

Rosemount™ 389/389VP

General Purpose pH/ORP Sensors



Essential Instructions

Read this page before proceeding!

Emerson designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using, and maintaining Emerson products. Failure to follow the proper instructions may cause any one of the following situations to occur: loss of life, personal injury, property damage, damage to this instrument, and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product.
- If this Reference Manual is not the correct one, call 1-800-999-9307 to request the correct Reference Manual. Save this Reference Manual for future reference.
- If you do not understand any of the instructions, contact your Emerson representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install equipment as specified in the installation instructions of the appropriate Reference Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Emerson. Unauthorized parts and procedures can affect the product's performance, place the safe operation of your process at risk, and VOID YOUR WARRANTY. Look-alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified people, to prevent electrical shock and personal injury.

WARNING

Hazardous area installation

Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel.

To secure and maintain intrinsically safe installation, use an appropriate transmitter/safety barrier/sensor combination. The installation system must be in accordance with the governing approval agency (FM, CSA, or BASEEFA/CENELEC) hazardous area classification requirements. Consult your transmitter Reference Manual for details.

Proper installation, operation, and servicing of this sensor in a hazardous area installation are entirely the operator's responsibility.

CAUTION

Sensor/process application compatibility

The wetted sensor materials may not be compatible with process composition and operating conditions.

Application compatibility is entirely the operator's responsibility.

CAUTION

Software modifications

If a 275, 375, or 475 Universal HART® Communicator is used with these transmitters, the software within the 275, 375, or 475 may require modification.

If a software modification is required, please contact your local Rosemount Service group or National Response Center at 1-800-654-7768.

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1 Description and Specifications

1.1 Features and applications

Rosemount 389VP triple-junction sensors are offered with SMART capabilities. SMART options are enabled when used with Rosemount 1056, 1057, 1066, and 56 transmitters. The pH-loop capabilities include auto-recognition of the SMART sensor, automatic upload of calibration data and associated time stamp, and historical recording of pH diagnostics (slope, offset, reference impedance, and glass impedance). This trending data allows technicians to predict frequency of maintenance and estimate sensor life for a particular process condition. Additional SMART features include factory calibration, resetting SMART sensor calibration data with user menus without power cycling, and manufacturing information.

The reference junction aids in the sensor's resistance to poisoning ions and helps prolong sensor life. Rosemount 389/389VP sensors have a triple junction reference, which protects the reference element from poisoning ions - such as ammonia, chlorine, cyanides, and sulfides - in the process. Both models are made with an outer ceramic junction constructed in an annular design around the pH/ORP sensitive membrane.

The AccuGLASS™ pH glass formulations exceed industry standards. The AccuGlass pH glass is a result of many years of glass research resulting in a formulation which has been found to increase the life of the sensor. Unlike other pH glasses presently on the market, this glass resists cracking, especially at higher temperatures, and reduces sodium ion errors commonly found in high pH applications. Overall, the AccuGlass formulation enhances the sensor performance to measure pH more accurately and have a longer sensor life than ever before.

A choice of pH glass electrodes is available to best meet various application needs. Two types are available: general purpose and high pH glass. The AccuGlass hemi bulb is the standard glass offered on both types and can be used for most applications.

The Rosemount 389VP is configured with a Variopol (VP8) sensor-to-cable connector which eliminates re-wiring and cable twisting when replacing sensors. The Variopol VP8 multiple pin connector option uses a mating VP cable. Once the cable is installed and wired to the transmitter, sensors are easily replaced without replacing the cable and without rewiring the transmitter. Also, the cable can be disconnected from the sensor before removal from the process which eliminates cable twisting. VP8 cable assemblies work with both VP8 and VP6 sensor connectors.

The Rosemount 389/389VP has a molded Tefzel body with Viton O-rings, making each sensor very robust and chemically resistant. Complete encapsulation eliminates leakage or high humidity problems traditionally found in other pH/ORP designs. The simplified construction, designed with user convenience in mind, does not require electrolyte (KCl) replenishment or any high maintenance troubleshooting procedures.

Rosemount 389/389VP sensors are combination sensors (pH, reference, and temperature within sensor body) and measure pH or ORP (oxidation/reduction potential) of aqueous solutions in pipelines, open tanks, or ponds. Rosemount 389/389VP sensors are suitable for virtually all applications and are compatible with Rosemount and other manufacturers' instruments.

Installation is easily achieved through the wide variety of mounting configurations. These sensors feature a 1 inch (MNPT) front and rear facing connections for insertion, submersion, or flow-through pH and ORP applications.

1.2 Specifications

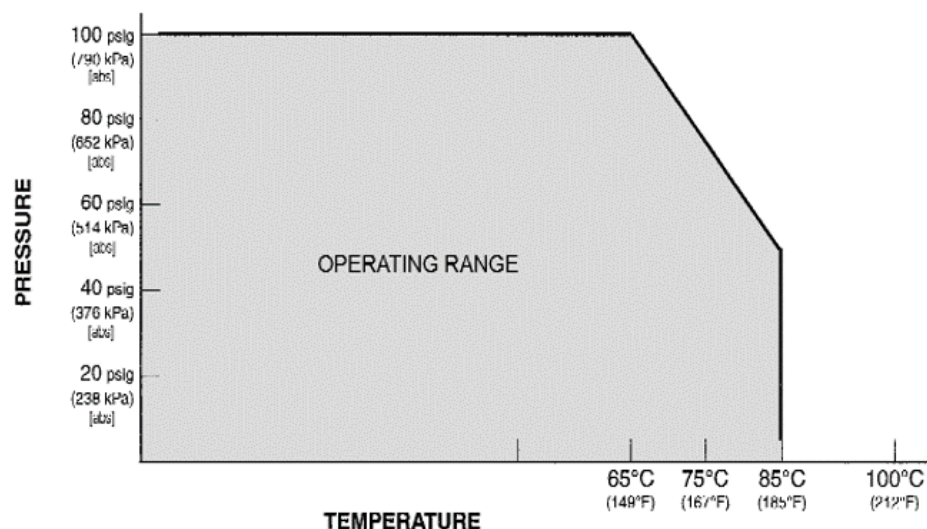
Table 1-1: Percent linearity over pH range

pH range	GPLR glass (-10)	High pH glass (-11)
0 to 2 pH	94%	94%
2 to 12 pH	99%	97%
12 to 13 pH	97%	98%
13 to 14 pH	92%	98%

Table 1-2: Rosemount 389/389VP pH/ORP sensor specifications

Measurement range	
pH	0 to 14
ORP	-1500 to +1500 mV
Temperature range	
32 to 185 °F (0 to 85 °C)	
Automatic temperature compensation : 32 to 185 °F (0 to 85 °C)	
Maximum pressure	
100 psig (790 kPa[abs]) at 150 °F (65 °C) - see Figure 1-1	
Materials of construction	
Sensor body	Tefzel
pH electrode	Glass
ORP electrode	Platinum
Junction	Ceramic
O-ring	Viton
Process connections	
Front facing	1 in. MNPT
Rear facing	1 in. MNPT
Cable	
389	Integral preamplifier - 25 ft (7.8 m); no preamplifier - 15 ft (4.6 m)
389VP	Use 24281-XX, 2.5 ft (0.8 m) to 100 ft (31 m) (see Accessories)
Weight/shipping weight	
1 lb / 2 lb (0.45 kg / 0.9 kg)	

Figure 1-1: Pressure/temperature operating range for Rosemount 389/389VP



1.3 Certifications

IECEx

Sensors without preamp (pH and ORP): Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Sensors with SMART preamp (pH only): Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Sensors with standard preamp (ORP only): Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +80 °C) or Ex IIC T5 Ga (-20 °C ≤ Ta ≤ +40 °C)

Per standards IEC60079-0: 2011, IEC 60079-11: 2011

ATEX

Sensors without preamp (pH and ORP): II 1 G Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Sensors with SMART preamp (pH only): II 1 G Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Sensors with standard preamp (ORP only) - II 1 G Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +80 °C) or II 1 G Ex ia IIC T5 Ga (-20 °C ≤ Ta ≤ +40 °C)

Per standards EN 60079-0:2012 + A11:2013, EN 60079-11:2012

FM

See online FM Certificate of Compliance for applicable sensor options:

Intrinsically safe for use in Class I, II, and III, Division 1, Groups A, B, C, D, E, F, and G; Temperature Class T6 Ta = -20 °C to + 60 °C

Intrinsically safe for use in Class I, Zone 0, AEx ia IIC T6 Ta = -20 °C to + 60 °C

Nonincendive for use in Class I, Division 2, Groups A, B, C, and D; Temperature Class T6 Ta = -20 °C to + 60 °C

Suitable for use in Class II and III, Division 2, Groups E, F, and G; Temperature Class Ta = -20 °C to + 60 °C Hazardous (Classified) Locations

IS/I, II, III/1/ABCDEFGH/T6 Ta = 60 °C - 140332; Entity: I/O/AEx ia IIC/T6 Ta = 60 °C - 1400332; Entity: NI/I/2/ABCD/T6 Ta = 60 °C; S/I, III/2/EFG/T6 Ta = 60 °C; Entity Parameters

Per standards 3600: 1998; 3610: 2010, 3611:2004, 3810:2005

CSA

See online CSA Certificate of Compliance for applicable sensor options:

Intrinsically Safe: Class I, Division 1, Groups ABCD; Class II, Division 1, Groups EFG; Class III, Class I, Division II, Groups ABCD; Ambient temperature rating -20 °C to + 60 °C; Ex ia IIC; T6

Intrinsically Safe and Non-Incendive: Class I, Division 1, Groups ABCD; Class II, Division 1, Groups EFG; Class III; Class 1, Division 2, Groups ABCD; Ex ia IIC; T6; Ambient temperature rating -20 °C to + 60 °C: (Simple Apparatus)

Class I, Division 1, Groups ABCD; Class II, Division 1, Groups EFG; Class III; Class I, Division 2, Groups ABCD; Ex ia IIC; T6; Ambient temperature rating -20 °C to + 60 °C: (Simple Apparatus)

Per standards C22.2 No. 144 -M1987, C22.2 No 157 - M1992, CAN/CSA E60079:0:07, CAN/CSA E60079:11:02, UL 50, UL 508, UL 913, UL 60079-0:2005, UL 60079-11: 2002

1.4 Ordering information

The Rosemount 389 and 389VP General Purpose pH/ORP Sensors are housed in a molded Tefzel body with 1 in. MNPT forward and rear facing threads suitable for insertion, submersion, or flow through installation. The sensors can be configured with a general purpose pH, high pH, or platinum ORP electrode. Rosemount 389VP sensors are offered with SMART preamplifiers for pH measurements and standard integral preamplifiers for ORP measurements. These sensors may be configured without a preamplifier, but must be used with a remote preamplifier (j-box or transmitter). Automatic temperature compensation is standard. Sensors are available with either an integral cable connection (389) or Variopol (VP6) connector (389VP). Variopol cables sold separately (see [Table 5-2](#)).

