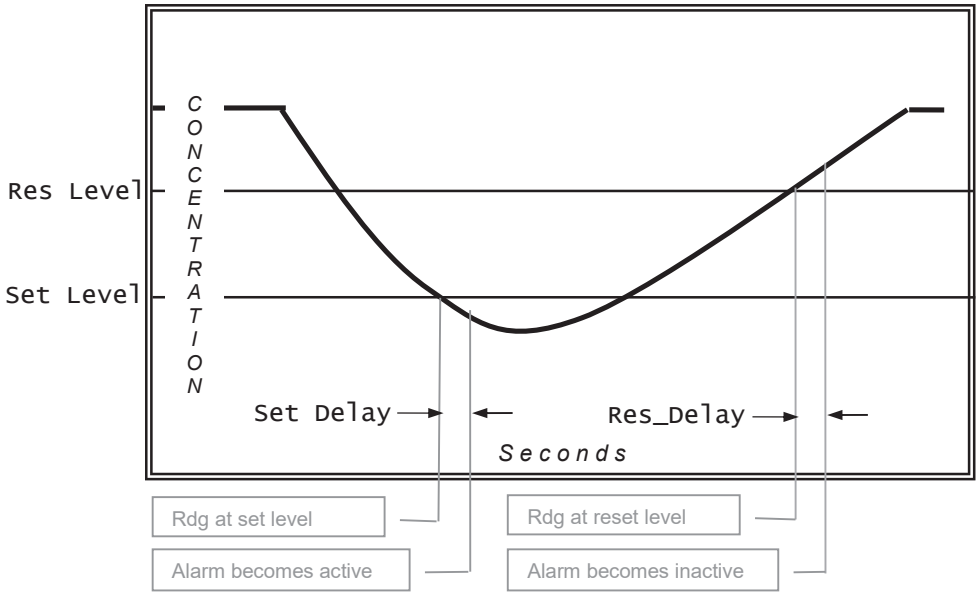
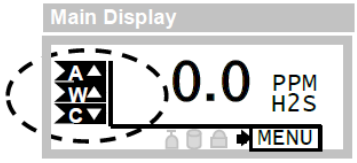


Figure 68: Low alarm operation

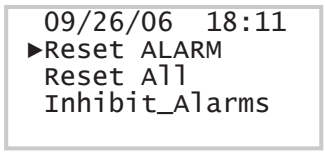
Alarm Indicators

Gas level alarms are indicated by three flags on the left side of the Main display. Each contains a letter indicating the alarm name and an arrow indicating the type of alarm - high (rising) alarm or low (falling) alarm.

Display	Item	Description
 Figure 69: Alarm indicator flags		Alarm – flag with letter 'A' on line 1 (top line)
		Warning – flag with letter 'W' on line 2
		Caution – flag with letter 'C' on line 3

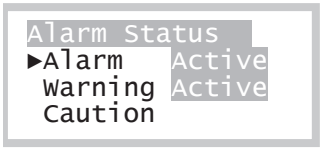
Alarm Status Menu

The Alarm Status menu appears only when a gas alarm is active. It is displayed by selecting **Menu** from the Main display, then selecting **Alarm Status** from the Alarm Active menu (see *page 38*). The menu lists the three gas alarms and the word "Active" if the alarm is currently active. Selecting an active alarm displays the specific Alarm Reset menu, below.

Display	Item	Select to …
 Figure 70: Alarm Status menu	(line 1)	Date and time of alarm event.
	Reset (alarm)	Manually reset the alarm selected on the Alarm Status menu above. Reset is performed only if the alarm conditions have subsided and the alarm is programmed for manual reset (see *"Alarm Setting menus" on page 52*),
	Reset All	Manually reset all manual-reset alarms once alarm conditions have subsided.
	Inhibit Alarms	Temporarily resets and inhibits gas level and Trouble alarms. See *"Alarm Inhibit" on page 57*.

Alarm Reset Menu

The Alarm Reset menu appears by selecting an active alarm from the *"Alarm Status Menu"* or by selecting an alarm indicator flag from the Main display. The menu presents the date and time of when the alarm became active and permits manual reset, along with the other options are listed below.

Display	Item	Select to …
 Figure 71: Alarm Reset menu	Alarm	View the time and date of Alarm and manually reset it, if required.
	Warning	View the time and date of the Warning alarm and manually reset it, if required.
	Caution	View the time and date of the Caution alarm and manually reset it, if required.

Remote Reset

Activating the "Remote Reset" input resets all manual reset alarms but only if the respective alarm conditions have subsided. See *"Figure 23: Remote reset input" on page 24*.

Alarm Setting Menus

The Alarm Setting menus are accessed from the *"Alarms Menu" on page 49* and are used to configure the three gas level alarms.

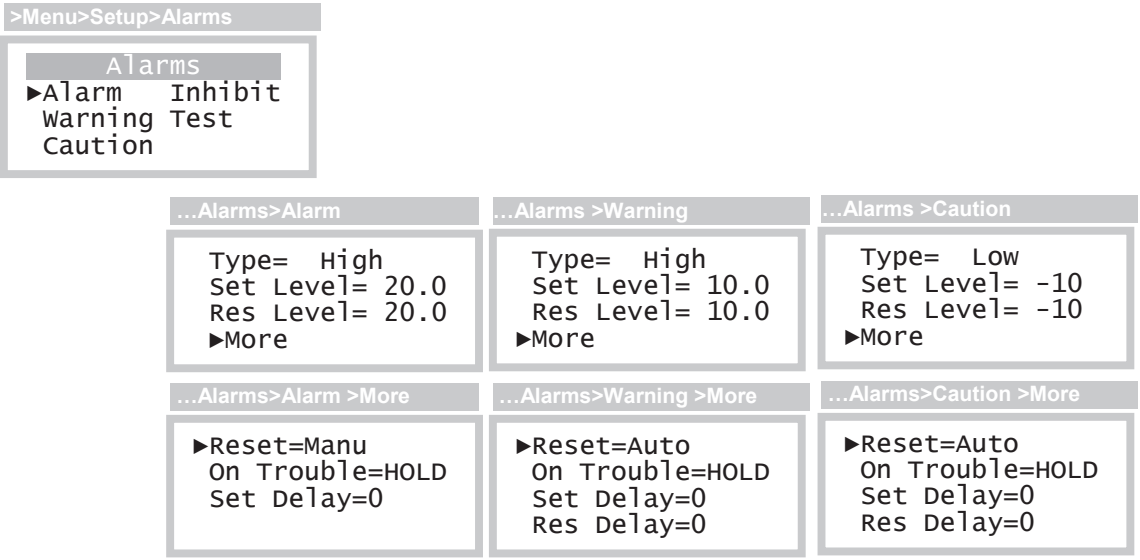


Figure 72: Alarm Setting menus

Item	Select to…
Type	Set the type of alarm as **High**, **Low** or **None**. When set to High, the alarm becomes active at and above the Set Level. When set to **Low**, the alarm becomes active at and below the Set Level. Setting the value to **None** permanently deactivates the alarm. The setting is stored in the sensor memory.
Set Level	Set the gas concentration level at which the alarm becomes active. The alarm then becomes active at the expiration of the **Set Delay** period. Changing **Set Level** changes **Res Level** to the same value. Limits for the **Set Level** are maintained in the gas sensor memory.
Res Level	Set the gas concentration level at which the alarm becomes inactive. The alarm then becomes inactive after expiration of the Res Delay period, and only if the Reset setting is programmed as Auto – see below. The limits for the Res Level depend on the alarm Type setting. Type = High Upper limit = Set Level Lower limit = Lowest Set Level Type = Low Upper limit = Highest Set Level Lower limit = Set Level Changing Set Level changes Res Level to the same value.

Item	Select to…
Reset	Select how the alarm is reset as **Manu** or **Auto**. When set to **Auto**, the alarm will Reset (clear) without operator intervention, as soon as conditions allow (concentration reaches Res Level and the Res Delay period expires). When set to **Manu**, the operator must reset the alarm manually after conditions subside through the operator interface, the serial interface or through the remote reset. See *"Figure 23: Remote reset input" on page 24*. **NOTE:** Res Delay is meaningful only when Reset = Auto. Setting Reset to **Manu** suppresses display of the Res Delay setting.
On Trouble	Specify the alarm state during Trouble alarms. This setting specifies alarm behavior during transmitter faults, and overrides all other alarm settings. If the trouble alarm should become active, you may program the concentration alarm to behave in one of three ways: • Hold - the transmitter attempts to hold the alarm in its current state. If the alarm is active, it remains active. If the alarm is inactive, it is inhibited from becoming active until after Trouble is cleared. • Set - activates the alarm immediately (the Set Delay period is ignored). This feature permits the alarm to signal both concentration and trouble conditions. • Reset – deactivates the alarm immediately (the Res Delay period is ignored).
Set Delay	Configure the amount of time (in seconds) that the gas concentration must be at or above a high alarm set level, or at or below a low alarm set level, before the alarm becomes active. This is used to avoid triggering alarms on relatively short gas exposures. The setting may be programmed between 0 (default) and 10 seconds.
Res Delay	Configure the amount of time (in seconds) that the gas concentration must be below a high alarm reset level, or above a low alarm reset level, before the alarm becomes inactive. The setting is typically used to keep relays energized to maintain exhaust fans after a gas leak. The setting is displayed only when Reset is set to **Auto**, and may be programmed between 0 (default) and 2 hours (7200 seconds).

Trouble Alarm

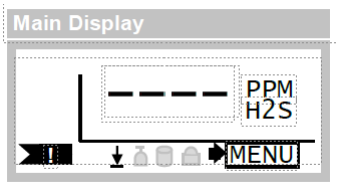


Figure 73: Trouble indication Main display

Trouble alarms are presented on the Main display as shown below. When active, new alarms are inhibited, and (by default) active alarms are held so that relays controlling lights, sirens and fans may continue to operate. This behavior may be modified on the Alarms Menu. See *"Alarms Menu" on page 49*. Certain Trouble alarm causes, like a temporary bus fault, may clear automatically without operator intervention. Others, such as a missing sensor, will not clear until corrected.

