



# American Magnetics

## MODEL 176

Two-Wire  
Continuous Level  
Transmitter



## INSTALLATION, OPERATION & MAINTENANCE MANUAL

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# SECTION A

## Foreword

This section contains the Installation instructions for the American Magnetics, Inc. (AMI) Model 176 Two-Wire Continuous Level Transmitter. Since it is impossible to cover all possible sensor/systems configurations, only the most common are discussed in this document. The user is encouraged to contact an authorized AMI Customer Support Representative for specific situations.

*Foreword* discusses safety precautions and safety notations as well as other generic information used throughout this manual.

*Introduction* explains the functions and characteristics of the instrument, describes the model number configurations for the instrument and the probe, and documents the performance specifications, as well as an explanation of the operating principle.

*Installation* describes the procedure for properly unpacking and installing the transmitter into your vessel.

## **Safety Precautions**

### **Conventions**

The conventions used in this manual follow ANSI Z535.4-2002 for “Product Safety Signs and Labels”. The safety markings in this manual are as follows:



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. This category also includes potential equipment damage.

### **Cryogen Safety**

Cryogenic liquefied gases are potentially extreme suffocation hazards since a small amount of liquid will vaporize and yield a very large volume of oxygen-displacing gas. Always ensure the location where the cryogen used is well ventilated.

Cryogenic liquids, due to their extremely low temperatures, will burn the skin in a similar manner as hot liquids. Never permit cryogenic liquids to contact the skin or allow them to soak clothing. Serious burns may result from careless handling. Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures. The vapors expelled during the venting process are sufficiently cold to burn flesh or freeze optic tissues.

Containers of cryogenic liquids are self-pressurizing (as the liquid boils off, vapor pressure increases). Hoses or lines used to transfer these liquids should never be sealed at both ends (i.e. by closing valves at both ends).

The properties of many materials at extremely low temperatures may be quite different from the properties that these same materials exhibit at room temperatures. Exercise extreme care when

handling materials cooled to cryogenic temperatures until the properties of these materials under these conditions are known.

Cryogenic storage systems are complex systems with the potential to seriously injure personnel or equipment if not operated according to procedures. Proper use of safety mechanisms (pressure relief valves, rupture disks, etc.) included in the cryostat and top plate assembly are necessary.

### ***Warranty***

American Magnetics, Inc. warrants its products to conform to the specifications described in its quotation for a period of fifteen months from the date of shipment. AMI makes no other warranty of any kind, expressed or implied. In the event of failure occurring during normal use, AMI, at its option, will repair or replace all products or components that fail under warranty and such repair or replacement shall constitute a fulfillment of all AMI liabilities with respect to its products. Since, however, AMI does not have control over the installation conditions or the use to which its products are put, no warranty can be made of fitness for a particular purpose, and AMI cannot be liable for special or consequential damages. All repairs are F.O.B. Oak Ridge, Tennessee, USA. If the repairs are covered under this warranty then standard shipping for return to the customer is paid for by AMI within the USA.

### ***Return Authorization***

Before shipping any item to AMI for repair, you must first obtain an RMA number from an authorized AMI representative. Do not attempt to repair or replace any items without first speaking to an authorized AMI representative. Doing so may expose the customer to hazards and will void this warranty. Customers requiring a more comprehensive warranty program may purchase additional coverage, the price of which may vary by product type.

## **Introduction**

The instructions in this manual pertain to the AMI Model 176 Two-Wire Continuous Level Transmitter. The Model 176 is designed to measure the level of non-conductive liquids and cryogenic fluids.

The instrument is available in two different mounting configurations: *integral-mounting* with the probe as shown in Figure 1, or *remote-mounting* a maximum of 15 feet from the probe as shown in Figure 2.

Unless otherwise noted in the specifications, when properly installed (and all covers closed) this instrument is intended for indoor or outdoor use in a pollution degree 3 environment per IEC 61010-1.

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

The *Appendix* in this manual also lists various installation parts and connectors that are included with the instrument and the optional remote-mounting configuration.



**Do not install this instrument in locations with intrinsically safe requirements.**



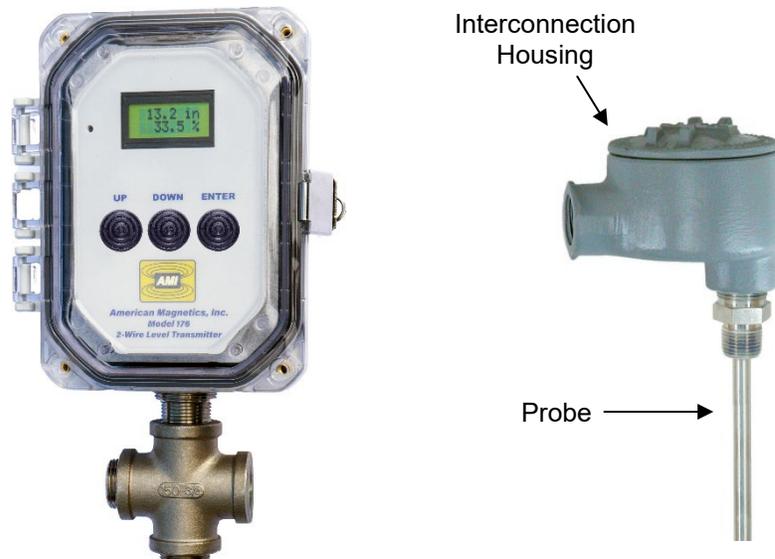
**The instrument and probe are not intended for use in space launch vehicles, space habitation modules, or in support facilities in the presence of potentially explosive materials.**

## **Instrument Cleaning**

The external of the instrument enclosure with the corner cover screws installed is rated as NEMA 4X and IP67. Do not attempt internal cleaning.



**Figure 1**



**Figure 2**

## System Description

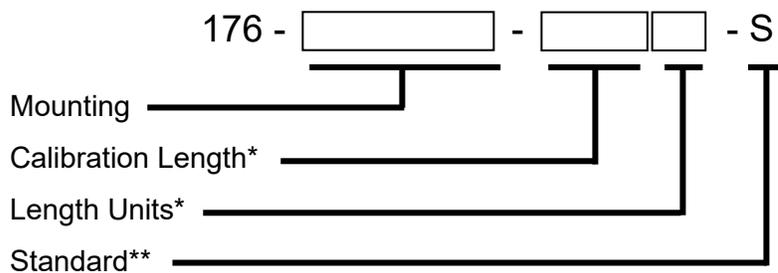
The Model 176 liquid level system consists of the Model 176 Instrument and an AMI CAPSEN Capacitance Probe. The instrument consists of the electronic assembly in a NEMA 4X/IP67 enclosure with installed printed circuit board, and an interconnection nipple. The enclosure provides a 3/4" NPT conduit opening for external wiring. The transparent cover allows for viewing of process variables and can be unlatched and opened to allow configuration. The probe is a concentric-tube assembly designed to electrically and physically mate to the Model 176, either directly or remotely (up to 15 feet).

(Shown here with Cover Open)



**Figure 3**

## Instrument Model Configuration



\*\*Custom versions of the Model 176 are not available.

### Mounting

Description	Code
Integral	Integral
Remote	Remote

### Length Units

Description	Code
Inches	in
Centimeters	cm

### \*Calibration Length and Length Units

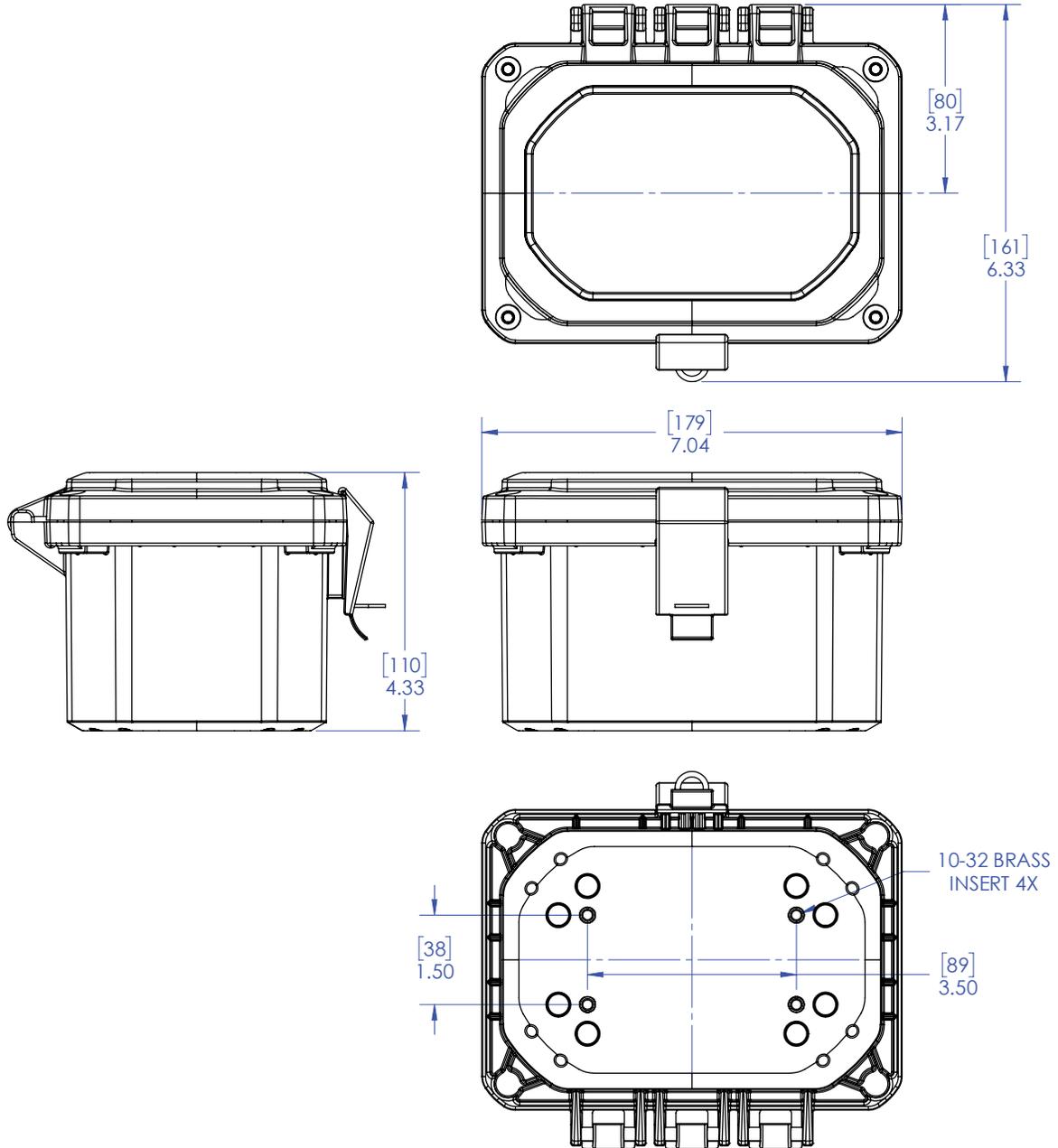
Calibration length will normally be set at the Active Length of the probe as defined in the probe configuration (see page 9). No leading zeroes.

