

# Signet 275X Series Wet-Tap DryLoc® pH and ORP Electrodes

## Signet 276X Series Differential DryLoc® pH and ORP Electrodes

## Signet 277X Series Threaded DryLoc® pH and ORP Electrodes



3-2764.090 Rev 12 12/19

### Operating Instructions

#### Description



The Signet General Purpose 275X Wet-Tap and High Performance 276X and 277X series of pH and ORP electrodes are designed to minimize maintenance time and maximize performance longevity and value. All three family of pH and ORP electrodes are memory chip enabled to store Manufacturing, Calibration and Operational Data. For more flexibility and unique features, pair any pH or ORP electrode with a 2751 Smart Sensor Electronics and the 9900 Transmitter, 9950 Dual Channel Transmitter or the 0486 Profibus Concentrator.

The 275X Wet-Tap electrodes are all-purpose sensors ideal for applications where the probe can be removed for cleaning and maintenance without the system shutdown. They feature a unique foul-proof DryLoc® connector with gold-plated contacts, designed specifically for use with the Signet 2751 Smart Sensor Electronics, and 2760 Preamplifier. These dependable and highly responsive electrodes feature a large reference chamber and intelligent positioning of internal elements that combine to extend the service life. The electrodes are offered with a bulb sensing element that can be used for general purpose applications where a fast response is required even at low temperatures. The choice of a Pt1000 or 3 K $\Omega$  temperature sensor allows compatibility into all Signet pH/ORP instruments. The 3719 Wet-Tap assembly allows installation and removal of electrode even under process pressure without the need for process shutdown.

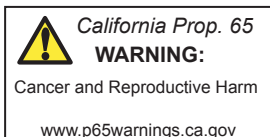
The Signet 276X Series Differential pH and ORP electrodes feature a Ryton® body and PTFE reference junction to resist fouling, clogging and chemical attack under harsh chemical applications. The Differential electrodes use a 3-electrode technique, measuring the pH and reference electrodes against a ground electrode for a more stable output signal. The solution ground eliminates noisy measurements by draining electrical current away from the reference electrode. The reference electrode is housed in a glass half-cell embedded in the reference chamber to protect it from poisoning or contamination. The electrolyte chamber is refillable and the salt bridge is field replaceable.

The Signet 277X Series pH and ORP electrodes are highly responsive electrodes featuring a PTFE double reference junction, potassium nitrate, KNO<sub>3</sub>, in the front chamber (to block various poisoning ions such as copper (Cu<sup>2+</sup>), lead (Pb<sup>2+</sup>), mercury (Hg<sup>2+</sup>)) and a large reference chamber. The two chambers combine to extend the service-life of the electrode.

Both the 276X Series and the 277X Series feature a unique foul-proof DryLoc® connector with gold-plated contacts designed specifically for use with the Signet 2751 Smart Sensor Electronics and 2760 Preamplifier. They are available with either flat or bulb style sensing elements. The bulb versions can be used for general-purpose applications. The flat versions allow sediment and particles to sweep past the measurement surface, minimizing risks of abrasion, breakage and coating. All versions can be installed at any angle. The temperature device in the pH electrodes is positioned at the tip of the measurement surface, resulting in a temperature response of less than 1 minute. Temperature devices available include 3 K $\Omega$ , or Pt1000 RTD.



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## Warranty Information

Refer to your local Georg Fischer Sales office for the most current warranty statement.

All warranty and non-warranty repairs being returned must include a fully completed Service Form and goods must be returned to your local GF Sales office or distributor. Product returned without a Service Form may not be warranty replaced or repaired.

Signet products with limited shelf-life (e.g. pH, ORP, chlorine electrodes, calibration solutions; e.g. pH buffers, turbidity standards or other solutions) are warranted out of box but not warranted against any damage, due to process or application failures (e.g. high temperature, chemical poisoning, dry-out) or mishandling (e.g. broken glass, damaged membrane, freezing and/or extreme temperatures).

## Product Registration

Thank you for purchasing the Signet line of Georg Fischer measurement products.

If you would like to register your product(s), you can now register online in one of the following ways:

- Visit our website [www.gfsignet.com](http://www.gfsignet.com). Under **Service and Support** click on **Product Registration Form**
- If this is a pdf manual (digital copy), [click here](#)

## Safety Information

1. Use appropriate eye, face, hand, body and/or respiratory protection when using chemicals or solvents.
2. Prior to installation or removal:
  - Depressurize and vent system
  - Drain below sensor level.
3. Confirm chemical compatibility before use.
4. Do not exceed the max. temperature/pressure specifications.
5. Do not alter product construction.

### If installing into a threaded connection:

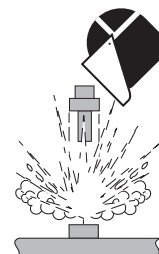
6. Inspect threads to ensure integrity. Do not install a sensor that has damaged threads.
7. Apply PTFE tape to the 3/4" M-NPT or ISO 7/1-R 3/4 process connection threads in accordance with industry practices.
8. **HAND TIGHTEN** the sensor into the process connection. **DO NOT USE TOOLS.**

|  |  |
|--|--|
|  | <b>Caution / Warning / Danger</b><br>Indicates a potential hazard.<br>Failure to follow all warnings may lead to equipment damage, injury, or death  |
|  | <b>Personal Protective Equipment (PPE)</b><br>Always utilize the most appropriate PPE during installation and service of Signet products.  |
|  | <b>Pressurized System Warning</b><br>Sensor may be under pressure, take caution to vent system prior to installation or removal.<br>Failure to do so may result in equipment damage and/or serious injury. |
|  | <b>Hand Tighten Only</b><br>Overtightening may permanently damage product threads and lead to failure of the retaining nut.  |
|  | <b>Do Not Use Tools</b><br>Use of tool(s) may damage product beyond repair and potentially void product warranty.  |
|  | <b>Note / Technical Notes</b><br>Highlights additional information or detailed procedure.  |
|  | <b>Do Not Freeze</b><br>Products are temperature sensitive and may contain freezable liquids. Freezing damage to pH, ORP, and Chlorine electrodes voids product warranty.                                  |