Trouble Status Display

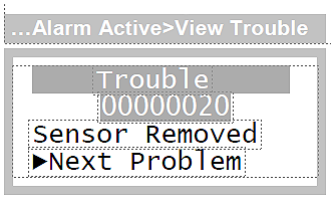


Figure 74: Trouble status display

The Trouble status display appears by selecting the Trouble indicator from the Main display. It may also be viewed by selecting **MENU** from the Main display when the Trouble alarm is active, then selecting **View Trouble**. The 8-digit hex code on line 2 represents all active faults and is useful when obtaining help from the factory. Select **Next Problem** to view a description of each problem in succession on line 3. Some problems are cleared after pressing **Esc** to return to the previous display. See *"Trouble Messages" on page 55*.

Corrective Actions

Prior to opening the transmitter housing:

- **Declassify the hazardous area** if the transmitter is located in a hazardous location.
- Check connections and wiring outside of the transmitter for shorts or opens.
- Unplug the sensor and generator modules and inspect the connectors for bent or recessed contacts.

After the transmitter housing is open:

- Start by checking connections inside the housings in the order listed under Corrective Actions.
- If none of the listed corrective actions solve the problem, replace the transmitter board electronics.

After replacing the sensor, generator, or SIB board:

- Review, verify and restore all Sensor and Auto-test settings. This includes the critical sensor settings like Range and Blank, and the Auto-test Status setting (Status must set to READY for automatic operation).

After replacing the CPU board:

- Review, verify and restore all transmitter settings.

General Trouble

The table below lists troubles for which no message is displayed.

Problem	Corrective Action
Transmitter does not start	At power on, transmitters powered in 3-wire or 4-wire mode demand two times the normal amount of supply current. If the supply is not sized properly, transmitters may not power on, or may produce a fault in the external power supply. If this is suspected, try starting transmitters one at a time. Check that each transmitter has at least 12V DC between pins 5(+) and 6(–) of TB1 on its Power Supply board. This is more easily done using temporary lead wires from the connector.
Gas reading unstable, drifting	Ground loops are a common cause of unstable readings, and may represent a dangerous condition. A ground loop occurs most often when a drain wire, cable shield, DC supply (–), or any other wire makes contact to two or more transmitter housings, remote sensor housings, receivers, power supplies, or metal cable conduits. Metal housings must be bonded to earth ground for safety, and any difference in earth potential between the two points will cause current to flow in the wire or shield. This current might then cause errors in the transmitter's high-gain analog input or possibly exceed the rating of the conductor.

Trouble Messages

This table describes the trouble messages and lists the corrective action codes, which are also listed below.

Trouble	Description	Corrective Action(s)
Gas Signal Err	The analog-to-digital converter channel assigned to the sensor's gas concentration output signal has failed, or is out of range.	1-3, 4, 6, 8
LCD Busy Error	The LCD driver chip cannot recover from an internal error.	1-3, 9, 7, 8
SPI/I2C Bus Error	An internal CPU bus has faulted.	1-3, 7, 9
Tmp. Signal Err	The analog-to-digital converter channel assigned to the sensor's temperature output signal has failed, or is out of range.	1-3, 4, 6, 8
Sensor (-)Range	The sensor has drifted –20% range (below zero).	See *"General Trouble" on page 54*. Zero calibrate the sensor. 4, 6, 8
Sensor Removed	The sensor cannot be detected.	2-4, 6, 8
Sensor NVM Err	One or more configuration settings in the sensor memory do not pass checksum test.	4, 6, 8
Sensor Config	One or more sensor configuration settings are outside of their expected range.	4
Generator NVM	The generator's non-volatile memory is corrupt.	5, 6, 8
Auto-test Fail With Gen. Config Err	Auto-test is enabled (Status = READY) and a problem has been detected with the gas generator, or the gas generator is not compatible with the sensor's type or range. This problem is reported on the display during startup, when a sensor is installed, and when a generator is removed or installed.	4, 5, or disable Auto-test. Set Status to OFF.
NVM1 User CRC	An error has been detected in the user settings stored in the transmitter's primary non-volatile memory.	2, 3 Otherwise reset the user memory defaults See *"Reset Menu" on page 76*. If the problem persists, replace the CPU board.
NVM1 Fact CRC	An error has been detected in the factory settings stored in the transmitter's primary non-volatile memory.	2, 3, 7
NVM2 User CRC	An error has been detected in the transmitter's secondary non-volatile memory.	Not applicable on this transmitter.
NVM2 Fact CRC	An error has been detected in the transmitter's secondary non-volatile memory.	Not applicable on this transmitter.
Auto-test Fail Without Gen. Config Err	Auto-test failed after three attempts (and the Auto-test Trouble is set to YES).	5, 4, 6
3W Pwr Required	Relays or RS232/485 communication is enabled, but transmitter does not have 3-wire power applied.	If relays are not being used, disable them. See *"Relays Menu" on page 71*.
Xmtr Uncal	The transmitter's factory calibration data has become corrupted.	2, 3, 7
CPU Trouble	A stack overflow or other internal error occurred in the CPU.	2, 3, 7
Fault Test	Trouble alarm is being tested, not a real fault.	

Trouble	Description	Corrective Action(s)
Gas Sensor Uncal	The gas sensor appears to be uncalibrated, which occurs after resetting its memory.	Zero and Span calibrate the sensor.
No User Verify	A setting was not verified l within 5 minutes.	Restart transmitter (2) and verify settings.
Hardware Fault	The real-time-clock, a memory chip, or some other component has failed or been corrupted. The transmitter will restart upon exit from the *"Trouble Status Display" on page 53*, or automatically from the Main display after 5 minutes.	1, 3, 7, 8
Sensor COM TmOut	The SIB is not responding.	2, 3, 6, 7, 8
Sensor COM Error	The SIB is responding with physical communication errors.	2, 3, 6, 7, 8
Sensor Proto Err	The SIB is responding with protocol errors (ie, bad crc). This could be caused by physical communication errors.	2, 3, 6, 7, 8
Sensor Reply Err	The SIB is responding with bad information.	2, 3, 6, 7, 8
Sensor CPU Trble	The SIB is reporting a stack overflow or other internal error occurred in its CPU.	2, 3, 6, 7, 8
Sensor H/W Error	The SIB is reporting a non-volatile memory or other hardware component has faulted.	2, 3, 6, 7, 8
Sensor NVM1 CRC	The SIB is reporting an error has been detected in the user or factory settings stored in its primary non-volatile memory.	2, 3, 6, 7, 8
Sensor NVM2 CRC	The SIB is reporting an error has been detected in the user or factory settings stored in its secondary non-volatile memory.	Not applicable on this transmitter.

Corrective Action Codes

1. Select **View Trouble** (Status is cleared on exit. See *"Trouble Status Display" on page 53*.)
2. Restart the transmitter (Menu>Setup>System>Reset>Restart).
3. Toggle power Off and On.
4. Replace the sensor.
5. Replace the generator.
6. Replace the SIB.
7. Replace the CPU Board.
8. Replace the Power Supply Board.
9. Replace the Display Board.

Alarm Inhibit

Alarms are inhibited to temporarily disable (false) activation and should be re-enabled as soon as possible to maximize the safety of the area. The duration of inhibit period depends the method used to activate it. For example, alarm inhibit occurs automatically during zero and span calibration and expires after 30 minutes. The table below summarizes the duration of the alarm inhibit periods for each method used to initiate it.

Alarm Inhibit Periods

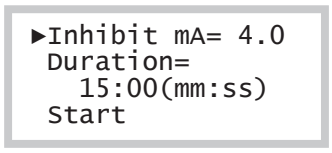
Method	Alarm Inhibit Period
Start up	Same as Sensor Install below.
Zero, Span	Set immediately on entering the method. Then for up to 30 minutes after pressing a key while in the method.
Sensor Auto-test	5 minutes during gas generation attempt. 10 minutes during recovery period.
Sensor Removal	60 seconds, then Trouble alarm active.
Sensor Install	Alarm inhibit active during sensor warm-up (usually 5 minutes).
Manual activation from Main display using **Esc** key	Duration value in Alarm Inhibit Menu.
Manual activation by Start in Alarm Inhibit menu	Duration value in Alarm Inhibit Menu.

The Main display indicates when alarms are inhibited. See Status Indicators in *"Figure 37: Main display" on page 35*. The 4…20 mA output is fixed at the Inhibit mA. See *"Alarm Inhibit Menu"* below.

The most convenient method for manually starting alarm inhibit is from the Main display. For more information on that method, see *"Inhibiting Alarms from the Main Display" on page 36*. Alarm inhibit may also be started through the Alarm Inhibit Menu, shown below.

Alarm Inhibit Menu

The Alarm Inhibit menu exposes the manual alarm inhibit start and stop control, and the duration and fixed 4…20 mA setting.

Display	Item	Select to …
 *Figure 75: Alarm Inhibit menu*	Inhibit_mA	Set the fixed value of the 4…20 mA output during alarm inhibit (3.5…22.0 mA). This is normally 4 mA for toxic gas sensors, and 17.4 mA for oxygen sensors.
	Duration	When alarm inhibit is off: Set the manual alarm inhibit period (0…60, default = 15 minutes). When alarm inhibit is on: Adjust the amount of time remaining.
	Start (Stop)	Start (or stop) alarm inhibit.

Alarm Test Menu

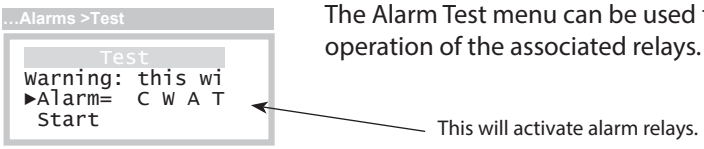


Figure 76: Alarm test menu

The Alarm Test menu can be used to test the gas level and Trouble alarms to verify operation of the associated relays. See *"Relay Operation, Menus and Settings" on page 70*.

NOTE: Devices wired to the relays may activate when **Start** is selected. Inform all personnel before performing the test.