### Liquid

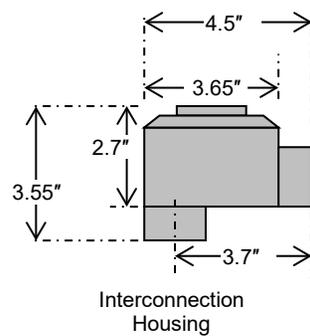
The liquid is not part of the instrument configuration but is required when calibrating the instrument to the probe. This information will be specified as part of the probe configuration (see page 9).

## Model 176 Transmitter Dimensions – Inches [mm]

### Transmitter Housing

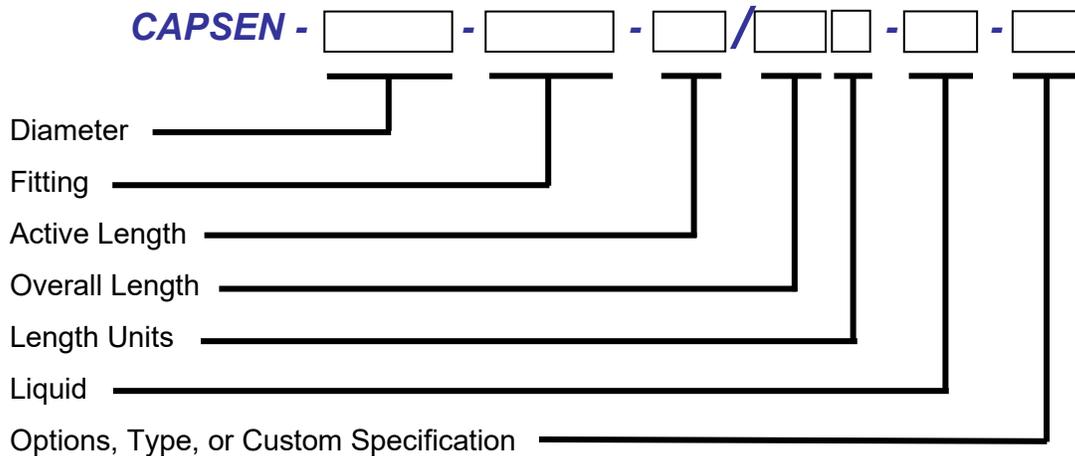


### Remote-mounted Sensor Housing



## Probe (Capacitance Sensor) Model Configuration

**⚠ CAUTION** Welded fittings cannot be adjusted. Ensure the dimensions are such that when the probe fitting is fully engaged, the probe does not tighten against the bottom of the container! Contact AMI Sales if you have any questions concerning the dimensions or options. See dimensional drawing below.



### Diameter

Description	Code
3/8" Outer Diameter	OD3/8
1/2" Outer Diameter	OD1/2

### Fitting

Description	Code
Model 176 Welded 1/2" NPT (3/8" or 1/2" diameter sensor)	M176NPT

### Active Length

This is the measurement range of the probe. It starts 0.375" above the bottom tip of the probe, and ends 1" below the upper-most vent hole on the probe.

### Overall Length

This is defined as the total length of the probe, measured from the bottom tip to the top of the connector. Contact the factory to discuss lengths over the Maximum Overall Lengths:

100" for 3/8"-diameter, and  
144" for 1/2"-diameter.

### Lengths and Length Units

Description	Code
Inches (nearest 1/10")	in
Centimeters (integer, no decimal)	cm

\*\*Custom probes require an AMI-approved customer-signed drawing. "Custom" applies to any probe not falling in the "S", "HCap", or "RSvc" Option categories. Also probes having a fitting other than the basic M176NPT with BNC, or those deviating from the length limits.

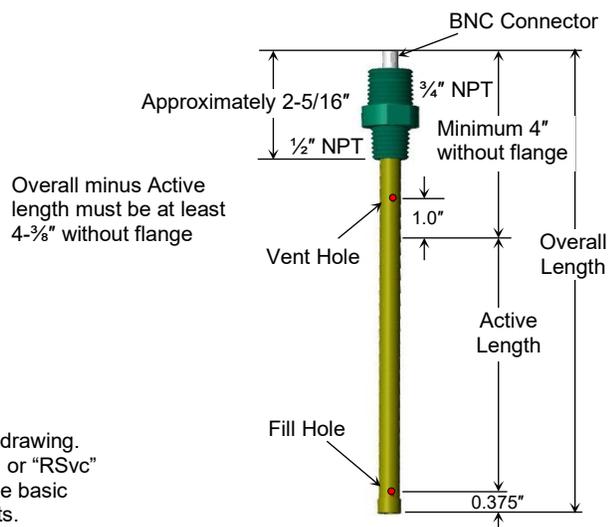
### Liquid\*

Description	Code
Liquid Nitrogen	LN2
Liquid Oxygen	O2
Liquid Carbon Dioxide	CO2

\*For others, the commonly recognized chemical formula (or abbreviation) will be used. Contact AMI.

### Options\*\*

Description	Code
Standard (3/8" only)	S
High Capacitance (1/2" dia. only)	HCap
Rugged Service (1/2" dia. only)	RSvc
Flange – Custom**, contact AMI.	TBD: per Spec



**Typical Capacitance Probe with M175NPT Welded Fitting and BNC Connector**

## Instrument Specifications @ 25°C

Description		Specification
Power Supply		12 – 30 VDC ±10%; 24 VDC nominal; 22.5 mA maximum current
Supply Voltage Effect		Less than 0.01% / volt change
Ambient Temperature Range		-40°F to 176°F (-40°C to 80°C)
Humidity		0 – 99% non-condensing
Accuracy		±0.1% of span
Repeatability		±0.05% of span
Linearity		±0.1% of span
Resolution		0.01 mA
Response Time		150 msec (Damping = 0 s)
Temperature Effect		±0.02 pF / °C
Operator Interface	Data Entry	3-button keypad
	Display	2 Line by 8-Character LCD <sup>1</sup>
Analog Output		4-20 mA; 3.8 – 20.5 mA overtravel; reversible
Error Indication		3.6 mA, 22 mA, or Hold last value; user selectable
Range		5 – 100,000 pF
Damping		0 – 60 seconds; field adjustable in 1 sec. increments
Maximum Remote Cable Length		15 feet between the transmitter and the probe
Instrument Weight		1.95 lbm
Instrument Enclosure		NEMA 4X/IP67

<sup>1</sup> Display is readable from -4°F to 140°F (-20°C to 60°C).



**Do not install this instrument in locations with intrinsically safe requirements.**

## Probe Specifications

Description	Specification
Process Temperature Range @ 0 psig (1 Bar)	-435°F – 180°F (-259°C – 82°C)
Process Pressure Range @ 100°F (37°C)	Vacuum to 1,000 psig



**The instrument and probe are not intended for use in space launch vehicles, space habitation modules, or in support facilities in the presence of potentially explosive materials.**

## Operating Principle

The probe materials and the media form a capacitor with the media being a portion of the dielectric (non-conductive media applications). As the level of the media changes over the Active Length, a corresponding change in capacitance occurs. The Model 176 transmitter measures this change, compares it to the calibrated values, and calculates and displays the level of the media.

# Installation

## *Unpacking*

Upon receiving the Model 176 transmitter, check all components carefully for damage incurred in shipping. If damage is evident, or suspected, do not attempt installation. Notify the carrier immediately and request a damage inspection. Check each item against the packing list.

## *Mounting Location*

Model 176 transmitters should be mounted in a location that is as free as possible from mechanical shock, vibration, and corrosive atmospheres. The area should have an ambient temperature in the range of  $-40^{\circ}\text{F}$  to  $176^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ ).

## *Integral-Mounted Transmitter Installation*



**Before starting installation procedures, ensure that all power sources have been turned off. Do not install this instrument in locations with intrinsically safe requirements. “Live” electrical circuits can ignite flammable gases and dusts.**

**Follow the wiring practices set forth in the National Electric Code, as well as local electrical codes. These Codes supercede any information in this manual.**



**Do not apply more than 33 VDC to the transmitter, as this may damage the instrument. Ensure all cables are routed to avoid pinching and damaging the instrument or other devices (see Figure 5).**

- 1.) Unlatch the transparent instrument cover and open.
- 2.) Remove the internal protective cover, Figure 4, from the instrument by removing the corner screws. Retain the screws for reinstallation of the protective cover. This will allow access to the circuit board, shown in Figure 5.