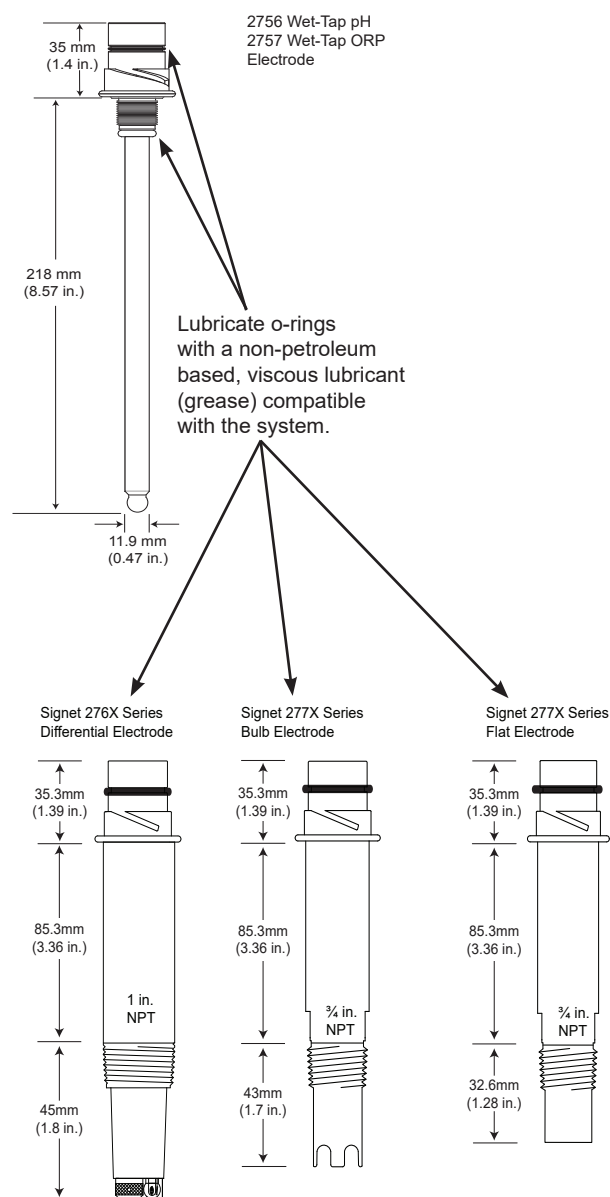
## Chemical Compatibility

The retaining nuts of pH and ORP sensors are not designed for prolonged contact with aggressive substances. Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances, e.g. due to leakage or spilling, must be replaced.

- The use of this product assumes operators are trained and familiar with this type of device.
- Operators should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators **MUST** follow all necessary safety procedures.



## Dimensions



## Specifications

### 276X Series Differential Electrodes

### 277X Series Threaded Electrodes

#### General

|                       |                               |
|-----------------------|-------------------------------|
| Compatibility .....   | Signet 2751 and 2760          |
| Shipping Weight ..... | 0.25 kg (0.55 lbs.)           |
| Operating Range       |                               |
| 276X Series .....     | 0 to 14 pH, $\pm 1500$ mV ORP |
| 277X Series .....     | 0 to 14 pH, $\pm 2000$ mV ORP |

#### Reference Electrolyte

|                   |  |
|-------------------|--|
| 276X Series ..... | Buffered $\text{KNO}_3$ solution             |
| 277X Series ..... | KCl/AgCl gel with $\text{KNO}_3$ salt bridge |

#### Reference Element

|                   |                    |
|-------------------|--------------------|
| 276X Series ..... | pH glass electrode |
| 277X Series ..... | Ag/AgCl            |

#### Temperature Sensor

|                       |  |
|-----------------------|--|
| 276X Series pH .....  | 3 K $\Omega$ or Pt1000 RTD               |
| 277X Series pH .....  | 3 K $\Omega$ or Pt1000 RTD               |
| 276X Series ORP ..... | 10 K $\Omega$ ID for Signet instruments; |
| 277X Series ORP ..... | 10 K $\Omega$ ID for Signet instruments  |

#### Wetted Materials

|                           |                                       |
|---------------------------|---------------------------------------|
| Body .....                | Ryton®                                |
| Reference junctions ..... | PTFE                                  |
| Sensing surface .....     | Glass (pH), Platinum (ORP)            |
| O-rings .....             | FKM                                   |
| Solution ground .....     | Carbon graphite<br>(276X series only) |

#### Operating Temperature

|                              |                                 |
|------------------------------|---------------------------------|
| 276X Series .....            | 0 °C to 95 °C (32 °F to 203 °F) |
| 277X Series .....            | 0 °C to 85 °C (32 °F to 185 °F) |
| Storage Temperature .....    | > 0 °C (32 °F)                  |
| Max Operating Pressure ..... | 6.89 bar (100 psi)              |