Display	Instructions
...Alarms >Test Test Warning: this wi ▶Alarm= - - - - Start	Select **Alarm**.
...Alarms >Test Test Warning: this wi ▶Alarm= ▲▼- - A - Start	Scroll up or down to specify which alarms to test - C, W, A, T, and save the selection by pressing the **Enter** key. (C = Caution, W = Warning, A = Alarm, T = Trouble)
...Alarms >Test Test Warning: this wi Alarm= - - A - >Start	Select **Start** to begin the test.
...Alarms >Test Test Warning: this wi Alarm= - - A - Any key to STOP	Press any key to end the test. The test stops automatically after five minutes.

Figure 77: Alarm Test menu

Data-log Menus, Methods, and Settings

The transmitter records gas concentrations in one of twelve intervals ranging from 1…60 minutes, providing data from 11 to 474 days. The table of data-log sampling metrics below details the sampling intervals and the samples/day and totals days for each interval.

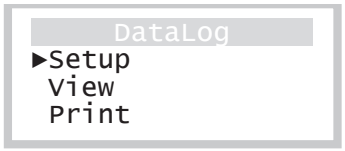
Data-log Sampling Metrics Table

Sampling (Minutes)	Samples/Day	Total Days
1	1440	11
2	720	22
3	480	32
4	360	43
5	288	54
6	240	64
10	144	104
12	120	124
15	96	152
20	72	196
30	48	278
60	24	474

The gas concentration reading is recorded as an instantaneous value and is not averaged or filtered in any way. When the data log memory is filled, new records overwrite older ones.

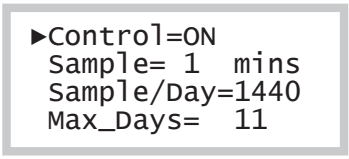
Data Log Menu

The Data Log menu permits access to configuration, review, and print menus.

Display	Item	Select to …
 *Figure 78: Data Log menu*	**Setup**	Configure the data log settings. See *"Data Log Setup Menu" on page 60*.
	View	View the logged data as a graph or single text records.
	Print	Send a tabular ASCII report to the device connected to the COM port (see *"Data Log Print Menus, Methods and Settings" on page 62*). **NOTE:** Only available on transmitters with an RS232 or RS485 interface. The data log must not be empty, and the COM protocol must be set to ASCII or the transmitter will display an exception message.

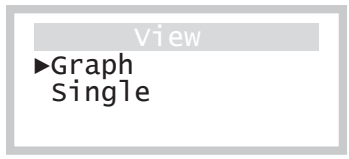
Data Log Setup Menu

Settings on the Data Log Setup page select one of the 12 discrete sampling intervals listed in the *"Data-log Sampling Metrics Table" on page 59*, and control starting, stopping and clearing of the data log.

Display	Item	Select to …
 *Figure 79: Data Log Setup menu*	Control	Turn data logging on or off, or clear stored data.
	Sample Sample/Day Max_Days	Set the sampling interval to one of the 12 values listed in the *"Data-log Sampling Metrics Table" on page 59*. Changing one automatically changes the other two. **Warning: Changing the sampling interval will clear the data log.**

Data Log View Menu

Data is presented as a gas concentration reading at a specific date and time and may be viewed collectively as points on a graph (Graph), or individually as a single text record (Single). In Graph view, readings are presented sequentially in time when scrolling the up and down keys. In Single view, both the date and time may be scrolled to provide a pseudo random-access method. Since the two views are connected, it is possible to navigate directly to the date and time of interest using the Single view, and then switch to the Graph view to see more readings around a particular time. Conversely, the view can be switched from Graph to Single to view readings taken around the same time on different days.

Display	Item	Select to …
 *Figure 80: Data Log View menu*	Graph	View multiple points of data as a graph (sequential selection).
	Single	View single records (pseudo random-access selection).

Samples reported are assumed to be in units of PPM, PPB or %, as determined by the gas concentration units appearing on the Main display. Sample values outside of printing limits are forced to the following values.

Samples …	Forced to…
Less than –999	–999
Greater than 9999	9999

Readings in both views are displayed in the same units and decimal precision as those on the Main display, and the date format is consistent [8] with the format selected in the sample values (see *"Figure 110: Clock menu" on page 76*). Both views also display special codes to indicate samples were unavailable. The table below summarizes the special codes.

Data Log Special Codes Table

Special Code	Description
----	Sample unavailable (transmitter powered off, or sample not yet recorded)
FFFF	Trouble alarm active at time of sample
TEST	Auto-test active at time of sample (if Log_Data = NO, see *"Auto-test Setup Options Menu" on page 46*)
****	Data is corrupted or unreliable

[8] Dates presented in the Graph view are shortened to just the month and date. The year is not presented.

Data Log Graph View

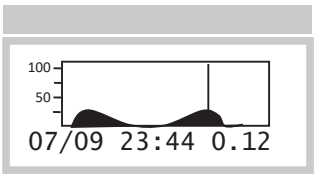


Figure 81: Data Log Graph view

The Graph view plots a sample as a vertical line, the height of which corresponds to the gas reading as a percentage of the sensor's range (height = 100* reading/range). Samples are plotted from left (oldest) to right (newest). On entry, a vertical cursor appears over the most recent sample (or sample of interest), and the corresponding date, time, and gas reading or special code (see above) are displayed on the lower line. These values are updated as the cursor is moved left and right by pressing the up and down keys. Note: the gas reading on the lower line is in the same units that appear in the Main display and Sensor menus.

New data is not plotted while viewing the page. Pressing the **Enter** key presents the Data Log menu shown below. Pressing the **Esc** key returns to the previous menu.

Data Log Graph View Menu

The Data Log Graph View menu appears by pressing the **Enter** key while viewing the *"Data Log Graph View"* (above).

Display	Item	Select to …
▶Single Print *Figure 82: Data Log Graph view menu*	Single	View single records (pseudo random-access selection) starting at the cursor position.
	Print	Send a tabular ASCII report to the device connected to the COM port. See *"Data Log Print Menu" on page 63*. **NOTE:** Only available on transmitters with an RS232 or RS485 interface. The data log must not be empty and the COM protocol must be set to ASCII or the transmitter will display an exception message.

Data Log Single View

The Data Log Single View menu allows scrolling to an exact date and time for viewing a single sample. Selecting Graph then presents the Graph view at the selected date and time.

Display	Item	Select to …
▶Date= 07/09/14 Time= 23:44 Conc= 0.12 Graph	Date	Scroll to a specific sample date.
	Time	Scroll to a specific sample time.
	Conc	View the gas reading when sample was recorded (not selectable).
	Graph	View the Graph at the specified date and time.

Figure 83: Data Log Single View menu

Data Log Print Menus, Methods and Settings

For transmitters with an optional RS232/RS485 interface, a data log report may be sent to a serial printer, or "captured" to a file using a terminal emulation program. Many terminal emulation programs exist for both Microsoft Windows® and non-Windows platforms.

The report consists of a series of lines, each containing a date and time, followed by up to 30 gas readings. All fields on the line are separated by a TAB character (ASCII 9), which serves to keep the fields aligned in columns. This format is suitable for most Epson protocol printers and for import into most spreadsheet programs after capture. The date and time apply to the first gas reading on the line following the time. Readings appearing in subsequent columns to the right were recorded at the programmed sampling interval after the first reading. The format of the gas readings appear as described in *"Data Log View Menu" on page 60*. A report example is shown below.

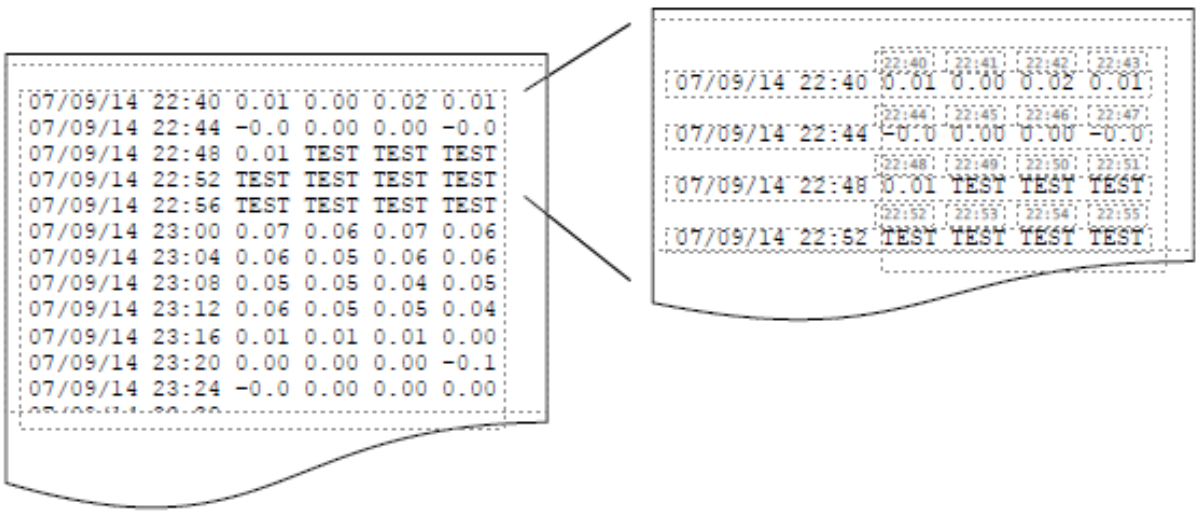
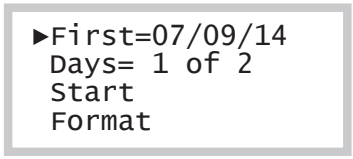


Figure 84: Data Log Print example

In the example above, the sample on the left occurred at 22:40. The sample on the right occurred at 22:41, followed by the next at 22:42, and so on. This pattern is repeated to the end of the line, and then repeats on the line below, and so on.

Data Log Print Menu

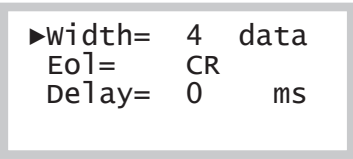
The Data Log Print menu appears by selecting **Print** from the *"Data Log Menu" on page 59*. The data log must not be empty and the communication protocol must be set to ASCII before entry or an exception message will be displayed. See *"COM Menus and Settings" on page 66*. The transmitter's real-time clock should also be set to the correct date and time.

