**Instruction Manual**
LIQ-MAN-389, Rev G
July 2017

# Rosemount™ 389/389VP

## General Purpose pH/ORP Sensors


ROSEMOUNT™

EMERSON™

## Essential instructions

Read this page before proceeding!

Emerson designs, manufactures, and tests its Rosemount 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 Rosemount 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 this product. If this instruction manual is not the correct manual, call 1-855-724-2638, and we will provide the requested manual. Save this 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 your equipment as specified in the installation instructions of the appropriate manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Install your equipment as specified in the Installation section 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 Rosemount. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. 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, an appropriate transmitter/safety barrier/sensor combination must be used. The installation system must be in accordance with the governing approval agency (FM, CSA, or BASEEFA/CENELEC) hazardous are classification requirements. Consult your analyzer/transmitter instruction manual for details.**

**Proper installation, operation, and servicing of this sensor in a hazardous area installation are entirely your responsibility.**

### ⚠ WARNING!

**SENSOR/PROCESS APPLICATION COMPATIBILITY**
**The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely your responsibility.**

### ⚠ CAUTION!

**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.**

## About this Document

This manual contains instructions for installation and operation of the Rosemount 389/389VP General Purpose pH/ORP Sensors. The following list provides notes concerning all revisions of this document.

| Rev. level | Date | Notes |
|---|---|---|
| A | 2/2001 | This is the intial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering. |

| Rev. level | Date | Notes |
|---|---|---|
| B | 2/2002 | Added 1055 wiring diagrams. |
| C | 10/2005 | Changed PN 933022 to PN 9320057 on the drawing 400389VP12, page 5 and Table 5-2, page 17. |
| D | 12/2008 | Updated to add VP. |
| E | 03/2012 | Updated pages 23 and 26. |
| F | 1/2013 | Incorporated SMART Sensor technology. |
| G | 4/2017 | Updated wiring diagrams. Reformatted to reflect new Emerson branding guidelines. |

# Contents

# 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 anouter ceramic junction constructed in an annualr 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 seimplified construction, designed with user convenience in mind, does not require electrolyte (KCl) replenishment or any high maintenance troubleshooting procedures.

Rosemount 389/389VP sensors are combintation 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% |

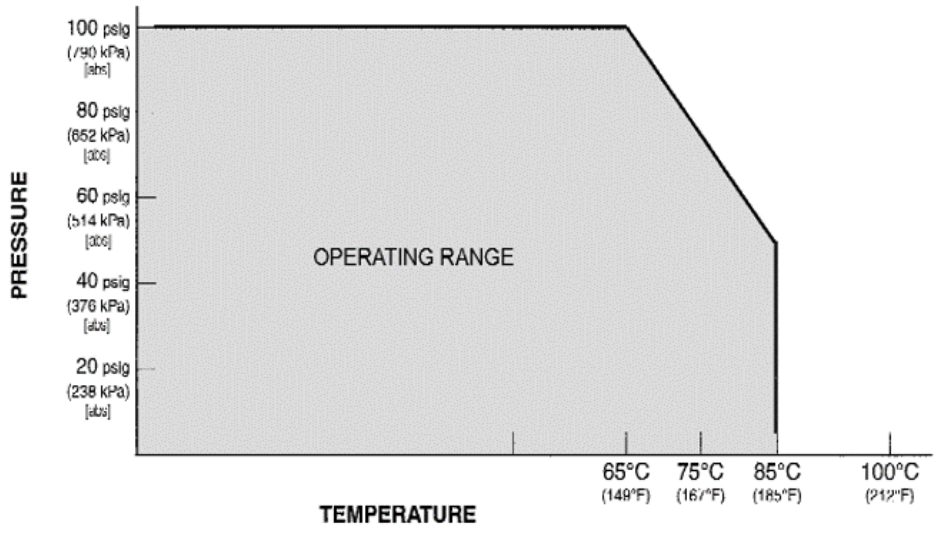
**Table 1-2: Rosemount 389/389VP pH/ORP sensor specifications**

| | |
|---|---|
| **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 |

**Table 1-2: Rosemount 389/389VP pH/ORP sensor specifications *(continued)***

| | |
|---|---|
| **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 ºC ≤ Ta ≤ +60 ºC)

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

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

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 ºC ≤ Ta ≤ +60 ºC)

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

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

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/ABCDEFG/T6 Ta = 60 °C - 140332; Entity: I/0/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)

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 |
| **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 compatiblity** | |
| 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 Installation

## 2.1 Unpacking and Inspection

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 Caution label regarding this matter is attached to the sensor with the cable. Please do not remove this label..

**Figure 2-1: Rosemount 389 Sensor dimensional drawing**

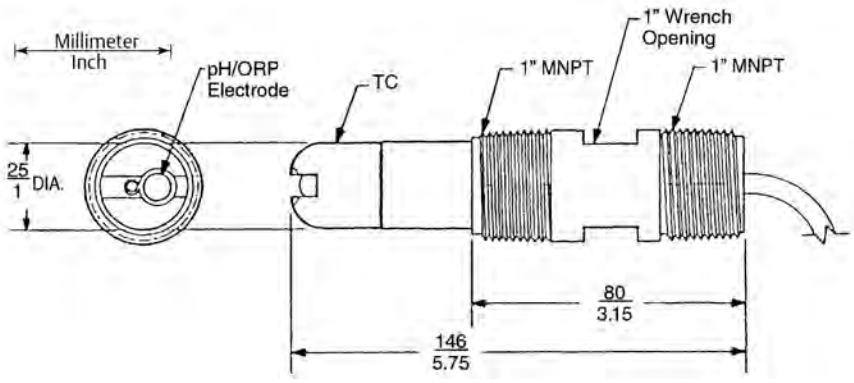
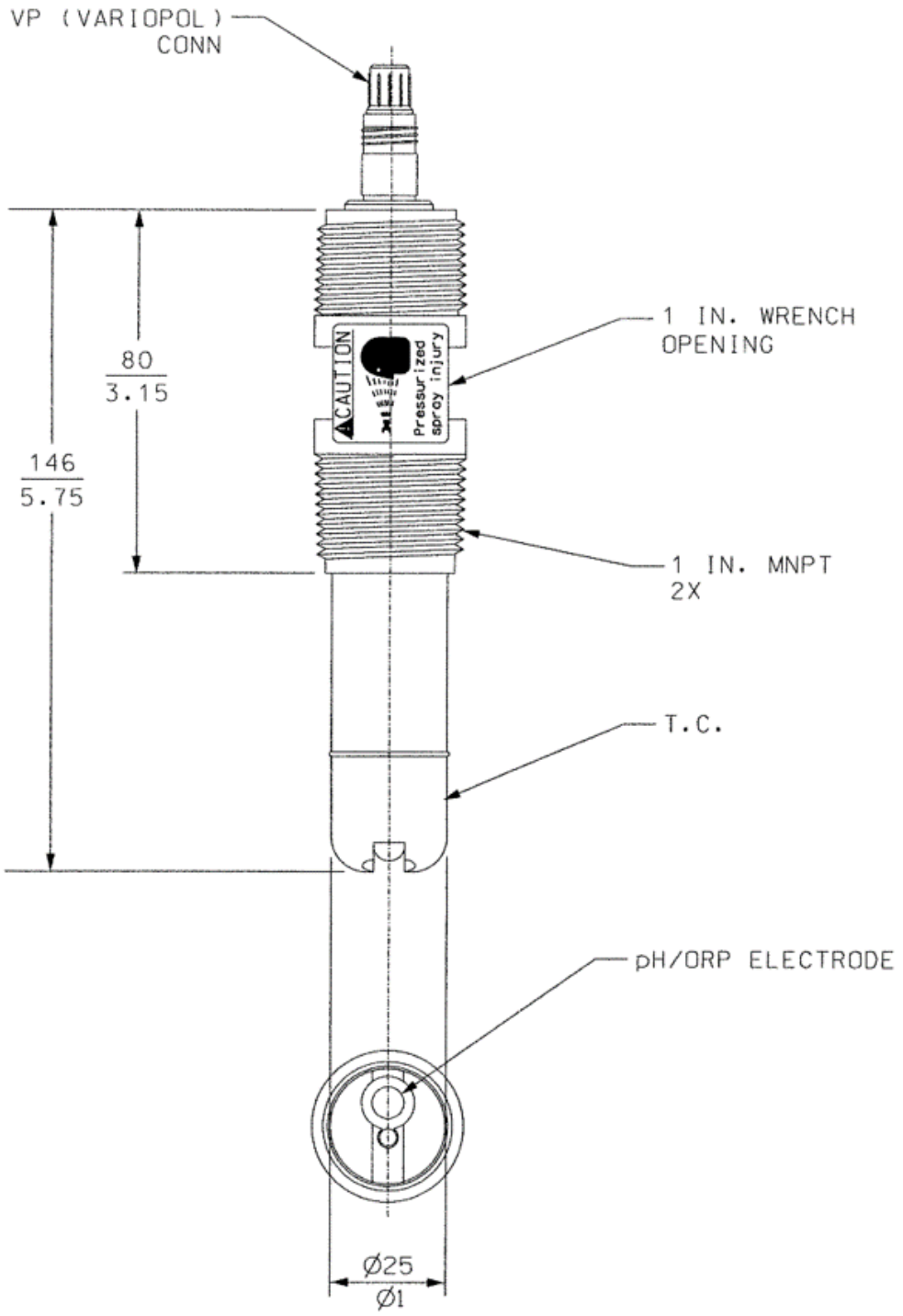


