

Instruction

MI 611-148
August 2008

**871PH pH/ORP
Sensors and Accessories
Installation and Maintenance**

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1. Introduction

The 871PH Sensor is used with Foxboro 870PH and 870ITPH Transmitters and 873PH, 873APH, 873DPX, and 875PH Analyzers. The 871PH Sensor permits multiple-purpose use with only one basic sensor. The sensor uses one of several electrodes as the sensitive element and a wetted, nonflowing ceramic disc as the primary reference junction. These components are mounted in the body of the sensor assembly with a temperature compensating device.

Dangers, Warning, and Cautions

—  **DANGER** —

When performing maintenance, wear appropriate protective clothing, including safety goggles. Escaping chemicals under pressure can cause severe injury including blindness.

—  **WARNING** —

Use care when connecting and disconnecting high pressure service connections. To avoid severe injury to personnel or damage to equipment, use proper gloves and follow the recommended procedures.

—  **WARNING** —

When processing hazardous liquids, follow the recommended procedures. Failure to do so could result in injury to personnel and damage to equipment.

—  **WARNING** —

Use only Foxboro recommended spare parts. Substitution parts could result in damage to equipment, damage to the process, and/or injury to personnel. Also safety certification may also be compromised by the substitution of improper parts.

—  **WARNING** —

Antimony is a toxic material. When an antimony electrode is installed, avoid contact with the surface of the antimony pellet. If skin contact is made with the antimony pellet, wash the contacted skin area with soap and water. Refer to MSDS051.

—  **CAUTION** —

Use care when handling and assembling sensor components (e.g., glass electrodes, O-rings, etc.) to prevent damage.

Theory of Operation

pH Measurement

pH indicates the concentration of hydrogen ions (H^+) present in aqueous solution. Since the concentration of hydrogen ions determines the degree of acidity or alkalinity of the solution, pH is also said to be a measure of acidity or alkalinity. pH is defined as the negative logarithm of the hydrogen ion concentration:

$$pH = -\log [H^+]$$

The pH scale ranges from 0 to 14, with a pH of 7 being neutral, a pH less than 7 being acidic, and a pH greater than 7 being basic (alkaline).

Measurement of pH by the 871PH sensor is accomplished by immersing the probe, which consists of integral pH and reference electrodes, in the process solution. The pH electrode, which is sensitive to hydrogen ions in solution, develops an electrical potential proportional to pH. The reference electrode, which consists of Silver/Silver Chloride connected to the process via a Potassium Chloride salt bridge through a ceramic junction, provides a stable reference potential against which the glass electrode potential is measured. These two electrodes constitute a galvanic cell having a millivolt output proportional to the pH of the solution.

ORP Measurement

ORP is a measure of the electrical potential of a reaction known as an oxidation-reduction (redox) reaction. A redox reaction is one in which one component loses one or more electrons (oxidation) while another component gains one or more electrons (reduction). The oxidation-reduction potential is related to the ratio of oxidation activity to reduction activity. By convention, a solution that contains an excess of oxidizing agent has a positive ORP, and a solution that contains an excess of reducing agent has a negative ORP.

Measurement of ORP is accomplished by immersing the 871PH sensor, configured with a gold or platinum electrode, in a solution along with its integral Silver/Silver Chloride reference electrode. This probe develops a millivolt output (similar to pH measurement) that is proportional to the ratio of oxidizing agent to reducing agent, or ORP.

Reference Documents

Document ^(a)	Description
DP 611-113	871PH pH and ORP Sensors
DP 611-121	Mounting Accessories used with 222 and 871PH pH and ORP Sensors
DP 611-122	Ball Valve Assembly for 222 and 871PH pH and ORP Sensors
DP 611-123	Optional Containment Device for 1, 2, or 4 in Spool Piece for 222 and 871PH pH and ORP Sensors
DP 611-140	Electrode Cleaning System (ECS); Flow-through Spool Piece for 222 and 871PH pH and ORP Sensors

Document ^(a)	Description
DP 611-141	Electrode Cleaning System (ECS); Flow-through Spoolpieces and Submersible Assemblies for use with 222, 871PH, 871A, and 871DO Sensors
MI 611-155	870PH pH and ORP Transmitters
MI 611-165	873PH Series Electrochemical Analyzers for pH or ORP Measurement
MI 611-190	873DPX Series Electrochemical Analyzers for Dual pH, ORP, or ISE Measurement
MI 611-191	873APH ACE Series Electrochemical Analyzers for pH Measurement
MI 611-206	Intrinsic Safety Connection Diagrams and Nonincendive Circuits
MI 611-208 ^(b)	Electrochemical Products Safety Information (for European installations)
MI 611-211	870ITPH Intelligent Transmitter for pH, ORP, and ISE Measurements
MI 611-125	Electrode Cleaning System (ECS) for 871A, 871DO, 871PH and 222 Series Sensors
MI 611-225	875PH Intelligent Electrochemical Analyzers for pH, ORP, or ISE Measurements
MI 611-229	Remote Preamplifier Junction Box, BS811MR
PL 611-014	871PH pH/ORP Sensors

(a) Documents are available on line at www.foxboro.com (pull down **Products** menu and select **Documentation**)

(b) If document is not yet available on website, contact Invensys Process Systems for current availability.

Standard Specifications

Item	Specification
Automatic Temperature Compensation (ATC) Limits	-5 and 125 °C (20 and 255°F)
Sensor Assembly Immersion/Submersion Depth	Minimum: 50 mm (2 in) Maximum: 6 m (20 ft)
Measuring Electrodes	Plug-in, interchangeable
Measuring Electrode Body Material: Glass pH*: Antimony pH: Platinum ORP: Gold ORP:	Ryton or ptfe body as specified Ryton or ctfe body as specified Ryton or ctfe body, as specified Ryton or ctfe body, as specified
Measuring Electrode O-rings	Standard: Viton; Optional EPDM and Chemraz
Solution Ground	Titanium (Grade 2 CP), Carpenter 20 Cb-3, 316L Stainless Steel, Monel 400, or Tantalum, as specified. The solution ground stud also acts as a keeper for securing electrodes in the sensor assembly.
Reference Electrode	Nonflowing, with Ag/AgCl internals and saturated potassium chloride (KCl) electrolyte.
Reference Junction and Body Materials	Ceramic/Ryton, Ceramic/ptfe, or Ceramic/Double Junction, Ion Barrier, pvdf
Reference Electrode O-rings	Standard: Viton; Optional EPDM and Chemraz
Sensor Body Material	Ryton or CPVC housing, as specified; Viton O-ring (see above for electrodes and solution ground).
Maximum Pressure and Temperature Limits	See Table 1, “Maximum Pressure and Operating Temperature Limits for Sensor with Ryton Body,” on page 5, and Table 2, “Maximum Pressure at Various Operating Temperatures for Sensor with CPVC Body,” on page 6.
Electrical Classification	See Tables 3 and 4.
Standard Cable	Integral 6 m (20 ft) screened, PVC jacketed, terminated with straight pin lugs for connection to all Foxboro analyzers and transmitters. Options are available.
Preamplifier	Integral, encapsulated, differential high impedance preamplifier is contained in the 871PH-1, -2, -3 and -4 sensors.
Installation Dimensions	See DP 611-113.
Electromagnetic Compatibility (EMC)	The 871PH Sensor, when its cable is connected through rigid metal conduit as recommended for 873PH, 873APH, 873DPX (220 V ac, 240 V ac Metal Enclosures only), 870ITPH Transmitters, or 875PH Analyzers, complies with the requirements of the European EMC Directive 89/336/EEC.

*Spherical, flat ruggedized, or domed high temperature glass (has high stability Ag/AgCl internals)

Sensor-Analyzer/Transmitter Compatibility

871PH-1, -2: Compatible but does not support the diagnostic features of the 870ITPH Transmitter and 875PH Analyzer.

871PH-3, -4, -5, -6: Compatible with 870ITPH Transmitter and 875PH Analyzer only.

Temperature Limits

Table 1. Maximum Pressure and Operating Temperature Limits for Sensor with Ryton Body

Measuring Electrode Type	Ball Valve or Submersible Installation		In-Line Installation	
	Maximum Pressure	Temperature Range ^(a)	Maximum Pressure	Temperature Range
Flat Glass pH	1 MPa (150 psi)	-5 to +80 °C (20 to 175°F)	1 MPa (150 psi)	-5 to +85 °C (20 to 185 °F)
Spherical Glass pH	0.7 MPa (100 psi)	-5 to +80 °C (20 to 175°F)	0.7 MPa (100 psi)	-5 to +100 °C (20 to 212°F)
Domed Glass pH	0.7 MPa (100 psi)	0 to +80 °C (32 to 175°F)	0.7 MPa (100 psi)	0 to +121 °C (32 to 250°F)
Antimony pH	1 MPa (150 psi)	-5 to +80 °C (20 to 175°F)	1 MPa (150 psi)	-5 to +125 °C (20 to 255 °F)
ORP	1 MPa (150 psi)	-5 to +80 °C (20 to 175°F)	1 MPa (150 psi)	-5 to +125 °C (20 to 255 °F)

(a) Temperature range for sensors with no preamplifier and with a high-temperature cable is the same as that for In-Line Installation.