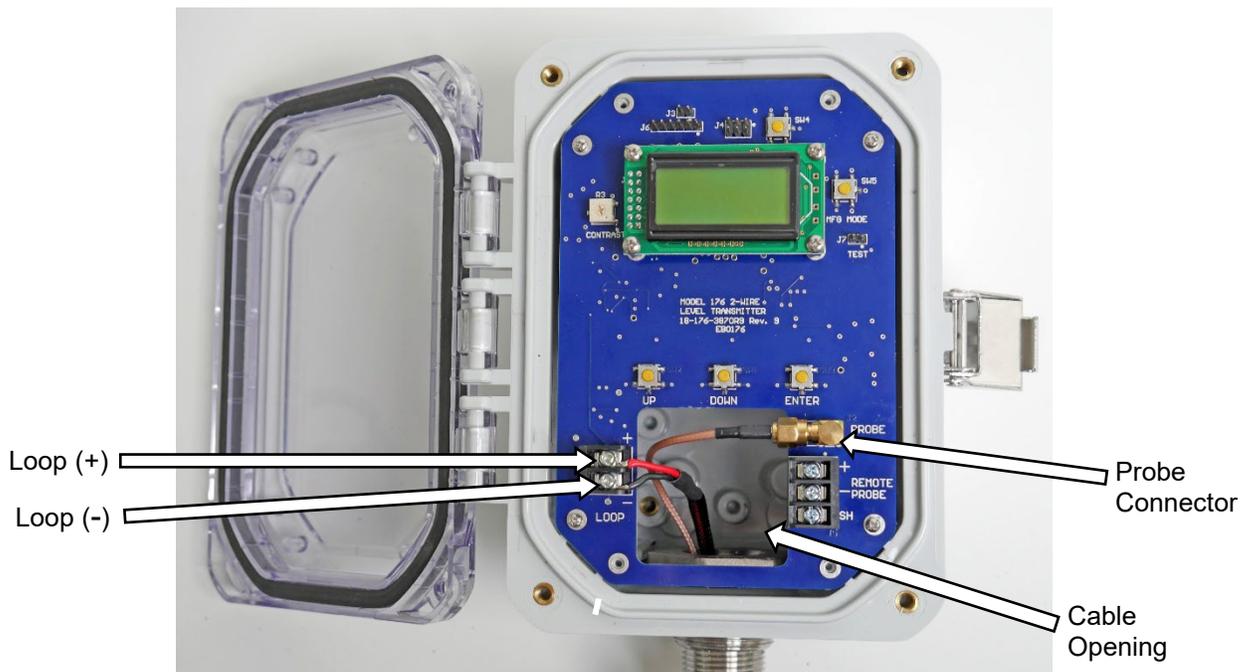


**Figure 4**



Only qualified personnel implementing industry best-practice ESD precautions should remove the cover and perform the wiring instructions detailed below. The most convenient connection point for circuit board ground is the housing of the SMA Probe connector.

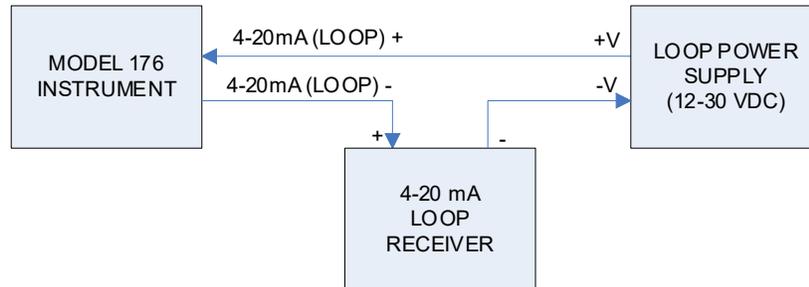
- 3.) The wiring nipple and 4-way cross may be attached to the instrument enclosure at the factory (see Figure 1). The probe will normally have a coaxial BNC-female electrical connector on top. Insert the probe's short coaxial cable (BNC-to-SMA) through the 4-way cross, wiring nipple, and into the instrument housing to the Cable Opening area.
- 4.) Ensure the BNC connector of the coaxial cable is attached to the top of the probe and then tighten the 4-way cross onto the top of the probe. **DO NOT** use the instrument enclosure for tightening.
- 5.) Connect to the PROBE connector (see Figure 5) in the instrument enclosure by screwing the SMA male connector on the coaxial cable into the right-angle mating connector on the circuit board.



**Figure 5**

- 6.) Connect conduit to the instrument using the supplied 4-way cross and plug if needed. Follow all applicable electrical codes when installing this conduit and wiring. It is strongly recommended that you use a drip-loop to prevent water from entering the instrument enclosure from the conduit.
- 7.) Using a shielded twisted pair cable inserted through the 4-way cross and wiring nipple, connect the positive wire to the + Loop terminal and the negative wire to the – Loop terminal (see Figure 5). Heatshrink or tape over any exposed drain wire and/or shield - **DO NOT** connect the shield and/or drain wire of the Loop cable to the instrument.

- 8.) Connect the Loop/4-20 mA external elements as necessary including the Loop Power Supply. A typical connection scheme is shown in Figure 6.
- 9.) Reinstall the protective cover and screws.
- 10.) Refer to Section B for calibration instructions.



**Figure 6**

### *Remote-Mounted Transmitter Installation*

#### **⚠ WARNING**

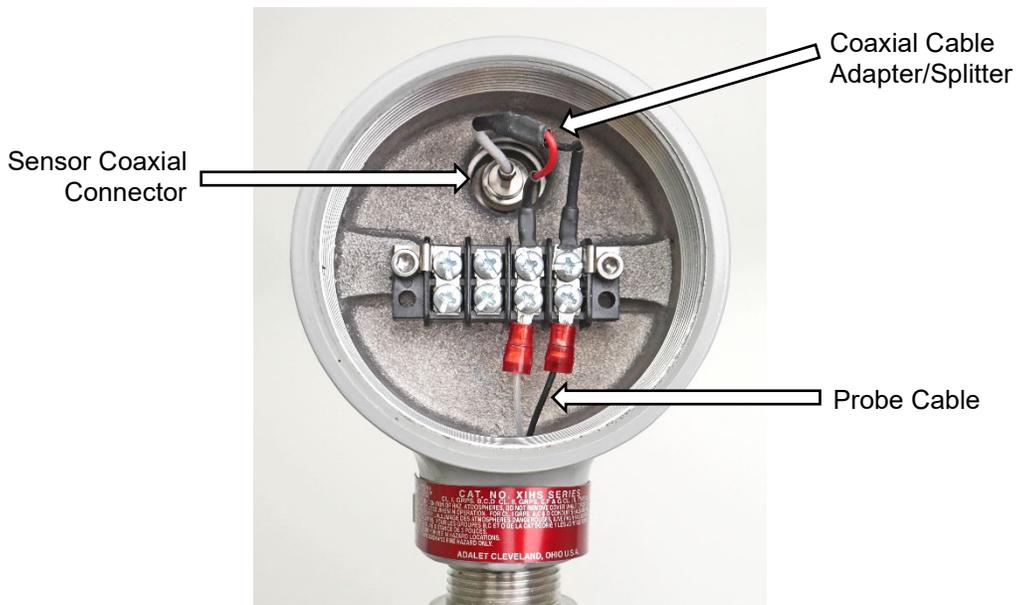
Before starting installation procedures, ensure that all power sources have been turned off and locked out. Do not install this instrument in locations with intrinsically safe requirements. “Live” electrical circuits can ignite flammable gases and dusts.

Follow the wiring practices set forth in the National Electric Code, as well as local electrical codes. These Codes supercede any information in this manual.

#### **⚠ CAUTION**

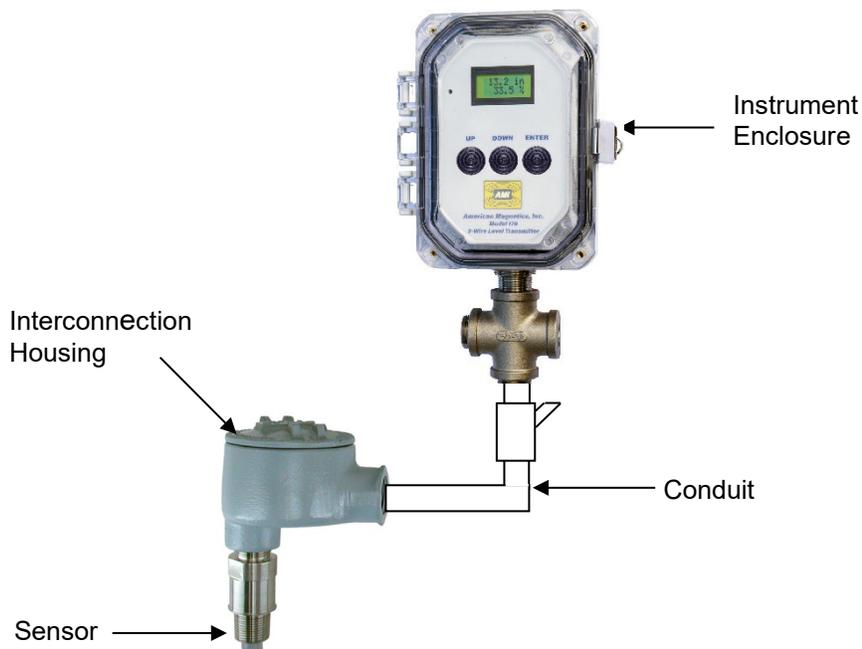
Do not apply more than 33 VDC to the transmitter, as this may damage the instrument. Ensure all cables are routed to avoid pinching and damaging the instrument or other devices (see Figure 5).