Display	Item	Select to …
 *Figure 85: Data Log Print menu*	First	Set the first date to print in the report. Scrolling this date automatically updates the *Days* field.
	Days	Set the number of days of data to include in the report.
	Start	Send the report to the device connected to the transmitter's COM port.
	Format	Configure the report format for the connected device.

To send the report, set the start date (First) and number of days to print (Days), and select **Start**. The line will blink Printing until the report is done. The report always begins at 00:00 on the start date, and continues for the number of days specified. If no data has yet been logged, the report will show four dashes (----) in place of samples.

Data Log Print Format Menu

The Data Log Print Format menu appears by selecting *Format* from the *"Data Log Print Menu"* and is used to control the appearance of the report and the interaction of the transmitter with the device.

Display	Item	Select to …
 *Figure 86: Data Log Print Format menu*	Width	Change the number of data samples (gas readings) printed on each line.
	Eol	Toggle the ASCII control code(s) transmitted at the end of each line from CR to CR/LF (more on this below).
	Delay	Add up to a 10 second delay at the end of each line.

The transmitter adds a CR (ASCII 13) or CR/LF (ASCII 13 and 10) at the end of each line. If the lines of the report appear to be printing over each other, choose the CR/LF option. If the lines appear to be double spaced, choose the CR option.

The number of sample data samples (gas readings) appearing across the page is programmable from 1…30. This is designed to allow reports to fit on small thermal printers and on conventional sized printers. A wider report takes less time to print because the date and time fields are printed less frequently.

A delay of up to 10 seconds can be added after each line is transmitted to help prevent buffer overflows on printers without XON/XOFF protocol. This is sometimes required to allow slow printers enough time to perform carriage return. If characters appear to be missing, increase the setting.

Flow Control

The transmitter uses XON/XOFF flow control while sending a report. That is, once the data stream has begun, it will continue until the XOFF character (19) is received. After sitting idle, the report stream will begin again upon reception of the XON character (17).

An RS232 connection can support full duplex communication and is perfectly suited for XON/XOFF flow control. However, an RS485 connection is only half duplex. It cannot receive while it is transmitting and might miss the XOFF character, resulting in a buffer overflow at the receiving device.

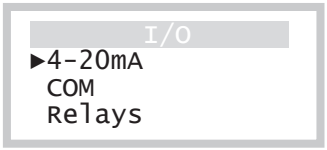
A receiving device will send the XOFF character when its buffer is nearly full. Some older dot-matrix printers will send an XOFF because they have a small receive buffers and cannot process characters while the head is returning to start a new line. By comparison, most computers have comparatively large buffers and can easily accept the report stream without sending an XOFF, so an RS485 connection may work in those cases.

The transmitter features an additional method to help avoid losing data due to buffer overflow problems on receiving devices that lack XON/XOFF capability (or have the capability but are using an RS485 connection). A programmable time delay of up to 10 seconds may be inserted at the end of each report line. This permits the receiver time to process more characters in its buffer and avoid an overflow. However, this may be a method of trial and error until the proper delay setting is determined so that no characters are missing from the report.

I/O Menus, Methods and Settings

I/O Menu

The I/O menu is shown below and appears by selecting I/O from the *"Main Menu" on page 38*.

Display	Item	Select to …
 *Figure 87: I/O menu*	4…20 mA	Configure and adjust the 4…20 mA output.
	COM	Configure the RS232/RS485 serial interface (option).
	Relays	Configure the three transmitter relays (option).

4…20 mA Output Menus and Methods

The transmitter sources (or sinks) a 4…20 mA current that is proportional to the gas reading on the Main display. See *"Main Reading" on page 35*. The current is normally 4 mA at zero and 20 mA at the programmed range of the sensor. See Range in *"Sensor Settings Menu" on page 39*. Since the Main Reading is blanked below zero, the output should never go below 4 mA in the course of normal operation. In the event of gas flooding, the current may go as high as 25 mA (125% Range).

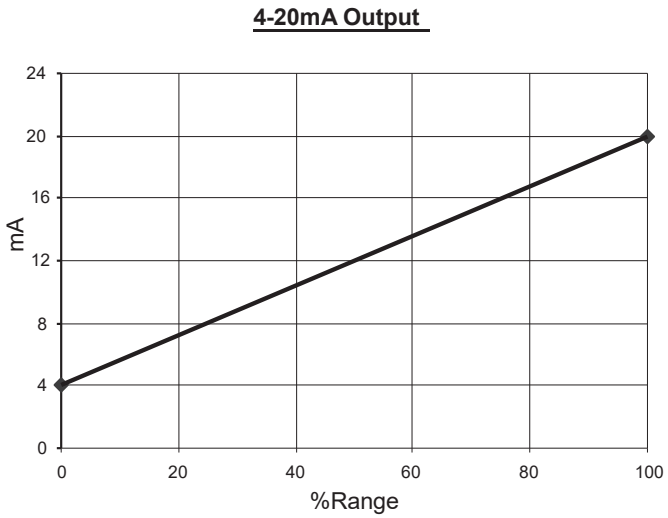
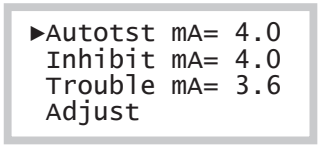


Figure 88: Graph of 4…20 mA output

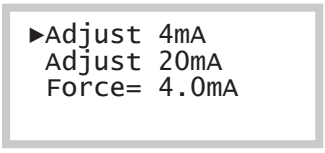
4…20 mA Menu

During alarm inhibit and Auto-test, the 4…20 mA output is fixed at 4.0 mA (17.4 mA for oxygen sensors) to prevent false alarms at the receiver. The output is forced to 3.6 mA to signal a Trouble alarm to the receiver. These are the default values, which may be changed in the 4…20 mA menu, below.

Display	Item	Select to …
 *Figure 89: 4…20 mA menu*	Autotst mA	Set the fixed output level during Auto-test (4.0 to 22.0 mA). This is normally 4.0 mA to prevent alarms at the receiver.
	Inhibit mA	Set the output level to indicate alarms are not enabled (4 to 22 mA). This is normally 4.0 mA to prevent alarms at the receiver.
	Trouble mA	Set the output level to indicate the Trouble alarm (3.5 to 3.8 mA). **NOTE:** 3.5 mA not allowed on 2-wire 4…20 mA connection.
	Adjust	Adjust the 4 mA and 20 mA levels, or force the output for testing.

4…20 mA Adjust Menu

These methods permit adjustment of the 4…20 mA output and provide a way to force it to a fixed value to test receiver alarms. They do not affect the computed gas concentration reading.

Display	Item	Select to …
 *Figure 90: 4…20 mA control page*	Adjust 4 mA	Adjust the 4 mA analog output level.
	Adjust 20 mA	Adjust the 20 mA analog output level.
	Force	Force the 4…20 mA output to a fixed level between 3.5… 22.0 mA. Displays the real time value when not selected.

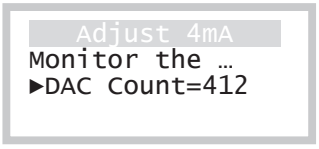
4…20 mA Adjustment

Loop adjustment consists of adjusting the 4 and 20 mA levels (order does not matter) by scrolling the corresponding DAC value. This may be accomplished by reading a calibrated current meter connected in series with the transmitter's 4…20 mA output, reading a calibrated volt meter across a precision load resistor in series with the transmitter's 4…20 mA output or reading the display of a calibrated, current loop receiver. [9]

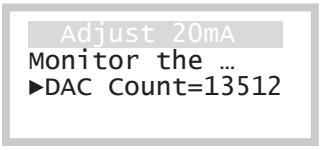
⚠ WARNING

DISABLE CURRENT LOOP RECEIVER ALARMS BEFORE PROCEEDING.

Adjust 4 mA Menu

Display	Item	Select to …
 *Figure 91: Adjust 4 mA menu*	DAC Count	Scroll the DAC (digital-to-analog converter) count up to increase or down to decrease the analog output to 4.00 mA. **NOTE:** The displayed value is "as left" by the previous adjustment.

[9] When using a current loop receiver, make certain the reading is not limited to 20 mA by hardware or programming. If so, adjust the reading first to 19.5 mA, then slowly increase it to 20.0 mA.

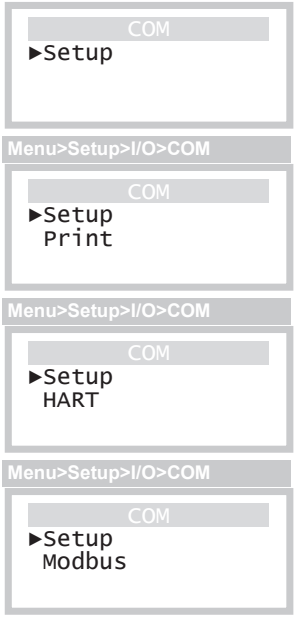
Display	Item	Select to …
 *Figure 92: Adjust 20 mA menu*	DAC Count	Scroll the DAC (digital-to-analog converter) count up to increase or down to decrease the analog output to 20.0 mA. **NOTE:** The displayed value is "as left" by the previous adjustment. When selected, however, the DAC count changes to the factory calibrated value of 20.0 mA. This is to help prevent adjustment errors caused by 4…20 mA receivers that limit readings to 20 mA.

COM Menus and Settings

The transmitter supports ASCII, HART, and Modbus communications, which are configured through the COM Menu below.

COM Menu

The COM menu is used to configure the protocol and connection settings of the serial COM interface and varies slightly, depending on the factory configured protocol.

Display	Item	Select to …
 *Figure 93: COM menu*	Setup	Configure the connection settings (only selection when Protocol is None).
	Print	Print the data log (appears only when the Protocol is ASCII. See *"Data Log Print Menu" on page 63*. Note that the transmitter must have an RS232 or RS485 interface.
	HART	Configure the HART protocol settings (appears only when Protocol is HART). Note that the transmitter must have a HART FSK modem interface, and be ordered with the HART FSK stack option.
	Modbus	Configure the Modbus protocol settings (appears only when Protocol is Modbus). Note that the transmitter must have an RS232 or RS485 interface, and be ordered with the optional Modbus protocol stack option.