### 275X Series Wet-Tap Electrodes

#### General

|                             |   |
|-----------------------------|---|
| Compatibility .....         | Signet 2751 and 2760                    |
| Shipping Weight .....       | 0.25 kg (0.55 lbs.)                     |
| Operating Range .....       | 0 to 14 pH, $\pm 1500$ mV ORP           |
| Reference Electrolyte ..... | Polymerized Acrylamide Gel              |
| Wet-Tap electrolyte .....   | 3.5 M KCl                               |
| Reference Element .....     | Ag/AgCl                                 |
| pH Temp Sensor .....        | Pt1000 RTD or 3 K $\Omega$ Balco        |
| ORP Identification .....    | 10 K $\Omega$ ID for Signet instruments |

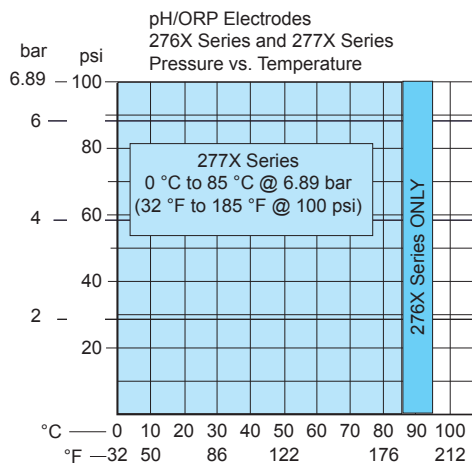
#### Wetted Materials

|                         |                            |
|-------------------------|----------------------------|
| Wet-Tap body .....      | PAS (Poly Aryl Sulphone)   |
| Wet-Tap Junctions ..... | Porous PTFE                |
| Sensing surface .....   | Glass (pH), Platinum (ORP) |
| O-rings .....           | FKM                        |

#### Temperatures

|   |                                 |
|---|---------------------------------|
| Operating Temperature .....                           | 0 °C to 85 °C (32 °F to 185 °F) |
| Storage Temperature .....                             | 0 °C to 85 °C (32 °F to 185 °F) |
| Maximum Temperature and Pressure rating               |                                 |
| 6.89 bar @ 0 °C to 65 °C (100 psi @ 32 °F to 149 °F)  |                                 |
| 4.00 bar @ 65 °C to 85 °C (58 psi @ 150 °F to 185 °F) |                                 |

Ryton® is a registered trademark of Chevron Phillips Chemical



#### Standards and Approvals

- CE, WEEE, RoHS Compliant
- Manufactured under ISO 9001 for Quality, ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.



China RoHS (Go to [www.gfsignet.com](http://www.gfsignet.com) for details)



Declaration of Conformity according to FCC Part 15

This device complies with Part 15 of the FCC rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

**REACH Information** Obligation: in accordance with Article 33 of the European REACH Regulation (EC) No. 1907/2006, the substances Lead and Acrylamide are present in the glass matrix and as a polymerized gel respectively; in a concentration >0.1% (w/w). During normal use, the articles do not pose any risks and no additional information is required for safe use.

## In-Line Installation

- 2774 and 2775 electrodes can be mounted at any angle
- Differential (276X series) electrodes must be mounted at a downward angle ( $> 15^\circ$  from horizontal)
- 275X Wet-Tap electrodes must be mounted in a 3719 Assembly at any angle
- Avoid air pockets and sediments
- Select a Signet installation fitting (0.5" to 4" size range) for convenience. Lightly lubricate o-ring with a non-petroleum based lubricate (grease) compatible with the system.
- Use the  $\frac{3}{4}$  in. M-NPT or ISO 7/1-R  $\frac{3}{4}$  threads on the electrode body to install the electrode into reducing tee fittings.
- Inspect threads to ensure integrity. Do not install an electrode with damaged threads.
- Apply PTFE tape to the M-NPT or ISO 7/1-R  $\frac{3}{4}$  process connection threads, in accordance with industry standards.
- Use piping installation hardware with smooth, well-finished threads to facilitate the installation.
- If necessary, the pipe should be plumbed with a depression (trap) so liquid is maintained around the electrode tip.
- Hand-tighten the electrode into the process connection. Do not use any tools to install the electrode. The use of wrenches, pliers or similar may over-stress the sensor body and lead to breakage and subsequent spillage of the process liquid.



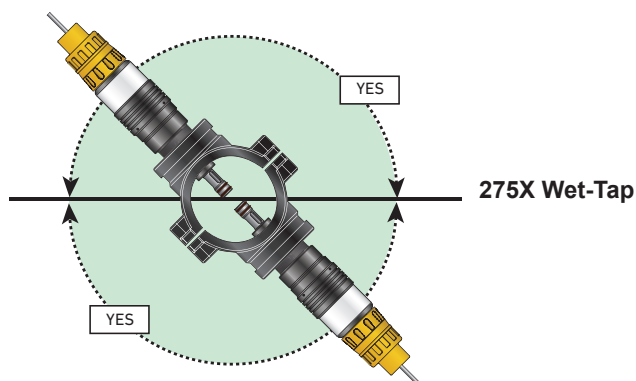
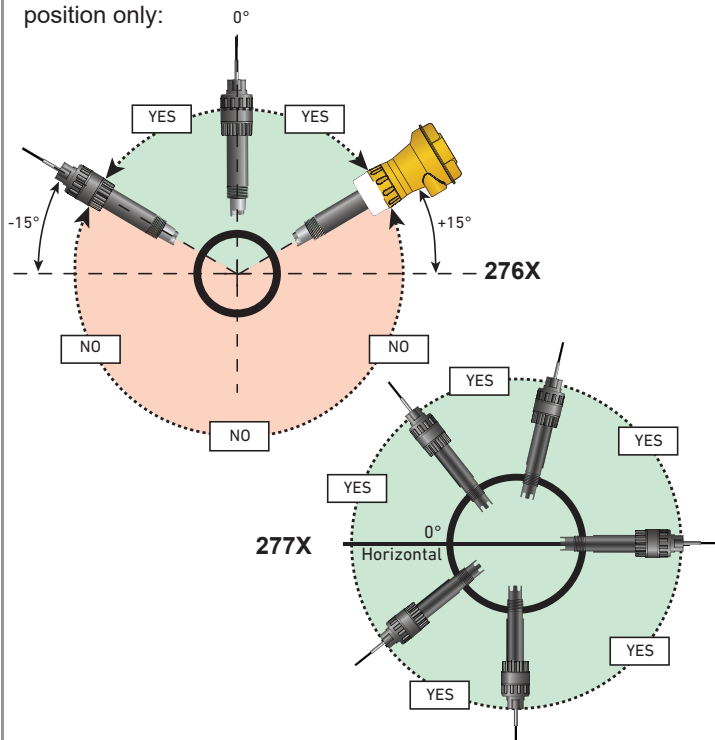
### CAUTION:

A broken sensor may be ejected forcefully from the fitting and can cause severe injury.

- The safety instructions have an adhesive label and should be placed near the sensor.

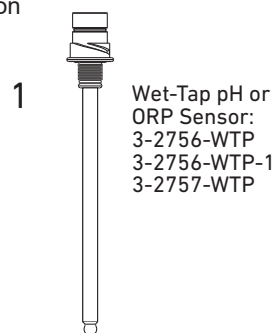
### NOTE:

When mounting in a standard threaded fitting, the electrode must be mounted horizontal to 60 degrees below horizontal position only:

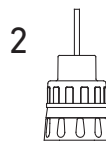


### 275X Wet-Tap with 2751 or 2760 and 3719 pH/ORP Wet-Tap Assembly

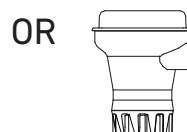
- Choose sensor; 2) Choose preamplifier or sensor electronics; 3) Choose Wet-Tap assembly; 4) Choose customer supplied mounting option



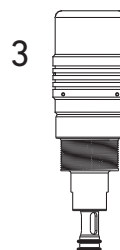
Wet-Tap pH or  
ORP Sensor:  
3-2756-WTP  
3-2756-WTP-1  
3-2757-WTP



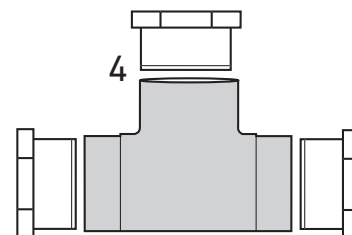
2760  
Preamplifier:  
3-2760-11  
3-2760-21



2751 Smart Sensor  
Electronics:  
3-2751-1  
3-2751-2

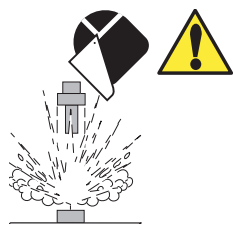


3719 Wet-Tap Assembly:  
3-3719-11  
3-3719-12  
3-3719-21  
3-3719-22



Customer supplied Tees and Fittings

## Removing from In-Line Installation



- The use of this product assumes that operators are trained and are familiar with this type of device.
- They should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators **MUST** follow all necessary safety procedures.

### In-line removal Instructions:

1. Wear safety goggles or face shield during removal. Use all appropriate eye, face, hand, body and/or respiratory protection when working with chemicals or solvents.
3. Depressurize and vent the piping system.
3. Drain the system to below sensor level.
4. Practice proper Lock Out/ Tag Out procedures when the sensor is removed for maintenance to prevent accidental opening and exposure to potentially hazardous chemicals.

## Submersible Installations

The user must supply the following hardware to complete a submersible installation:

- $\frac{3}{4}$  in. Pipe,  $\frac{3}{4}$  in. (DN 20) Male Adapter, Liquid Tight Connection at top of pipe assembly
- Wiring junction box
- Pipe clamps (quick-release type recommended)
- Tank flange for closed tanks
- Silicone Caulking Sealant & PTFE Tape