- 1.) The sensor will normally have a coaxial electrical connector on top. Connect the supplied short coaxial cable adapter/splitter to the sensor coaxial connector.
- 2.) Remove the cover of the interconnection housing.
- 3.) Insert the sensor’s adapter/splitter cable end into the bottom of the interconnection housing. Screw the interconnection housing onto the sensor fitting. Use the wrench flats on the nipple and the body of the housing for tightening.
- 4.) The + Probe wire is the center (red) conductor of the sensor. Connect the + Probe wire to one of the two inner terminals on the terminal block inside the Interconnection Housing. The outer conductor of the sensor (black wire) is the – Probe and connects to an outer terminal as shown in Figure 7.
- 5.) Connect conduit between the Interconnection Housing and the Remote-Mounting Bracket (see Figure 8). At the Interconnection Housing end, using up to 15-ft. of shielded twisted pair cable (Belden 8761 or equivalent) through the conduit.



**Figure 7**

- 6.) As shown in Figure 7, the shielded twisted pair cable's translucent/gray wire (+ Probe) connects to the red wire from the sensor via the terminal block. The probe cable black wire (- Probe) connects to the black wire from the sensor via the terminal block. Heatshrink or tape over any exposed drain wire and/or shield - **DO NOT** connect the shield and/or drain wire of the probe cable to this housing.



**Figure 8**

- 7.) Connect conduit between the sensor interconnection housing and the instrument, using the supplied 4-way cross and plug if needed. Follow all applicable electrical

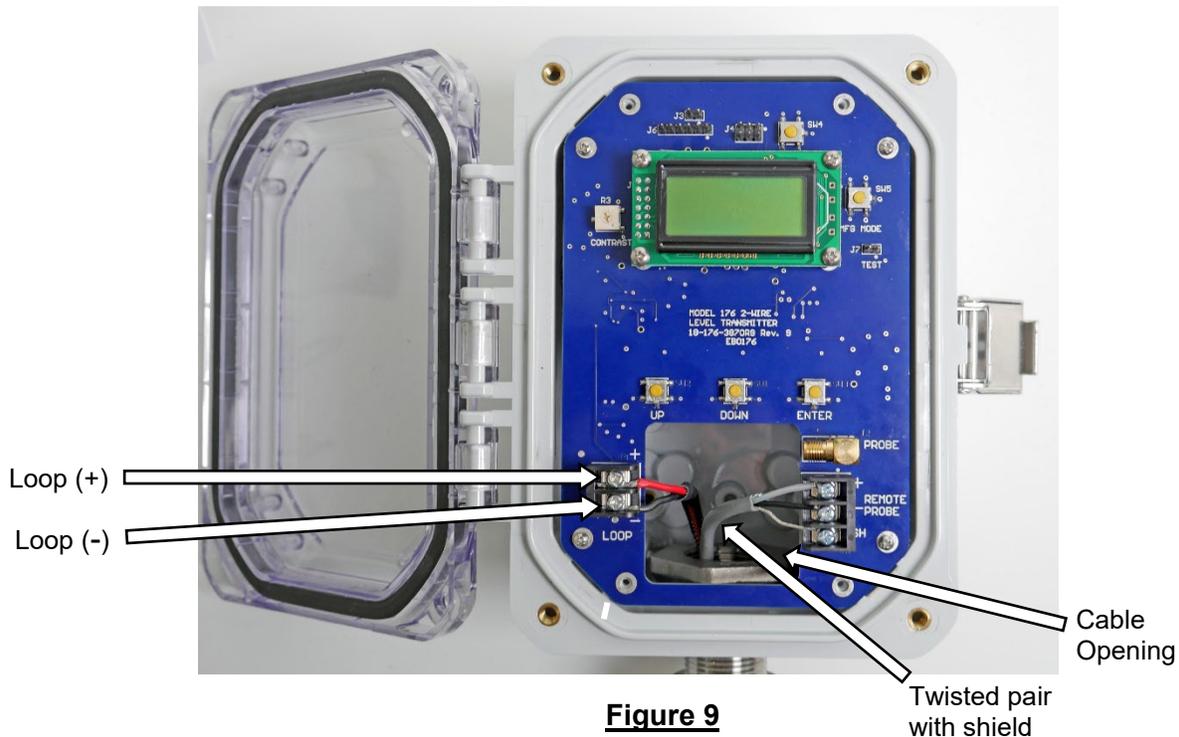
codes when installing this conduit and wiring. It is strongly recommended that you use a drip-loop to prevent water from entering the instrument enclosure from the conduit.

- 8.) Unlatch and open the clear outer cover on the instrument enclosure.



**Only qualified personnel implementing industry best-practice ESD precautions should expose the circuit board and perform the wiring instructions detailed below. The most convenient connection point for circuit board ground is the housing of the SMA Probe connector.**

- 9.) Remove the corner screws from the internal protective cover to expose the circuit board as shown in Figure 4.
- 10.) Route the probe cable twisted pair and shield through the NPT feedthrough at the bottom of the enclosure as shown in Figure 9.
- 11.) Connect the probe cable wire with translucent/gray insulation to the + REMOTE PROBE terminal. Connect the probe cable wire with black insulation to the – REMOTE PROBE terminal. Connect the uninsulated shield drain wire to the SH REMOTE PROBE terminal.



**Figure 9**

- 12.) Using a shielded twisted pair cable, connect the positive wire to the + Loop terminal and the negative wire to the – Loop terminal. Heatshrink or tape over any exposed drain wire and/or shield - **DO NOT** connect the shield and/or drain wire of the Loop cable to the instrument.
- 13.) Connect the Loop/4-20 mA external elements as necessary including the Loop Power Supply. A typical connection scheme is shown in Figure 6.
- 14.) Reinstall the protective cover and screws.
- 15.) Refer to Section B for calibration and programming instructions.

# SECTION B

This section contains the Operation and Maintenance instructions for the AMI Model 176 Two-Wire Continuous Level Transmitter. Since it is impossible to cover all possible sensor/systems configurations, only the most common are discussed in this document. The user is encouraged to contact an authorized AMI Instrument Technical Support Representative for special situations.

*Set-up* details the software commands and procedures for matching (calibrating) the transmitter to your application.

*Calibration* details the available methods of calibration including Open Dewar, Closed Dewar, and Approximate.

*Troubleshooting* provides information and various tests used to determine the cause of any issues with the Model 176 instrument.

## Set-Up

The Model 176 Transmitter displays information locally in a 2-line by 8-character format. The normal operating display can be set to either LEVEL and %OUTPUT, or LEVEL and LOOP CURRENT. The keypad consists of three buttons. “Up” and “Down” are used to scroll through the menu or change the numeric value of a particular option. Depress either of the buttons continuously to rapidly change the numeric value. “Enter” is used to accept the data that has been selected with the “Up” and “Down” buttons.

The buttons are accessed by unlatching and opening the transparent cover.

### **ProxCal™ Calculation**

This method is the least accurate form of calibration and should be used only when it is impossible to change the level of the actual process fluid. This method allows a substitute fluid to be used for calibration. A cryogenic stilling well should be used if the actual process vessel is not available for the calibration process.

To use ProxCal, the level measurements used for Probe LO Cal and Probe HI Cal must be referenced from the bottom of the probe. In other words, the probe bottom must be considered zero (inches or mm).

The dielectric constant for the reference (substitute) fluid  $\epsilon_1$ , and the target (process) fluid  $\epsilon_2$  are needed for the ProxCal factor calculation. The equation is as follows:

$$ProxCal\ Value = \frac{\epsilon_2 - 1}{\epsilon_1 - 1} \times 100$$

Install the transmitter into the target vessel containing the process fluid. See the “Menu Structure” section for directions on how to enter the ProxCal factor into the transmitter.

A value of 100.0 for ProxCal™ means any approximate scaling is inactive.

If you do not know the dielectric constant of the fluids, obtain the actual level of the process fluid in the target vessel. Install the transmitter into the target vessel. Adjust the ProxCal factor until the transmitter displays the level in the vessel obtained previously.

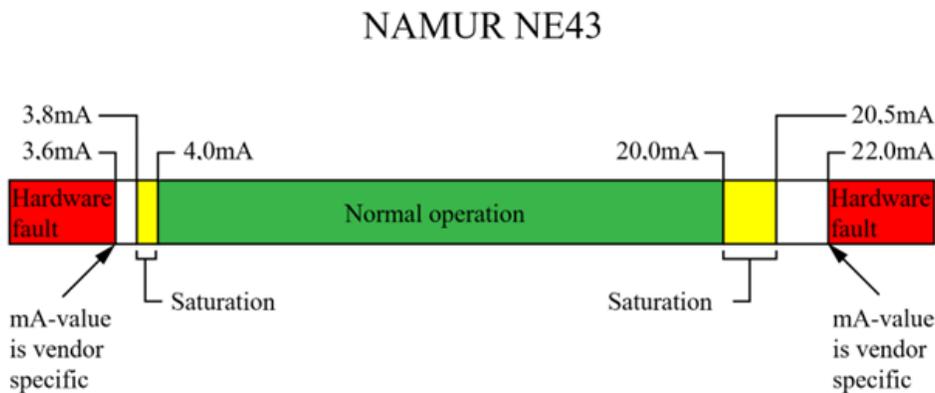
### Menu Item Descriptions

FUNCTION	DESCRIPTION
Units	This is used to select the measurement units shown on the display. These units are used during the calibration process.
Hi Cal	This is used to set the high calibration point on the probe. This can either be the highest liquid level on the probe (preferably), or the highest achievable level during calibration. The order in which the "Lo Cal" and "Hi Cal" are set is not important, only that the "Lo Cal" must be below the "Hi Cal". A minimum 2% of span change is required between the two points. The Cal points are independent of the 4mA/20mA points and must be referenced in the measurement units on the probe.
Lo Cal	This is used to set the low calibration point on the probe. This can either be the lowest liquid level on the probe (preferably), or the lowest achievable level during calibration. The order in which the "Lo Cal" and "Hi Cal" are set is not important, only that the "Lo Cal" is below the "Hi Cal". A minimum 2% of span change is required between the two points. The Cal points are independent of the 4mA/20mA points.
20 mA Pt	These are the levels in the vessel corresponding to the 4mA (or LRV*) and 20mA (or URV**) outputs. They can be the same or different than the "Lo Cal" & "Hi Cal" points.  * Lower Range Value ** Upper Range Value
4 mA Pt	
Prox Cal	After the unit has been calibrated for a particular fluid, "ProxCal" will allow you to adjust the calibration span for a different fluid without recalibrating. The "Hi Cal" and "Lo Cal" points need not be changed when using ProxCal. If you do recalibrate the Hi/Lo Cal points in a new target fluid, change the ProxCal value back to 100.0.
Damping	This is an exponential decay filter used to slow down the output response time of the transmitter. This, in effect, stabilizes the output and display in a turbulent vessel.
Error	This determines the value of the output current upon detection of a fault condition (capacitance out of range, dead oscillator, loss of signal, etc.).
Trim 20	This allows for an adjustment of the D/A converter for the 4-20mA output. This ensures that the unit display matches the remotely measured 4-20mA signal (measured with an in-line ammeter, or voltmeter across a sense resistor).
Trim 4	
Loop Cur	This feature allows the user to force the transmitter output to a fixed value from 3.6 to 22mA. This allows the user to test other devices in the loop.