**Figure 2-2: Rosemount 389VP Sensor dimensional drawing**



**⚠ 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 º 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.

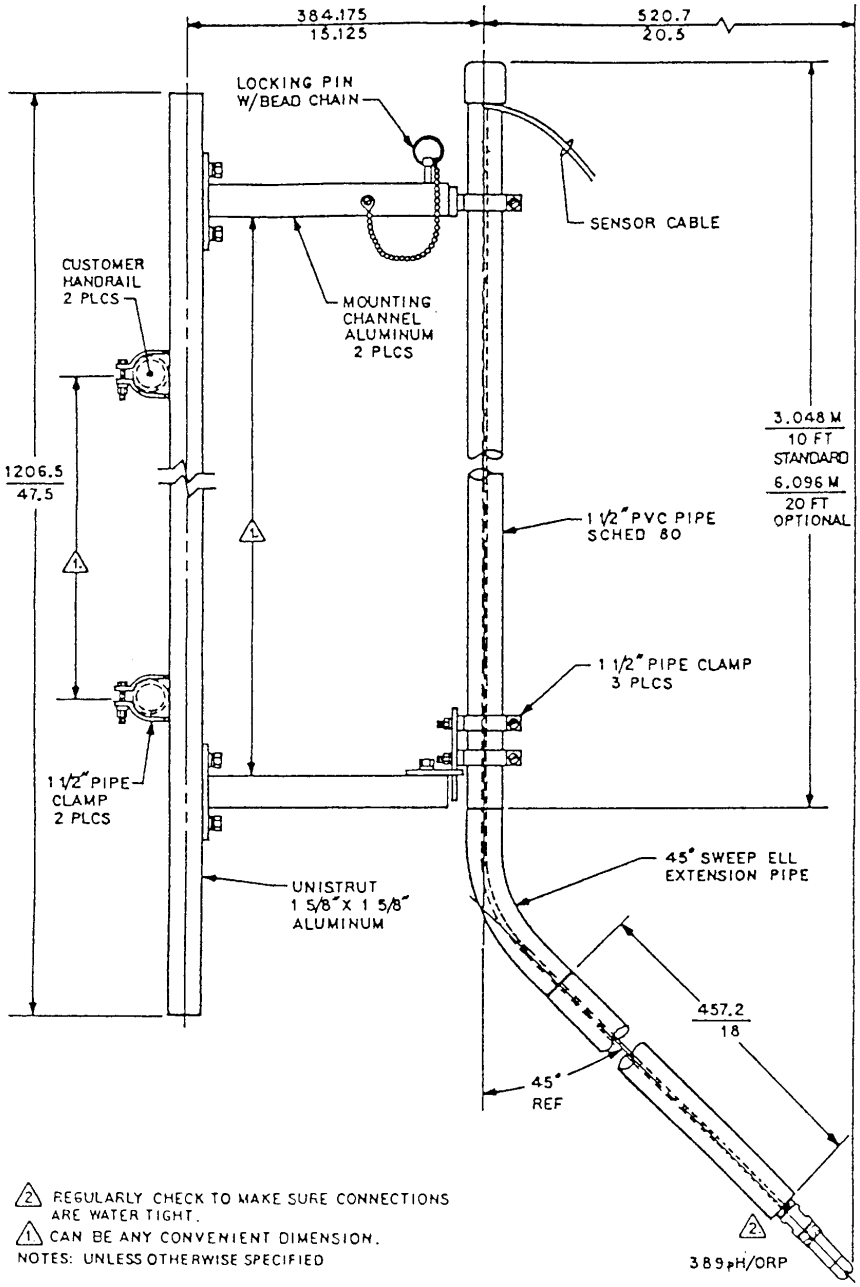
In most cases, the sensor can simply be installed as shipped, and you can obtain readings with an accuracy of ±0.2 pH. To obtain greater accuracy or to verify proper operation, the sensor must be calibrated as a loop with its compatible analyzer or transmitter.

## 2.2.1 Submersion mounting

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

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

**Figure 2-3: Submersion installations**



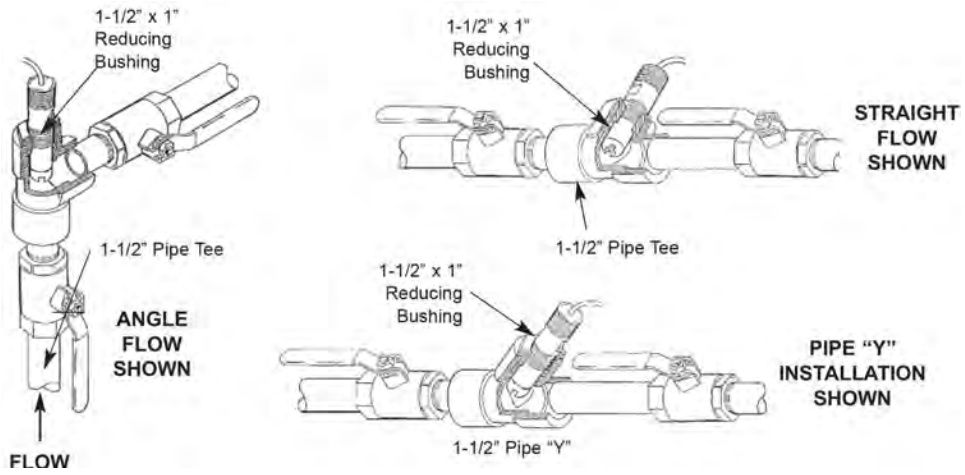

4. Run the sensor cable through a protective conduit for isolation from electrical interference or physical abuse from the process.
5. Install the sensor within 80 ° of vertical, with the electrode facing down.

   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 1-1/4 in. tee or the process. See Figure for installation configurations.