— NOTE —

Maximum allowable temperature and pressure may be limited by installation hardware used. Refer also to the temperature and pressure specifications on all appropriate bushings, tees, flow chambers, and ball valve assemblies.

Table 2. Maximum Pressure at Various Operating Temperatures for Sensor with CPVC Body

Measuring Electrode Type	Ball Valve or Submersible Installation			In-Line Installation		
	Maximum Pressure at Operating Temperature			Maximum Pressure at Operating Temperature		
Flat Glass pH	0.9 MPa (125 psi) at -5 °C (20 °F)			0.9 MPa (125 psi) at -5 °C (20 °F)		
Spherical Glass pH	0.7 MPa (100 psi) at -5 °C (20 °F)	0.6 MPa (90 psi) at 50 °C (120 °F)	0.3 MPa (50 psi) at 80 °C (175 °F)	0.7 MPa (100 psi) at -5 °C (20 °F)	0.3 MPa (50 psi) at 80 °C (175 °F)	0.1 MPa (15 psi) at 100 °C (212 °F)
Domed Glass pH						
Antimony pH	0.9 MPa (125 psi) at -5 °C (20 °F)			0.9 MPa (125 psi) at -5 °C (20 °F)		
ORP						

— NOTE —

Maximum allowable temperature and pressure may be limited by installation hardware used. Refer also to the temperature and pressure specifications on all appropriate bushings, tees, flow chambers, and ball valve assemblies.

Electrical Safety Specifications

— NOTE —

These sensors have been designed to meet the electrical safety descriptions listed in Tables 3 and 4. For detailed information, or status of testing laboratory approvals/certifications, contact Invensys Process Systems.

Table 3. 871PH Sensor Certification

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
ATEX Type n energy limited for II 3 GD EEx nL IIC, Zone 2.	Connect to instrument per MI 611-208. Temperature Class T4 - T6. T110°C - T235°C	CS-E/ANN
ATEX intrinsically safe for II 1 GD EEx ia IIC, Zone 0.	Connect to instrument per MI 611-208. Temperature Class T4 - T6. T110°C - T235°C	CS-E/AAA

Table 3. 871PH Sensor Certification (Continued)

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
FM intrinsically safe for Class I; Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Connect to associated apparatus with compatible entity parameters per MI 611-206. Temperature Class T4 at 85°C (185°F) maximum ambient.	CS-E/FAA
FM nonincendive Class I, Division 2, Groups A, B, C, and D; Suitable for Class II, Division 2, Groups F and G; Class III, Division 2.	Connect to associated apparatus with compatible entity parameters per MI 611-206. Temperature Class T4 at 85°C (185°F) maximum ambient.	CS-E/FNN

Table 4. 871PH and Transmitter/Analyzer Loop Certifications

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
CSA Class I, Division 2, Groups A, B, C, and D hazardous locations.	Connect to 873PH / 873APH. For use with enclosure W, X, Y and Z.	CS-E/CNZ
CSA; ia.	Connect to 870PH Transmitter. For use with 871PH style A all configurations.	CS-E/CA-A
CSA intrinsically safe for Class I, Division 1, Groups A, B, C, D; Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Connect to 870ITPH Transmitter per MI 611-206. Temperature Class T3C at 85°C (185°F) maximum ambient.	870ITPH-..CAA
CSA Class I, Division 2, Groups A, B, C, and D, hazardous locations.	Connect to 870PH Transmitter. For use with 871PH style A all configurations.	CS-A/CN-A
CSA Class I, Division 2, Groups A, B, C, and D.	Connect to certified 873PH Transmitter per MI 611-206. Temperature Class T6.	CS-E/CN-A
CSA suitable for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups E, F and G; Class III, Division 2.	Connect to 875PH Transmitter. Supply Voltage -A, -B, -C, E, and -J. Temperature Class T4 at 85°C (185°F) maximum ambient	875PH-..C
CSA suitable for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Connect to 870ITPH Transmitter per MI 611-206. Temperature Class T4.	870ITPH-..CNZ
CSA ordinary locations.	Connect to 870PH Transmitter. For use with 871PH style A all configurations.	CS-E/CG-A

Table 4. 871PH and Transmitter/Analyzer Loop Certifications (Continued)

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
CSA ordinary locations.	Connect to 873PH / 873APH. For use with enclosure P, W, X, Y, and Z. Supply voltage -A, -J and -E.	CS-E/CGZ
CSA ordinary locations.	Connect to 875PH Transmitter. Supply Voltage -A, -B, -C, E, and -J. Temperature Class T4A at 85°C (185°F) maximum ambient	875PH-..C
CSA ordinary locations.	Connect to 870ITPH Transmitter.	870ITPH-..CAA 870ITPH-..CNZ
FM intrinsically safe Class I; Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Connect to approved 870PH Transmitter per MI 611-206. Temperature Class T6.	CS-E/FB-A
FM intrinsically safe Class I, II, and III, Division 1, Groups A, B, C, D, E, F, and G.	Connect to 870ITPH Transmitter per MI 611-206. Temperature Class T4.	870ITPH-..FAA
FM; n.	Connect to 873PH / 873APH. For use with enclosure W, X, Y and Z. Supply voltage -A, -J and -E.	CS-E/FNZ
FM nonincendive Zone 2; Division 2.	Connect to 870PH Transmitter. For use with 871PH style A all configurations.	CS-A/FN-A
FM nonincendive Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Connect to 875PH Transmitter. Supply Voltage -A, -B, -C, and -J. Temperature Class T4A at 75°C (167°F) maximum ambient.	875PH-..F
FM nonincendive Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Connect to 870ITPH Transmitter per MI 611-206. Temperature Class T4.	870ITPH-..FNZ
FM ordinary locations.	Connect to 873PH / 873APH. For use with enclosure P, W, X, Y and Z.	CS-E/FGZ
FM ordinary locations.	Connect to 875PH Transmitter. Supply Voltage -A, -B, -C, and -J. Temperature Class T4A at 75°C (167°F) maximum ambient.	875PH-..F
FM ordinary locations	Connect to 870ITPH Transmitter.	870ITPH-..FAA 870ITPH-..FNZ
KEMA intrinsically safe CENELEC EEx ia, Zone 0.	Connect to 870ITPH-..EAA or equivalent .	CS-E/KA-E

Sensor Identification

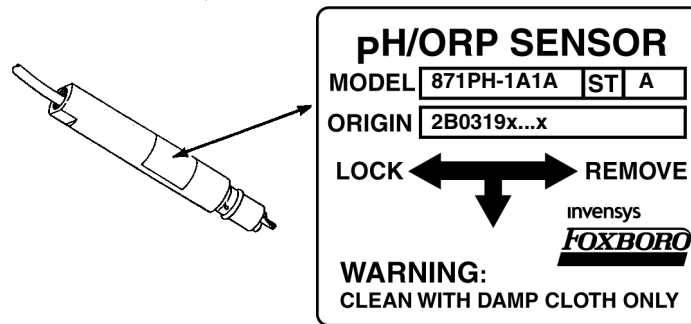


Figure 1. 871PH Sensor Identification

The **ORIGIN** code is the manufacturing date code. In the example 2B0319x...x, 2B means that the product was manufactured in the Analytical Division, 03 identifies the year of manufacture, 19, the week of manufacture, and x...x, positions for digits of the serial number.