FUNCTION	DESCRIPTION									
RNG:CNTS	<p>RNG displays the calibration range (0 to 7). The transmitter automatically selects the Range value during the calibration process.</p> <table border="0"> <tr> <td>0 = 0 to 781pF</td> <td>3 = 0 to 6,250pF</td> <td>6 = 0 to 50,000pF</td> </tr> <tr> <td>1 = 0 to 1,562pF</td> <td>4 = 0 to 12,500pF</td> <td>7 = 0 to 100,000pF</td> </tr> <tr> <td>2 = 0 to 3,125pF</td> <td>5 = 0 to 25,000pF</td> <td></td> </tr> </table> <p>CNTS displays the digital counts that correspond to the capacitance being measured within the Range selected (Troubleshooting tool). 0 to 65,535 counts within each range.</p>	0 = 0 to 781pF	3 = 0 to 6,250pF	6 = 0 to 50,000pF	1 = 0 to 1,562pF	4 = 0 to 12,500pF	7 = 0 to 100,000pF	2 = 0 to 3,125pF	5 = 0 to 25,000pF	
0 = 0 to 781pF	3 = 0 to 6,250pF	6 = 0 to 50,000pF								
1 = 0 to 1,562pF	4 = 0 to 12,500pF	7 = 0 to 100,000pF								
2 = 0 to 3,125pF	5 = 0 to 25,000pF									
Factory Reset?	This resets <b>all</b> values in the transmitter back to factory values. This may include a factory calibration in LN2 depending on whether a paired sensor was purchased at the time of order.									

### Current Loop Output Convention

The current loop output conforms to NAMUR NE43 which standardizes the signal level of the failure information in the analog current signal. The range of the output is defined as shown below (Figure 10):



**Figure 10**

The specific fault indication signal levels chosen by AMI are 3.6 mA and 22 mA.

The saturation ranges allow for a small amount of under-range (-1.3% of range) and over-range (103.1% of range). A level below or above the saturation range will cease to exhibit a decrease or increase, respectively, of the current loop output, but an error state will *not* be indicated so long as the system is functioning normally otherwise. The display will indicate <Under> or <Over>.

The simplest configuration of the normal operation range of the current loop output is to set the 4 mA Pt and 20 mA Pt equal to the positions of the Lo Cal and Hi Cal, respectively. However, this is not strictly required as the 4 mA Pt and 20 mA Pt can be set to any position within the calibrated range. For example, if you desire the current loop to output 4 mA at 2 inches above the bottom vent hole (Lo Cal point of zero), then set the 4 mA Pt value to 2.0 inches.

## Menu Structure

DISPLAY	FUNCTION	NOTES
0.0 <i>Iu</i> 0.0%	Run Mode (Display only) ( <i>Iu</i> = level units)	Level Measurement = in. or mm Level % = Percentage of loop current span
0.0 <i>Iu</i> 4.0 mA	Run Mode (Display only) ( <i>Iu</i> = level units)	Level Measurement = in. or mm Loop Current in mA
Units <i>Iu</i>	Select level measurement units. ( <i>Iu</i> = level units)	Press "Enter". Use "Up" / "Down" to select between in (inches) and mm. Press "Enter" to store the value.
Hi Cal XXX.X <i>Iu</i>	Enter the Upper Calibration Point ( <i>Iu</i> = level units)	Press "Enter". Use "Up" / "Down" to select the actual level as measured from the bottom hole of the sensor. Press "Enter" to lock the value. Press "Enter" again to store the value.
Lo Cal XXX.X <i>Iu</i>	Enter the Lower Calibration Point ( <i>Iu</i> = level units)	Press "Enter". Use "Up" / "Down" to select the actual level as measured from the bottom hole of the sensor. Press "Enter" to lock the value. Press "Enter" again to store the value.
20 mA Pt XXX.X <i>Iu</i>	Enter the 20mA Point ( <i>Iu</i> = level units)	Press "Enter". Use "Up" / "Down" to select the level on the sensor to equal the 20mA output. Press "Enter" to store the value.
4 mA Pt XXX.X <i>Iu</i>	Enter the 4mA Point ( <i>Iu</i> = level units)	Press "Enter". Use "Up" / "Down" to select the level on the sensor to equal the 4mA output. Press "Enter" to store the value.
ProxCal 100.0	Enter the Dielectric Compensation value	Press "Enter". Use "Up" / "Down" to select the value calculated to correctly adjust the span calibration. Press "Enter" to store the value. (See section "ProxCal Calculation" to determine this value).
Damping XX sec	Select the Damping value	Press "Enter". Use "Up" / "Down" to select the number of seconds (0 – 60) needed to stabilize your output.
Error 3.6 mA	Select the Error Output State	Press "Enter". Use "Up" / "Down" to select between "3.6mA", "22mA", or "Hold". Press "Enter" to store.
Trim 20 XXXX	Enter the 20mA Trim Value	Connect an ammeter in the loop. Press "Enter". Use "Up" / "Down" to adjust the current output until the ammeter reading matches the transmitter display. Press "Enter" to store the value.

DISPLAY	FUNCTION	NOTES
Trim 4 XXXX	Enter the 4mA Trim Value	Connect an ammeter in the loop. Press "Enter". Use "Up" / "Down" to adjust the current output until the ammeter reading matches the transmitter display. Press "Enter" to store the value.
Loop Cur XX.X mA	Manually change the loop current	Press "Enter". Use "Up" / "Down" to select the desired loop current. Press "Enter" to select this value. Press "Enter" to end the test and return to the actual loop current value
RNG: CNTS 0:66535	RNG: Calibration range (Display only) CNTS: Digital measurement counts (Display only)	RNG Valid value = 0 - 7 CNTS Valid value = 0 – 65535
Factory Reset?	Reset the transmitter to factory settings.	Press "Enter". If you really want to reset the memory, press "Enter" again. Otherwise, press "Up" or "Down".

## **Calibration**

Model 176 may be calibrated at American Magnetics, Inc. for a specific length sensor for use in a specific liquid. The calibration length and calibration liquid are listed on the instrument's calibration sticker. If the factory calibration method utilized was approximate (i.e. a specific liquid was not available for use at the factory), the calibration would be noted as approximate and a ProxCal™ value entered.

### ***Understanding the Sensor Active Length***

American Magnetics, Inc. fabricates the liquid level sensor with at least two vent holes; a lower vent hole in the side wall near the bottom which is typically the minimum liquid level calibration point (LO Cal) and the upper vent hole in the sensor side typically near the top of the sensor. The liquid level location approximately 2.5 cm (1 in) below the upper vent hole is typically the 100% (HI Cal) calibration point.

The Model 176 Instrument requires the user to enter the length (physical distance between the HI Cal and LO Cal calibration locations on the sensor) for the absolute units (inches, cm) to be displayed.

The user must enter the HI Cal and LO Cal positions in millimeters or nearest tenth of an inch. Use the Active Length value noted on the level sensor documentation or measure the distance between the lower vent hole on the sensor and 1.0 inch (25 mm) below the upper vent hole on the sensor as illustrated on page 7.

### ***Relationship between Calibration and Sensor Length***

The capacitance-based method of measuring the liquid level operates by measuring the period of a signal from an oscillator, which is internal to the Model 176. As the liquid level varies, the value of the sensor capacitance varies proportionally. Since the dielectric properties of liquids vary and the component tolerances for the sensor and oscillator introduce variations, a calibration is required to assure maximum accuracy for a specific sensor immersed in the target liquid. The LO Cal and HI Cal settings correspond to the minimum and maximum oscillation periods, respectively, for a given sensor and target liquid configuration.

The length settings of the instrument are needed as a means of scaling the LO Cal to HI Cal range of the measurement to meaningful units of length. During the calibration it is important to accurately measure the distance between the physical locations on the sensor corresponding to the HI Cal and LO Cal calibration points. The measured values will be used in configuring the instrument for operation.

### ***Variations in the Dielectric with Changing Density***

For cryogenic liquids, the dielectric of the liquid will change with a change in density. The amount of change is dependent on the properties of the specific liquid. Since the instrument uses a capacitance-based method for determining liquid level, such a change in the dielectric of the liquid will result in a shift in the level reading of the instrument. The calibration procedures described herein are most accurate when applied in situations where the operating conditions of the cryo-vessel are relatively constant, i.e. the operating pressure and temperature of the cryo-vessel are relatively constant.