**Figure 2-4: Flow Through and Insertion Installations**




***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 neatly 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. For your convenience, a spade lug kit is furnished (in a plastic bag wrapped around the cable).

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

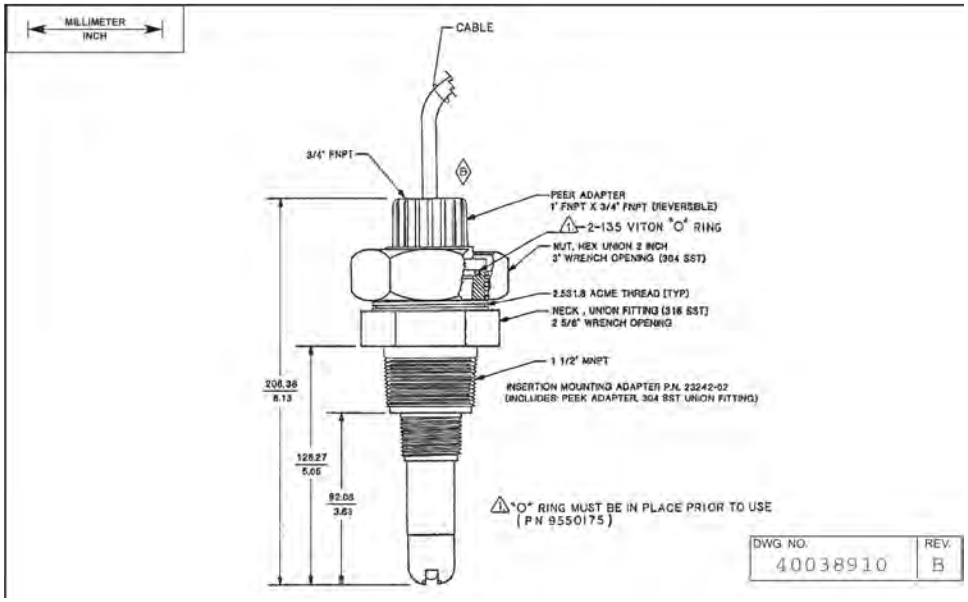



**Figure 2-6: VP 8 Cable, Rosemount 389VP Sensor End**

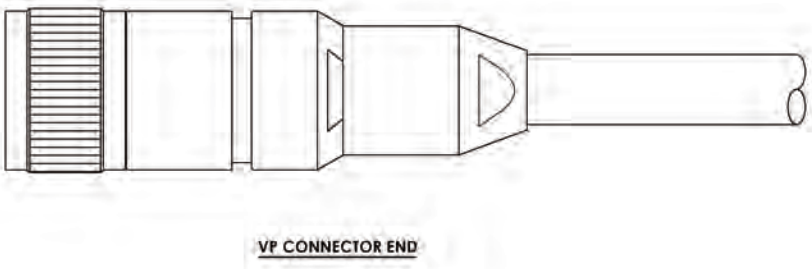
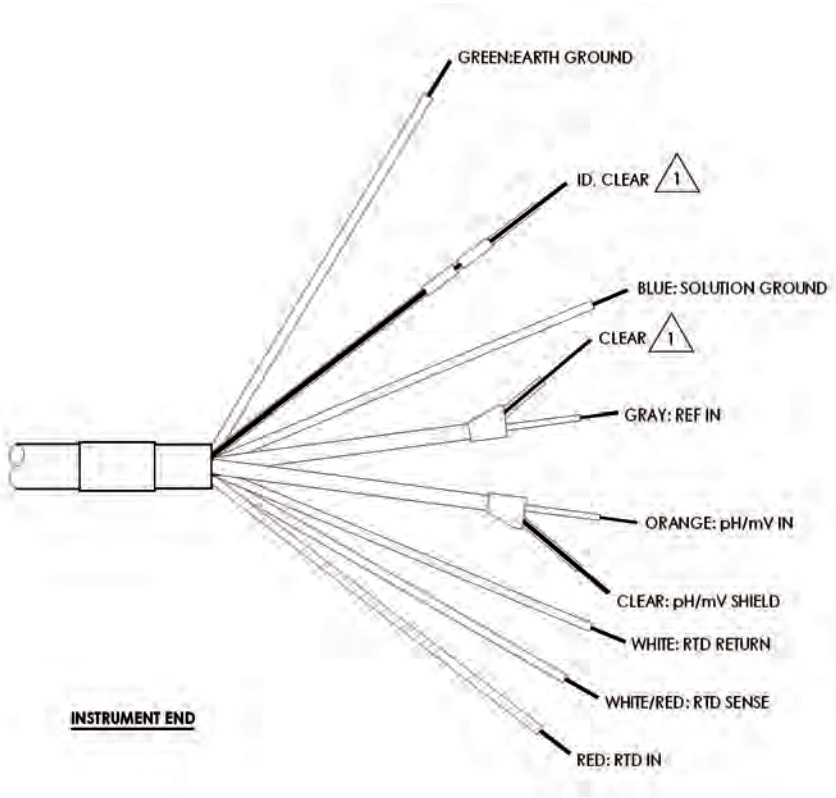


**Figure 2-7: VP8 Cable, Instrument End**




## *NOTICE*

**For additional wiring information on this product, including sensor combinations not shown here, please refer to the *Liquid Transmitter Wiring Diagrams.***