Table 1-3: Rosemount 389 pH/ORP Sensor ordering information

Model	Sensor type
389	pH/ORP Sensor
Preamplifier/cable	
01	Integral pramplifier, 25 ft cable ⁽¹⁾
02	No preamplifier, 15 ft cable
Combination electrode	
10	pH -GPLR glass
11	pH-high pH glass
12	ORP

Table 1-3: Rosemount 389 pH/ORP Sensor ordering information (continued)

Transmitter/TC compatibility	
50	1181, 1050, 1060 (code -01 or -02)
54	1054A/B, 81, 2081, (code -01 or -02); for 54, 56, 1055, 1056, 1057, 1066, 5081, 6081, and XMT (code -02 only)
55	54, 56, 1055, 1056, 1057, 5081, 6081, and XMT (code -01 only)
Optional	
-	No selection
62	Cable without BNC for models: 54, 56, 1055, 1056, 1057, 1066, 5081, 6081, and XMT (codes -02 and -54 only)
Typical model number: 389-02-10-54-62	

(1) Preamplifier is SMART if selected with pH electrode and option 55 only. Preamplifier is standard for ORP electrodes and for options 50 and 54.

Table 1-4: Rosemount 389VP pH/ORP Sensor ordering information

Model	Sensor type
389VP	pH/ORP sensor
Combination electrode	
10	pH - GPLR glass
11	pH - high pH glass
12	ORP
Transmitter/TC compatibility	
50	1181, 1050, 1060 (code -01 or -02)
54	1054A/B, 81, 2081 (code -01 or -02); for 54, 56, 1055, 1056, 1057, 1066, 5081, 6081, and XMT (code -02 only)
55	54, 56, 1055, 1056, 1057, 5081, 6081, and XMT (code -01 only)
Preamplifier option	
-	No preamplifier
70	SMART preamplifier ⁽¹⁾
Typical model number: 389VP-10-55-70	

(1) Only available with -10, -11, and -55 options.

2 Install

2.1 Unpacking and inspection

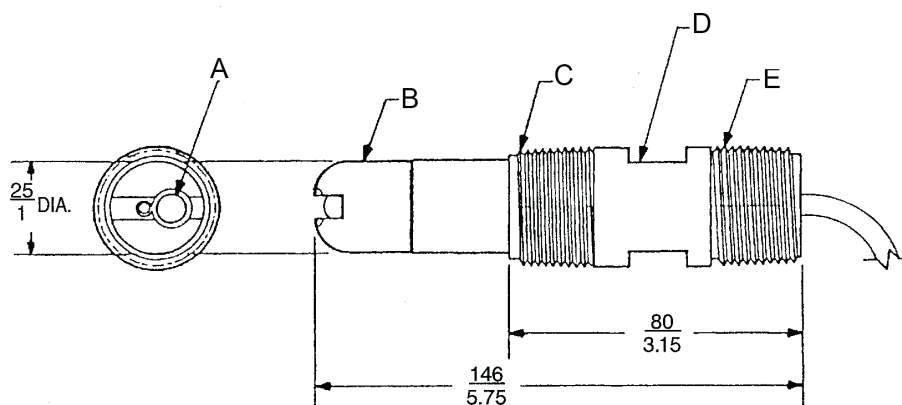
Procedure

1. Inspect the outside of the carton for any damage.
2. If damage is detected, contact the carrier immediately.
3. Inspect the hardware.
4. Make sure all the items in the packing list are present and in good condition.
5. Notify the factory if any part is missing.

2.2 Mounting

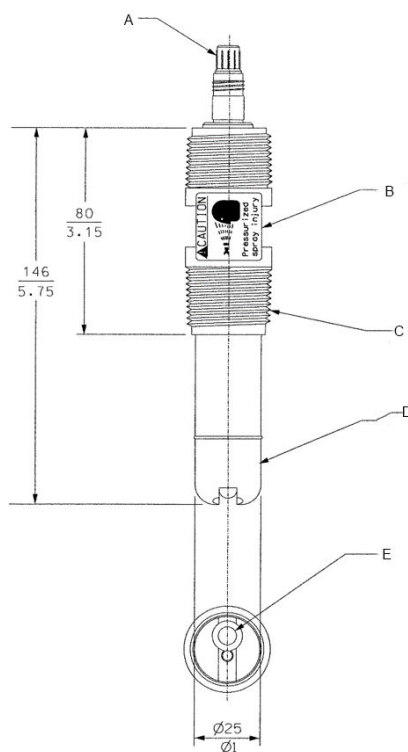
The sensor has been designed to be located in industrial process environments. Temperature and pressure limitations must not be exceeded at any time. A label regarding this matter is attached to the sensor with the cable and should not be removed.

Figure 2-1: Rosemount 389 Sensor Dimensional Drawing



- A. pH/ORP electrode
- B. TC
- C. 1-in. MNPT
- D. 1-in. wrench opening
- E. 1-in. MNPT

Figure 2-2: Rosemount 389VP Sensor Dimensional Drawing



- A. VP (Variopol Connection)
- B. 1-in. wrench opening
- C. 1-in. MNPT x 2
- D. T.C.
- E. pH/ORP electrode

⚠ WARNING

IRRITANT

Internal electrolyte fill may cause skin or eye irritation.

Mounting guidelines

1. Shake down the sensor to remove any air bubbles that may be present inside the tip of the pH glass.
2. Do not install the sensor horizontally. The sensor must be 10° off the horizontal to ensure accuracy.
3. Do not install the sensor upside down.
4. With the standard recessed electrode, air bubbles may become trapped in the sensor end. This problem is most commonly encountered in areas of low flow or during calibration. Shake the probe while it is immersed in solution to remove bubbles.

In most cases, the sensor can simply be installed as shipped, and you can obtain readings with an accuracy of ± 0.2 pH. To obtain greater accuracy or to verify proper operation, the sensor must be calibrated as a loop with its compatible analyzer or transmitter.

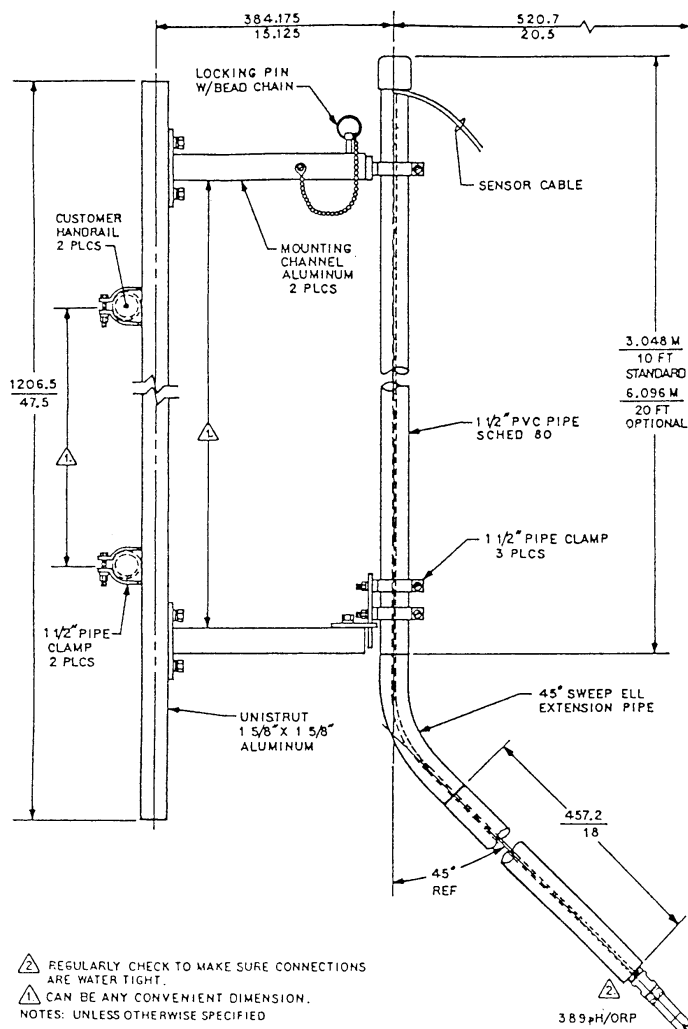
2.2.1 Submersion mounting

Rosemount 389 and 389VP Sensors have a 1-in. MNPT process connection at the back of the sensor.