Model Code

Description	Model
Rebuildable Style pH/ORP Sensor	871PH
Sensor Body Material and Diagnostic Configuration	
Ryton, Standard Configuration, Integral 6 m (20 ft) Cable, Integral Preamplifier (a)	-1
CPVC, Standard Configuration, Integral 6 m (20 ft) Cable, Integral Preamplifier (a)	-2
Ryton, Intelligent Configuration, Integral 6 m (20 ft) Cable, Integral Preamplifier (b)	-3
CPVC, Intelligent Configuration, Integral 6 m (20 ft) Cable, Integral Preamplifier (b)	-4
Ryton, Intelligent Configuration, Integral 6 m (20 ft) Cable, No Preamplifier (b)	-5
CPVC, Intelligent Configuration, Integral 6 m (20 ft) Cable, No Preamplifier (b)	-6
Measuring Electrode and Body Material	
Spherical Glass, pH, Ryton	A
Antimony, pH, Ryton	B
Platinum, ORP, Ryton	D
Gold, ORP, Ryton	E
Flat Ruggedized Glass, pH, Ryton (c)	F
Domed High Temperature Glass, pH, Ryton	G
Spherical Glass, pH, ptfe	P
Antimony pH, ctfe	Q
Platinum, ORP, ctfe	R
Gold, ORP, ctfe	S
Flat Ruggedized Glass, pH, ptfe (c)	T
Domed High Temperature Glass, pH, ptfe	U
None	X
Sensor Wetted Metallic Parts Material	
Titanium	1
Carpenter 20 Cb	2
AISI Type 316L Stainless Steel (316L ss)	3
Monel	5
Tantalum	6
Reference Junction and Body Material	
Ceramic, Ryton	A
Ceramic, ptfe	B
Ceramic, Double Junction, Ion Barrier, pvdf	D
Optional Selections	
Cable; Integral to Sensor; Standard and High Temperature	
Nonstandard Integral Cable Length, standard temperature at 85°C (185°F); (not available with Option -Q) (d)	-3
Nonstandard Integral Cable Length, terminated in generic connector plug; standard temperature at 85°C (185°F); specify length; Not available with Options -4, -B, -Q, -H) (d)(e)(f)(g)	-5
Standard Integral Cable Length 6 m (20 ft), terminated in generic connector plug; standard temperature Not available with Options -4, -B, -Q, -H) (e)(f)(g)	-7
Integral High Temperature Cable rated 125°C (255°F) (with Sensor Body -5, -6; Not available with Options -5, -7, -Q)	-H
Variopin Quick Connector on Integral Cable or Sensor Body	
Integral Cable Terminated w/Variopin Quick Connector (not available with Options -4, -5, -7) (f)(j)	-B
Variopin Quick Connector Integral to Sensor Body (not available with Options -3, -4, -5, -7) (f)(j)	-Q
O-Rings	
EPDM O-Rings (standard O-rings are Viton)	-E
Chemraz O-Rings (standard O-rings are Viton)	-C
Miscellaneous Optional Selections	
No spade lug terminals attached to end of cable (not available with Option -5, -7, -B, -Q) (h)	-4
ptfe Collar	-T
Example: 871PH-1F1A-4	

(a) Does not support the sensor diagnostic features of 870ITPH Transmitter and 875PH Analyzer.

(b) Compatible with 870ITPH Intelligent Transmitter and 875PH Analyzer only.

- (c) Optimum accuracy is in the range of 2 to 12 pH. It can, however, be used with pH instruments ranged from 0 to 14 pH.
- (d) Standard cable length if not specified = 6 m (20 ft).
Maximum integral cable length with Transmitters or Analyzers is:
 - 33 m (100 ft) for 870PH pH/ORP transmitters;
 - 150 m (500 ft) for 870ITPH Transmitters, and for 873PH, 873APH, and 873DPX, and 875PH Analyzers.
- (e) Requires Patch Cable. See Accessories section.
- (f) Not compatible with ball valve assembly mountings.
- (g) Compatible with 870PH-1 and 870PH-2 only; this option is NOT a Variopin style connector.
- (h) All cables that do not have connectors, have leads terminated with straight pin lugs, and are now compatible with all Foxboro Analyzers and Transmitters. Option -4 is no longer required for compatibility with 873 Series. Option -4 is included for customers who automatically order it.
- (j) When used with 871PH-3, -4, the standard 3-wire 1000 ohm RTD is supplied as a 2-wire, 1000 ohm RTD.

2. Installation

Removing the Sensor Protection Cap

The key to proper storage of your sensor is keeping both the measuring electrode and the reference junction hydrated while it is stored at normal room temperature. Your sensor was shipped with a protection cap, containing an electrolyte solution. The cap should remain in place until you are ready to install your sensor in the process. The cap is removed by pulling it off with a slight twisting motion using care not to splash its liquid contents. Invensys Foxboro recommends saving the cap for future use if the sensor may be removed from the process for more than a few hours. For information on how to store your sensor, see “Storing a Sensor” on page 30.

Measuring Electrode Installation

Most 871PH Sensors come with the measuring electrode installed in the sensor body. If the electrode has not been installed at the factory, use the following procedure to do so.

1. Clean the measuring electrode cavity thoroughly with the cotton swab provided. The cavity **must** be dry.
2. Using another cotton swab, lubricate (lightly) all the internal surfaces of the electrode cavity with the silicone grease provided.
3. Apply a light coat of silicone grease to the electrode O-rings. Be careful that grease does not get on the electrode measuring surface.
4. Holding the sensor with the electrode cavity facing up, insert the electrode stem into the cavity.

⚠ WARNING

Antimony is a toxic material. When an antimony electrode is installed, avoid contact with the surface of the antimony pellet. If skin contact is made with the antimony pellet, wash the contacted skin area with soap and water. Refer to MSDS051.

5. Gently press the electrode into place until the first O-ring engages with the surface of the sensor body. Continue to press on the electrode until the second O-ring is engaged.

⚠ CAUTION

1. When a spherical glass electrode is installed, do **not** push on the glass bulb with your finger. Use the insertion cap provided with the sensor. Place the insertion cap over the glass bulb and press the electrode into place. To prevent damage to the glass stem of the electrode body, push the electrode straight into the sensor cavity. Avoid twisting the electrode.
 2. With a flat glass or metal electrode, place a lab tissue or soft cloth over the electrode surface and gently press in place.
-

6. Slide the keeper into position between the electrode and the reference junction while holding the electrode down.

— **NOTE** —

Make sure that the keeper engages both electrode and reference junction slots.

7. Install and secure the keeper lock screw (finger tight). Do **not** use any tool (for example, needle-nose pliers) to tighten the keeper lock screw. Do **not** overtighten.

General Sensor Installation Guidelines

— **NOTE** —

All piping techniques should comply with standard and acceptable practices.

Proper mounting of the sensor is important for efficient and accurate operation. For dimensional information, see Dimensional Prints listed in “Reference Documents” on page 2.

For all applications and sensor configurations, mounting arrangements must be located so that:

- ◆ Sample at the sensing area is representative of the solution.
- ◆ Solution circulates actively and continuously past the sensing area (electrodes should stay wetted at all times).
- ◆ Flow velocity at sensing area does not cause cavitation or electrode damage.
- ◆ Position and orientation of the sensor does not trap air bubbles within the sensing area.
- ◆ Orientation of the sensor is any position up to 90° from vertical with the electrode end downward.
- ◆ Accessibility for replacement is considered. A flow-type installation must have blocking valves (user supplied) to allow for sensor replacement.
- ◆ Deposits of sediment or other foreign material do not accumulate within the sensing area.
- ◆ Provision for removal of the sensor from the process is considered. If cable is installed in metal conduit (recommended), either use flexible conduit or make some other provision.

—  **CAUTION** —

When installing a sensor, be careful **not** to bottom the sensor in the vessel, particularly in a small diameter pipe.

Flow Chamber Installation

Flow chambers are a convenient way of mounting sensors in a system where a sample is provided by a small diameter sample line. The inlet and outlet ports of the flow chamber have 1/4 NPT internal threads and connect to the system with user supplied fittings. The flow chamber is offered in PVC and 316 ss. Refer to Table 5 for flow chamber specifications.

Table 5. Flow Chamber Specifications

Flow Chamber Material	Maximum Pressure/Temp Rating	Foxboro Part Number
PVC	0.4 MPa (60 psi) at 50°C at (120°F) 0.2 MPa (30 psi) at 60°C (140°F)	0051181
316 ss	1.4 MPa (200 psi) at 125°C (260°F)	0051179

! WARNING

Do **not** exceed the pressure/temperature ratings of the materials used.

! CAUTION

The flow chamber can pass up to 125 mL/s (2 gpm) of process sample without introducing a damagingly high pressure drop. To avoid damage to the sensor, do **not** exceed 125 mL/s (2 gpm).

NOTE

All piping techniques should comply with standard and acceptable practices.

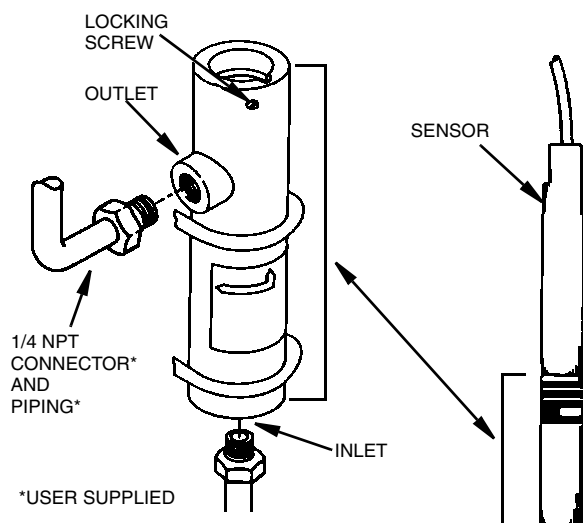


Figure 2. Flow Chamber Installation

A flow chamber installation must meet mounting arrangements specified in “General Sensor Installation Guidelines” on page 14 as well as the following requirements:

- ◆ Mount the flow chamber so that the sensor is located between vertical and 45° with the electrodes facing down.