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

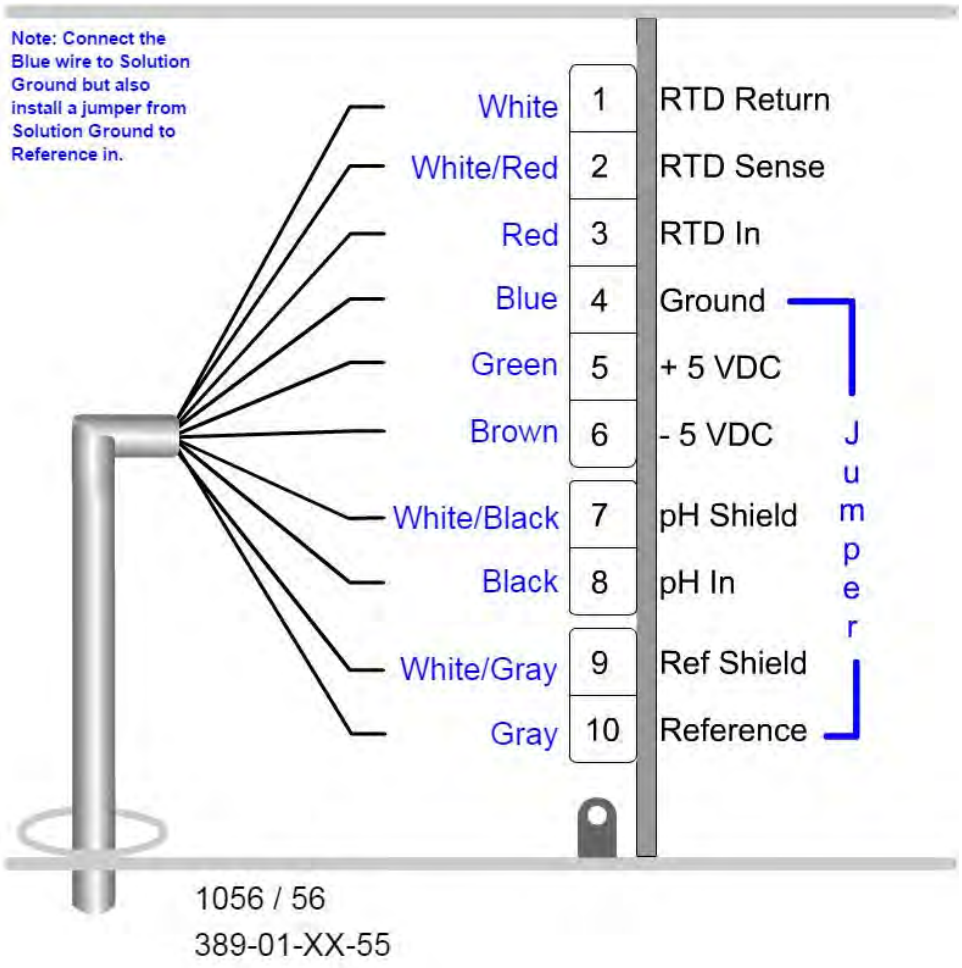


**Figure 2-9: Rosemount 389-01-xx-55 Wiring to Rosemount 1066 Transmitter**

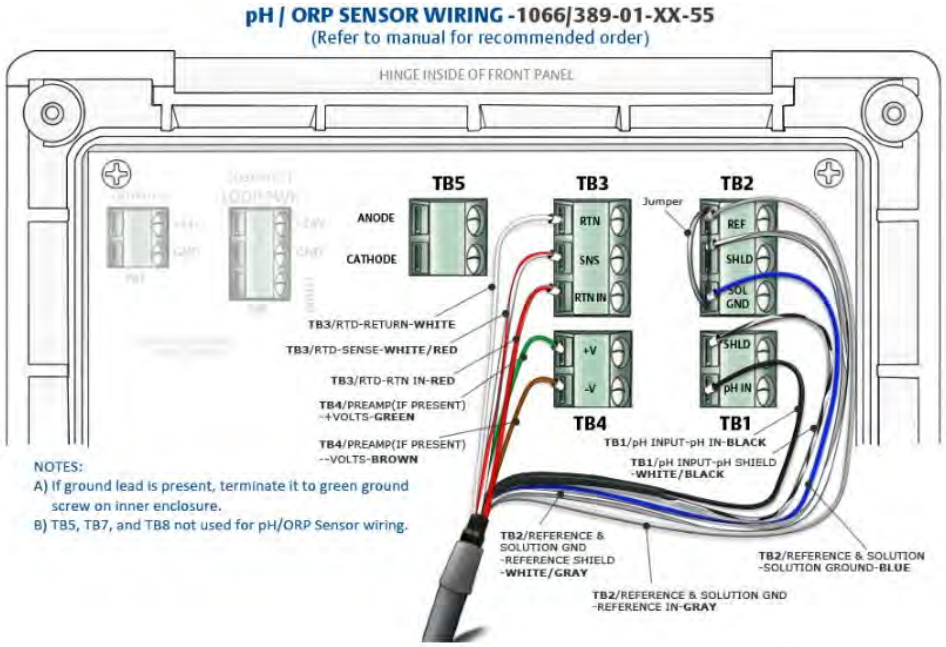



**Figure 2-10: Rosemount 389-01-xx-55 Wiring to Rosemount 5091 Transmitter**

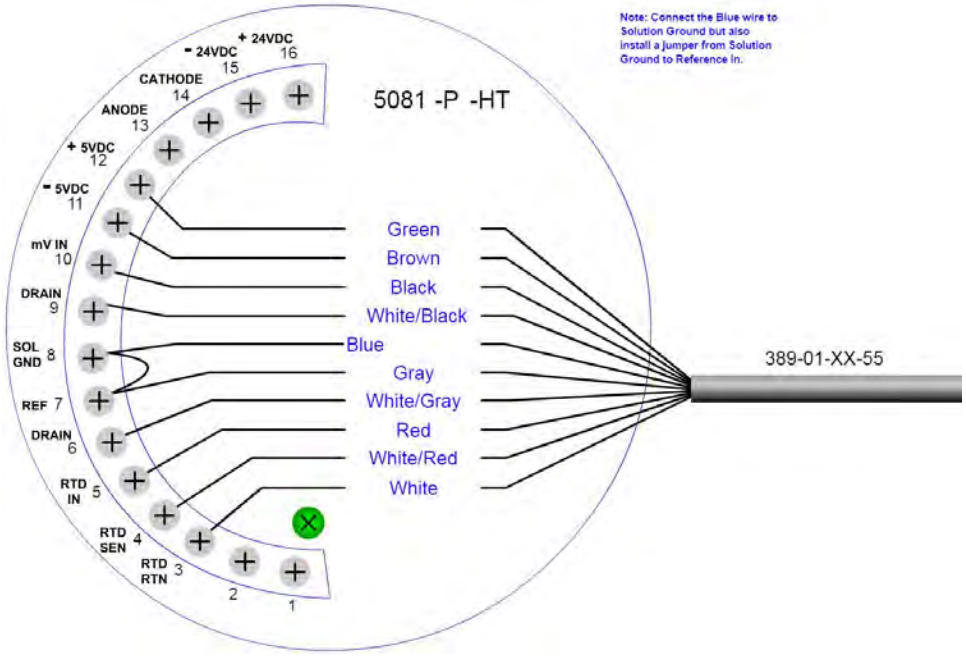


**Figure 2-11: Rosemount 389VP Wiring to Rosemount 1056, 1057, and 56 Transmitters**

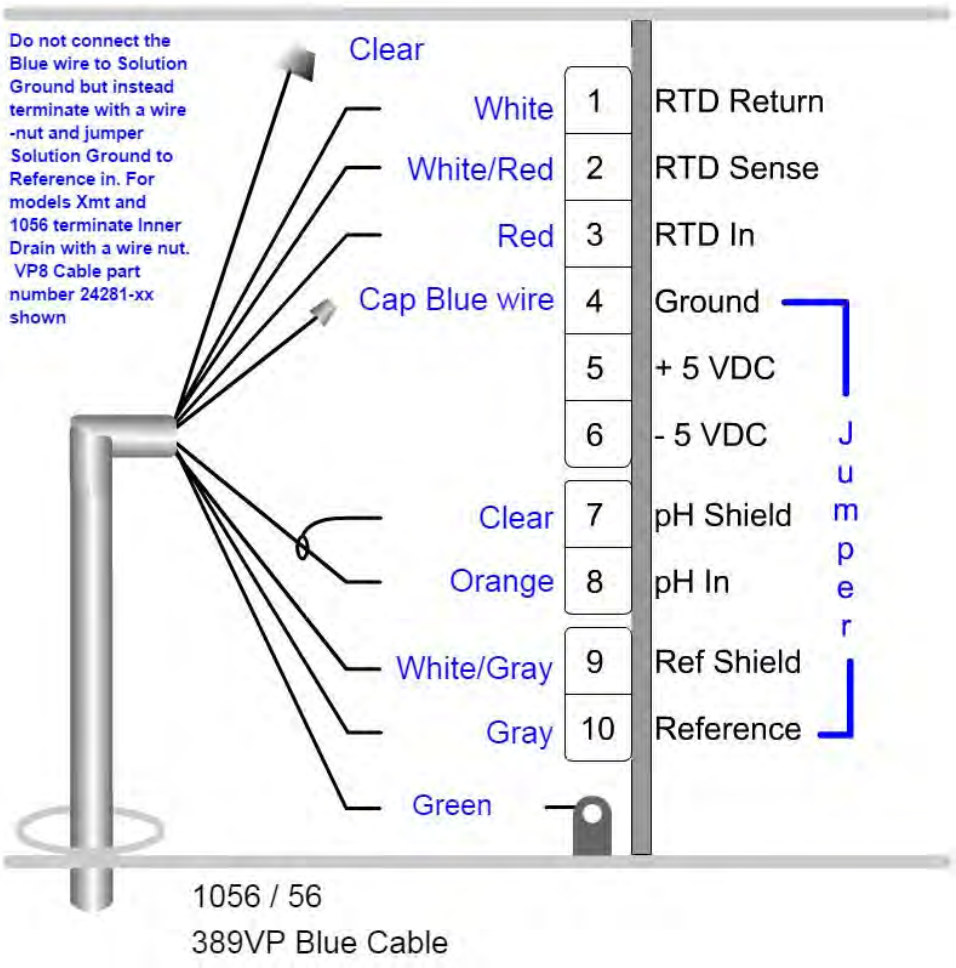


**Figure 2-12: Rosemount 389VP Wiring to Rosemount 1066 Transmitter**

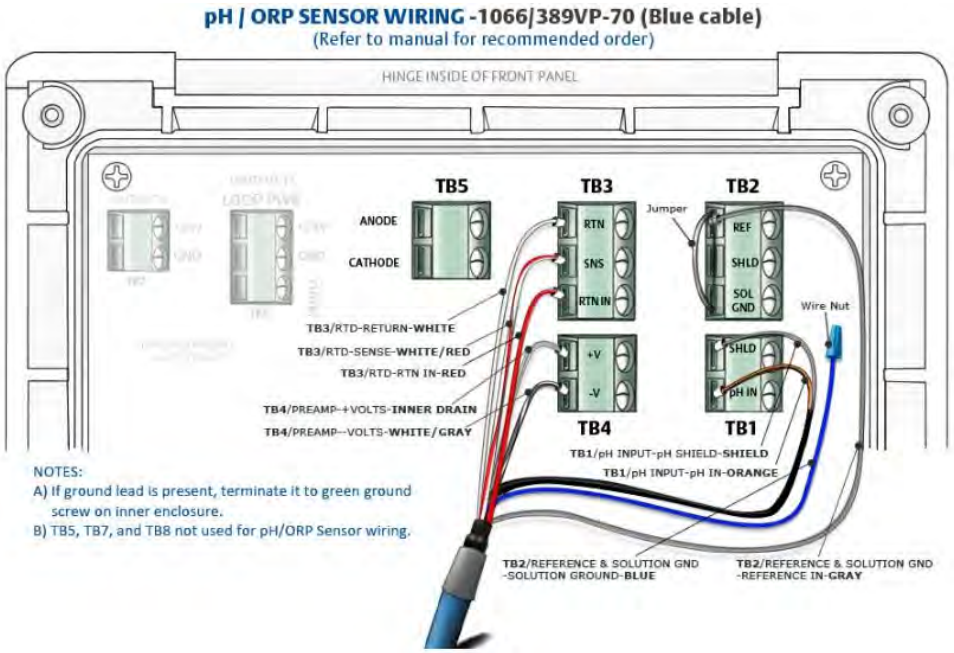



**Figure 2-13: Rosemount 389VP Wiring to Rosemount 5081 Transmitter**

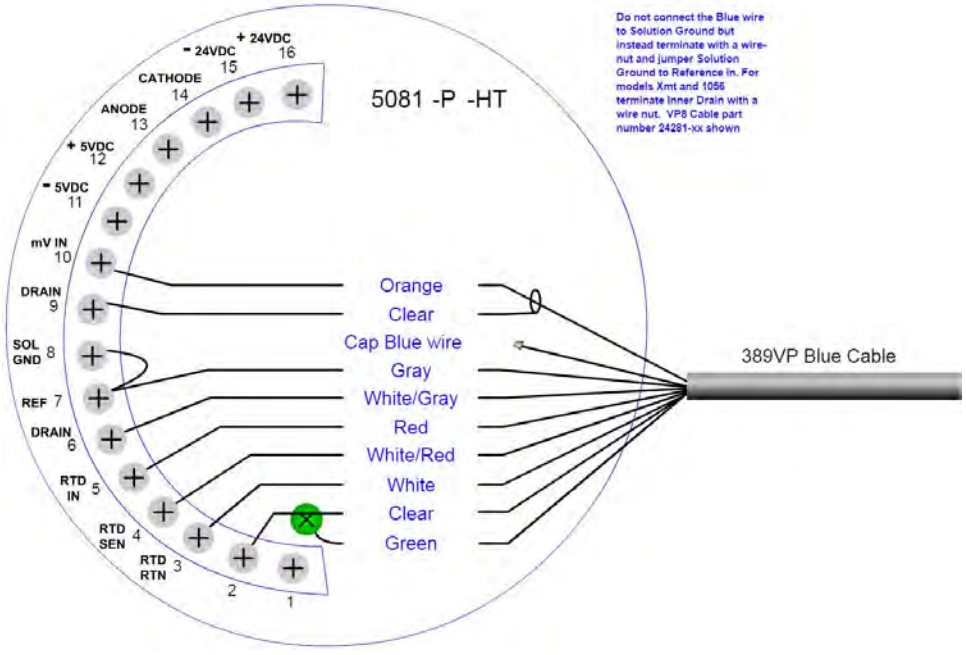


**Figure 2-14: Rosemount 389VP-xx-55-70 Wiring to Rosemount 1056, 1057, and 56 Transmitters**

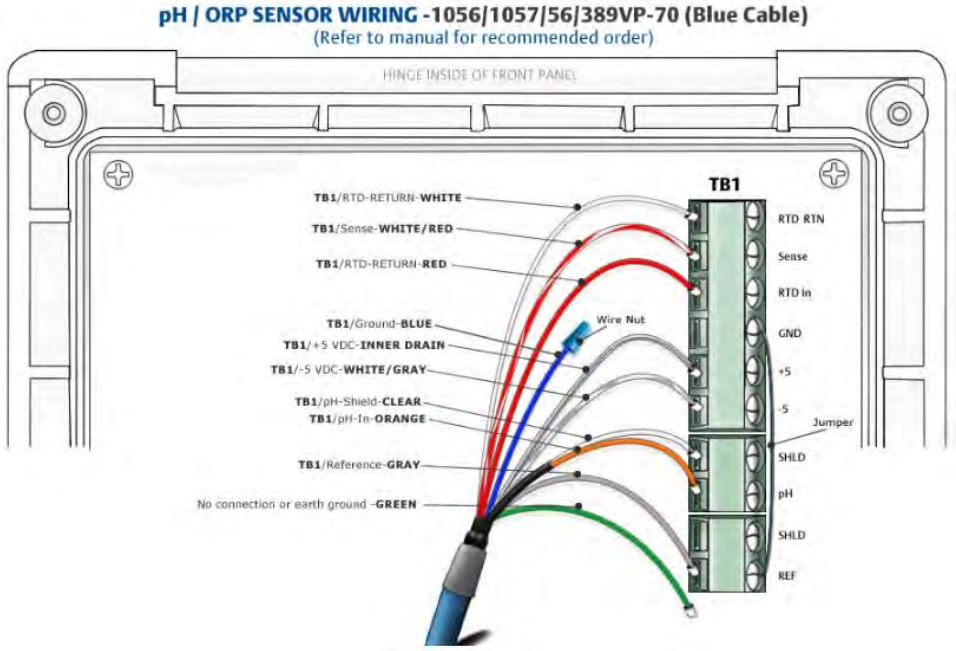



**Figure 2-15: Rosemount 389VP-xx-55-70 Wiring to Rosemount 1066 Transmitter**

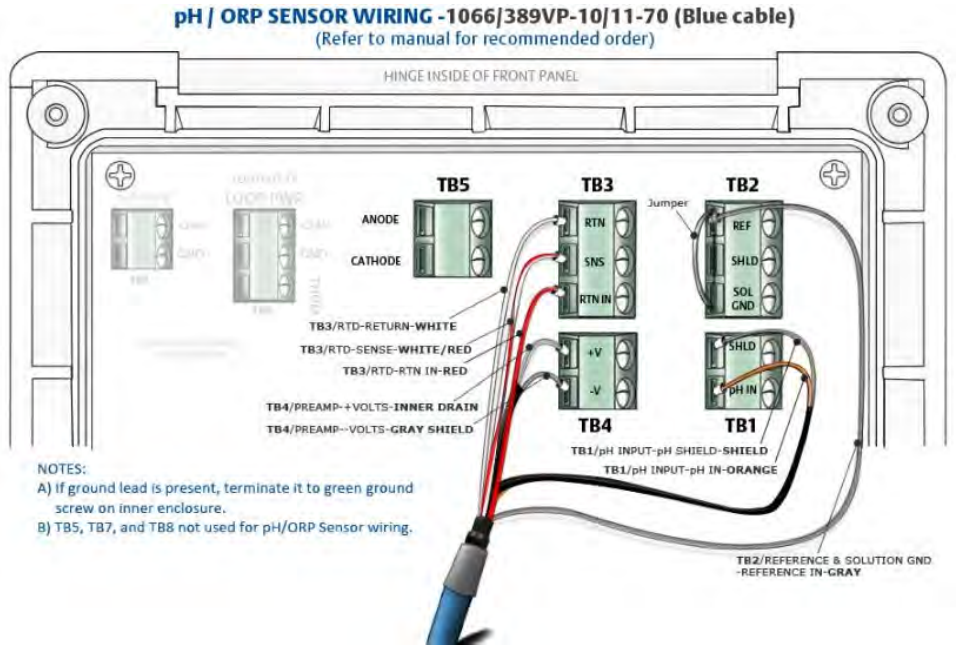


**Figure 2-16: Rosemount 389VP-xx-55-70 Wiring to Rosemount 5081 Transmitter**

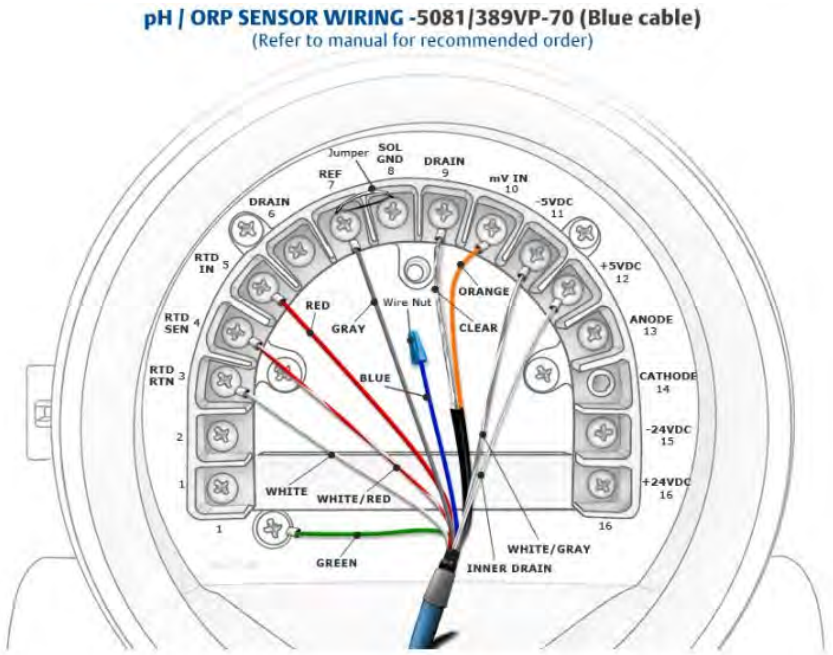


**Figure 2-17: Rosemount 389-02-xx-54-62 Wiring to Rosemount 1056, 56, and 1057 Transmitters**

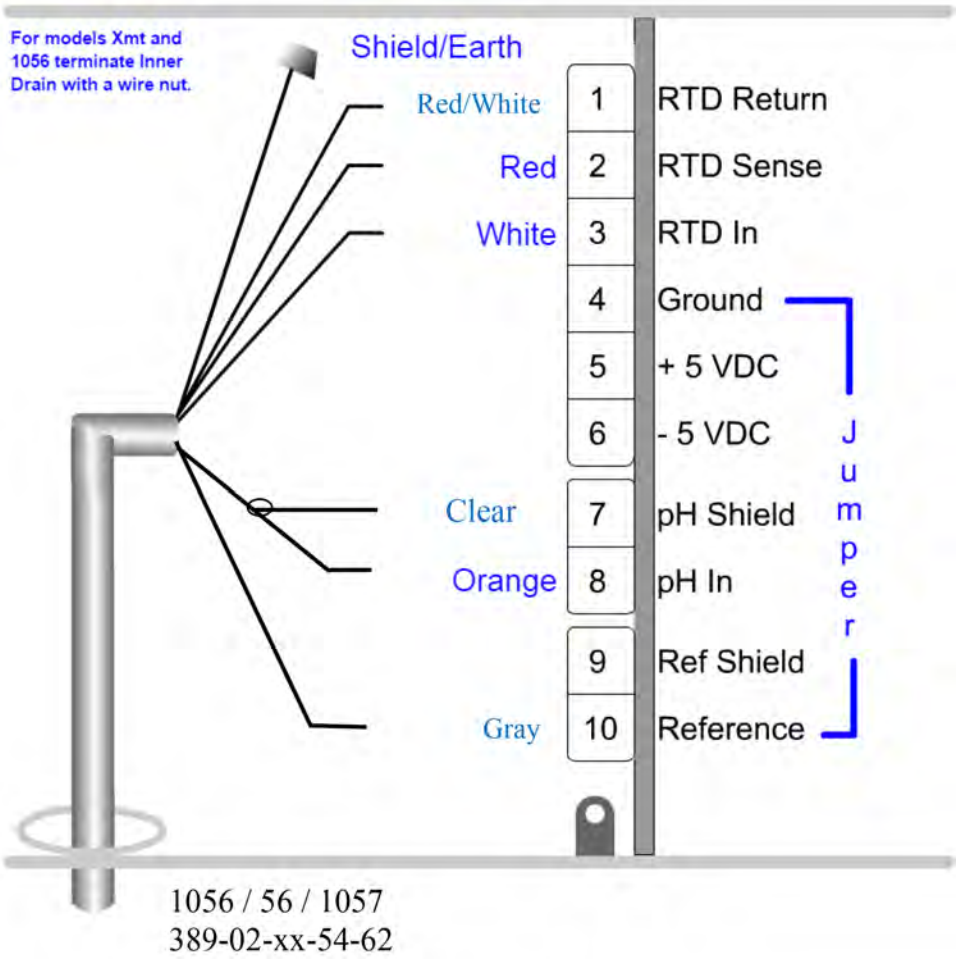


**Figure 2-18: Rosemount 389-02-xx-54-62 Wiring to Rosemount 1066 Transmitter**

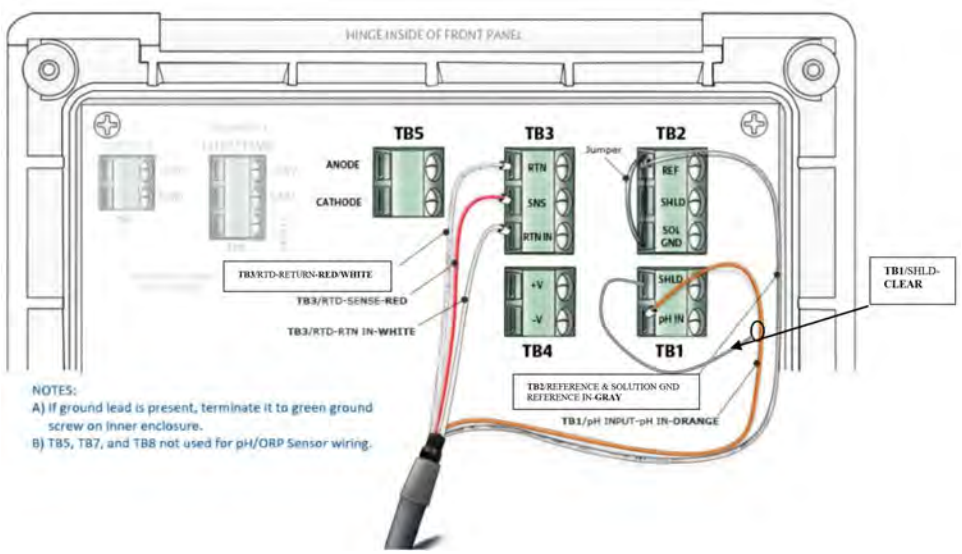