Procedure

1. To prevent rain water or condensation from running into the sensor, use a weatherproof junction box (see [Figure 2-3](#)).
2. Using a standard 1-in. union, mount the sensor to a 1-in. SCH 80 CPVC or PVDF standpipe.
3. Tapered pipe threads in plastic tend to loosen after installation. We therefore recommend that you use PTFE tape on the threads and check the tightness of the connection frequently to ensure that no loosening has occurred.

Figure 2-3: Submersion Installations

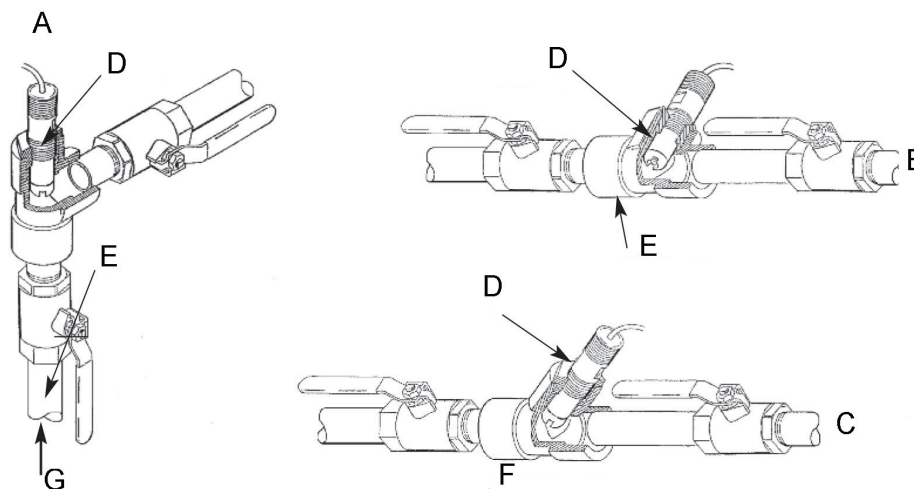


4. Run the sensor cable through a protective conduit for isolation from electrical interference or physical abuse from the process.
5. Install the sensor within 80° of vertical, with the electrode facing down.
Do not run the sensor's cable with power or control wiring.

2.2.2 Flow through and insertion mounting

Rosemount 389 and 389VP sensors also have a 1-in. MNPT process at the front of the sensor for mounting into a 1/4-in. tee or the process. See [Figure 2-4](#) for installation configurations.

Figure 2-4: Flow Through and Insertion Installations



- A. Angle flow
- B. Straight flow
- C. Pipe "Y"
- D. 1½-in. x 1-in. reducing bushing
- E. 1½-in. pipe tee
- F. 1½-in. pipe "Y"
- G. flow

Note

Valves and fittings by others. Mount the sensor at least 10° from horizontal.

Note

Do not use large pipe wrenches to tighten the sensor into a flange or other type of mounting.

2.3 Electrical installation

Figure 2-5 through Figure 2-19 provide the guidelines for wiring Rosemount 389/389VP sensors to various Rosemount transmitters.

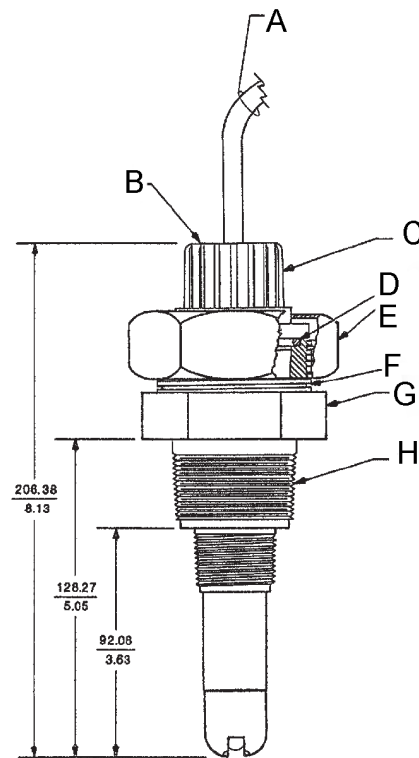
1. If the cable needs to be extended, use a high quality four-conductor shielded instrument cable available from Rosemount.

Note

If the cable is too long, loop up the excess cable. If the cable has to be shortened, splice and terminate each conductor and make sure that the overall (outermost) drain wire is not shorted out with either of the two inner drain wires (shields).

2. Signal cable should be run in a dedicated conduit (preferably an earth grounded metallic conduit) and should be kept away from AC power lines. A spade lug kit is provided in a plastic bag wrapped around the cable.

Figure 2-5: Rosemount 389 with Insertion Mounting Adapter P/N 23242-02



- A. Cable
- B. $\frac{3}{4}$ -in. FNPT
- C. Peek adapter; 1-in. PNPT x $\frac{3}{4}$ -in. FNPT (reversible)
- D. 2-135 Viton "O" ring

Note

"O" ring must be in place prior to use (PN 9550175)

- E. Nut, hex union 2-in.; 3-in. wrench opening (304 SST)
- F. 2.531.8 ACME thread (TYP)
- G. Neck, union fitting (316 SST); 2 $\frac{5}{8}$ -in. wrench opening
- H. $1\frac{1}{2}$ -in. MNPT

Figure 2-6: VP 8 Cable, Rosemount 389VP Sensor End

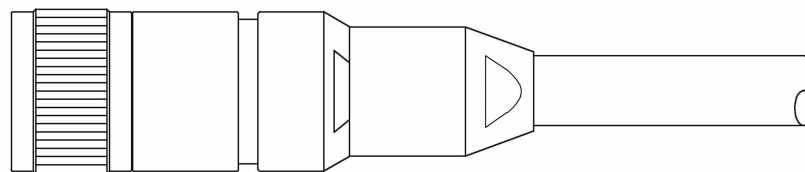
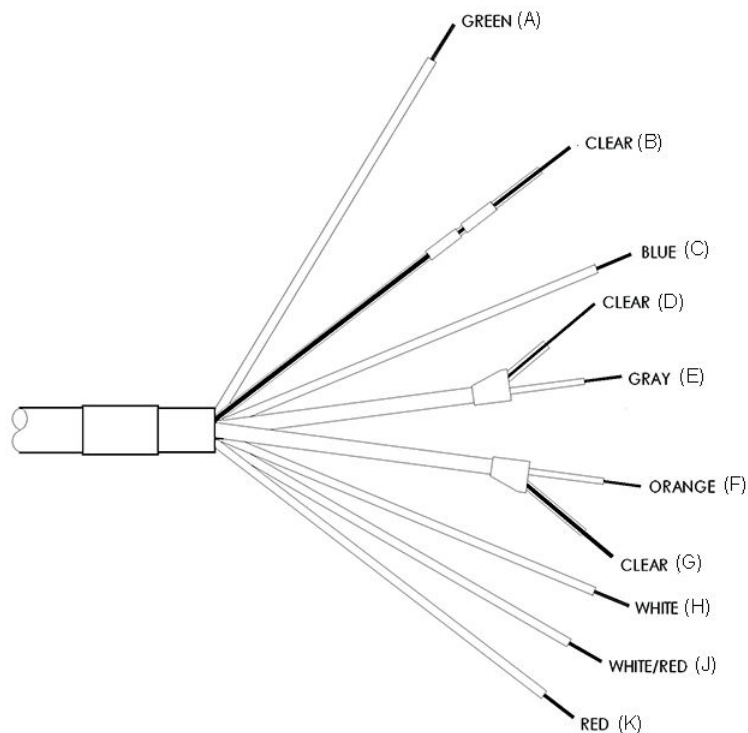


Figure 2-7: VP8 Cable, Instrument End



- A. Earth ground
- B. ID

Note

For additional wiring information on this product, including sensor combinations not shown here, refer to the [Liquid Transmitter Wiring Diagrams](#).

- C. Solution ground

D. **Note**

For additional wiring information on this product, including sensor combinations not shown here, refer to the [Liquid Transmitter Wiring Diagrams](#).

- E. Ref in
- F. pH/mV IN
- G. pH/mV SHIELD
- H. RTD return
- I. RTF sense
- J. RTD IN

Figure 2-8: Rosemount 389-01-xx-55 Wiring to Rosemount 1056, 1057, and 56 Transmitters