To minimize the effects of shifts in the dielectric of the target liquid, perform a closed dewar calibration (see page 23) at the expected operating condition of the cryo-vessel. If this is not feasible, then calibrate the sensor at atmospheric pressure and use the approximate calibration method to compensate for the

shift of the dielectric when the cryogenic liquid is under pressure. For this type of approximate calibration, the reference liquid will be the target liquid at atmospheric pressure — see page 26 for a detailed discussion of the approximate calibration method. If any questions exist regarding calibration issues, contact AMI for assistance in determining the optimal calibration strategy.

All references to “dielectric constant” herein refer to the unitless value relative to  $\epsilon_0$ , the dielectric constant of a vacuum.

## **Sensor Calibration Methods**

The most straightforward calibration method is the Open Dewar Calibration which requires the customer to have access to a filled dewar where the full active length of the sensor can be dipped. The Closed Dewar Calibration method can be performed in situations where it is not feasible for the customer to dip the sensor into an open dewar, such as situations where the target liquid is under pressure. The closed dewar calibration is more complex, may require initial preparations to ensure success and avoid saturation of the signal during the calibration, and unfortunately possibly requires wasting a tank full of liquid to complete the process. Occasionally customers ask AMI to calibrate an instrument and sensor for a liquid which is not available at AMI for calibration purposes and/or for a sensor which is too long to be calibrated at our facilities.

For the case of the target liquid being unavailable, AMI uses liquid nitrogen as the reference liquid and an approximate calibration is performed using mathematical manipulation of the ratio of the dielectric constants between liquid nitrogen and the desired liquid. This procedure is outlined in the Approximate Calibration (ProxCal™) section beginning on page 26. The technique is intended to provide the instrument with an *approximate* calibration so that it can be used immediately by the customer. However, the customer is still expected to perform a more accurate calibration where feasible, such as the open dewar or closed dewar calibration, with the target liquid.

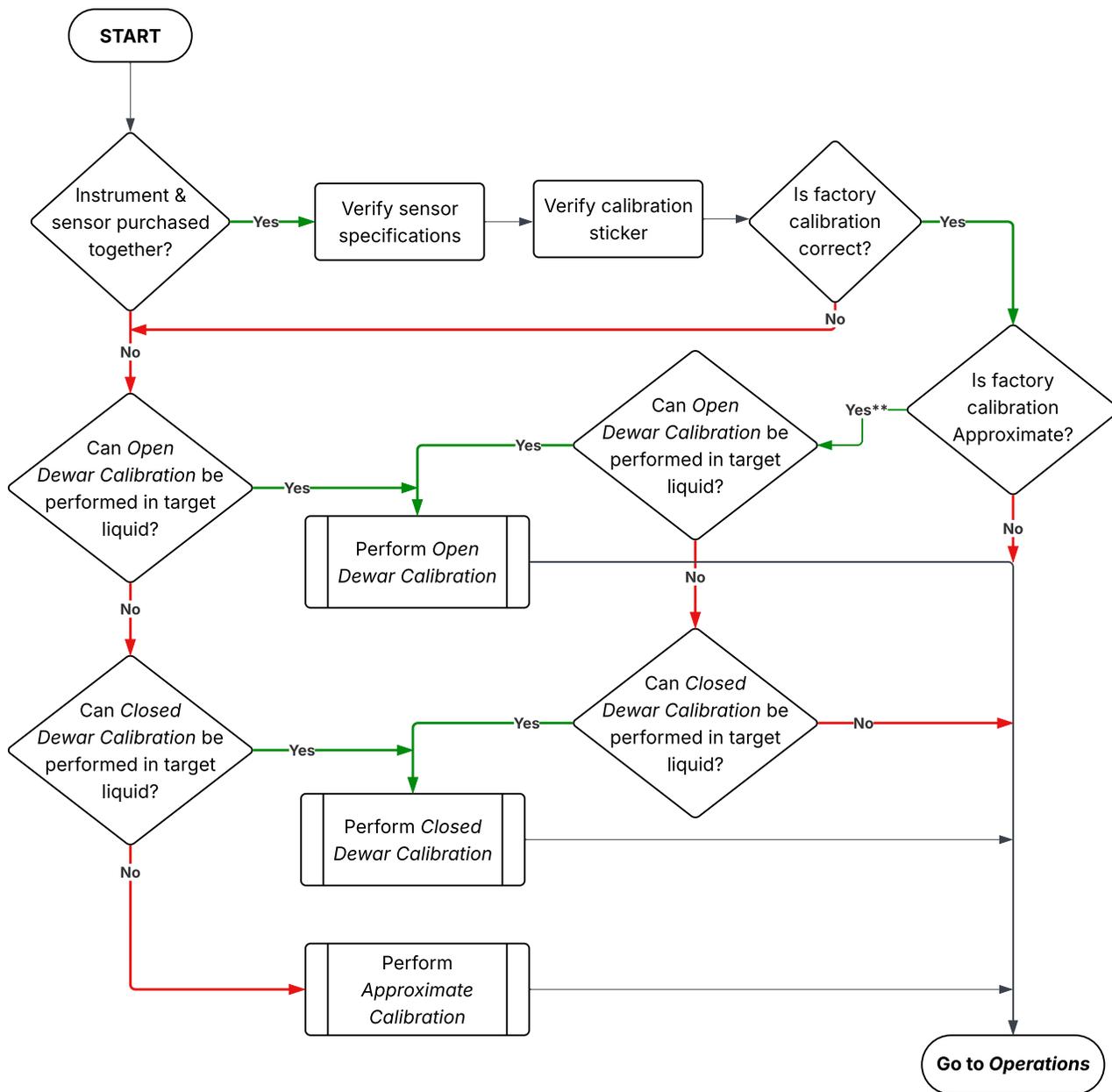
For the case where a sensor is too long to be calibrated in AMI facilities, AMI can perform a partial length open dewar calibration in liquid nitrogen, and then use the ProxCal feature to transform the calibrated span to the full active length. A dielectric ratio may also be subsequently utilized to adjust for a target liquid other than liquid nitrogen. The customer should consider performing a more accurate open dewar or closed dewar calibration if feasible.

## **Selection of Capacitance Sensor Calibration Methods**

As a quick guide for selection of the best calibration method available, a calibration selection diagram is presented in Figure 11 on the following page.

If the instrument and sensor are purchased as a unit from AMI, then the factory calibration, including sensor serial number and sensor physical parameter information entered at the factory, will be adequate in most cases. However, for the exceptions noted in the previous paragraphs (which are approximate calibrations), the customer should perform a more accurate open dewar or closed dewar calibration if at all possible. A customer-performed calibration is also required for sensors that are purchased as a separate item from the instrument, since the instrument and sensor were not both available for calibration at AMI facilities.

Each Model 176 instrument must be calibrated with a sensor before use. If the instrument was purchased with a sensor to be used in liquid nitrogen, the instrument has been calibrated at the factory.



\*\* Factory Approximate Calibration should only be used if open dewar or closed dewar calibration is not feasible in the target liquid at the customer's facility.

**Figure 11**

## Open Dewar Calibration

The instrument should be energized with the sensor connected to the instrument. The user should also first review the Menu Structure section beginning on page 17. Be sure to choose the desired units (inches or millimeters) for entering the calibration points.

1. Display the HI Cal menu by using the UP/DOWN keys to cycle through the available menus.

2. Press the ENTER key to make the HI Cal menu active. Note an \* is shown in the display (*Iu* = level units).

```
Hi Cal*  
XX.X Iu
```

3. Use the UP/DOWN keys to specify the position of the HI Cal point on the sensor as measured from the bottom vent hole (see page 7) to typically 1 inch (25 mm) below the topmost vent hole. Press ENTER to accept the position. The menu display will change to Press <-.

```
Hi Cal*  
Press <-
```

4. Slowly insert the sensor into the liquid until the level rests approximately one inch below the top sensor hole, hold steady, and then press the ENTER button (<-) as prompted by the display. The display will change to Wait... When the HI calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Hi Cal*  
Wait...
```

The HI Cal point should always be lower than the upper hole to ensure the instrument will always reach 100% in the event the overall sensor capacitance changes slightly due to component drift, pressure variations, fluid impurities, etc.

5. Display the LO Cal menu by using the UP/DOWN keys to cycle through the available menus.

6. Press the ENTER key to make the LO Cal menu active (an \* is shown in the display).

```
Lo Cal*  
0.0 Iu
```

7. Use the UP/DOWN keys to specify the desired position of the LO Cal point on the sensor as measured from the bottom vent hole (see page 7). If the desired LO Cal point is even with the bottom vent hole (recommended!), enter zero in the chosen units. Press ENTER to accept the position. The menu display will change to Press <-.

```
Lo Cal*  
Press <-
```

8. Slowly withdraw the sensor out of the liquid to be measured until the level is approximately even with the bottom vent hole in the sensor (or the desired LO Cal point).

9. While holding the sensor steady, press the ENTER button (<-) as prompted by the display. The display will change to Wait... When the LO calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Lo Cal*  
Wait...
```

Having a small amount of liquid in contact with the sensor at the MIN calibration level helps stabilize the sensor capacitance for the LO calibration point.

Permanently install the sensor in the vessel and proceed to the *Setup* section for directions for configuring the instrument. The 4 mA Pt (LRV) and 20 mA Pt (URV) can be set to any position with the calibration range to scale the loop current output and percent level reading.

## Closed Dewar Calibration

A calibration can be performed in a closed dewar system by monitoring the liquid level while transferring the target liquid to an initially empty (or near empty) dewar at a constant rate. In order to ensure success with the closed dewar technique, it is necessary to prepare the instrument by presetting the LO Cal and HI Cal points outside the estimated level range. If the instrument is not prepared in this manner before the calibration procedure, it is possible to reach the HI Cal point of the instrument before the target vessel is at the desired maximum level point.

If minimum and maximum liquid level indication is available via some other means (e.g. flow calculation, visual determination, point sensors, etc.), then the presetting of the instrument is not necessary.