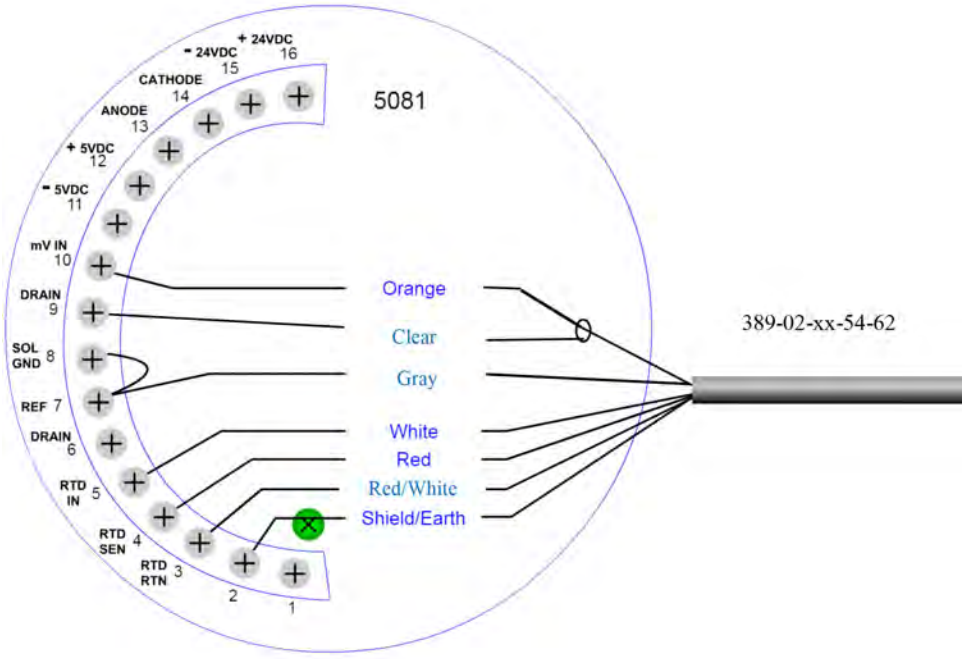



**Figure 2-19: Rosemount 389-02-xx-54-62 Wiring to Rosemount 5081 Transmitter**



# 3 Calibration and maintenance

## 3.1 Sensor Preparation

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 you can obtain readings 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 Rosemount 389/389VP pH Calibration

1. After a temporary connection is established between the sensor and the instrument, you may perform a buffer calibration.
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.

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 occuring 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.

### 3.3.1 Calibration

**⚠ 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 (refer to Section for an alternate ORP standard solution).

3. Immerse the sensor in the standard solution. Allow 1-2 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 ºC | 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 manual for proper test procedures. If you determine that the sensor has failed, discard and replace it.

## 4.1 Electrode Cleaning

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

1. Remove the sensor from process.
2. 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 3 (detergents clean oil and grease; acids remove scale.)