COM Setup Menu

The COM Setup menu is used to select the protocol and configure the transmitter's connection settings.

Display	Item	Select to …
…COM>Setup ▶Protocol=None …COM>Setup ▶Protocol=ASCII Interface=RS232 Baud Rate=9600 Settings= N,8,1 …COM>Setup ▶Protocol=HART Interface=FSK Baud Rate=1200 Settings= O,8,1 …COM>Setup ▶Protocol=Modbus Interface=RS485 Baud Rate=9600 Settings= N,8,1 *Figure 94: COM Setup menu*	Protocol	Change the slave protocol. • ASCII (default) • Modbus (option) • HART (option) • None Protocol selection is performed at the factory and may not be changed. Settings for the ASCII and Modbus protocols may be changed, but are restricted for the HART protocol.
	Interface	Change the physical communication interface that the transmitter will control during transmit and receive functions: • RS232 (available for ASCII or Modbus, not for HART) • RS485 (available for ASCII or Modbus, not for HART) • FSK (HART only)
	Baud Rate	Change the baud rate of the transmitter's UART. May be set to: 300, 600,1200, 2400, 4800, 9600, 14.4k, 19.2k, 28.8k, 38.4k, 57.6k, 115.2k, 230.4k, and 460.8k. The value is fixed at 1200 for HART FSK, and defaults to 9600 for Modbus and ASCII.
	Settings	Change the parity, number of data bits, and number of stop bits of the transmitter's UART: N,8,1 …no parity, 8 data bits, 1 stop bits N,8,2 …no parity, 8 data bits, 2 stop bits E,8,1 …even parity, 8 data bits, 1 stop bit O,8,1 …odd parity, 8 data bits, 1 stop bit The value is fixed at O,8,1 for HART protocol, and defaults to N,8,1 for Modbus and ASCII.

HART

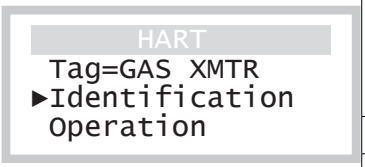
The following applies to transmitters that have the HART FSK modem interface and HART FSK firmware option.

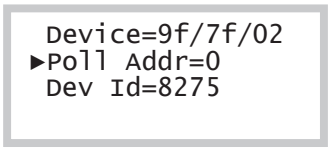
A HART point-to-point connection permits simultaneous digital and analog communication between one or two masters and one slave device. A HART multi-drop connection permits one or two masters and up to 15 devices to communicate digitally but prohibits analog communication by requiring each slave device to fix its output at its lowest level (4 mA). For more information, see the HART Transmitter connection examples in *"HART point-to-point (2-wire)" on page 29*, or consult the HART Foundation (*fieldcommgroup.org*) for details on how to connect a HART transmitter.

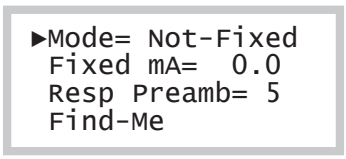
HART FSK devices communicate digitally by imposing a 1 mA pk-pk waveform on the 4…20 mA output using a technique called Frequency-Shift-Keying. FSK interprets binary 0 as one cycle at 2200 Hz, and binary 1 as one cycle at 1200 Hz. Since each cycle increases the output by 0.5 mA and then decreases it by 0.5 mA, it FSK does not affect the average analog level. This allows a HART FSK device to use both analog and digital communication on a single connection.

HART Menu

The HART menu appears by selecting HART from the *"COM Menu" on page 66*.

Display	Item	Select to …
 *Figure 95: HART menu*	Tag	This setting is read-only and can be used as a unique identifier for communicating to the transmitter. The setting is read only at the operator interface but may be modified using HART network management commands. This field is assigned by the HART master.
	Identification	View the HART Identification Menu.
	Operation	View the HART Operation Menu.

Display	Item	Select to …
 *Figure 96: Hart Identification menu*	Device	This setting is read-only and displays device information used in long-frame address commands, and by devices capable of utilizing the transmitter's DDL (device description language) file. The format of the information is, MFG_ID/DEV/REV. The MFG_ID is 9f and identifies Badger Meter as the manufacturer. DEV is 7f and identifies the device as a D12 transmitter. REV is the revision level of the transmitter, currently set at 2 (may increment in the future).
	Poll Addr	Use this to change the polling address of the transmitter. The default value is 0, which allows the transmitter to communicate digitally, while preserving the function of the 4…20 mA output. The value may be set from 1…15, which fixes the output at 4 mA and disables analog signaling.
	Dev Id	This setting is used to form a unique identifier in the HART long frame address. This value is set at the factory, and appears on a label attached to the transmitter. Changing this setting is not recommended.

Display	Item	Description
 *Figure 97: HART Operation menu*	Loop	This setting specifies the analog operating mode of the 4…20 mA output. When the HART polling address is 0, the value is Not-Fixed and analog signaling functions normally. When the address is set to 1 or higher, the value is Fixed and the analog output is fixed at 4 mA. The ability to alter this behavior is reserved for future use, and changing this setting is not recommended.
	Fixed mA	This setting provides direct access the associated HART network management setting. The value is adjustable only when the Loop setting is FIXED and may be adjusted between 3.5 (4 mA on 2-wire power) and 22 mA.
	Resp Preamb	This setting provides direct access to the associated HART network management setting, which determines the number of preamble characters (FF hex) transmitted at the beginning of each message. The default value is 5 and may be set from 3…20. Changing this setting is not recommended.
	Find-Me	This method places the transmitter into a mode that causes the transmitter to respond to the Find Device command. This is used by personnel identify transmitter in the field. The method is described in *"HART Find Device" on page 69*.

HART Find Device

Selecting Find Me presents a special page that remains until the master device issues a Find Device command to the transmitter, at which point line 1 of the display changes from FIND ME ARMED to DEVICE FOUND.

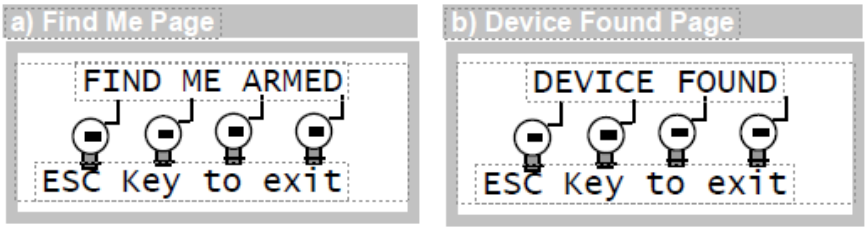


Figure 98: HART Find Device display

Modbus

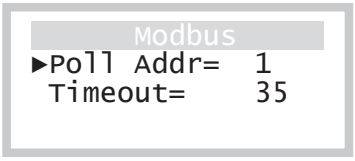
IMPORTANT

The following applies to transmitters that have an RS232 or RS485 COM interface and Modbus firmware options. The RS232 and RS485 option is NOT INTENDED for use in Hazardous Locations.

Modbus is a master/slave protocol that supports a single master, and up to 247 slave devices on a common bus. The RS485 interface physically limits this number to 32 (1 master, 31 slaves), and RS232 restricts communication to a master and a single slave. Note that the 4…20 mA output is fully functional even when using the transmitter's Modbus interface.

Modbus Menu

The Modbus Menu appears by selecting Modbus from the *"COM Menu" on page 66*.

Display	Item	Description
 *Figure 99: Modbus menu*	Poll Addr	This setting controls the address to which the transmitter responds to queries from the host (1-247, default =1).
	Timeout	This setting belongs to the data-link layer of the protocol and defines the number of character bits used to frame Modbus RTU messages. The protocol specifies the silent interval as 3.5 characters, which corresponds to 35 bit-times at 10 bits per character. This setting is reserved for future use and changing it is not recommended.

More information about configuring the Modbus connection can be found in the table below.

More Information…	Where to find…
Connect to a master using an RS485 multi-drop connection.	*Figure 21 on page 23*
Connect to a master using an RS232 connection.	*Figure 21 on page 23*
Select Modbus protocol and configure the communication settings.	*"COM Setup Menu" on page 67*
Modbus register map	The transmitter's Modbus interface is robust and maintained in a separate document. Refer to the *D12/F12 Series Modbus Interface User Manual*, available at *badgermeter.com*.

Relay Operation, Menus and Settings

The following applies to F12 transmitters ordered with optional 3 SPST relays that are NOT INTENDED for Hazardous Locations.

The F12 Alarm Relay option provides three SPST mechanical relays on the Power Supply board. The relays are rated for 5 amps, non-inductive loads at 250V AC, and are suitable for switching small loads, such as horns and warning lights, but should not be used to switch motors or other high current, inductive loads.

Each relay coil may be assigned to one of the four alarms and operate as normally energized (Norm=1, also called "fail-safe"), or normally de-energized (Norm=0). Selecting normally energized (1) allows the relay to indicate an alarm, or a power failure. This selection is made in the *"Relay Setup Menu" on page 71*.

Relay Coil Norm Setting Table

The table below details the contact states for the two selections in the no-alarm, alarm, and power fail conditions.

Relay Coil "Norm" Setting	No-Alarm	Alarm	Power Failure
0 (normally de-energized)			
Coil	De-energized	Energized	De-energized
Closed Contacts	C-NC	C-NO	C-NC
1 (normally energized, "fail-safe")			
Coil	Energized	De-energized	De-energized
Closed Contacts	C-NO	C-NC	C-NC

The figure below illustrates the alarm and relay operation.