- ◆ Direct the outlet piping **upward** a minimum of 50 mm (2 in) so that bubbles do not settle in the measuring electrode.
- ◆ Provide space for removal of the sensor from the flow chamber.

Install the flow chamber as follows:

1. Drill four mounting holes for the two U-bolt clamps.
2. Mount the flow chamber and connect the two 1/4 NPT user supplied connections (see Figure 2).
3. Loosen the locking screw and insert the sensor into the flow chamber.

⚠ CAUTION

Do not damage the sensor O-ring.

4. Rotate the sensor 1/4-turn clockwise and secure the locking screw.
5. Fill and pressurize the flow chamber as required. Check for and eliminate leaks.
6. Complete sensor conduit connection installation.

Plug Installation

A plug (Figure 3) provides system sealing if a sensor is removed from the process for maintenance, cleaning, and so forth). The plug is compatible with any Foxboro Twist-Lock receptacles (for example, flow chamber, bushing, tee). See Table 6 for plug specifications and Figure 3 for a typical installation.

Table 6. Plug Specifications

Plug Material	Maximum Pressure/Temp Rating	Foxboro Part Number
PVC	0.4 MPa (60 psi) at 50°C at (120°F) 0.2 MPa (30 psi) at 60°C (140°F)	0051187
316 ss	1.4 MPa (200 psi) at 125°C (260°F)	0051188

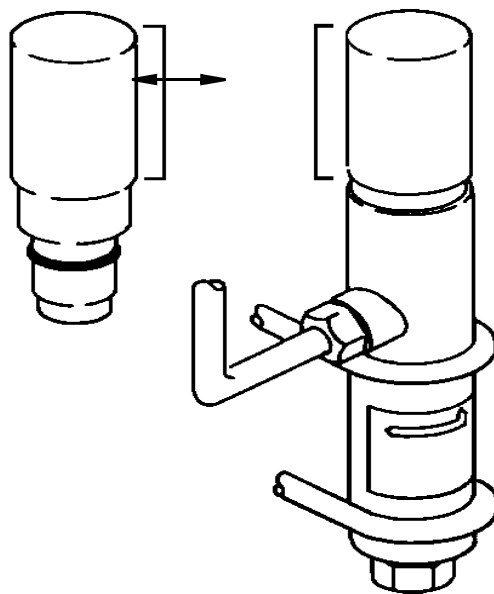


Figure 3. Plug Installation on Flow Chamber

Bushing Installation

Bushings are used for permanent installations using process piping larger than DN20 or 3/4-inch. A Twist-Lock connection secures the sensor into the bushing. See Table 7 for bushing specifications and Figure 4 for a typical installation.

Table 7. Bushing Specifications

Material	Thread Size	Maximum Pressure/Temp Rating	Foxboro Part Number
PVC	1-1/4 NPT	0.4 MPa (60 psi) at 50°C at (120°F) 0.2 MPa (30 psi) at 60°C (140°F)	0051183
316 SS	1-1/4 NPT	1.4 MPa (200 psi) at 125°C (260°F)	0051185
	1-1/2 NPT		0051186

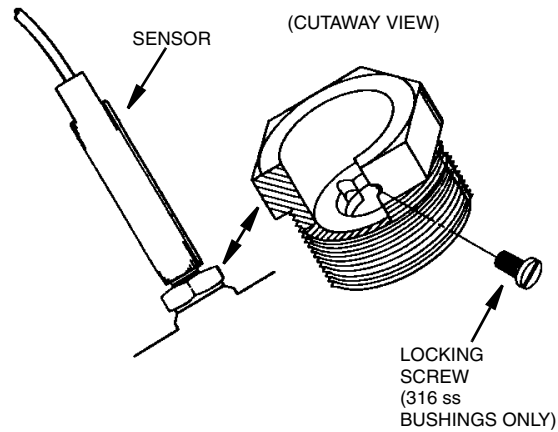


Figure 4. Twist-Lock Bushing Installation

Tee Installation

A solvent weld DN 25 or 1-inch PVC tee is available for insertion in a pipeline. Mating to a sensor is achieved via a Twist-Lock connection. See Figure 5 for a typical installation.

Maximum Pressure/Temperature Rating:

0.4 MPa (60 psi) at 50°C (120°F) or 0.2 MPa (30 psi) at 60°C (140°F).

Nominal Length: 95 mm (3.8 in)

Foxboro Part Number: 0051184

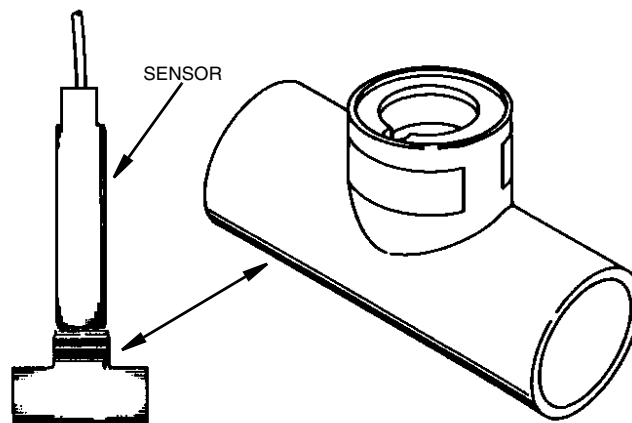


Figure 5. Twist-Lock Tee Installation

Electrode Protection Sleeve Installation

The electrode protection sleeve (Figure 6) protects glass electrodes from contacting the bottom or side of a tank. This PVC sleeve [with a maximum temperature rating of 60°C (140°F)] is available for submersible or ball valve assembly applications. Mating to the sensor is achieved via a Twist-Lock connection. See Figure 6 for a typical installation.

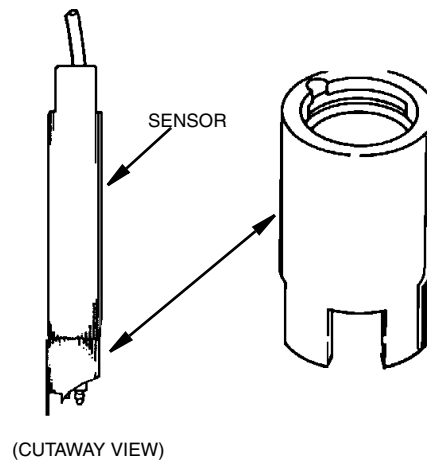


Figure 6. Electrode Protection Sleeve Installation

Submersion/Immersion Installation

It is recommended that the sensor be supported by a length of 1/2-inch pipe (user-supplied) in a tank or stream. The sensor cable should be protected from damage by using user supplied conduit. Install the sensor as follows:

1. Wrap ptfе tape on the 1/2 NPSM pipe threads. See Figure 7.

CAUTION

Use of an NPT (instead of NPSM) thread can cause the sensor body to split.

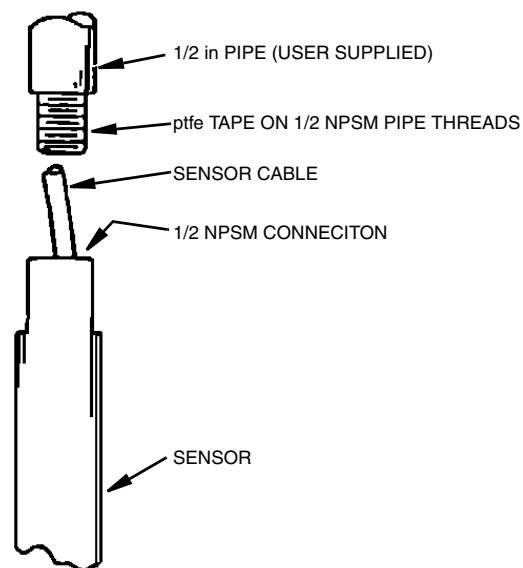


Figure 7. Submersion/Immersion Installation

2. Slide the pipe over the sensor cable using care not to damage the cable. Thread the pipe into the end of the sensor.
3. Use a liquid-tight connector (user-supplied) at the top of the pipe to prevent condensation from forming inside the pipe.
4. Slide the protective conduit (user supplied) over the cable up to the pipe and secure the conduit.

Ball Valve Assembly Installation

The ball valve assembly permits the sensor to be inserted or removed from a process stream or tank under rated temperature and pressure without draining the system or resorting to a bypass arrangement. The assembly consists of the ball valve unit and an insertion shaft assembly. Standard flexible conduit (user provided) can be used for cable protection. For ball valve assembly specifications, see Table 8.