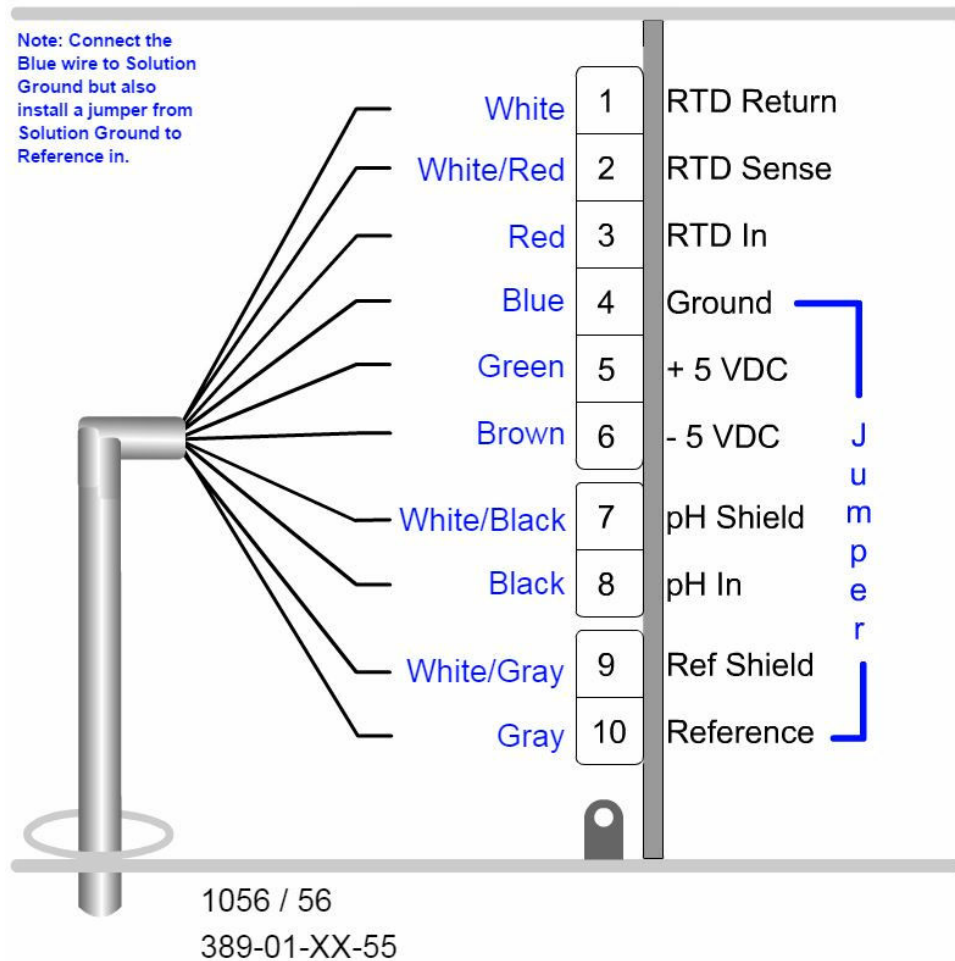


Figure 2-9: Rosemount 389-01-xx-55 Wiring to Rosemount 1066 Transmitter

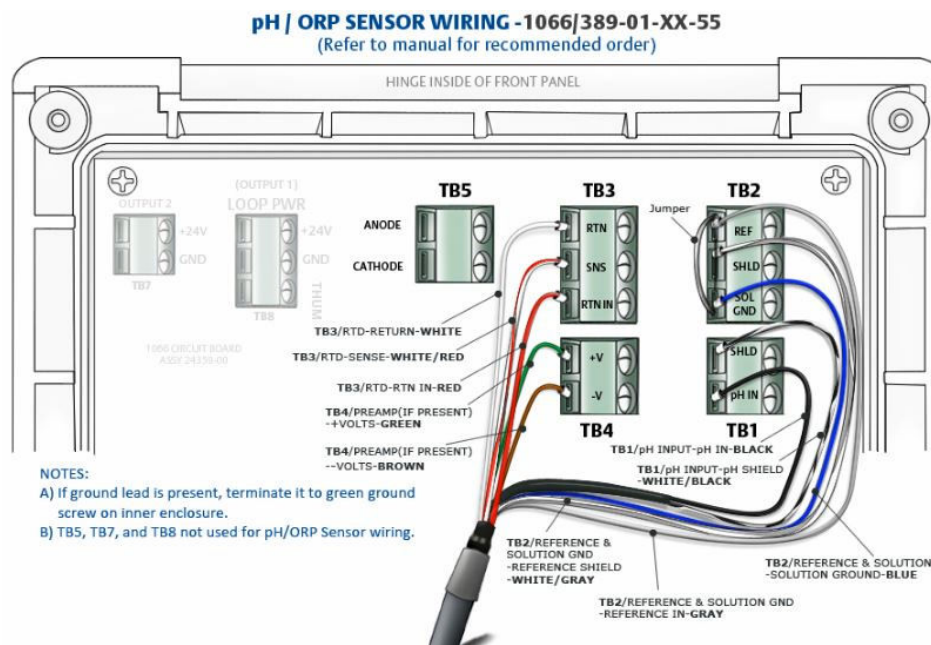


Figure 2-10: Rosemount 389-01-xx-55 Wiring to Rosemount 5091 Transmitter

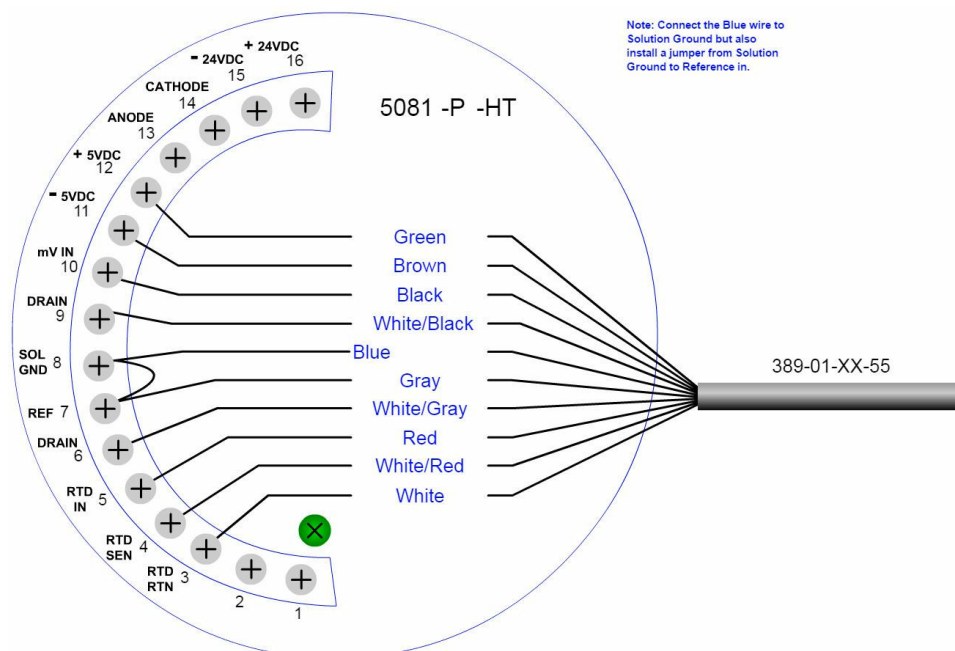


Figure 2-11: Rosemount 389VP Wiring to Rosemount 1056, 1057, and 56 Transmitters

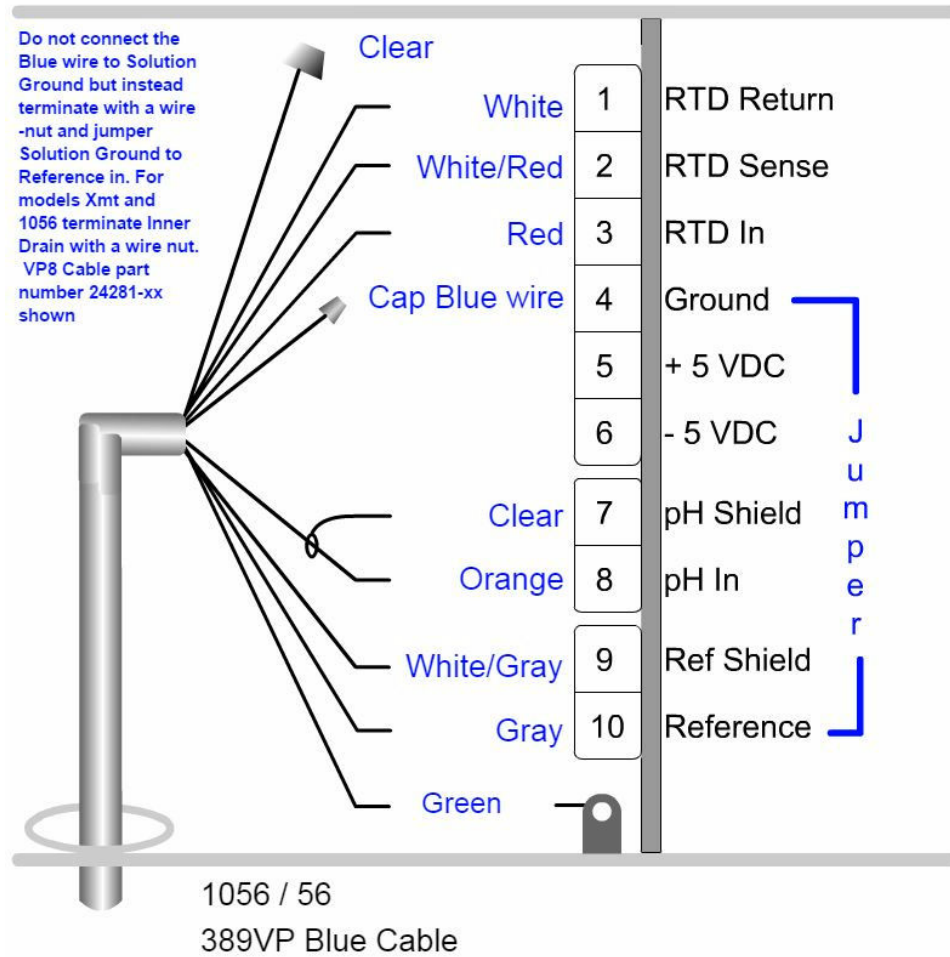


Figure 2-12: Rosemount 389VP Wiring to Rosemount 1066 Transmitter

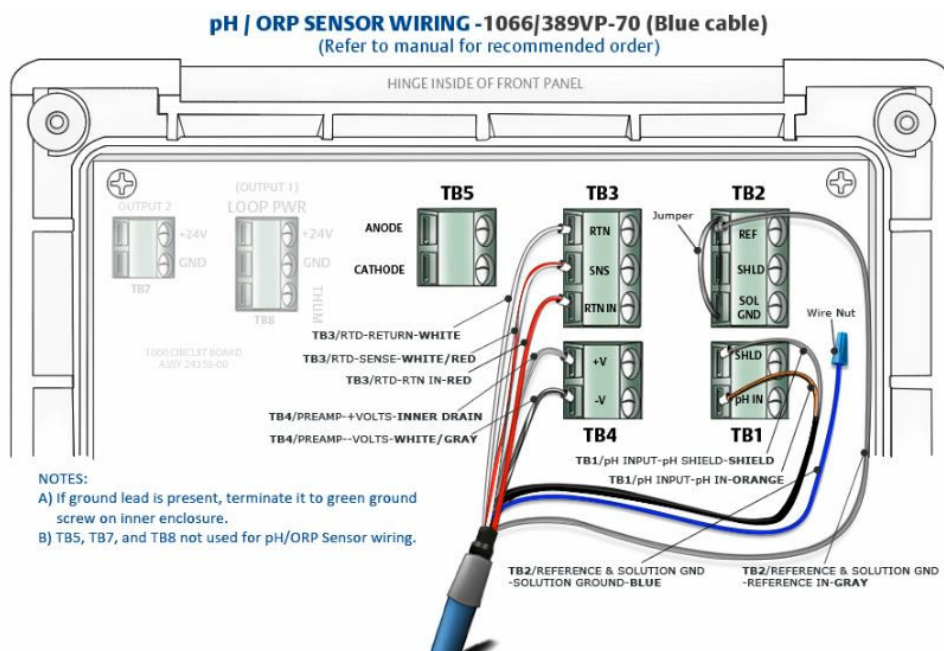


Figure 2-13: Rosemount 389VP Wiring to Rosemount 5081 Transmitter