### **Presetting the LO and HI Calibration Points**

The following procedure should be performed *before* installation of the sensor in the target cryo-vessel.

1. Connect the sensor cabling to the sensor input connector. Do not connect the actual sensor at the end of the cabling.
2. Display the LO Cal menu by using the UP/DOWN keys to cycle through the available menus.

3. Press the ENTER key to make the LO Cal menu active. Note an \* is shown in the display (*lu* = level units).

```
Lo Cal*  
0.0 lu
```

4. Use the UP/DOWN keys to specify 0.0 in the selected units. Press ENTER to accept. The menu display will change to Press <-.

```
Lo Cal*  
Press <-
```

5. Press the ENTER button (<-) as prompted by the display. The display will change to Wait... When the LO calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Lo Cal*  
Wait...
```

This presets the LO Cal point to a capacitance load that is less than the sensor connected in air.

6. Now connect the sensor cable to the sensor exposed to air.
7. Display the HI Cal menu by using the UP/DOWN keys to cycle through the available menus.

8. Press the ENTER key to make the HI Cal menu active (an \* is shown in the display).

```
Hi Cal*  
XX.X lu
```

9. Use the UP/DOWN keys to specify the position of the HI Cal point on the sensor as measured from the bottom vent hole (see page 7) to typically 1 inch (25 mm) below the topmost vent hole. Press ENTER to accept the position. The menu display will change to `Press <-`.

```
Hi Cal*
Press <-
```

10. Press the ENTER button (<-) as prompted by the display. The display will change to `Wait...`. When the HI calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Hi Cal*
Wait...
```

11. Calculate a *temporary* ProxCAL value using the following equation:

$$\text{ProxCAL Value} = 120 \left[ 1 + (\varepsilon - 1) \frac{L_{\text{active}}}{L_{\text{total}}} \right]$$

where  $L_{\text{total}}$  is the total sensor length,  $L_{\text{active}}$  is the active sensor length in the same units as  $L_{\text{total}}$ , and  $\varepsilon$  is the dielectric constant of the target liquid.

12. Enter the ProxCAL value calculated above into the instrument by placing the instrument in the ProxCAL factor entry screen using the UP/DOWN buttons to cycle through the menus. Press ENTER to make the menu active (\*) and then use the UP/DOWN keys to adjust. Press ENTER again to accept the result.

```
Prox Cal*
XXX.X
```

13. Ensure the 4 mA Pt is set to the LO Cal value (0.0) and that the 20 mA Pt is set to the HI Cal value (XX.X lu)

The presetting procedure is complete. The presetting procedure has temporarily calibrated a measurement span that should register an unsaturated loop current response for the full range of a closed dewar fill with the target liquid. Proceed to the remainder of the Closed Dewar Calibration procedure presented below.

### **Completing the Closed Dewar Calibration Procedure**

Install the sensor in the dewar and energize the instrument with the sensor appropriately connected to the instrument. Use the 4-20 mA current loop output to plot the liquid level at regular time intervals during the fill and emptying actions.

1. Commence filling the dewar. While the sensor is cooling down, there may be a slow drift in the displayed liquid level. However, when the liquid touches the bottom of the sensor, contact with the liquid surface may become apparent by virtue of more random and frequent fluctuations in the displayed liquid level. The liquid level trace will also start to show an increasing profile with positive slope.
2. Continue the transfer while observing the liquid level trace whose slope is proportional to the transfer rate. The slope of the liquid level trace should decrease significantly when the liquid reaches the topmost vent hole at the top of the sensor.

3. When the break in the slope of the level trace occurs, stop the filling of the dewar and complete the following steps:

a) Display the HI Cal menu by using the UP/DOWN keys to cycle through the available menus.

b) Press the ENTER key to make the HI Cal menu active (an \* is shown in the display).

```
Hi Cal*  
XX.X lu
```

c) Press ENTER to accept the position. The menu display will change to Press <-.

```
Hi Cal*  
Press <-
```

d) Press the ENTER button (<-) as prompted by the display. The display will change to Wait... When the HI calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Hi Cal*  
Wait...
```

4. Once the HI Cal point has been successfully entered, return to the ProxCal menu and reset to 100.0 which makes the function inactive.

```
Prox Cal*  
100.0
```

5. Commence emptying the dewar.

6. Continue the emptying while observing the liquid level trace whose slope is proportional to the transfer rate. The slope of the liquid level trace should decrease significantly when the liquid reaches the bottom hole of the sensor.

7. When the break in the slope of the level trace occurs (i.e. the slope of the level trace becomes 0 or horizontal), complete the following steps:

a) Display the LO Cal menu by using the UP/DOWN keys to cycle through the available menus.

b) Press the ENTER key to make the LO Cal menu active. Note an \* is shown in the display (*lu* = level units).

```
Lo Cal*  
0.0 lu
```

c) Use the UP/DOWN keys to specify 0.0 in the selected units. Press ENTER to accept. The menu display will change to Press <-.

```
Lo Cal*  
Press <-
```

d) Press the ENTER button (<-) as prompted by the display. The display will change to Wait... When the LO calibration point has been accepted, the display will revert to the entered position value and the \* will no longer be shown indicating the process completed.

```
Lo Cal*  
Wait...
```

8. To achieve a standard calibration of the sensor with the active region located from the lower hole to one inch below the upper hole, use the level indication from the instrument to recalibrate the HI Cal point when the percent level corresponds to one inch below the

upper hole (ensure the 4 mA Pt = LO Cal value and 20 mA Pt = HI Cal value). Use the following equation to determine the percent level at which to reset the HI Cal point:

$$\text{Standard Hi Cal (\%)} = 100 - 100 \left[ \frac{1}{L_{\text{hole-to-hole}}} \right]$$

where  $L_{\text{hole-to-hole}}$  is the measured length from the bottom hole of the sensor to the uppermost hole of the sensor in *inches*. This technique can be used assuming the sensor was built as a standard sensor. If the sensor was made in a custom configuration, refer to the sensor documentation and/or drawing, or contact AMI.

**Example: 100" active length sensor:**

When the sensor is calibrated by the closed dewar procedure, the actual length of calibration will be 101" (distance between the bottom and top holes in the sensor). When the liquid is 1" below the upper hole, the display will show 99.0% [e.g.  $100\% - (1"/101" \times 100\%)$ ]. When the liquid level reaches this point during usage, enter the HI Cal menu and press ENTER until the HI Cal process completes. The instrument and sensor are now calibrated with a standard active region of 100". The HI Cal setting of the instrument should also be configured for 100".

The instrument should now have a standard calibration in the target liquid. The 4 mA Pt (LRV) and 20 mA Pt (URV) can be set to any position with the calibration range to scale the loop current output and percent level reading.

### Approximate Calibration (ProxCal™)

This procedure is the least accurate form of calibration and should be used only when the aforementioned calibration procedures are not possible. The approximate calibration method can be used in cases where the sensor cannot be dipped into the target liquid, the full active length of the sensor cannot be dipped into an open dewar, or both. Approximate calibration may also be useful for situations where the sensor cannot be dipped into the target liquid under the expected operating pressure.

If the target liquid is not available for dipping, a substitute non-conducting reference liquid can be used. If the full length of the sensor cannot be dipped, then a partial length dip can be performed. If both situations are encountered, then a partial length dip can be performed in a substitute reference liquid.

1. First, cool the sensor as much as possible by dipping the sensor as far as possible in the available reference liquid.
2. Slowly withdraw the sensor out of the reference liquid until the level is approximately even with the bottom hole in the sensor and then complete the following steps:
  - a) Display the LO Cal menu by using the UP/DOWN keys to cycle through the available menus.

- b) Press the ENTER key to make the LO Cal menu active.  
Note an \* is shown in the display (*Lu* = level units).

```
Lo Cal*
0.0 Lu
```

- c) Use the UP/DOWN keys to specify 0.0 in the selected units.  
Press ENTER to accept. The menu display will change to  
Press <-.

```
Lo Cal*
Press <-
```

- d) Press the ENTER button (<-) as prompted by the display.  
The display will change to Wait... When the LO calibration  
point has been accepted, the display will revert to the  
entered position value and the \* will no longer be shown  
indicating the process completed.

```
Lo Cal*
Wait...
```

Having a small amount of liquid in contact with the sensor helps stabilize the sensor capacitance for 0% level indication.

3. Reinsert the sensor in the reference liquid as far as possible, but not exceeding 1" below the top hole. Note the physical location of the liquid level on the sensor at the maximum feasible insertion depth.
4. While the sensor is submerged at the maximum feasible depth, complete the following steps:
- a) Display the HI Cal menu by using the UP/DOWN keys to cycle through the available menus.

- b) Press the ENTER key to make the HI Cal menu active (an \* is shown in the display).

```
Hi Cal*
XX.X Lu
```

- c) Use the UP/DOWN keys to specify the position of the HI Cal point on the sensor as measured from the bottom vent hole (see page 7) to typically 1 inch (25 mm) below the topmost vent hole. In this case, the entered value is the desired final active length of the sensor regardless of the dipped length of step 3. Press ENTER to accept the value.  
The menu display will change to Press <-.

```
Hi Cal*
Press <-
```

- d) Press the ENTER button (<-) as prompted by the display.  
The display will change to Wait... When the HI calibration  
point has been accepted, the display will revert to the  
entered position value and the \* will no longer be shown  
indicating the process completed.