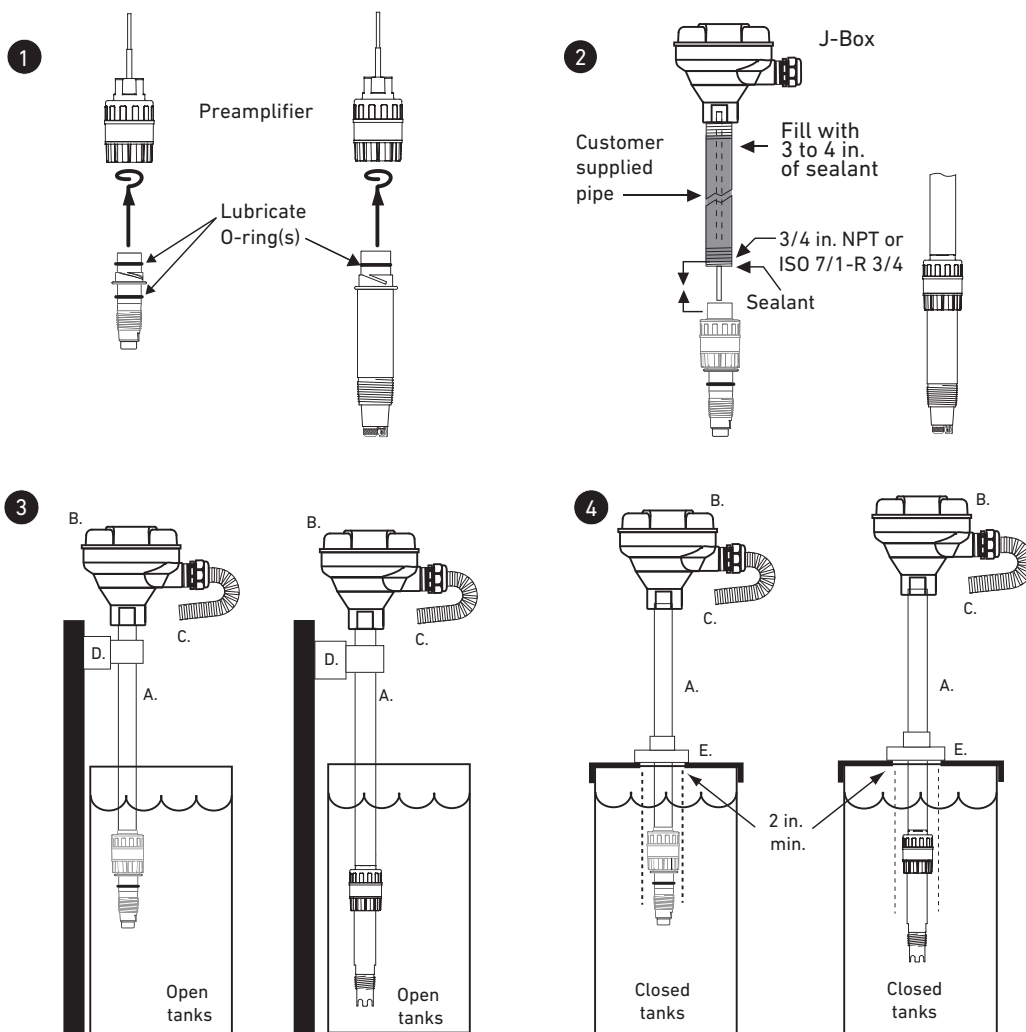


### Technical Note:

- Mount the electrode near tank outlets, away from reagent addition areas.
- Use the  $\frac{3}{4}$  in. (ISO 7/1-R  $\frac{3}{4}$ ) threads at the top of the preamplifier to run the cable inside pipe or conduit.
- Place the electrode tip in 3.0M KCl solution or pH 4 Buffer for temporary storage during system maintenance to avoid dehydration. For long term storage place the electrode tip in 3.0M KCl solution.

The Signet pH/ORP electrodes are designed to install in tanks by attaching conduit to the  $\frac{3}{4}$  in. (ISO 7/1-R  $\frac{3}{4}$ ) threads at the top of the accompanying preamplifier or sensor electronics:

1. The O-ring at the top of the electrode fits very tightly into the preamplifier. Use a small amount of non-petroleum based lubricant to assist the assembly.
2. To prevent moisture from migrating into the preamplifier, backfill the conduit with 3 in. to 4 in. of sealant.
3. Mount electrodes in a location with ample clearance to remove them for periodic cleaning and recalibration.
4. Choose a location that keeps the electrode glass completely submersed at all times.



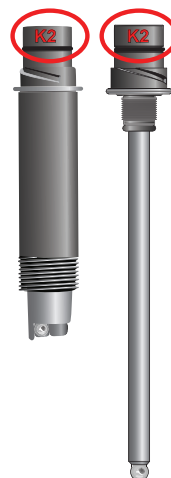
Caution: If liquid level is not constant, always ensure liquid contact with electrode tip



## Electrode Date Code

- The electrode date code indicates the manufacturing date of the electrode.
- Electrodes should be put into service as soon as possible and should not remain in the box for more than two years.
- Over time, the storage solution (found in the "boot" covering the electrode tip) will evaporate or leak, allowing the delicate sensing tip and reference junction to dry.
- To rehydrate a dry electrode, soak the tip in 3.0 mol/L KCl solution for 24 to 48 hours. Preheating the KCl solution to <140 °F may speed up the re-hydration process.
- Electrodes more than 2 years old may still be functional, but will take longer to rehydrate.
- Restoration may not be effective for severely dehydrated electrodes.

| Letter = Month |
|----------------|
| N = January    |
| M = February   |
| L = March      |
| K = April      |
| J = May        |
| H = June       |
| G = July       |
| F = August     |
| E = September  |
| D = October    |
| C = November   |
| B = December   |



| Numeral = Year |
|----------------|
| 5 = 2010       |
| 6 = 2011       |
| 7 = 2012       |
| 8 = 2013       |
| 9 = 2014       |
| 0 = 2015       |
| 1 = 2016       |
| 2 = 2017       |
| 3 = 2018       |
| 4 = 2019       |
| 5 = 2020       |
| 6 = 2021       |

Example: K2 = manufactured in April 2017

## Electrode Care

Depending on the type of application and the accuracy needed, pH and ORP electrodes will require routine maintenance. Contaminated/dirty electrodes should be swapped with properly cleaned conditioned and calibrated electrodes.