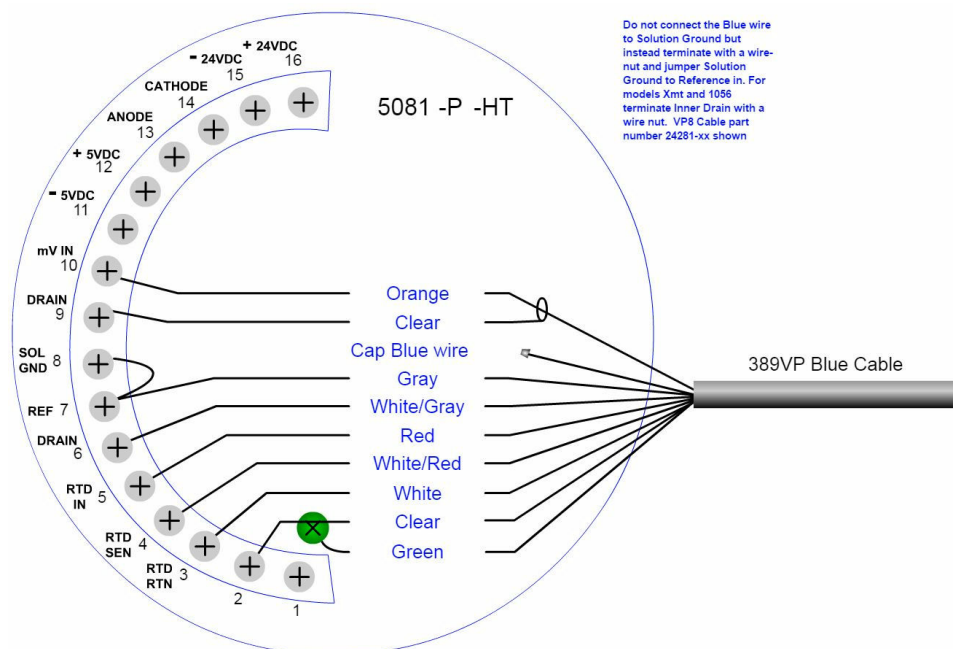


Figure 2-14: Rosemount 389VP-xx-55-70 Wiring to Rosemount 1056, 1057, and 56 Transmitters

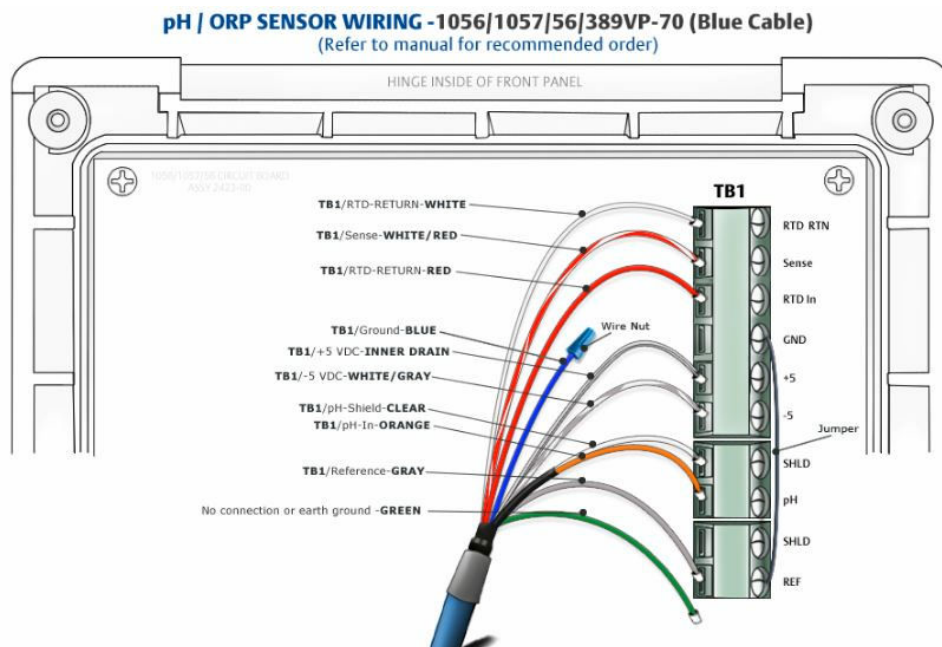


Figure 2-15: Rosemount 389VP-xx-55-70 Wiring to Rosemount 1066 Transmitter

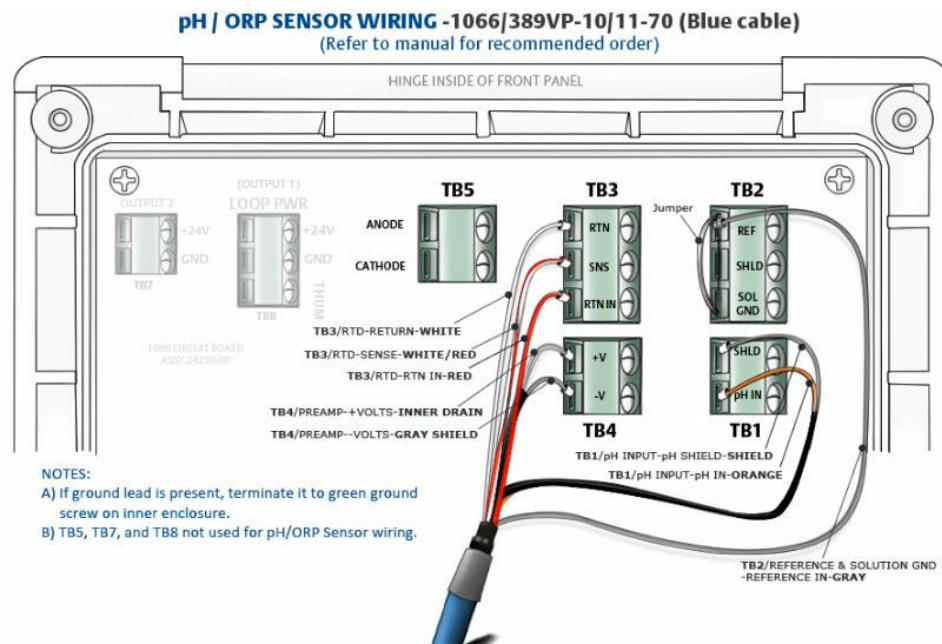


Figure 2-16: Rosemount 389VP-xx-55-70 Wiring to Rosemount 5081 Transmitter

pH / ORP SENSOR WIRING -5081/389VP-70 (Blue cable)
(Refer to manual for recommended order)

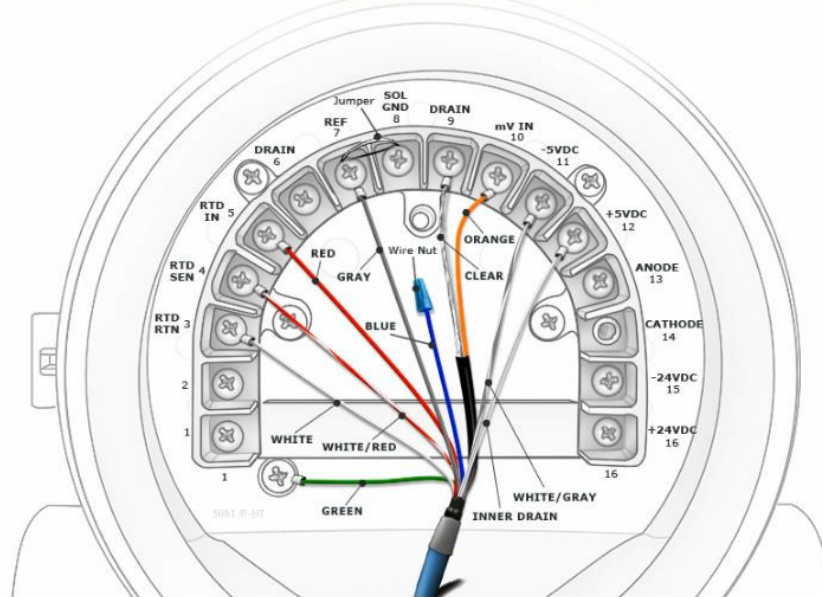


Figure 2-17: Rosemount 389-02-xx-54-62 Wiring to Rosemount 1056, 56, and 1057 Transmitters