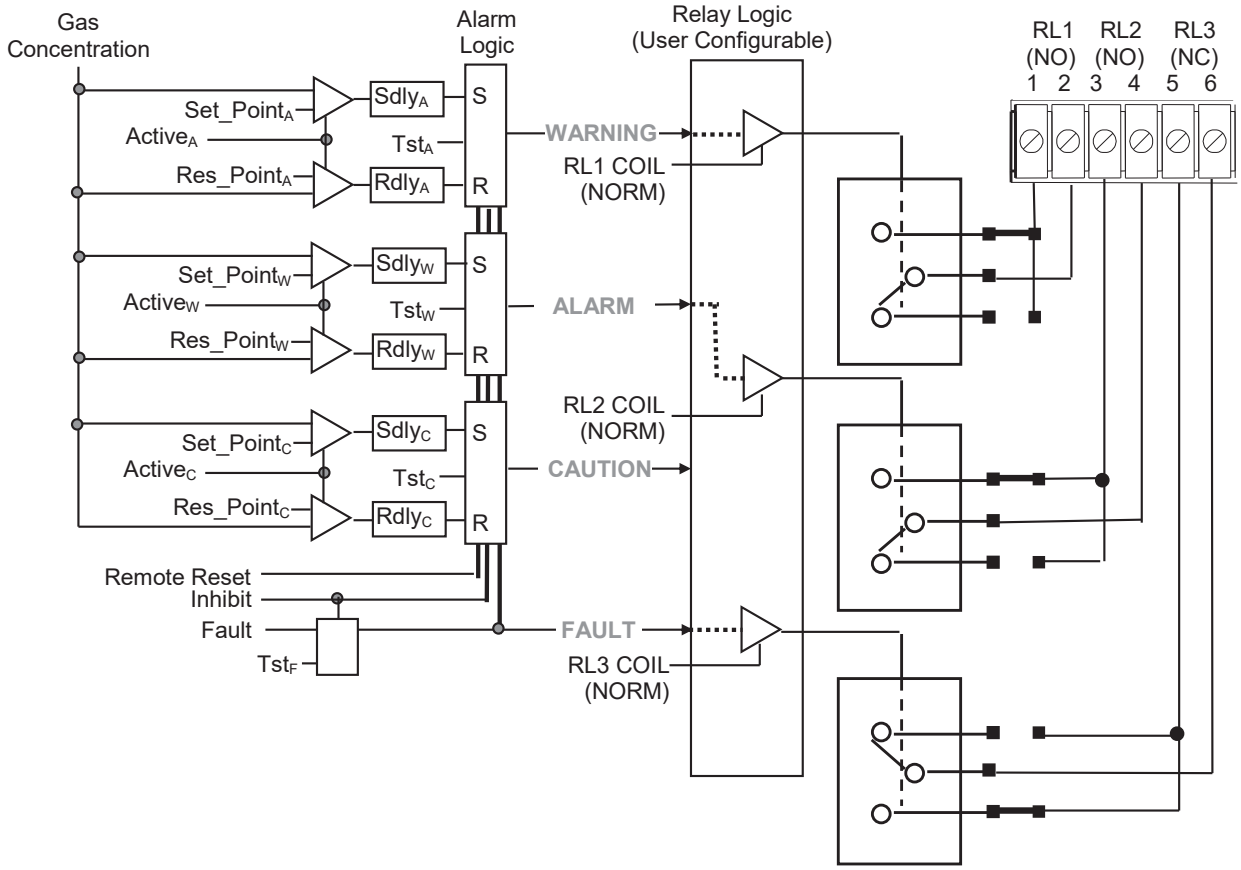
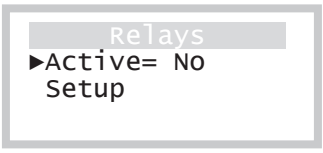


Figure 100: Alarm relay diagram

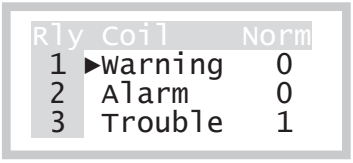
Relays Menu

The Relays menu appears by selecting **Relays** from the *"I/O Menu" on page 64*.

Display	Item	Select to …
 *Figure 101: Relays menu*	Active	Permanently enable or disable operation of .the relays.
	Setup	Assign each relay to an alarm and select the normal state of its coil.

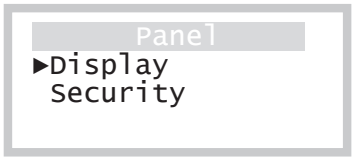
Relay Setup Menu

The Relay Setup menu appears by selecting **Setup** from the Relays Menu above.

Display	Item	Select to …
 *Figure 102: Relay Setup menu*	Coil	Change the alarm assigned to the relay coil. Selections are ALARM, WARNING, CAUTION or TROUBLE.
	Norm	Change the normal (no-alarm) state of the coil to: normally de-energized normally energized ("fail-safe") See*"Relay Coil Norm Setting Table" on page 70*.

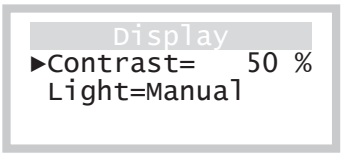
Panel Menus, Methods and Settings

Panel Menu

Display	Item	Select to …
 *Figure 103: Panel menu*	Display	Adjust the display contrast or when the backlight comes on. **NOTE:** Backlight operates only when powered in 3- or 4-wire mode.
	Security	Lock or unlock the transmitter panel, or change the password.

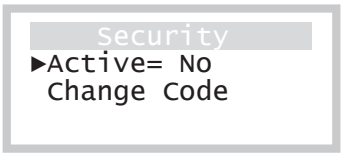
Display Menu

The transmitter features a backlit 96 W × 32 H graphics LCD. The Display menu is used to control the display contrast and manage the backlight.

Display	Item	Select to …
 *Figure 104: Display menu*	Contrast	Adjust the LCD contrast. Scroll the setting up to increase contrast (darker text) or down to decrease it (lighter text). The default value is 50% and is adjustable between 0…100%.
	Light*	Control when the LCD backlight is turned on and off* : Manual On when any key is pressed Off when no key pressed for 5 minutes Auto On when any key is pressed or alarm is active Off when no key pressed for 5 minutes, and no alarms active Never On Off permanently Always On On permanently (not recommended)

Security Menu

The transmitter prevents changes to the transmitter configuration through the front panel when security is active. Settings may be read, but not modified, and methods will not execute, including verifications during Sensor Review (see *page 33*). To do so, security must be disabled, either permanently or temporarily, by entering the correct 4-digit code. Panel security status is indicated on the Main display as shown on *page 35*.

Display	Item	Select to …
 *Figure 105: Security menu*	Active	Activate or deactivate panel security. You must enter the panel code in either case. See *"Figure 106: Activating security" on page 73* and *"Figure 107: Deactivating security" on page 74*.
	Change Code	Change the panel code.

Activating Security

The following display sequence appears when attempting to activate panel security.

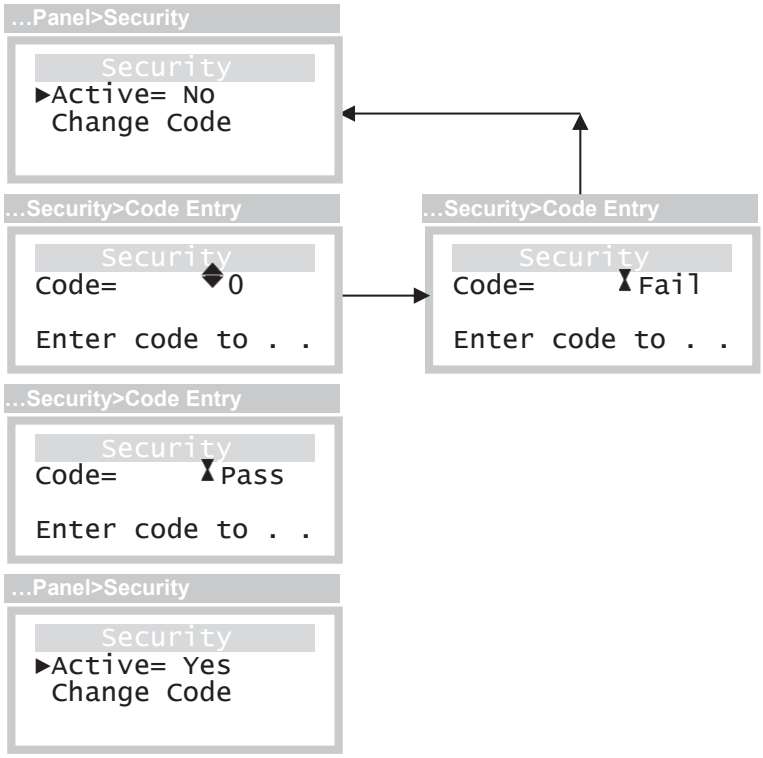
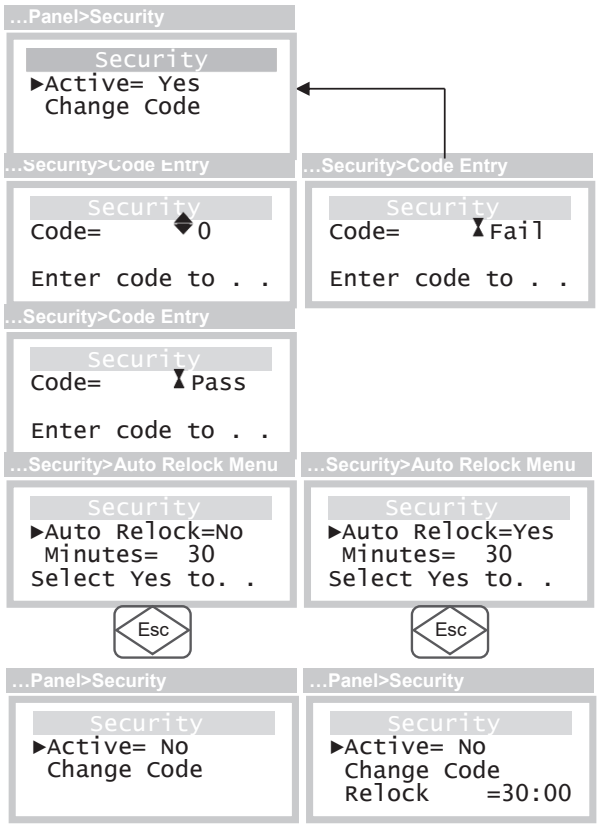


Figure 106: Activating security

Deactivating Security

The following display sequence appears when attempting to deactivate panel security. Note the option for automatically relocking the panel after a timed period.