The solution used to clean an electrode varies depending on the type of coating:

**Caution:** Always wear appropriate safety gear and exercise proper safety practices when working with or near chemicals

- General Cleaning** – Soak the electrode for 5 minutes in a mixture of warm tap water (< 140° F), and mild detergent such as liquid dish detergent. A soft brush, like a toothbrush may also be used to clean off particulates.
- Biofilm and bacterial growth** – soak the electrode in a diluted household laundry bleach solution (pH electrodes only), 1part bleach to 10 parts water for 10 minutes.
- Alkaline or Scale** – Lime/calcium and mineral buildup deposits may be removed by soaking the electrode in a solution of 2% to 5% hydrochloric acid (HCl) or vinegar for no more than 5 minutes.
- Acidic contaminants** – may be removed by soaking the electrode in a weak caustic (less than 2% to 5% NaOH) for a few minutes only. Use the least harsh chemical which will remove the contaminant within 2-5 minutes of soaking without attacking the materials of construction.
- Oily or organic coatings** – Soak the probe for 5 to 10 minutes in a solution of warm tap water < 140° F, and dish detergent. Alternatively, use an appropriate solvent (isopropyl alcohol or similar) that will not attack the materials of construction. If required gently clean junction and/or glass with a very soft tooth brush, and follow up with brief soaking (2-5 minutes) in 2% to 5% NaOH (sodium hydroxide). In the case of pH (not ORP) a difficult organic fouling can be treated with household bleach (4-6%) as a substitute for the dish detergent.
- ORP Platinum Coating** – Gently wipe the electrode surface with a soft lint-free paper towel. If the various forms of chemical cleaning are not sufficient to achieve an accurate measurement and response time, a last resort would be to polish the platinum surface with a 0.3-1.0 micron alumina polishing slurry to remove any stubborn coatings.
- After cleaning, rinse pH/ORP electrode in distilled or tap water, then re-examine the electrode for damage that may have been hidden from view. Sensor may not initially behave properly; and have a temporary offset due to the cleaning chemistry. Proper conditioning is always recommended

## Electrode Conditioning

Soak sensor tip (pH or ORP) in 3 mol/L KCl (potassium chloride), for at least 45 minutes to regenerate / condition.

The more aggressive the cleaning, the longer the soak in potassium chloride.

Failure to soak the electrode will cause the electrode to drift for a time after the cleaning procedure, and could adversely affect the calibration process/results.

If the cleaning and conditioning yield results within operational tolerance, the pH/ORP sensor is once again suitable for use. However, if the results do not bring the readings of the pH/ORP sensor within tolerance, it is time to replace the sensor.

## pH System Calibration

There are two functions in a pH electrode that require the system to be calibrated:

### Temperature Calibration

- The temperature output of the electrode (measured by a 3KΩ Balco or Pt1000 RTD) must be calibrated only once. When a new electrode is installed, it does not need to be repeated.
- Because the temperature measurement has a significant influence on the electrochemical measurement, the temperature output in new pH electrodes should always be calibrated before the pH/mV calibration.

**NOTE:** All Signet transmitters and controllers incorporate automatic temperature compensation.

| pH error due to temperature changes in fluid |      |      |      |               |      |      |      |      |       |       |       |
|--|------|------|------|---------------|------|------|------|------|-------|-------|-------|
| °C   | pH 2 | pH 3 | pH 4 | pH 5          | pH 6 | pH 7 | pH 8 | pH 9 | pH 10 | pH 11 | pH 12 |
| 15   | 0.15 | 0.12 | 0.09 | <b>**0.06</b> | 0.03 | 0    | 0.03 | 0.06 | 0.09  | 0.12  | 0.15  |
| 25   | 0    | 0    | 0    | <b>* 0</b>    | 0    | 0    | 0    | 0    | 0     | 0     | 0     |
| 35   | 0.15 | 0.12 | 0.09 | 0.06          | 0.03 | 0    | 0.03 | 0.06 | 0.09  | 0.12  | 0.15  |
| 45   | 0.3  | 0.24 | 0.18 | 0.12          | 0.06 | 0    | 0.06 | 0.12 | 0.18  | 0.24  | 0.3   |
| 55   | 0.45 | 0.36 | 0.27 | 0.18          | 0.09 | 0    | 0.09 | 0.18 | 0.27  | 0.36  | 0.45  |

Table 1

As the pH value moves away from neutral (7 pH) or the temperature moves away from 25 °C, the electrochemical output is affected.

\* Example: At pH 5 the mV output of the electrode is not affected if the temperature is at 25 °C.

\*\* The electrode output will be shifted by 0.06 pH units if the temperature is reduced to 15 °C.

### Offset and Slope Calibration

The pH electrode calibration is an important function that must be done routinely to standardize the electrode due to its ever-changing characteristics. The electrode contains a gel that depletes over time, so the instrument must be readjusted periodically to maintain system accuracy. There are many influences, including aging, temperature, coatings and chemicals used that will affect the probe characteristics. After cleaning and conditioning, Signet pH electrodes may be calibrated in two pH buffer solutions of different pH values (a two point calibration).

The pH electrode is calibrated by placing it in a buffer solution of known pH and measuring the cell potential. This is a linear function of pH in the range of pH 2-11, therefore two calibration points are needed. Most common calibration buffers are pH 4.01 and pH 7.00 (@ 25 °C). If the pH measurements are made in an acid to neutral range, we recommend using buffer pH 4.01 and buffer pH 7.00 for calibration. If an alkaline sample is measured, we recommend using buffer 7.00 and buffer 10.01 for calibration.

The response of the glass electrode is characterized by two parameters, offset and slope. The theoretical output of a pH electrode at pH 7 is 0 mV. The offset, or zero pH is the deviation of the pH from the nominal value. In the Signet transmitters, the offset calibration is performed under STANDARD.