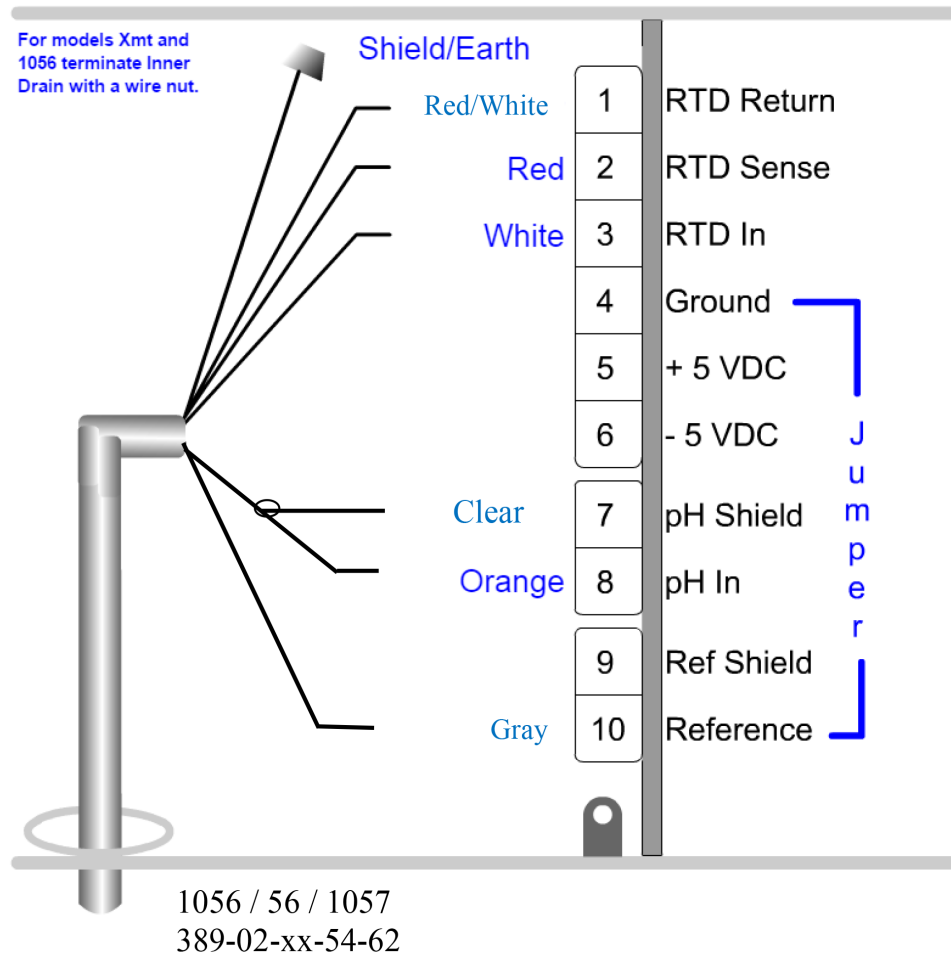


Figure 2-18: Rosemount 389-02-xx-54-62 Wiring to Rosemount 1066 Transmitter

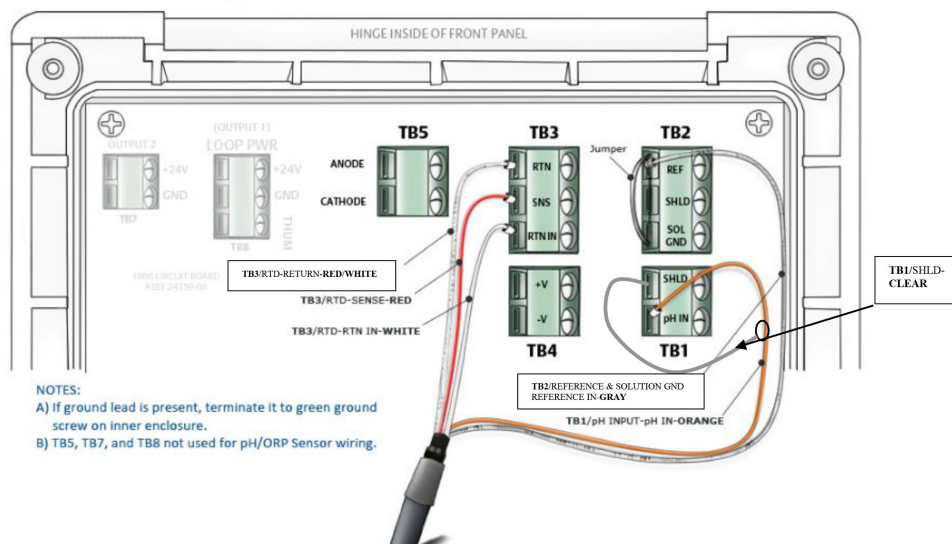
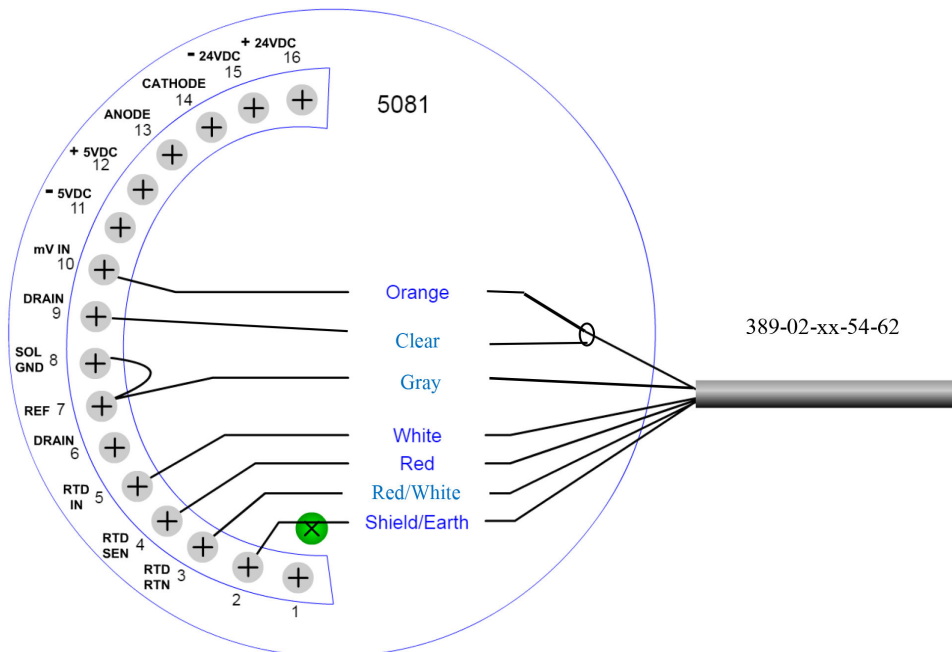


Figure 2-19: Rosemount 389-02-xx-54-62 Wiring to Rosemount 5081 Transmitter



3 Calibration

3.1 Sensor preparation

Procedure

1. Shake down the sensor to remove any air bubbles that may be present at the tip of the pH glass bulb.
2. In most cases, the pH sensor can simply be installed as shipped, and readings may be obtained with an accuracy of ± 0.2 pH. To obtain greater accuracy or to verify proper operation, calibrate the sensor as a loop with its compatible transmitter.

3.2 pH calibration

1. After a temporary connection is established between the sensor and the instrument, a buffer calibration may be performed.
2. Consult the appropriate pH/ORP transmitter instruction manual for specific calibration and standardization procedures, or see below for the recommended two-point buffer calibration procedure.

3.2.1 Recommended two point buffer calibration procedure

Prerequisites

Select two stable buffer solutions, preferably pH 4.0 and 7.0. (pH buffers other than pH 4.0 and pH 7.0 can be used as long as the pH values are at least two pH units apart).

Note

A pH 7 buffer solution reads an mV value of approximately zero, and pH buffers read approximately ± 59.1 mV for each pH unit above or below pH 7. Check the pH buffer manufacturer specifications for millivolt values at various temperatures, as it may affect the actual value of the buffer solution mV/pH value.

Procedure

1. Immerse the sensor in the first buffer solution. Allow the sensor to adjust to the buffer temperature (to avoid errors due to temperature differences between the buffer solution and sensor temperature) and wait for readings to stabilize.
The value of the buffer can now be acknowledged by the transmitter.
2. Once the first buffer has been acknowledged by the transmitter, rinse the buffer solution off the sensor with distilled or deionized water.
3. Repeat steps 1 and 2 using the second buffer solution.
Once the transmitter has acknowledged both buffer solutions, a sensor slope (mV/pH) is established (the slope value can be found within the transmitter). The slope value should read about 59.1 mV/pH for a new sensor and will decrease over

time to approximately 47 -49 mV/pH. Once the slope reads below the 47-49 mV/pH range, install a new sensor to maintain accurate readings.

3.2.2 Recommended pH sensor standardization

For maximum accuracy, the sensor can be standardized in-line or with a process grab sample after a buffer calibration has been performed and the sensor has been conditioned to the process. Standardization accounts for the sensor junction potential and other interferences. Standardization does not change the sensor's slope, but simply adjusts transmitter's reading to match that of a known process pH.

Procedure

1. While obtaining a process solution sample (we recommend that you take the sample close to the sensor), record the pH value that is shown on the transmitter display.
2. Measure and record the pH of the process solution sample with another temperature compensated, calibrated pH instrument. For best results, perform standardization at the process temperature.
3. Adjust the transmitter to the standardized value.