```
Hi Cal*
Wait...
```

5. Measure the distance between the bottom hole of the sensor and the location of the dipped liquid level noted during step 3. This measured length is  $L_{dipped}$ .

The dielectric constant for the reference liquid,  $\epsilon_1$ , and the target liquid,  $\epsilon_2$ , must be known to complete the approximate calibration. These values must be placed in the equation:

$$ProxCal\ Value = \left[ \frac{\epsilon_2 - 1}{\epsilon_1 - 1} \times 100 \right] \frac{L_{active}}{L_{dipped}}$$

where  $L_{\text{dipped}}$  is the length of the sensor dipped in the reference liquid and  $L_{\text{active}}$  is the active sensor length.

If the target liquid is available for dipping (i.e. the reference liquid and target liquid are the same), then the dielectric ratio,  $(\epsilon_2 - 1)/(\epsilon_1 - 1)$ , becomes 1. If the full active length of the sensor can be dipped, then the length ratio,  $L_{\text{active}} / L_{\text{dipped}}$ , becomes 1.

Note that  $\epsilon_1 = 1.4336$  for saturated liquid nitrogen at atmospheric pressure. The dielectric constant varies with temperature and pressure, therefore for best accuracy use the dielectric constant for the target liquid at the equilibrium temperature and pressure maintained in the containing vessel.

6. Enter the ProxCAL value calculated above into the instrument by placing the instrument in the ProxCAL factor entry screen using the UP/DOWN buttons to cycle through the menus. Press ENTER to make the menu active (\*) and then use the UP/DOWN keys to adjust the value. Press ENTER again to accept the result.
7. The ProxCAL calibration factor is retained in the Model 176 memory. Therefore, the ProxCAL factor can be readjusted as desired at any time without modifying the base LO/HI calibration.

ProxCAL* XXX.X
-------------------

**Example:** Purchased a 100" active length sensor for operation in liquid argon at atmospheric pressure, however only liquid nitrogen is available for calibration at a maximum depth of 30":

First, the sensor is dipped as far as possible into the liquid nitrogen and cooled. The LO Cal point is then set as outlined in step 2. The HI Cal point is set as outlined in step 4 while the sensor is submerged 30" in liquid nitrogen. The dielectric constant for liquid nitrogen is 1.4336 and for liquid argon is 1.53. Substituting all values into the approximate calibration factor equation yields:

$$\text{ProxCAL Example} = \left[ \frac{1.53 - 1}{1.4336 - 1} \times 100 \right] \frac{100}{30} = 407.4$$

A value of 407.4 would be entered as a ProxCAL factor as outlined in step 6. The sensor is now approximately calibrated for 100" active length operation in liquid argon at 1 atm. The sensor can now be installed in the dewar containing the target liquid. The approximate calibration can be used until an open dewar or closed dewar calibration can be performed with the target liquid if feasible.

# Troubleshooting

## General

Indication	Cause	Solution
Level, Level %, and Loop values are incorrect	Poor Calibration	Recalibrate using more accurate Cal Points. Increase the distance between the Cal Points.
Level readings are repeatable, but consistently wrong.	Poor Calibration	Recalibrate using more accurate Cal Points. Increase the distance between the Cal Points.
Display values "bounce"	Turbulence	Adjust the Damping value. Increase it until the display is stable.

## Error Display

Indication	Cause	Solution
EEPROM Failure	Bad checksum of stored configuration	Press "Up" & "Down" simultaneously and hold until the display changes. This will completely reset the transmitter back to factory default values. <b>Recalibration will be necessary.</b> If this occurs, contact AMI.
<No lo>	The LO Cal point has not been set	Calibrate the LO Cal point
<No hi>	The HI Cal point has not been set	Calibrate the HI Cal point
<No cal>	The transmitter has not been calibrated	Calibrate the transmitter
<Over> (level exceeds 103.1% of range)	The capacitance measured is greater than the configured range	Increase the 20mA Pt value
<Under> (level is below -1.3% of range)	The capacitance measured is less than the configured range	Decrease the 4mA Pt value
	Open Probe	Check the wiring between the Probe terminals in the Instrument housing and the Probe.
<No inp>	Shorted Probe	Test the Probe using the procedure shown in the "Check Probe" section.
	Shorted Probe Wiring	Check the wiring between the Probe terminals in the Instrument housing and the Probe.



**“Live” electrical circuits can ignite flammable gases and dusts. Do not install this instrument in locations with intrinsically safe requirements.**

### **Drift Test**

This test will determine if the transmitter or probe/application is the cause of a drifting (unstable) output.

- 1.) Unlatch the transparent instrument cover and open.



**Only qualified personnel implementing industry best-practice ESD precautions should expose the circuit board and perform the wiring instructions detailed below. The most convenient connection point for circuit board ground is the housing of the SMA Probe connector.**

- 2.) Remove the protective cover over the circuit board (see Figure 4).
- 3.) Disconnect the probe wiring from the SMA probe connector on the circuit board (see Figure 5).
- 4.) Connect a temperature stable (COG-type) 200pF capacitor between the “Probe” and ground terminals.
- 5.) Observe the output over a 24-hour period. Check for stability.
- 6.) If the reading has drifted, contact the factory. If the reading is stable, either the probe or the application must be the cause. Go to the “Check Probe” section to test the probe. If the probe is OK, contact the factory for application assistance.
- 7.) Reinstall the protective cover and screws.



**“Live” electrical circuits can ignite flammable gases and dusts. Do not install this instrument in locations with intrinsically safe requirements.**

### **System Loop Test**

This test will determine if the correct voltage is available for the transmitter.

- 1.) Unlatch the transparent instrument cover and open.



**Only qualified personnel implementing industry best-practice ESD precautions should expose the circuit board and perform the wiring instructions detailed below. The most convenient connection point for circuit board ground is the housing of the SMA Probe connector.**

- 2.) Remove the protective cover over the circuit board (see Figure 4).
- 3.) Disconnect the loop wires from the transmitter.
- 4.) Use a voltmeter to measure the open circuit voltage of the loop. The value must be between 10.8 and 33 VDC.
- 5.) Reconnect the loop wires to the transmitter.
- 6.) Use a voltmeter to measure the voltage at the Loop (+) and Loop (-) terminals. The value must be between 10.8 and 33 VDC.
- 7.) If you do not measure these values, contact the factory for assistance.
- 8.) Reinstall the protective cover and screws.



**“Live” electrical circuits can ignite flammable gases and dusts. Do not install this instrument in locations with intrinsically safe requirements. Ensure that power has been removed from the unit before performing this test.**

### **Check Probe**

This test will determine whether the probe is functional.

#### *Integral-mounted Units*

- 1.) Unlatch the transparent instrument cover and open.



**Only qualified personnel implementing industry best-practice ESD precautions should expose the circuit board and perform the wiring instructions detailed below. The most convenient connection point for circuit board ground is the housing of the SMA Probe connector.**

- 2.) Remove the protective cover over the circuit board (see Figure 4).
- 3.) Disconnect the probe wiring from the SMA probe connector on the circuit board (see Figure 5).
- 4.) Unscrew the Instrument Housing / Wiring Nipple assembly from the probe.
- 5.) Lower the process fluid level below the bottom of the probe. If this is not possible, remove the probe from the process vessel.
  - a. Ensure the probe is free from any coatings or residue.
  - b. Ensure the probe is free from ice or water vapor condensation, including inside the probe. If not, the probe must be warmed and completely dried before checking the resistance.
  - c. Ensure the probe's BNC connector is treated with dielectric grease to prevent condensation from shorting the coaxial connection.
- 6.) Use an Ohmmeter to measure the resistance between the center of the BNC connector at the top of the probe and the probe mounting nut.
- 7.) If the resistance is below 40 Meg $\Omega$  wipe any coating or residue off the probe and repeat the measurement. If the reading is still below 40 Meg $\Omega$  contact the factory.
- 8.) Reinstall the protective cover and screws.

#### *Remote-mounted Units*

- 1.) Remove the cover of the interconnection housing.
- 2.) Disconnect the coaxial cable adapter/splitter wiring from the terminal block (see Figure 7).
- 3.) Lower the process fluid level below the bottom of the probe. If this is not possible, remove the probe from the process vessel.
  - a. Ensure the probe is free from any coatings or residue.
  - b. Ensure the probe is free from ice or water vapor condensation, including inside the probe. If not, the probe must be warmed and completely dried before checking the resistance.
  - c. Ensure the probe's BNC connector is treated with dielectric grease to prevent condensation from shorting the coaxial connection.
- 4.) Use an Ohmmeter to measure the resistance between the center of the BNC connector at the top of the sensor (the red wire of the coaxial adapter/splitter) and the sensor mounting nut.

- 5.) If the resistance is below 40 Meg $\Omega$  wipe any coating or residue off the probe, and repeat the measurement. If the reading is still below 40 Meg $\Omega$  contact the factory.
- 6.) Reinstall the cover of the interconnection housing.

## Appendix

Installation parts included with the Model 176 Two-Wire Continuous Level Transmitter:

No.	Qty.	Description	
1	1	Standard-Wall 304/304L SS Pipe Nipple; Fully Threaded, 3/4 NPT, 1-3/8" Long	
2	1	304 SS Threaded Pipe Fitting, Low-Pressure, Cross Connector, 3/4 NPT Female	
3	1	Low-Pressure 302 SS Plug with Hex Drive, 3/4 NPTF	
4	1	Tape, Teflon, 1/2" x 520", 3.5 mil thick; Meets MIL Spec MIL-T-27730A	
5	2	Spade terminal, 18-22 AWG, #4 stud, Red, Molex 191310045 or equiv.	
6	1	Silicone dielectric grease (electrical connection lubricant, or electrical insulating synthetic grease), slightly translucent white, 5 gram tube.	

Installation parts included with the Model 176 Remote-mounted Transmitter Option Kit:

No.	Qty.	Description	
1	1	Cable, 2 conductor, twisted, 22 AWG, foil shield with 22 AWG drain wire; Polyethylene wire insulation; 10 feet, Belden 8761 or equiv.	
2	3	Spade terminal, 18-22 AWG, #4 stud, uninsulated, Molex 0191290053 or equiv.	
3	2	Ring Terminal, No. 6 stud, insulated, 18-22 AWG, 3M MNG18-6R/SK or equiv.	