The glass electrode slope is the mV developed per each pH unit (mV/pH). At 25 °C, the theoretical slope is 59.16 mV/pH. So, at pH 4.01, +177 mV will be generated, while at pH 10.01 (with a lower H<sup>+</sup> concentration), a potential of -177 mV will be generated, (see Table 2). A new electrode however, will generate 0 ± 15 mV in pH 7.00 and will have a slope efficiency between 93.2 and 103%. In the Signet transmitters, manual slope calibration is performed under SLOPE.

| Theoretical mV Values @ 25 °C |         |
|-------------------------------|---------|
| pH                            | mV      |
| 2                             | +295.8  |
| 3                             | +236.64 |
| 4                             | +177.48 |
| 5                             | +118.32 |
| 6                             | +59.16  |
| 7                             | 0       |
| 8                             | -59.16  |
| 9                             | -118.32 |
| 10                            | -177.48 |
| 11                            | -236.64 |
| 12                            | -295.8  |

Table 2

## pH System Calibration cont.

### How to calculate a pH electrode slope efficiency

Two pH buffers are selected to check the pH probe performance, pH 4.01 and pH 7.00. The ratio of the measured potentials (E2-E1) to the difference of pH (7.00 – 4.01) gives the slope of the straight line.

1. Read the mV potential generated by the electrode in two calibration buffers
2. Determine the slope (the mV potential generated per pH unit)
3. Divide this number by the theoretical slope, 59.16 mV/pH @ 25 °C and multiply by 100.

#### Example 1

pH electrode generates -12 mV in pH 7.00 buffer and +162 mV in pH 4.01 buffer.

$$160 \text{ mV} - (-12 \text{ mV}) = 172 \text{ mV}$$

$$172 \text{ mV} / 3 = 57.33 \text{ mV/pH unit}$$

$$57.33 / 59.16 \times 100 = 96.9 \% \text{ slope efficiency}$$

#### Example 2

pH electrode generates -45 mV in pH 7.00 buffer and +115 mV in pH 4.01 buffer.

$$115 \text{ mV} - (-45 \text{ mV}) = 160 \text{ mV}$$

$$160 \text{ mV} / 3 = 53.33 \text{ mV/pH unit}$$

$$53.33 / 59.16 \times 100 = 90.1\%$$

In Example 2, slope efficiency of 90.1% is acceptable but the offset of -45 mV is not.

An offset shift can be the result of the reference electrode being contaminated or poisoned.

A slope shift can be the result of the glass being etched or coated with a hard build-up.

As the electrode ages, the slope decreases gradually, generally a slope between 85% and 105% is acceptable. If the offset value (pH 7.00) is > +/- 45 mV, electrode should be replaced. When a great accuracy is required from the electrode, the offset and the slope values need to be as close as possible to the theoretical values.

Refer to the Calibration Procedure section of the instrument manual for a 2 point pH calibration. If the sensor is used in a 4 to 20 mA 'blind application' refer to the Calibration section of the 2751 Smart Sensor Electronics for a 2-point EasyCal pH calibration.

## ORP System Calibration

**ORP electrodes do not incorporate a temperature sensor, so the only system calibration required is the electrochemical adjustment.**

ORP electrodes should need less frequent calibration than a typical pH sensor, the redox potential is a characteristic of the interaction between the platinum measuring electrode and the redox species in solution.

ORP measurement is only an indicator of the process solution reducing or oxidizing potential. Always perform a single point calibration (standardization). Using the 9900 or 9950 transmitter, this can be performed under STANDARD. Disregard the SLOPE calibration.

If calibrating the ORP electrode under EasyCal (9900 Transmitters, Gen IV or later), one point calibration will be your only option.

A new ORP electrode measures the listed value +/- 20 mV. A two-point calibration will not increase the accuracy of the measurement given the +/- 20 mV repeatability of the sensor itself. On top of that, the ORP is not temperature compensated, so if the measurement is not done at 25 °C, any benefit gained will be lost. A true two-point calibration is possible in very few applications where only one redox couple is present in solution and its chemistry is known.

Calibration should be done using ORP premade standard solutions such as Zobell's solution and Light's solution, or solutions made using the standard pH 4.01 buffer and pH 7.00 buffer with quinhydrone powder mixed in until saturation is reached (Table 3). If all the quinhydrone does dissolve, continue to add small amounts and stir until a small amount of quinhydrone remains un-dissolved after mixing. Quinhydrone is the oxidizer that is measured by the ORP electrode. Please note that Zobell's solution is not compatible with the AutoCal function in Signet ORP instrumentation.

Pre-packaged or mixed Quinhydrone solutions are strong and may have a long lasting effect on the electrode, therefore after calibration it's recommended to properly condition the electrode before returning to the process. It is also possible to calibrate the ORP electronics based upon a known grab sample confirmed with a lab meter.

Pick a solution with a mV value closest to the process value and if possible adjust the temperature of the solution to the process temperature to minimize the offset.

The ORP electrode is functional until the offset exceeds 50 mV.

When the offset measures greater than 50 mV, the electrode should be replaced.

**Table 3:**  
ORP test solutions

\*Saturate 50 mL of pH 4 or  
pH 7 buffer with 1/8 g quinhydrone

|              | Zobell's solution | Light's solution | 4 pH buffer w/quinhydrone* | 7 pH buffer w/quinhydrone* |
|--------------|-------------------|------------------|----------------------------|----------------------------|
| ORP at 20 °C |                   |                  | 268 mV                     | 92 mV                      |
| ORP at 25 °C | 228 mV            | 469 mV           | 263 mV                     | 86 mV                      |
| ORP at 30 °C |                   |                  | 258 mV                     | 79 mV                      |



## Buffer Solutions

Proper handling, storage and use of buffers is very important on the pH and ORP measurement accuracy. If the buffers are contaminated or used improperly, the calibration will be inaccurate and all subsequent measurements will be wrong.