Table 8. Ball Valve Assembly Specifications

Process Line Connection	Material of Process Wetted Parts				Rated Pressure		Max. Temp. at Rated Pressure ^(a)		Foxboro Part Number ^(b)
	Process Conn. and Housing	Ball Seat	Ball Valve	O-ring	MPa	psi	°C	°F	
1-1/2 NPT	316 SS	ptfe	Glass-filled poly-propylene	Viton	1.0	145	20	70	BS805JP and BS805JN
					0.4	55	65	150	
					0.07	10	88	190	
1-1/2 NPT	Titanium	ptfe	Kynar	Viton	1.0	145	60	140	BS805JQ
					0.6	85	100	212	
					0.4	60	120	250	

(a) Maximum temperature and pressure specifications for the 871PH Sensor are a function of both the sensor employed and mounting accessory used.

(b) BS805JP and BS805JQ have purgable housing; BS805JN, nonpurgable housing.

A ball valve assembly installation must meet mounting arrangements specified under “General Sensor Installation Guidelines” on page 14. In addition, please adhere to the following requirements:

- ◆ Direct the flow of the solution (as much as possible) toward the sensing area.
- ◆ Provide sufficient space for removal of the sensor from the ball valve unit (see DP 611-122).

Installing the Ball Valve Assembly Into the Process

1. Unscrew the housing nut and remove the insertion shaft assembly.
2. Close the ball valve by turning the handle so that it is perpendicular to the housing (as indicated by the arrow on top of the handle).

3. Screw the 1 1/2 NPT nipple of the ball valve into the process vessel. Tighten as required.

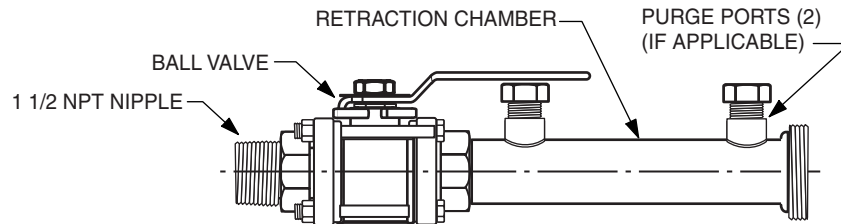


Figure 8. Ball Valve Assembly

4. Connect appropriate piping to the purge ports of the retraction chamber (if applicable).

Connecting the Sensor to the Insertion Shaft Assembly

1. Wrap ptfе tape onto the threads of the shaft assembly.
2. Feed the sensor cable through the shaft assembly. Screw the shaft assembly into the end of the sensor (finger tight). See Figure 9. Do **not** overtighten.

— NOTE —

To prevent the cable from twisting, it is recommended that this be done by holding the sensor and turning the insertion shaft.

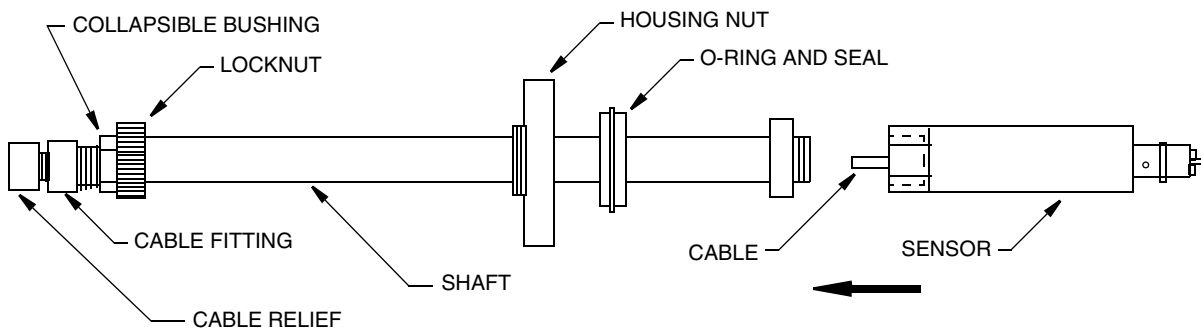


Figure 9. Insertion Shaft Assembly

Installing the Insertion Shaft into the Ball Valve

— ⚠ WARNING —

Do not exceed the sensor or ball valve temperature and pressure limits.

— ⚠ WARNING —

Stand to the side, not directly behind the assembly, during insertion of the sensor.

— NOTE

The sensor should have been connected to the insertion shaft assembly prior to performing this procedure. See “Connecting the Sensor to the Insertion Shaft Assembly” on page 21.

1. Assure that the ball valve is closed. The handle should be perpendicular to the housing (as indicated by the arrow on top of the handle).
2. Fill and pressurize the process line or tank as required. Check for and eliminate leaks.
3. Lightly lubricate the shaft with silicone grease (or equivalent).
4. Slide the O-ring and seal along the insertion shaft towards the sensor as far as it goes.

— ⚠ CAUTION

Failure to do this makes it possible for the sensor to contact the closed ball valve when performing the next step. Such contact could damage the sensor.

5. Carefully insert the sensor (connected to the insertion shaft assembly) into the housing retraction chamber until the O-ring and seal are seated into the end of the chamber (see Figure 10).

— ⚠ CAUTION

Do **not** damage the O-rings. Do **not** force the electrodes against the closed ball valve.

6. Tighten the housing nut onto the end of the retraction chamber.
7. Slowly turn the handle on top of the ball valve unit (see Figure 10) to the open position (parallel to the housing as indicated by the arrow on top of the handle).

— ⚠ WARNING

Depending on the condition of the seal, process seepage is possible as you perform the next step.

— ⚠ CAUTION

Failure to open the ball valve causes the sensor to contact the closed ball valve when performing the next step. Such contact could damage the sensor.

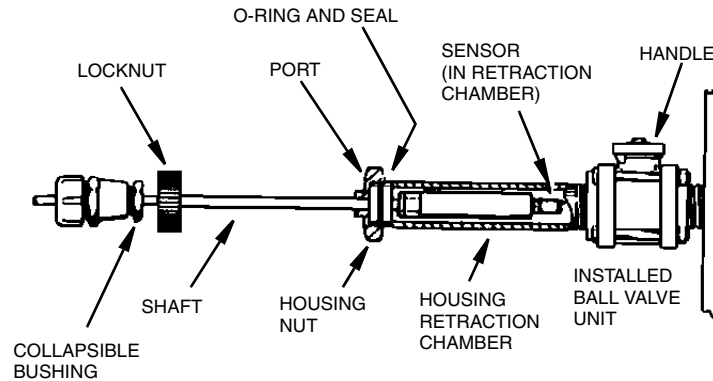


Figure 10. Ball Valve Shaft Installation and Removal

8. Insert the shaft slowly until the locknut reaches the housing nut. Tighten the locknut onto the housing nut. When this is done, the sensor is inserted at a depth of 21 mm (0.8 in) when using a polypropylene ball valve or 53 mm (2.1 in) when using a Kynar ball valve.
9. Push the collapsible bushing against the locknut.
10. Screw the cable fitting onto the collapsible bushing.
11. Tighten the cable relief until it captures the cable.

Removing and Replacing a Sensor

— **⚠ WARNING** —
Stand to the side, not directly behind the assembly, during removal or insertion of the sensor.

— **⚠ WARNING** —
If process fluid is present, there could be some process seepage as you perform Steps 2 and 5. Take all necessary precautions.

— **⚠ WARNING** —
Do **not** loosen the **housing nut** (see Figure 10) when the ball valve unit is open and the process line or tank is filled and pressurized.

1. Carefully loosen and detach the locknut **only**. Do **not** loosen the housing nut at this time.
2. Pull the insertion shaft out of the process as far as you can. This positions the sensor in the retraction chamber.
3. Close the ball valve by turning the handle so that it is perpendicular to the housing (as indicated by the arrow on top of the handle).

4. Drain and flush the purgable retraction chamber (if applicable). Then close the purge fittings.
5. Slowly loosen and detach the housing nut. Withdraw the shaft assembly from the housing retraction chamber.
6. Remove the cable fitting and cable relief from the insertion shaft.
7. Unscrew and remove the sensor from the insertion shaft.
8. Perform “Connecting the Sensor to the Insertion Shaft Assembly” on page 21.
9. Perform “Installing the Insertion Shaft into the Ball Valve” on page 21.

Electrode Cleaning System (ECS)

For information on installation, operation, etc., refer to Instruction MI 611-125.

Wiring

Cable Variations

Sensor cables are permanently attached to the sensor. Additional length can be achieved through the use of an extension cable (with straight pin lugs on each end) or a patch cord (with a Variopin or generic connector on one end and straight pin lugs on the other). See Figures 11 through 13 for typical sensor cable, extension cable, and patch cord configurations.