The automatic relock time defaults to 30 minutes, but may be extended up to 60 minutes.

Press the Esc key to exit the Relock display.

The panel re-lock timer is displayed on line 4, but is fixed to prevent relocking while viewing this display. You may select Relock to return to the Auto Relock Menu to extend the period, if necessary.

Figure 107: Deactivating security

Changing the Security Code

The security code is changed by selecting **Change Code** from the Security Menu.

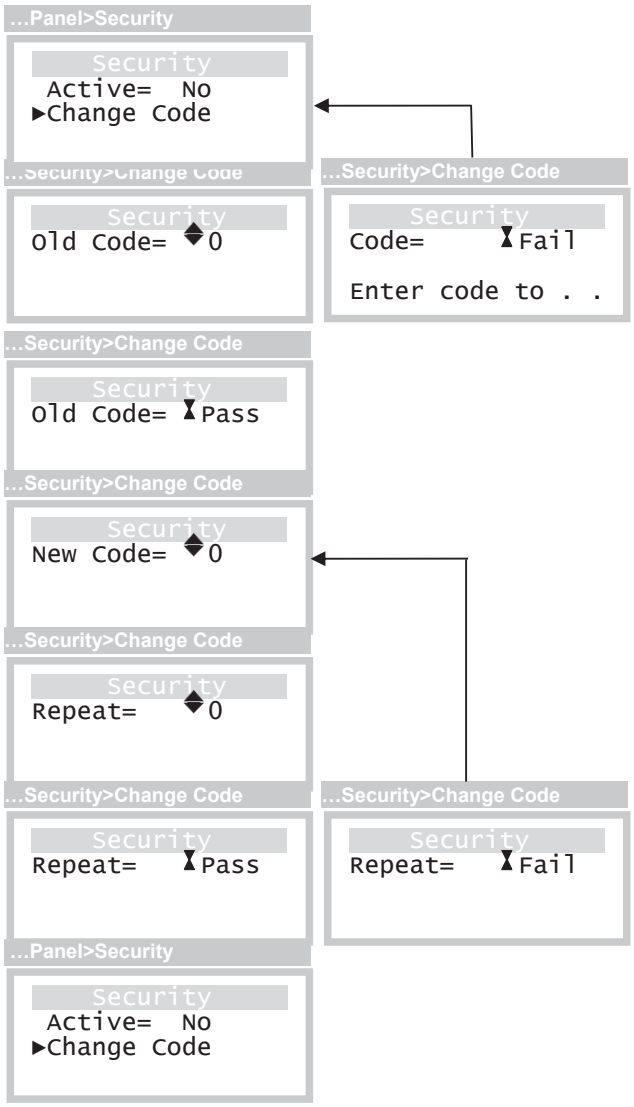
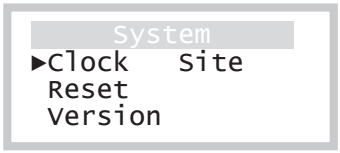


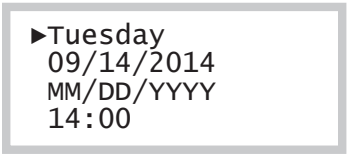
Figure 108: Changing security code

System Menu

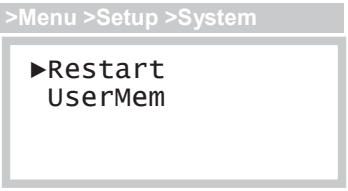
Display	Item	Select to …
 *Figure 109: System menu*	Clock	Set or update the transmitter's real-time-clock.
	Reset	Restart the transmitter or change all user settings to default values.
	Version	Display transmitter and sensor version information.
	Site	Change the site name displayed during startup review.

Clock Menu

The Clock menu is used to set the transmitter's real-time clock, which is recorded during sensor calibration and data logging, and is used to trigger Auto-test starts.

Display	Item	Select to …
 *Figure 110: Clock menu*	Line 1	Change the day of the week: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday
	Line 2	Configure the month, date, and year, in the format specified by the *Format* setting (below). Built-in support for leap year. **NOTE:** You may select and adjust the year separately.
	Line 3	Change the date format: MM/DD/YYYY, example: 09/14/2014 DDMMM/YYYY, example: 09Sep/2014
	Line 4	Change the time of day (24-hour format, 00:00 to 23:59)

Reset Menu

Display	Item	Select to …
 *Figure 111: Reset menu*	Restart	Restart the transmitter without cycling power.
	UserMem	Reset all user settings to default values. **NOTE:** This method is provided to recover from a corrupted user memory. It does not affect calibration of the sensor or transmitter analog inputs or outputs. After running this method, you will be required to manually restore all of the transmitter alarm, data logger, I/O (communications, relays and 4…20 mA), panel (display and security), settings, as well as the transmitter's real-time clock.

Version Menu

The Version menu appears by selecting **Version** from the System menu and lists the major components of the transmitter as menu entries. See *"System menu" on page 76*.

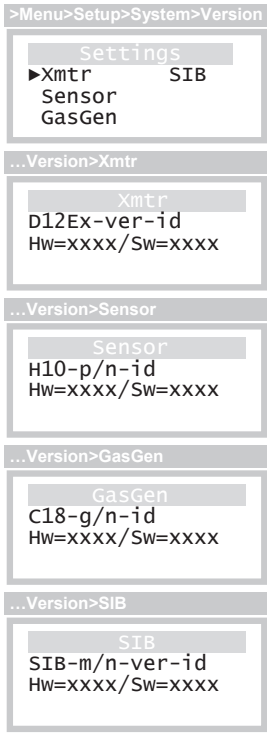
Display	Item	Select to …
	Xmtr	View the transmitter version information.
	Sensor	View the sensor version information.
	GasGen	View the gas generator version information.
	SIB	View the SIB (board) version information.
	g/n	Gas number – identifies a gas species
	m/n	Model number – identifies a series model type
	p/n	Part number – identifies a specific assembly
	id	Identity – uniquely identifies a CPU board assembly*
	ver	Version number – indexes a specific assembly (shorter text)
	Hw	Hardware revision – revision level of the electronics
	Sw	Software revision – revision level of the software
		* ID numbers displayed here are used to identify board level components and are not intended to identify the complete device. These numbers will not match serial numbers printed on labels physically attached to the device.

Figure 112: Version menu

MAINTENANCE

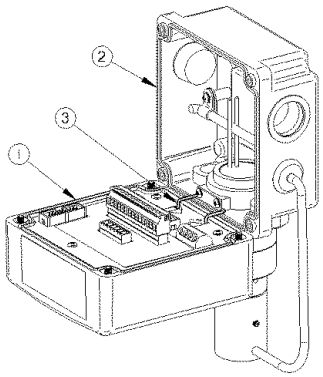
The F12/D gas transmitter is virtually maintenance free. Other than the consumable sensor and auto-test generator, the battery backup for the real-time clock and the instrument fuse are the only other user replaceable parts.

Real-Time Clock Battery Replacement

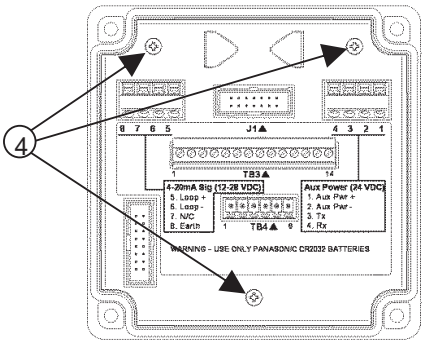
⚠ WARNING

DISCONNECT POWER AND MOVE UNIT TO A NON-HAZARDOUS AREA BEFORE SERVICING.
REPLACE WITH PANASONIC CR2032 BATTERY ONLY.

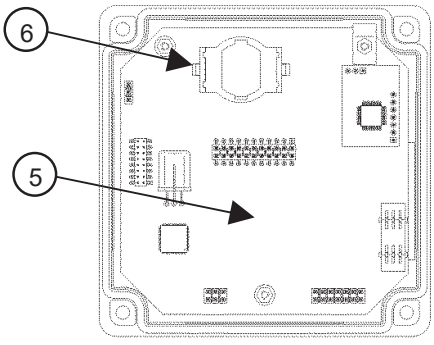
1. Loosen the four screws securing the front enclosure (1).
2. Remove the front enclosure (1) from the rear enclosure (2), by squeezing the hinge pin (3).



3. Remove the internal shield by removing the three screws (4).



4. Remove the terminal PCB by pulling straight up, to expose the CPU PCB (5).
5. Remove the battery (6), and replace with same kind.
6. Reverse steps 4 through 1 to re-assemble the unit.
7. After powering up the unit, set the data and time.



NOTE: You will be forced to disable Auto-test on startup until the clock has been set.

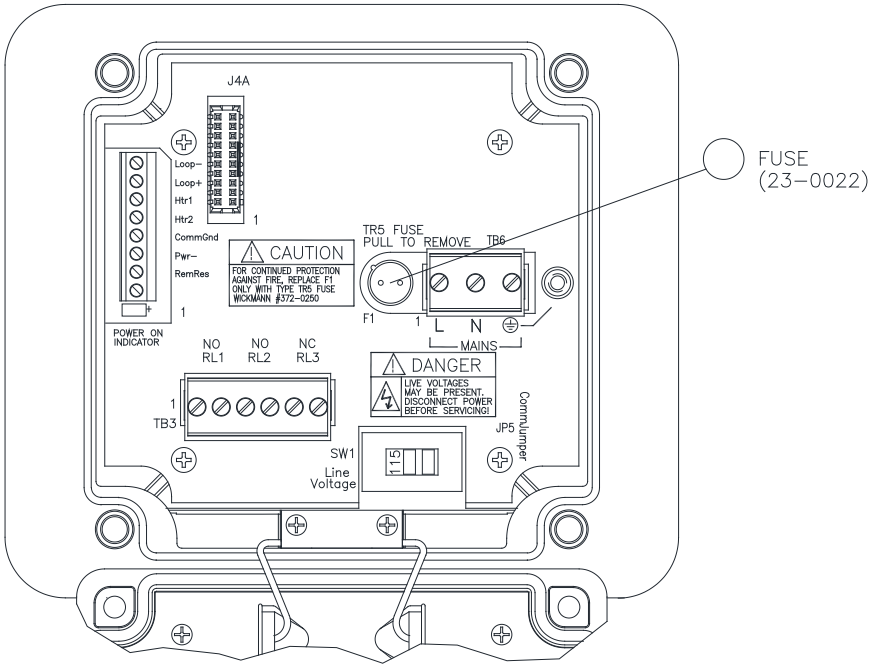
Instrument Fuse Replacement

⚠ WARNING

DISCONNECT POWER AND MOVE UNIT TO A NON-HAZARDOUS AREA BEFORE SERVICING.