3.3 Rosemount™ 389/389VP ORP calibration

Most industrial applications have a number of ORP reactions occurring in sequence or simultaneously. There can be several components that are oxidized or reduced by the reagents that are used. Theoretically, the ORP potential is absolute, because it is the result of the oxidation/reduction equilibrium. However, the actual measured potential is dependent on many factors, including the condition of the surface of the ORP platinum electrode. Therefore the sensor should be allowed 1-2 hours to become *conditioned* to the stream when first set up or after being cleaned.

⚠ WARNING

CORROSIVE SUBSTANCE

The solution used during the following check is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with skin is made, immediately rinse with clean water.

Procedure

1. Make a temporary electrical connection between the sensor and the instrument.
2. Obtain a standard solution of saturated quinhydrone (PN R508-16OZ). To make this solution, add a few crystals of quinhydrone to either pH 4 or pH 7 buffer. Quinhydrone is only slightly soluble, but only a few crystals are required.
3. Immerse the sensor in the standard solution. Allow one to two minutes for the ORP sensor to stabilize.
4. Adjust the standardized control of the transmitter to the solution value shown in [Table 3-1](#).

The resulting potentials, measured with a clean platinum electrode and saturated KCl/AgCL reference electrode, should be within ± 20 millivolts of the value shown in [Table 3-1](#). Note solution temperature to ensure accurate interpretation of results. The ORP value of saturated quinhydrone solution is not stable over long periods of time. Therefore, make these standards fresh each time they are used.

Table 3-1: ORP of Saturated Quinhydrone Solution (Millivolts)

	pH 4 solution			pH 7 solution		
Temp °C	20	25	30	20	25	30
mV potential	268	264	260	94	87	80

5. Remove the sensor from the buffer, rinse, and install in the process.

4 Maintenance

Rosemount™ 389/389VP sensors require minimum maintenance. Keep the sensors clean and free of debris and sediment at all times. The frequency of cleaning by wiping or brushing with a soft cloth or brush is determined by the nature of the solution being measured. Remove sensors from the process periodically and check them in buffer solutions.

⚠ WARNING

PRESSURE AND TEMPERATURE

Before removing the sensor, be absolutely certain that the process pressure is reduced to 0 psig and the process temperature is lowered to a safe level!

If the sensor will not calibrate, refer to your transmitter reference manual for proper test procedures. If you determine that the sensor has failed, discard and replace it.

4.1 Clean electrode

If the electrode is coated or dirty, clean as follows:

Procedure

1. Remove the sensor from process.
2. Remove the sensor from process as instructed in [Retractable version](#)
3. Wipe the glass bulb with a soft, clean, lint free cloth or tissue. If this does not remove the dirt or coating, go to [Step 4](#) (detergents clean oil and grease; acids remove scale.)
4. Wash the glass bulb in a strong detergent solution and rinse it in clean water. If this does not clean the glass bulb, go to [Step 5](#).

⚠ WARNING

CORROSIVE SUBSTANCE

The solution used during the following step is an acid; handle with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with skin is made, immediately rinse with clean water.

5. Wash the bulb in a dilute 5% hydrochloric acid solution and rinse with clean water. Soaking the sensor overnight in the acid solution can improve cleaning action. Replace the sensor if it cannot be cleaned.
6. Following the Warning above, wash the glass bulb in dilute 5% hydrochloric acid solution and then rinse it thoroughly with clean tap water. Replace the sensor if it cannot be clean. If the glass bulb appears clean, proceed to [Step 7](#).
7. Buffer calibrate the sensor.

Refer to [Startup and calibration](#). If the sensor appears to respond sluggishly to pH change, soaking it overnight in a weak acid solution (5% hydrochloric acid) may improve its response. Be sure to follow the Warning above and to rinse the sensor's tip thoroughly with tap water. If the sensor will not calibrate, it must be replaced.

4.2 Automatic temperature compensator

The temperature compensator element is a temperature sensitive resistor and can be checked with an ohmmeter. Resistance increases with temperature.

The 3K element reads 3000 ohms $\pm 1\%$ at 77 °F (25 °C), and a Pt100 reads 110 ohms. Resistance varies with temperature for a 3K and Pt-100 element and can be determined according to [Table 4-2](#) or the following formula:

$$R_T = R_0 [1 + R_1(T-20)]$$

Where R_T = Resistance and T = Temperature in °C

Refer to [Table 4-1](#) for R_0 and R_1 values.

Table 4-1: R_0 and R_1 Values for Temperature Compensation Elements

Temperature compensation element	R_0	R_1
3K	2934	0.0045
PT-100	107.7	0.00385

Table 4-2: Temperature vs. Resistance of Auto T.C. Elements

Temperature °C	Resistance (Ohms) $\pm 1\%$	
	3K	PT-100
0	26270	100.0
10	2802	103.8
20	2934	107.7
25	3000	109.6
30	3066	111.5
40	3198	115.4
50	3330	119.2
60	3462	123.1
70	3594	126.9
80	3726	130.8
90	3858	134.6
100	3990	138.5

4.3 ORP

4.3.1 Check platinum electrode

Check the platinum electrode as follows. There are two types of standard solutions which may be used to check the ORP electrode/transmitter system.

Type 1: One type of commonly used ORP standard solution is the saturated quinhydrone solution (PN R508-16OZ). Refer to [Rosemount™ 389/389VP ORP calibration](#).

⚠ WARNING

The solution used during the following check is an acid.

Handle the solution with care.

Follow the manufacturer's directions.

Wear the proper protective equipment.

If contact with skin or clothing is made, immediately rinse with plenty of clean water.

Type 2: A second ORP standard solution can be prepared from the following recipe:

Procedure

1. Dissolve 39.2 grams of reagent grade ferrous ammonium sulfate, $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \bullet 6\text{H}_2\text{O}$ and 48.2 grams of reagent grade ferric ammonium sulfate, $\text{FeNH}_4(\text{SO}_4)_2 \bullet 12\text{H}_2\text{O}$ in approximately 700 ml of water.
Distilled water is preferred, but tap water is acceptable.
2. Slowly and carefully add 56.2 ml of concentrated sulfuric acid.
3. Add sufficient water to bring the total solution volume up to 1000 ml.

This standard ORP solution, although not as simple to prepare as the quinhydrone recipe, is much more stable and will maintain its millivolt value for approximately one year when stored in glass containers. This solution (ferric/ferrous ammonium sulfate) produces a nominal ORO of 476 +20 mV at 77 °F (25 °C) when used with a saturated KCL/AgCl reference electrode and platinum measuring electrode. Some tolerance in mV values is to be expected due to the rather large liquid reference junction potentials that can arise when measuring this strongly acidic and concentrated solution. However, if measuring electrodes are kept clean and in good operating condition, consistently repeatable calibrations can be carried out using this standard solution.

4.3.2 Cleaning platinum electrode

To restore the electrode to normal operation, clean the platinum electrode with baking soda. Polish it by rubbing it with a damp paper towel and baking soda until it appears bright and shiny.

5 Troubleshooting

Table 5-1: Troubleshooting

Trouble	Probable Cause	Remedy
Meter reads off scale (Display reads overrange).	Defective preamplifier.	Replace preamplifier (for code 02 sensors). For code 01, replace sensor.
	T.C. element shorted	Check T.C. element as instructed in Automatic temperature compensator and replace sensor if defective.
	Sensor not in process or sample stream is low.	Make sure sensor is in process with sufficient sample stream (refer to Install for installation details).
	Open glass electrode.	Replace sensor.
	Reference element open - no contact.	Replace sensor.
Display reads between 3 and 6 pH regardless of actual pH of solution or sample.	Electrode cracked.	Replace sensor.
Meter or display indication swings or jumps widely in AUTO T.C. Mode.	T.C. element shorted.	Check T.C. element as instructed in Automatic temperature compensator and replace sensor if defective.
Span between buffers extremely short in AUTO T.C. Mode.	T.C. element shorted.	Check T.C. element as instructed in Automatic temperature compensator and replace sensor if defective.
Sluggish or slow meter indication for real changes in pH level.	Electrode cracked.	Clean sensor as instructed in Clean electrode or Cleaning platinum electrode . Replace sensor if cracked.
	Electrode defective.	Replace sensor.
Transmitter cannot be standardized.	Electrode coated or cracked.	Clean sensor as instructed in Clean electrode or Cleaning platinum electrode . Replace sensor if cracked.
	Defective preamplifier	Replace preamplifier.
Transmitter short spans between two different buffer values.	Old glass electrode or high temperature exposure.	Replace sensor.
	Coated glass.	Clean sensor as instructed in Clean electrode or Cleaning platinum electrode . Replace sensor if cracked.




Table 5-2: Rosemount 389/389VP pH/ORP Sensor Accessories Information

Part number	Description
11275-01	Handrail mounting assembly
12707-00	Jet spray cleaner
2002011	CPVC in-line tee, 1.5 in. size, 1.0 in. threaded process connection ends
915240-03	PVC in-line tee, 2.0 in. size, 3/4 in. threaded process connection ends
915240-04	PVC in-line tee, 2.0 in. size, 1.0 in. threaded process connection ends
915240-05	PVC in-line tee, 2.0 in. size, 1.5 in. threaded process connection ends
23242-02	Insertion mounting adapter, 1.5 in. MNPT process connection, 1 in. x 3/4 in. FPT sensor adapter/union thread size
33081-00	PEEK adapter insert, 1 x 3/4 in., for 23242-02
23646-01	11-conductor extension cable, shielded and prepped (for use with remote junction box)
9200273	11-conductor extension cable, shielded and unprepped (for use with remote junction box)
24091-00	Low flow cell, 1 in. sensor threaded connectio, 1/4 in. process connection
23555-00	Weatherproof junction box with preamplifier
2002565	Mounting bracket kit
9210012	pH 4.01 buffer solution, 16 oz
9210013	pH 6.86 buffer solution, 16 oz
9210014	pH 9.18 buffer solution, 16 oz
24281-00	15 ft VP8 cable
24281-01	25 ft VP8 cable
24281-02	2.5 ft VP8 cable
24281-03	50 ft VP8 cable
24281-04	100 ft VP8 cable
24281-05	4 ft VP8 cable
24281-06	10 ft VP8 cable
24281-07	20 ft VP8 cable
24281-08	30 ft VP8 cable

6 Return of Material

For all repair or return of material requests, please contact the factory.