Cable Length

When a internal preamplifier is used, the analyzer/transmitter can be up to 152 m (500 ft) away from the sensor. If no preamplifier is used, the distance is limited to 15 m (50 ft).

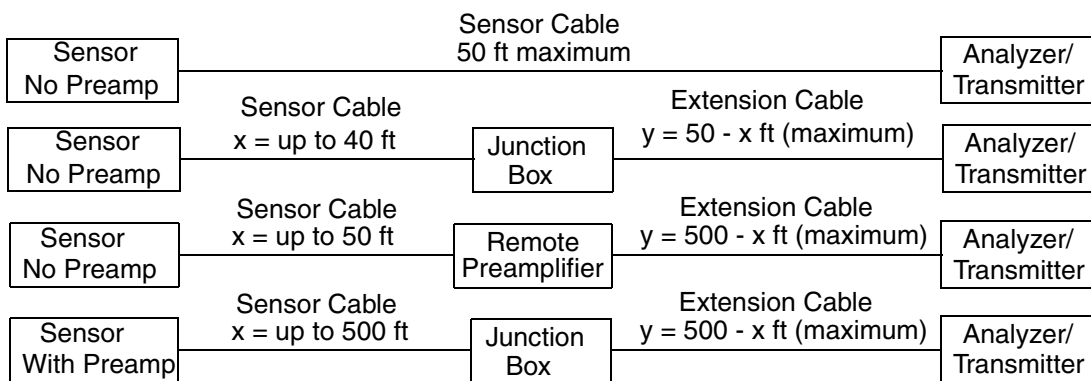


Figure 11. Cable Lengths for Cable With Pin Lugs

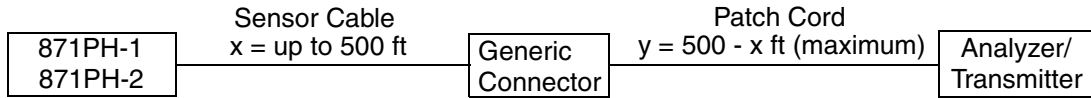


Figure 12. Cable Lengths for Cable With Generic Connector

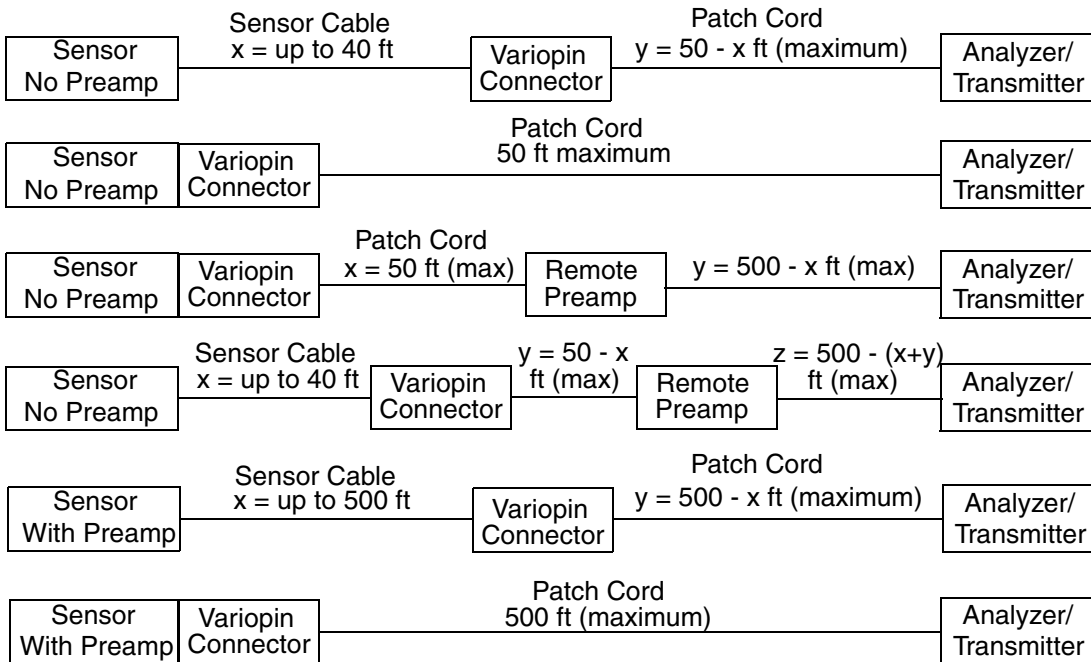


Figure 13. Cable Lengths for Cable With Variopin Quick Connector

Connections to Analyzer or Transmitter

Connect the numbered wires from the sensor to the appropriate terminals on the transmitter, analyzer, or junction box. For sensor connections to an analyzer or transmitter, refer to Table 9 through Table 11. Extension cables and patch cords have the same numbering and color coding as the sensor cables.

Table 9. Analyzer and Transmitter Connections

Instruction	Analyzer or Transmitter
MI 611-165	873PH Series Electrochemical Analyzers for pH or ORP Measurement
MI 611-190	873DPX Dual pH, ORP, or ISE Electrochemical Analyzers
MI 611-191	873APH Ace Series Electrochemical Analyzers for pH Measurement
MI 611-211	870ITPH pH and ORP Transmitters
MI 611-225	875PH pH and ORP Analyzers

Table 10. Standard Temperature Cable Wiring - Sensor Without Preamplifier

Wire Number	Cable Color	Function
1	Black	RTD Return
2	White or Dark Green ^(a)	RTD Drive
3	Clear (Coax)	Measuring Electrode
3A	Clear (Coax Shield)	Screen for Measuring Electrode
4	Green (Outer Shield)	Solution Ground
5	Red	Reference Junction

(a) Depending on shipment date

Table 11. Cable Wiring - Sensor With Preamplifier

Wire Number	Cable Color	Function
1	Black	RTD Return
2	White	RTD Drive
2A ^(a)	Orange	RTD (871PH-3 and -4 Only)
3	Red	Measuring Electrode
4	Clear	Solution Ground
5	Clear or Yellow ^(b)	Reference Junction
6	Brown	Power to Sensor (+)
7	Blue	Power to Sensor (-)
8 ^(c)	Green	Diagnostic Signal

(a) Patch cords used with sensors with preamplifiers do not have a 2A wire, so be sure your transmitter is configured for a 2-wire RTD.

(b) Depending on shipment date

(c) 871PH-1 and -2 do not have wire number 8.

Table 12. High Temperature Cable Wiring - Sensor Without Preamplifier

Wire Number	Cable Color	Function
1	Black	RTD Return
2	Brown	RTD Drive
3	White (Coax)	Measuring Electrode
3A	Clear (Coax Shield)	Screen for Measuring Electrode
4	Green (Outer Shield)	Solution Ground
5	Red	Reference Junction

Variopin Connectors

Do **not** disconnect Variopin connectors in the rain or in condensing moisture environments or otherwise allow moisture to get inside the connector.

Even though sensors with a Variopin quick connector meets the watertight standards of IEC IP67 for submersion at a depth of 1 m for 24 hours, Invensys Process Systems recommends that sensors with a Variopin quick connector not be submerged.

Before reassembly, inspect the two parts of the connector for any sign of moisture or residue. Thoroughly remove any moisture or residue from all surfaces to ensure high performance.

Remote Preamplifier

The remote preamplifier (BS811MR) is used in those applications that require a sensor without an integral preamplifier but with a cabling distance between the sensor and the analyzer/transmitter of more than 15 m (50 ft) but less than 150 m (500 ft). The remote preamplifier junction box enclosure has a NEMA 4X rating for watertight, dusttight, and corrosion resistant protection.

3. Maintenance

Electrode Inspection


Fouling (the build-up of a film) on the measuring electrode and the reference junction can cause erratic output.


Inspect the electrodes as needed. Once a week is recommended for new installations. If fouling is evident, clean the electrode as described in the following sections.

Electrode Cleaning

Cleaning a Glass Electrode

First, consider the contamination you are trying to remove. In what is it soluble? What will chemically attack it? Next, consider the sensor. What cleaner will have little or no effect on the sensor itself? Choose the solvent, soap, or chemical that is the mildest but removes the contamination. Caustic is a risky choice for glass electrodes. Stronger concentrations can attack the glass. Dilute HCl (muriatic acid) is frequently a good choice. The concentration of HCl should be as low as possible and still remove the contamination. Consider 4% or 1 N to be a maximum.


—  **CAUTION** —————
Do not clean glass electrodes with abrasive cleaners or coarse wipers.

—  **CAUTION** —————
Handle the sensor very carefully to avoid damage to the glass electrode.