FUSES ARE AVAILABLE FROM BADGER METER. OTHERWISE REPLACE WITH WICKMANN PART #372-0250 ONLY!

1. Loosen the four (4) screws holding the lid to the rear enclosure and allow the lid to hang open.
2. Observe location of Fuse (F1). Fuse is located next to the Power Input Terminal Block.
3. Pull up on the blown fuse (fuse is installed in a socket), and discard.
4. Install new fuse into socket. ORIENTATION IS NOT IMPORTANT.
5. Re-attach the lid to the enclosure.



SPARE PARTS

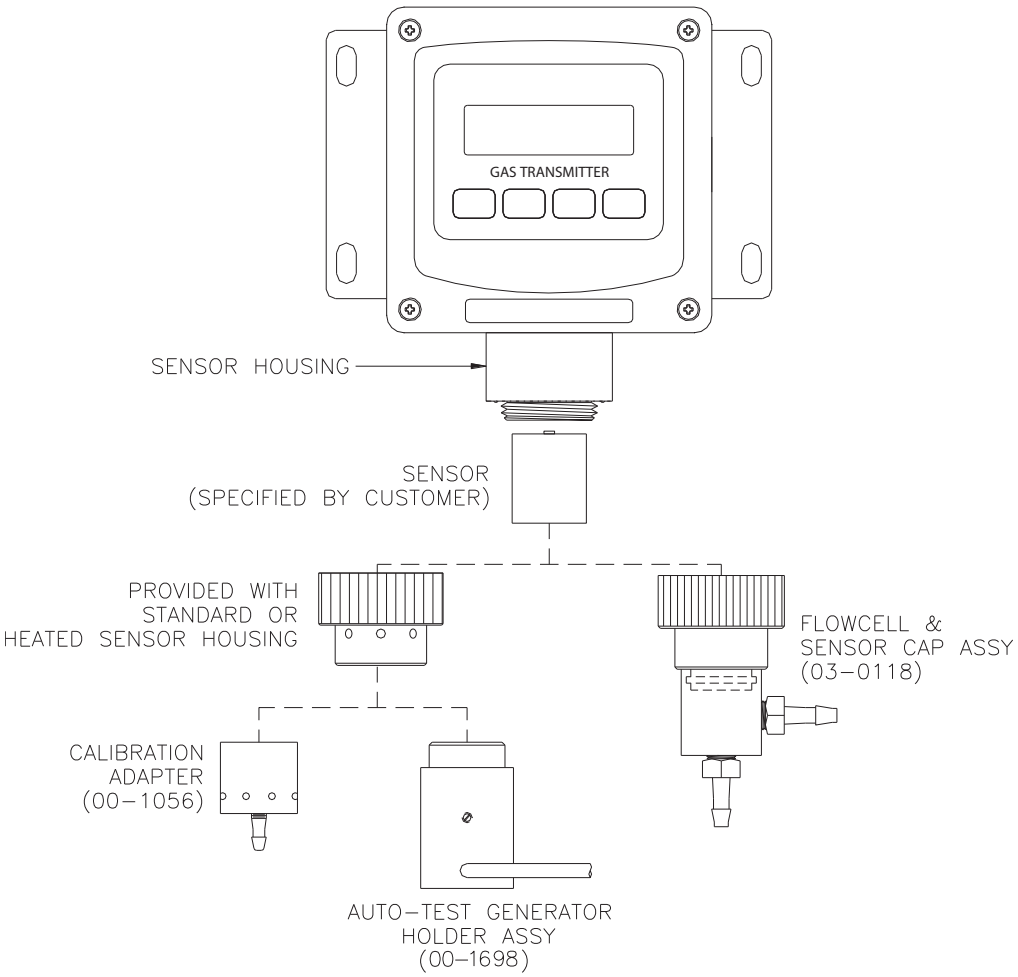


Figure 113: Exploded view

Part No.	Description
00-1699	F12 sensor holder assembly (heated)
00-1700	F12 sensor holder assembly
03-0332	Standard sensor cap
00-1698	Auto-test generator holder assembly
29-0013	Battery
23-0022	Fuse, 250 mA, 250V, TR5
00-1056	Calibration adapter
03-0118	Flowcell & solid sensor cap assy
00-1702	6 ft. sensor housing assembly

H10 Sensor Modules

Part No.	Description
00-1000	Bromine, 0…1/5 PPM (2 PPM standard)
00-1001	Bromine, 0…5/200 (20 PPM standard)
00-1002	Chlorine, 0…1/5 PPM (2 PPM standard)
00-1003	Chlorine, 0…5/200 (20 PPM standard)
00-1004	Chlorine dioxide, 0…1/5 PPM (2 PPM standard)
00-1005	Chlorine dioxide, 0…5/200 (20 PPM standard)
00-1006	Fluorine, 0…1/5 PPM (2 PPM standard)
00-1007	Fluorine, 0…5/200 (20 PPM standard)
00-1008	Ozone, 0…1/5 PPM (2 PPM standard)
00-1009	Ozone, 0…5/200 PPM (20 PPM standard)
00-1010	Ammonia, 0…50/500 PPM (200 PPM standard)
00-1011	Ammonia, 0…500/2000 PPM (1000 PPM standard)
00-1012	Carbon monoxide, 0…50/1000 PPM (200 PPM standard)
00-1013	Hydrogen, 0…1/10% (4% standard)
00-1014	Oxygen, 0…5/25% (25% standard)
00-1015	Phosgene, 0…1/5 PPM (2 PPM standard)
00-1016	Phosgene, 0…5/100 PPM (100 PPM standard)
00-1017	Hydrogen chloride, 0…10/200 PPM (20 PPM standard)
00-1018	Hydrogen cyanide, 0…10/200 PPM (20 PPM standard)
00-1019	Hydrogen fluoride, 0…10/200 PPM (20 PPM standard)
00-1020	Hydrogen sulfide, 0…10/200 PPM (50 PPM standard)
00-1021	Nitric oxide, 0…50/500 PPM (200 PPM standard)
00-1022	Nitrogen dioxide, 0…10/200 PPM (20 PPM standard)
00-1023	Sulfur dioxide, 0…10/500 PPM (20 PPM standard)
00-1024	Arsine, 0…500/2000 PPB (1000 PPB standard)
00-1025	Arsine, 0…10/200 PPM (10 PPM standard)
00-1026	Diborane, 0…500/2000 PPB (1000 PPB standard)
00-1027	Diborane, 0…10/200 PPM (10 PPM standard)
00-1028	Germane, 0…500/2000 PPB (1000 PPB standard)
00-1029	Germane, 0…10/200 PPM (10 PPM standard)
00-1030	Hydrogen selenide, 0…500/2000 PPB (1000 PPB standard)
00-1031	Hydrogen selenide, 0…10/200 PPM (10 PPM standard)
00-1032	Phosphine, 0…500/2000 PPB (1000 PPB standard)
00-1033	Phosphine, 0…10/200 PPM (10 PPM standard)
00-1034	Phosphine, 0…200/2000 PPM (1000 PPM standard)
00-1035	Silane, 0…10/200 PPM (10 PPM standard)
00-1036	Iodine, 0…1/5 PPM (2 PPM standard)
00-1037	Iodine, 0…5/200 PPM (20 PPM standard)
00-1038	Acid gases, 0…10/200 PPM (20 PPM standard)
00-1039	Ethylene oxide, 0…20/200 PPM (20 PPM standard)
00-1040	Formaldehyde, 0…20/200 PPM (20 PPM standard)
00-1041	Hydrogen, 0…500/2000 PPM (2000 PPM standard)

Part No.	Description
00-1042	Hydrogen peroxide, 0…10/100 PPM (20 PPM standard)
00-1043	Alcohol, 0…50/500 PPM (200 PPM standard)
00-1044	Alcohol, 0…500/2000 PPM (2000 PPM standard)
00-1057	Acetylene, 0…50/500 PPM (0…200 PPM standard)
00-1169	Hydrogen peroxide, 200/2000 PPM (500 PPM standard)
00-1181	NOx, 50/500 PPM (200 PPM standard)
00-1285	Silane, 500/2000 PPB (1000 PPB standard)
00-1349	Formaldehyde, 500/2000 PPM (1000 PPM standard)
00-1358	Ozone, 200/1000 PPM (1000 PPM standard)
00-1359	Chlorine dioxide, 200/1000 PPM (1000 PPM standard)
00-1425	Chlorine dioxide, 1/5 PPM (low Cl_2 response)
00-1450	Dimethylamine (DMA), 100/200 PPM (100 PPM standard)
00-1455	Hydrogen bromide, 10/200 PPM (20 PPM standard)
00-1469	Hydrogen sulfide, 200/1000 PPM (500 PPM standard)

E18 Gas Generators

Part No.	Description
00-1538	Chlorine
00-1539	Ammonia
00-1540	Carbon monoxide
00-1541	Hydrogen sulfide
00-1542	Sulfur dioxide

Miscellaneous Accessories

Part No.	Description
00-1388	H10 duct mount adapter
00-1649	H10 duct mount sensor holder
46-0003	Sensor gasket for (00-1649)
03-0414	Duct mount cable assembly
03-0370	Communications jumper plug (for RS232/RS485 options)

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