A EC Declaration of Conformity

	
EU Declaration of Conformity No: RAD 1119 Rev. B	
<small>pH/ORP Sensors</small>	
<p>We,</p> <p>Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317-9685 USA</p> <p>declare under our sole responsibility that the product,</p> <p>Rosemount™ Sensor Models: 328A, 385, 385+ -04, 385+ -02/03, 385+ -03-12, 389-01, 389-01-10/11-50, 389-01-10/11-54, 389-01-12-50, 389-01-12-54, 389-01-12-55, 389-02, 389VP, 389VP-70, 396, 396P-01-10/13-50, 396P-01-10/13-54, 396P-01-12-50, 396P-01-12-54, 396P-01-12-55, 396P-01-55, 396VP, 396VP-70, 396R, 396RVP, 396RVP-70, 396P-02, 396PVP, 396PVP-70, 397, 398, 398VP, 398R, 398RVP, 398RVP-70, 3200HP, 3300HT, 3300HT VP, 3300HTVP-70, 3400HT, 3400HT VP, 3400HTVP-70, 3500P-01, 3500P-01-12, 3500P-02, 3500VP-01, 3500VP-01-12, 3500VP-02, 3800, 3800VP, 3900-01, 3900-02, 3900VP-01, 3900VP-02</p> <p>manufactured by,</p> <p>Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317-9685 USA</p> <p>to which this declaration relates, is in conformity with the provisions of the European Union Directives, including the latest amendments, as shown in the attached schedule.</p> <p>Assumption of conformity is based on the application of the harmonized standards and, when applicable or required, a European Union notified body certification, as shown in the attached schedule.</p>	
	Vice President of Global Quality
(signature)	(function)
Chris LaPoint	1-Feb-19; Shakopee, MN USA
(name)	(date of issue & place)
Page 1 of 3	



EU Declaration of Conformity



No: RAD 1119 Rev. B

ATEX Directive (2014/34/EU)

Baseefa10ATEX0156X– Intrinsically Safe

Equipment Group II, Category 1 G Ex ia IIC T4 Ga (-20°C ≤ Ta ≤ +60°C)
(exceptions noted below)

Model 328A Steam sterilizable pH sensor with integral cable
Model 385 Retractable pH/ORP sensor with integral cable
Model 385+ -04 pH/ORP sensor with integral cable
Model 385+ -02/03 pH/ORP sensor with integral cable & Smart preamplifier
Model 385+ -03-12 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C), T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01 pH sensor with integral cable & Smart preamplifier
Model 389-01-10/11-50 pH sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) or T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01-10/11-54 pH sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) or T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01-12-50 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-01-12-54 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-01-12-55 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-02 pH/ORP sensor with integral cable
Model 389VP-70 pH sensor with Variopole connector & Smart preamplifier
Model 389VP pH/ORP sensor with Variopole connector
Model 396 TUpH sensor with integral cable
Model 396P-01-10/13-50 polypropylene pH sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ 80°C) or T5 (-20°C ≤ Ta ≤ 40°C)
Model 396P-01-10/13-54 polypropylene pH sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ 80°C) or T5 (-20°C ≤ Ta ≤ 40°C)
Model 396P-01-12-50 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-12-54 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-12-55 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-55 pH sensor with integral cable & Smart preamp
Model 396VP TUpH sensor with Variopole connector
Model 396VP-70 TUpH sensor with Variopole connector & Smart preamplifier
Model 396R TUpH Retractable pH/ORP sensor with integral cable
Model 396RVP TUpH Retractable pH/ORP sensor with Variopole connector
Model 396RVP-70 TUpH Retractable pH sensor with Variopole connector & Smart preamplifier
Model 396P-02 TUpH Polypropylene pH/ORP sensor with integral cable
Model 396PVP TUpH Polypropylene pH/ORP sensor with Variopole connector
Model 396PVP-70 TUpH Polypropylene pH sensor with Variopole connector & Smart preamplifier
Model 397 TUpH sensor with integral cable
Model 398 TUpH pH/ORP sensor with integral cable
Model 398VP TUpH pH/ORP sensor with Variopole connector
Model 398R TUpH Retractable pH/ORP sensor with integral cable
Model 398RVP TUpH Retractable pH/ORP sensor with Variopole connector
Model 398RVP-70 TUpH Retractable pH sensor with Variopole connector & Smart preamplifier
Model 3200HP Flowing junction pH sensor with Variopole connector
Model 3300HT Insertion/submersion pH sensor with integral cable
Model 3300HTVP Insertion/submersion pH sensor with Variopole connector

	
<h2>EU Declaration of Conformity</h2> <p>No: RAD 1119 Rev. B</p>	
<p>Model 3300HTVP-70 Insertion/submersion pH sensor with Variopole connector & Smart preamplifier Model 3400HT Retractable pH sensor with integral cable Model 3400HTVP Retractable pH sensor with Variopole connector Model 3400HTVP-70 Retractable pH sensor with Variopole connector & Smart preamplifier Model 3500P-01 High performance pH sensor with integral cable & Smart preamplifier Model 3500P-01-12 PerPH-X ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) Model 3500P-02 High performance pH sensor with integral cable Model 3500VP-01 High performance pH sensor with Variopole connector & Smart preamplifier Model 3500VP-01-12 PerPH-X ORP sensor with Variopole connector & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) Model 3500VP-02 High performance pH sensor with Variopole connector Model 3800 Steam sterilizable pH sensor with single pole Eurocap connector CE marking was first affixed to this product in 2011 Model 3800VP Steam sterilizable pH sensor with Variopole connector Model 3900-01 pH/ORP sensor with integral cable & Smart preamplifier Model 3900-02 pH/ORP sensor with integral cable Model 3900VP-01 pH sensor with Variopole connector & Smart preamplifier Model 3900VP-02 pH/ORP sensor with Variopole connector</p>	
<p>Special conditions for safe use: 1) All pH/ORP sensor models with a plastic enclosure or exposed plastic parts may provide an electrostatic ignition hazard and must only be cleaned with a damp cloth to avoid the danger of ignition due to a buildup of electrostatic charge. 2) All pH/ORP sensor models with a metallic enclosure may provide a risk of ignition by impact or friction. Care should be taken during installation to protect the sensor from this risk. 3) External connections to the sensor must be suitably terminated and provide a degree of protection of at least IP20. All pH/ORP sensor models are intended to be in contact with the process fluid and may not meet the 500V r.m.s test to earth. This must be taken into consideration at installation.</p>	
<p>Harmonized Standards: EN 60079-0:2012+A11:2013 EN 60079-11:2012</p>	
<p>ATEX Notified Body for EC Type Examination Certificate & Quality Assurance SGS FIMKO OY [Notified Body Number: 0598] P.O. Box 30 (Särkiniementie 3) 00211 HELSINKI Finland</p>	
<p>Page 3 of 3</p>	

B China RoHS Table

含有China RoHS管控物质超过最大浓度限值的部件型号列表 1056
List of 389 Parts with China RoHS Concentration above MCVs

部件名称 Part Name	有害物质 / Hazardous Substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴联苯醚 Polybrominated diphenyl ethers (PBDE)
传感器组件 Sensor Assembly	X	O	O	O	O	O

本表格系依据SJ/T11364的规定而制作。

This table is proposed in accordance with the provision of SJ/T11364.

O: 意为该部件的所有均质材料中该有害物质的含量均低于GB/T 26572所规定的限量要求。

O: Indicate that said hazardous substance in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: 意为在该部件所使用的所有均质材料里，至少有一类均质材料中该有害物质的含量高于GB/T 26572所规定的限量要求。

X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.

部件名称 Part Name	组装备件说明 Spare Parts Descriptions for Assemblies
传感器组件 Sensor Assembly	传感器模块 Sensor Module

[illegible]

GLOBAL HEADQUARTERS

Emerson Automation Solutions
6021 Innovation Blvd
Shakopee, MN 55379, USA

📞 +1 800 999 9307 or +1 952 906 8888

📠 F +1 952 949 7001

✉️ liquid.csc@emerson.com

NORTH AMERICA

Emerson Automation Solutions
8200 Market Blvd
Chanhassen, MN 55317

📞 Toll Free +1 800 999 9307

📠 F +1 952 949 7001

✉️ liquid.csc@emerson.com

EUROPE

Emerson Automation Solutions
Neuhofstrasse 19a P.O. Box 1046
CH-6340 Baar
Switzerland

📞 T +41 (0) 41 768 6111

📠 F +41 (0) 41 768 6300

✉️ liquid.csc@emerson.com

MIDDLE EAST AND AFRICA

Emerson Automation Solutions
Emerson FZE
Jebel Ali Free Zone
Dubai, United Arab Emirates, P.O. Box 17033

📞 T +971 4 811 8100

📠 F +971 4 886 5465

✉️ liquid.csc@emerson.com


ASIA-PACIFIC


Emerson Automation Solutions
1 Pandan Crescent
Singapore 128461
Singapore

📞 T +65 777 8211

📠 F +65 777 0947

✉️ liquid.csc@emerson.com

 [Linkedin.com/company/Emerson-Automation-Solutions](https://www.linkedin.com/company/Emerson-Automation-Solutions)

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