Rinse the electrode with distilled water. Blot the electrode and reference junction with a soft cloth. In hard-water areas, dip the tip of the sensor in a 1 to 4% solution of HCl to remove surface film. Then rinse thoroughly.

If the electrode surface is oily, clean it with a mild detergent and fine bristle brush.

Cleaning an Antimony Electrode

—  **WARNING** —————
Antimony is a toxic material. When an antimony electrode is installed, avoid contact with the surface of the antimony pellet. If skin contact is made with the antimony pellet, wash the contacted skin area with soap and water. Refer to MSDS051.

First consider the contamination you are trying to remove. In what is it soluble? What will chemically attack it? Next, consider the sensor. What cleaner will have little or no effect on the sensor itself? Choose the solvent, soap, or chemical that is the mildest but removes the contamination.

If the electrode surface remains black after cleaning, it may be due to self-fouling antimony oxide formation. Remove the oxide layer by scraping the surface with a knife blade. Remove as little material as possible to reveal a metallic luster while leaving the bulk of the electrode intact.

Cleaning an ORP Electrode

ORP electrodes rarely require cleaning. However when they do, first consider the contamination you are trying to remove. In what is it soluble? What will chemically attack it? Next, consider the sensor. What cleaner will have little or no effect on the sensor itself? Choose the solvent, soap, or chemical that is the mildest but removes the contamination. The electrode surface can also be polished with powdered alumina or a fine grained emery cloth.

Cleaning the Reference Junction

Carefully clean the reference junction with detergent and a fine bristle brush.

Storing a Sensor

The shelf life of your sensor depends on the storage conditions. Although Invensys Foxboro does not specify a shelf life, a reasonable estimate is 6 to 12 months. Under the best conditions, sensors may last well over a year on the shelf.

The key to proper storage is keeping both the measuring electrode and the reference junction hydrated at normal room temperature. Store your sensor in a 1 M potassium chloride solution or a pH 4 or pH 7 buffer solution. Sensors should not be stored in distilled or deionized water. New sensor assemblies are shipped with the measuring and reference junction sealed in a protection cap containing liquid potassium chloride salt solution. The cap should remain in place until you are ready to install your sensor in the process. The protection cap can be reused to store a sensor by replenishing the solution and fitting it on to the sensor. Invensys Process Systems recommends this if the sensor is removed from the process for more than a few hours. Proper storage maximizes both shelf life and service life of a sensor.

Measuring Electrode Replacement

A series of Electrode Kits containing electrodes, supplies, and tools required to replace an electrode are available from Invensys Foxboro.

Removing the Old Electrode

— CAUTION —

Do **not** remove the measuring electrode when the reference junction is not in place. Contamination by the reference solution is very possible.

1. Wipe away any crystallized reference solution from the reference junction. Make sure area is dry so that no moisture gets into the electrode socket.
2. Hold the sensor vertically with the electrode end up.

3. Remove the knurled keeper lockscrew (or pan head screw if the optional -T teflon collar or ECS-5 electrode cleaning system is used) and disengage the keeper from the electrode and reference junction.
4. Slide the extractor tool (beveled edges up) into position as shown in Figure 14. Note that the edges fit into the electrode retaining slot.
5. Press down lightly on the end of the extractor.
6. Lift the electrode out of its cavity until the O-ring is clear.
7. Carefully remove the extractor tool.
8. Grasp the electrode and pull it straight out of the cavity using a slight turning motion to assist the removal.

— **! CAUTION** —

Never grasp a glass electrode by the bulb. The glass is fragile and can be easily broken. For removal of a broken glass electrode, refer to “Removing a Broken Glass Electrode” below.

— **! WARNING** —

Antimony is a toxic material. When an antimony electrode is installed, avoid contact with the surface of the antimony pellet. If skin contact is made with the antimony pellet, wash the contacted skin area with soap and water. Refer to MSDS051.

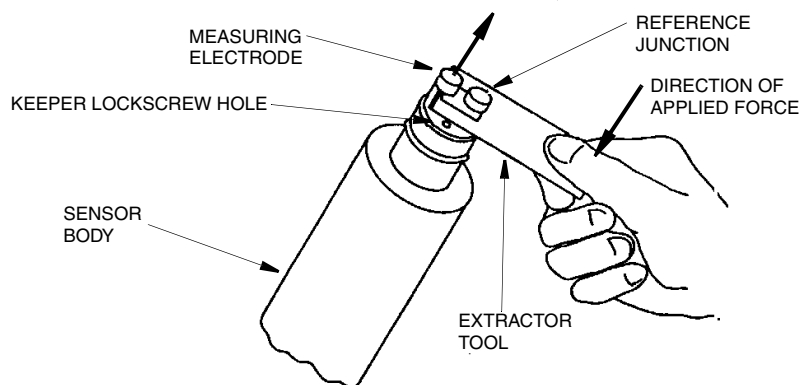


Figure 14. Removing Measuring Electrode

Removing a Broken Glass Electrode

— **NOTE** —

The procedures for removing a broken glass electrode vary depending on the exact condition of the electrode.

The following procedures should be followed until the broken electrode has been completely removed.

1. Follow the “Measuring Electrode Replacement” procedure described above.
2. If the extractor tool removes only the bulb support, grasp the electrode wire with a pair of pliers and pull gently until the remaining electrode parts are removed.
3. If the wire breaks before the electrode has been removed completely:
 - a. Break any remaining glass envelope and remove the O-rings and the O-ring spacer.
 - b. Reach into the cavity with a pair of long-nose pliers, grasp the end of the electrode stem and pull it straight out to remove the stem and end cap.
4. Remove any remaining glass fragments from the cavity with a cotton swab.

Installing the New Measuring Electrode

1. Clean the measuring electrode cavity thoroughly with the cotton swab provided. The cavity **must** be dry.
2. Using another cotton swab, lubricate (lightly) all the internal surfaces of the electrode cavity with the silicone grease provided.
3. Apply a light coat of silicone grease to the electrode O-rings. Be careful that grease does not get on the electrode measuring surface.
4. Holding the sensor with the electrode cavity facing up, insert the electrode stem into the cavity.

—  **WARNING** —

Antimony is a toxic material. When an antimony electrode is installed, avoid contact with the surface of the antimony pellet. If skin contact is made with the antimony pellet, wash the contacted skin area with soap and water. Refer to MSDS051.

5. Gently press the electrode into place until the first O-ring engages with the surface of the sensor body. Continue to press on the electrode until the second O-ring is engaged.

—  **CAUTION** —

1. When installing a glass electrode, do **not** push on the glass bulb with your finger. Use the insertion cap provided with the sensor. Place the insertion cap over the glass bulb and press the electrode into place.
 2. To prevent damage to the glass stem of the electrode body, push the electrode straight into the sensor cavity. Avoid twisting the electrode.
 3. When installing a flat glass or metal electrode, place a lab tissue or soft cloth over the electrode surface and gently press in place.
-

6. Slide the keeper into position between the electrode and the reference junction while holding the electrode down.

— **NOTE** —

Make sure that the keeper engages both electrode and reference junction slots.

7. Install and secure the knurled keeper lockscrew (finger tight) or the pan-head screw (if the optional -T teflon collar or ECS-5 electrode cleaning system is used). Do **not** overtighten.
8. Perform a calibration (1-point for ORP measurement, 2-point for pH measurement).

Refilling the Reference Cavity


The reference cavity should be refilled (and the reference junction perhaps replaced) when standardization is no longer possible or when erratic readings cannot be corrected by other means explained in “Troubleshooting” on page 37. The time interval at which refilling should be done depends on variable conditions such as temperature cycling, pressure cycling, and so forth. Under normal conditions, it should not be required more often than every six months.

The procedure to refill the reference cavity is explained in “Reference Junction Replacement” below.

Reference Junction Replacement

A series of Reference Junction Refill Kits containing reference junctions, supplies, and tools required to replace a reference junction are available from Invensys Foxboro.

Removing the Reference Junction

—  **CAUTION** —
Do **not** remove a reference junction without having a measuring electrode installed.

1. Hold the sensor vertically with the electrode end up.
2. Remove the knurled keeper lockscrew (or pan head screw if the optional -T teflon collar or ECS-5 electrode cleaning system is used) and disengage the keeper from the electrode and reference junction.
3. Slide the extractor tool (beveled edges up) into position as shown in Figure 15. Note that the edges fit into the reference junction retaining slot.

— **NOTE** —
The reference junction is the white, ceramic faced disk.

4. Press down lightly on the end of the extractor.
5. Lift the electrode out of its cavity until the O-ring is clear.
6. Carefully remove the extractor tool.
7. Grasp the reference junction and pull it straight out of the cavity using a slight turning motion to assist the removal.

Remove all solution in the reference cavity by turning the sensor upside-down and shaking it (like a thermometer).