3. 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 4.

   **⚠ WARNING!**

   **CORROSIVE SUBSTANCE**
   **The solution used during the following test 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.**

4. 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.

## 4.2 Automatic Temperature Compensator

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

The 3K element reads 3000 ohms ±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 or the following formula:

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

Where $R_T$ = Resistance and T = Temperature in °C

Refer to *Table 4-1* for $R_O$ and $R_1$ values.

**Table 4-1: $R_O$ and $R_1$ Values for Temperature Compensation Elements**

| Temperature Compensation Element | $R_O$ | $R_1$ |
|---|---|---|
| 3K | 2934 | .0045 |
| PT-100 | 107.7 | .00385 |

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

| Temperatre °C | Resistance (Ohms) ±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 | 138.5 |
| 90 | 3858 | 134.6 |
| 100 | 3990 | 138.5 |

# 4.3 ORP

## 4.3.1 Platinum Electrode Check

The platinum electrode may be checked 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 *Section 3.3*.

**⚠ WARNING!**

**CORROSIVE SUBSTANCE**
**The solution used during the following check is an acid and should be handled 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, $Fe(NH_4)_2(SO_4)_2 \bullet 6H_2O$ and 48.2 grams of reagent grade ferric ammonium sulfate, $FeNH_4(SO_4)_2 \bullet 12 H_2O$ 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 25 ºC 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 a bright, shiny appearance is attained.

# 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 *Section 4.2* 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 *Chapter 2* 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.Cl. element as instructed in *Section 4.2* and replace sensor if defective. |
| Span between buffers extremely short in AUTO T.C. Mode. | T.C. element shorted. | Check T.Cl. element as instructed in *Section 4.2* and replace sensor if defective. |
| Sluggish or slow meter indication for real changes in pH level. | Electrode cracked. | Clean sensor as instructed in *Section 4.1* or *Section 4.3.2*. Replace sensor if cracked. |
| | Electrode defective. | Replace sensor. |
| Transmitter cannot be standardized. | Electrode coated or cracked. | Clean sensor as instructed in *Section 4.1* or *Section 4.3.2*. 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 *Section 4.1* or *Section 4.3.2*. Replace sensor if cracked. |

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

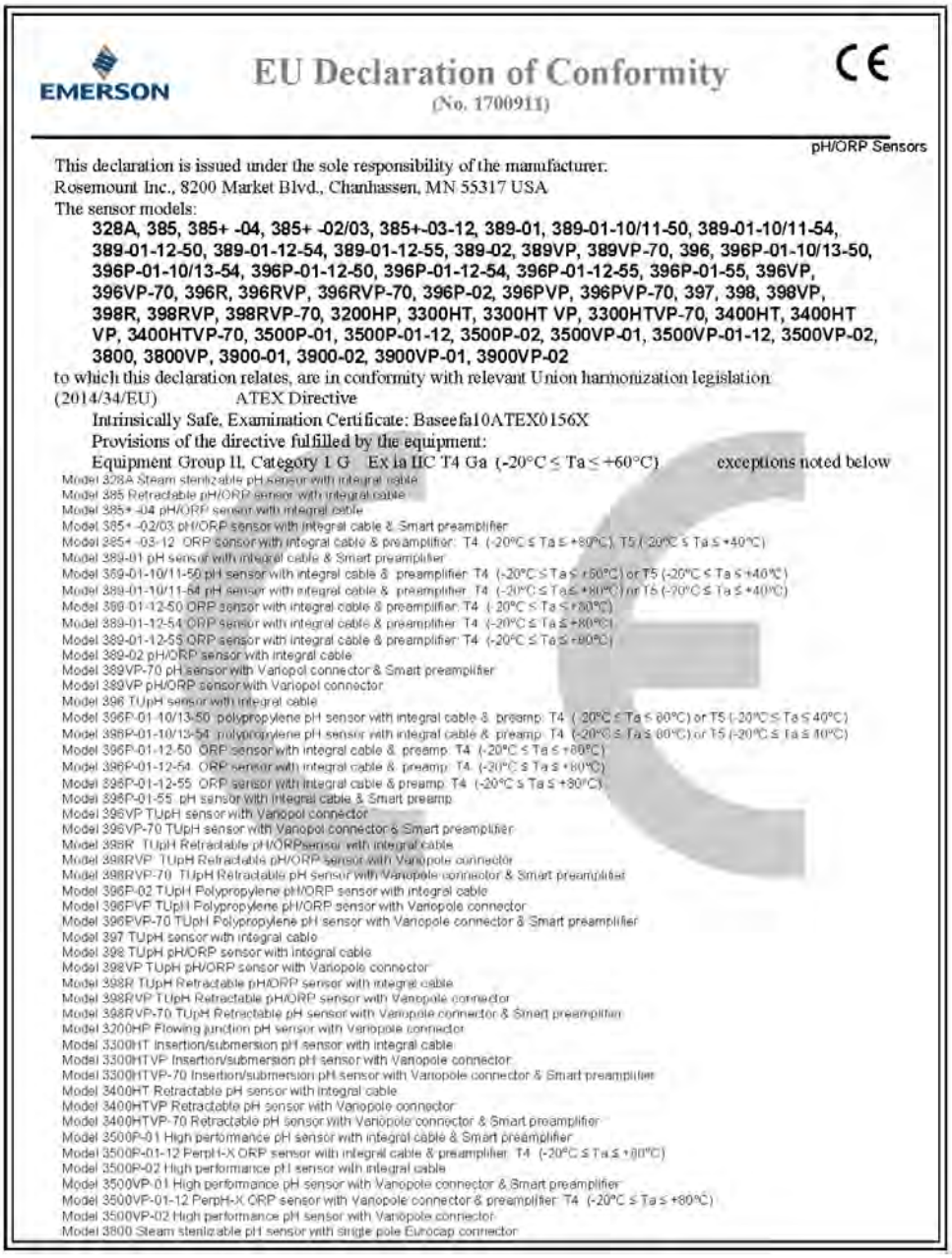
| Part number | Description |
|---|---|
| 11275-01 | Handrail mounting assembly |
| 12707-00 | Jet spray cleaner |
| 2002011 | CPVC in-line tee, 1.5 in. size, 1.0 in. threaded process connection ends |
| 915240-03 | PVC in-line tee, 2.0 in. size, 3/4 in. threaded process connection ends |
| 915240-04 | 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.

# 7 EC Declaration of Conformity

Note: Please see *website* for most recent Declaration.



EMERSON

## EU Declaration of Conformity

(No. 1700911)

CE

pH/ORP Sensors

This declaration is issued under the sole responsibility of the manufacturer:
Rosemount Inc., 8200 Market Blvd., Chanhassen, MN 55317 USA
The 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**

to which this declaration relates, are in conformity with relevant Union harmonization legislation
(2014/34/EU) ATEX Directive
Intrinsically Safe, Examination Certificate: Baseefa10ATEX0156X
Provisions of the directive fulfilled by the equipment:
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 ≤ +60°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 Variopol connector & Smart preamplifier
Model 389VP pH/ORP sensor with Variopol 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 Variopol connector
Model 396VP-70 TUpH sensor with Variopol 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
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

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

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 build up 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.

ATEX Notified Body for EC Type Examination Certificate & Quality Assurance:
SGS Baseefa[Notified Body Number:1180], Rockhead Business Park, Staden Lane, Buxton SK17 9RZ UNITED KINGDOM

Assumption of conformity is based on the application of the harmonized standards:
EN 60079-0:2012+A11:2013 Explosive atmospheres. Equipment. General requirements
EN 60079-11:2012 Explosive atmospheres. Equipment protection by intrinsic safety "i"

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(Signature)

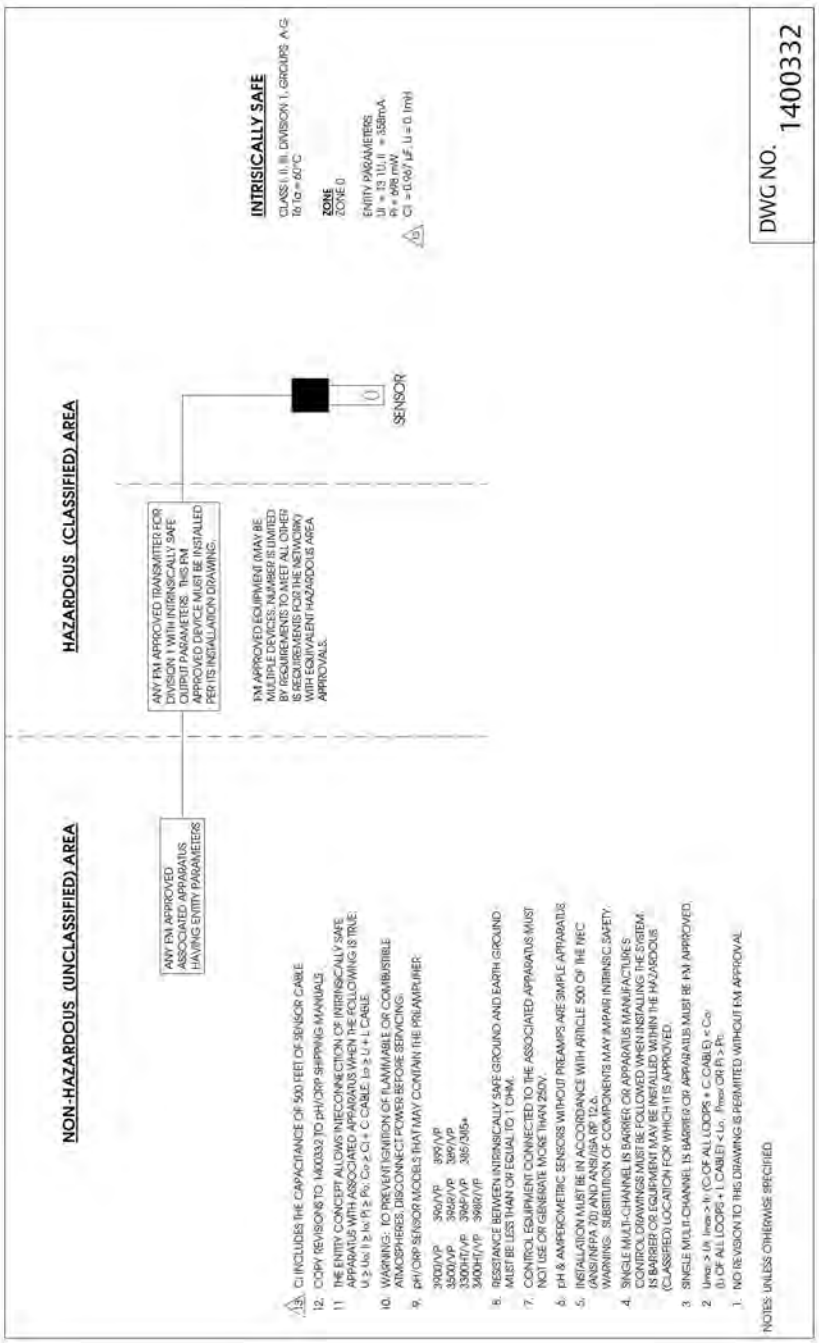
Kim Freeman
(Name printed)

Director of Global Quality
(Function name)

March 23, 2017
(Date of issue)

CE marking was first affixed to this product in 2011

# 8 Intrinsically Safe Sensor Installation Drawing - FM



LIQ-MAN-389
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2017

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