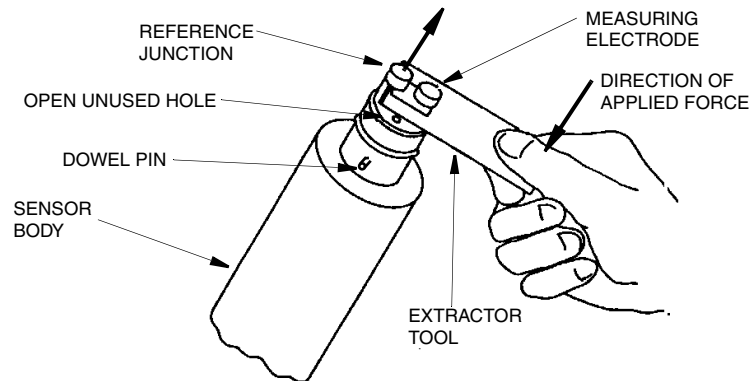


Figure 15. Removing the Reference Junction

Refilling the Reference Cavity

1. Inject new reference cavity solution into the reference cavity until the cavity is about half full.
2. Cover the opening with your thumb and shake the sensor vigorously.
3. Remove all of this new solution from the cavity by turning the sensor upside-down and shaking it (like a thermometer).
4. Inject new solution into the cavity until the cavity is nearly full.

— NOTE —

The -D ion barrier reference junction requires less solution.

5. Tap the sensor to eliminate all air bubbles.

Installing the Reference Junction

Replace the old reference junction or install the new reference junction as follows:

1. Push the reference junction into place until the O-ring seats, allowing excess solution to flow out.
2. An additional small amount of solution may have to be removed to allow the junction to seat. If so, do this by removing the reference junction and shaking off solution adhering to the junction body.
3. Repeat Steps 1 and 2 to remove enough solution for the junction to seat properly.
4. Press the reference junction firmly into the cavity and hold it in the seated position.

— CAUTION —

Do not use excessive force to seat the reference junction because this might damage the internal seals.

5. Slide the keeper into place between the reference junction and the electrode while holding the junction down.
6. Install and secure the knurled keeper lockscrew (finger tight) or the pan-head screw (if the optional -T teflon collar or ECS-5 electrode cleaning system is used). Do **not** overtighten.
7. Perform a calibration (1-point for ORP measurement, 2-point for pH measurement).

4. Troubleshooting

Use the following procedure for diagnosing and correcting sensor problems:

1. Check the RTD.

871PH -1, -2 sensors use 100 ohm 2-wire RTDs. 871PH -5, -6 sensors use 1000 ohm 2-wire RTDs. Disconnect sensor leads 1 and 2 from the analyzer or transmitter and use an ohmmeter to measure the resistance between these leads. Resistance with temperature values for the two RTDs are shown in Table 13.

871PH -3, -4 sensors use 1000 ohm 3-wire RTDs. Disconnect sensor leads 1, 2, and 2a from the analyzer or transmitter and use an ohmmeter to measure the resistance between 1 and 2 and 1 and 2a. Resistance with temperature values for the 1000 ohm RTD are shown in Table 13. Leads 2 and 2a are common; the resistance between them should be small or effectively zero.

If these checks are OK, proceed to Step 2.

Table 13. Process Temperature vs. RTD Resistance

Process Temperature		871PH -1, -2 100 ohm RTD Resistance	871PH -3, -4, -5, -6 1000 ohm RTD Resistance
°C	°F	Ohms	Ohms
-5	+20	98.04	980.4
0	32	100.00	1000.0
10	50	103.90	1039.0
20	68	107.79	1077.9
25	75	109.73	1097.3
30	86	111.67	1116.7
40	104	115.54	1155.4
50	122	119.40	1194.0
60	140	123.24	1232.4
70	158	127.07	1270.7
80	176	130.89	1308.9
90	194	134.70	1347.0
100	212	138.50	1385.0
105	225	140.39	1403.9
110	230	142.28	1422.8
120	248	146.06	1460.6
130	266	149.82	1498.2
160	320	161.04	1610.4

2. Check the solution ground.

Remove the sensor from the process. Thoroughly clean the sensor body with distilled water and dry the body completely. With sensor leads connected to the analyzer or transmitter, use an ohmmeter to measure between the keeper lock screw (or grounding stud) and terminal #4. Resistance should be less than 1 k Ω . If this check is not OK, sensor must be replaced. If this check is OK, proceed to Step 3.

3. Check the power to the preamplifier (sensor types -1, -2, -3, and -4 only).

Leave all sensor leads connected to the analyzer or transmitter. Use a voltmeter to measure the voltage between terminals 4 and 6 (clear and brown) and between 4 and 7 (clear and blue).

- a. With an 870PH Transmitter, the voltage should be approximately ± 5.5 V.
- b. With an 873 Analyzer, the voltage should be approximately ± 6.2 V.
- c. With an 870ITPH Intelligent Transmitter, the voltage should be approximately +5 V from 6 to 4, and -2.5 V from 7 to 4.
- d. With an 875PH Analyzer, the voltage should be approximately +5 V from 6 to 4, and -5 v from 7 to 4.

If the above check is OK, proceed to Step 4. If check is not OK, disconnect sensor leads 4, 6, and 7 from the analyzer or transmitter. Repeat the voltage checks above (measure at the analyzer or transmitter, not at the sensor leads). If voltage checks are now OK, the sensor must be replaced. If checks are not OK, there is a problem in the analyzer or transmitter.

4. Check the system with buffers.

Reconnect all sensor leads to the analyzer or transmitter. Leave power on to the analyzer or transmitter. Clean the measuring pH and reference junction. Place the sensor in a pH 7 buffer solution. Use a voltmeter (or press SHIFT mV on the 873) to measure the voltage between terminals 3 and 5 (red and clear). The voltmeter should read approximately 0 mV in the pH 7 buffer and should change approximately 59 mV per pH unit (for example, in pH 4 buffer, the reading should be approximately -177 mV; in pH 10 buffer, the reading should be approximately +177 mV).

If the above check is OK and there is still a problem with the measurement, the problem resides in the analyzer or transmitter. If the above check is not OK, proceed to Step 5.

5. Check the sensor alone with buffers.

Disconnect sensor leads 3 and 5 from the analyzer or transmitter. Repeat the voltage checks described in Step 4, except make the measurement at the sensor leads. If the voltage checks are OK, there is a problem in the analyzer or transmitter. If voltage checks are not OK, the electrodes must be replaced and/or the reference cavity must be refilled.

Table 14. Sensor Troubleshooting

Problem	Possible Cause	Remedy
No response.	<ol style="list-style-type: none"> 1. Broken measuring electrode. 2. Heavily coated electrodes. 	<ol style="list-style-type: none"> 1. Replace measuring electrode. 2. Clean and/or replace.
Elongated span.	<ol style="list-style-type: none"> 1. Incorrect instrument calibration 2. Instrument temperature compensation inactive or incorrectly configured. 3. Incorrect temperature measurement. 	<ol style="list-style-type: none"> 1. Recalibrate. 2. Refer to instrument manual for proper configuration. 3a. Check RTD resistance across leads 1 and 2 (see Table 12) 3b. if OK, calibrate instrument temperature circuit. If bad, replace sensor.
Sluggish response.	<ol style="list-style-type: none"> 1. Aged or dehydrated measuring electrodes. 2. Coated or dirty electrodes. 	<ol style="list-style-type: none"> 1. Replace electrode. (If dehydrated, soak in pH 4 buffer or KCl solution.) 2. Clean/replace electrodes.
Erratic or noisy measurement.	<ol style="list-style-type: none"> 1. No electrolyte in reference cavity. 2. Fouled reference electrode. 3. No solution ground. 4. Air bubbles in solution. 	<ol style="list-style-type: none"> 1. Fill reference cavity. 2. Clean/replace reference junction. 3a. Ensure electrical connection between sensor lead 4 and grounding stud. If not OK, replace sensor. 3b. Ensure that lead 4 is connected to instrument solution ground terminal. 4. Arrange sensor mounting to avoid air bubbles.
Discrepancy between process reading and laboratory grab sample results.	<ol style="list-style-type: none"> 1. Laboratory reading in error. 2. Change in grab sample temperature (i.e., sample temperature changed before laboratory measurement was made — causing a change in pH). 3. Incorrect instrument calibration. 	<ol style="list-style-type: none"> 1. Verify calibration and/or operation of laboratory pH equipment. 2. Make off-line measurement as soon as possible after collecting grab sample. If sample cooling is inevitable, a change in pH from the process to the lab may be unavoidable. 3. Recalibrate.

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JUN 1994

JUN 1995

JAN 1997

SEP 2004

MAR 2006

AUG 2008

Vertical lines to right of text or illustrations indicate areas changed at last issue date.

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Printed in U.S.A.

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