- When calibrating pH electrodes, always use pH buffers in the range of your sample.
- To achieve an accurate calibration make sure the electrode and the buffer are at the same temperature.
- Buffers have limited shelf life. Do not use a buffer if the expiration date has passed.
- Never return used buffers to the buffer bottle. Discard it.
- Do not leave the buffer bottle open (exposed to air).  
The atmospheric carbon dioxide lowers the pH of the alkaline buffers (10.01 pH).
- To avoid contamination, rinse the electrode with distilled or tap water before placing it in the buffer. If necessary, the electrode might be blotted dry using a lint-free paper towel (e.g. Kimwipes) to remove excess water. Be extra careful not to touch or rub the surface of the glass. The wiping of the glass can produce a static charge that will interfere with the voltage reading of the electrode. In addition to this, the hydration gel layer is interrupted.
- Store buffers at room temperature.
- Signet offers the following pH buffer solutions, pH 4.01, pH 7.00 and pH 10.01.
- Make fresh buffer solutions just before using. ORP solutions made with quinhydrone are very unstable and may not read properly after being exposed to air for a prolonged time. These solutions must be discarded after a few hours.
- Dispose of all calibration solutions in accordance with local guidelines and regulations.

## Electrode Storage

Proper electrode storage maximizes electrode performance and extends electrode life.

**Prior to storage** - add 3 mol/L KCl to the electrode storage cap (about half full), and carefully secure the cap onto the electrode tip.

- Store boxed electrodes wet, flat or upright (electrode tip down) to maximize hydration of the glass surface.
- Store electrodes in stable temperature environment, avoiding freezing conditions (below 0 °C (<33° F) and heat above 100° F).
- Never store the electrode in deionized (DI) water. Use 3 mol/L KCl solution to keep the glass wet when out of the process.

**Short term storage (up to 24 hours)** - soak the electrode tip in either pH 4.01 buffer or 3 mol/L KCl solution.

- Drying out of the pH sensitive glass and the junction must be avoided (or damage to the electrode will occur).
- Prior to electrode installation, make sure there's a light film of synthetic grease (such as silicone-free grease) applied to the upper electrode O-ring. If the electrode will be installed into a GF Signet Installation Fitting, then also apply a thin film of synthetic grease to the lower O-ring.

**Long term storage (longer than 24 hrs)** - add 3 mol/L KCl solution to the storage cap (about half full) and carefully secure the cap onto the electrode tip. This will ensure probes are always ready to use.

## Response Time/Stability

Response time and stability are affected by the condition of the pH glass measuring surface (for an ORP electrode, the platinum surface), the reference junction and the reference solution. Electrodes may sometimes be restored to acceptable levels by cleaning the measuring surface and reference junction.

Electrode mV values should remain stable  $\pm 3$  mV. Conditions that may cause fluctuations are:

- Electrode coating
- Clogged reference junction
- Ground fault: If proper operation is observed in the beaker, but readings are unstable in the application, a ground fault may exist.
  - Using instrumentation with isolated inputs and outputs may restore stable operation.
  - Solution grounding may also restore stable operation.

## Maintenance and Cleaning

### 276X Series Differential Electrodes

Differential electrodes have a replaceable salt bridge and the electrolyte chamber can be refilled. The electrolyte chamber should be full. If any fluid is audible when shaken, the chamber should be refilled. Refill the electrolyte chamber when the electrode offset exceeds 40-45 mV. Replace the salt bridge when performance becomes sluggish or if the output is erratic or inaccurate.

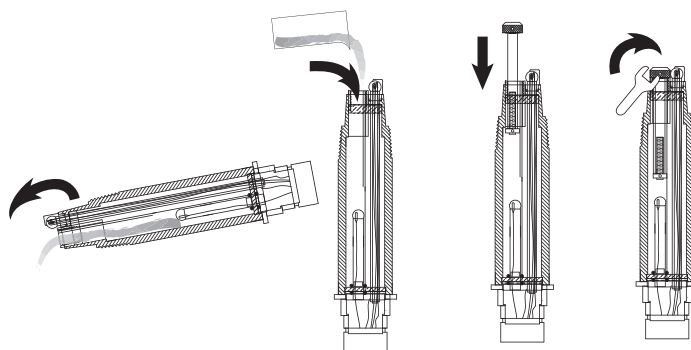
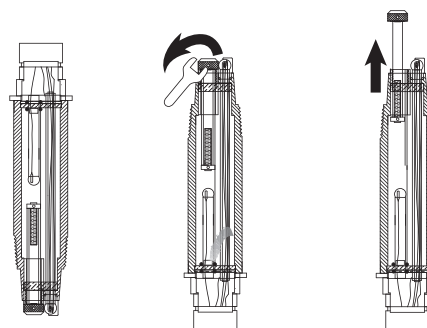
#### Replacing the Salt Bridge

Parts Required: Salt Bridge (order number 3864-0001) and Differential Reference Solution (order number 3864-0002)

Tools Required: Small pliers

#### Procedure:

1. Remove sensor from mounting.
2. Hold upside down and unscrew salt bridge using a pair of small pliers. Be careful not to damage the glass bulb!
3. Drain the depleted reference solution and dispose of properly.
4. Fill reference chamber with fresh reference solution (approx. 30 ml).
5. Replace salt bridge and screw finger tight. Solution will drip out while screwing in salt bridge. Use pliers to turn approximately  $\frac{1}{4}$  turn past finger-tight.
6. Perform calibration (standard and slope) before returning the system to service.



#### NOTE:

The refillable electrolyte chamber in 276X series differential electrodes may leak during storage and shipping. Check the fluid and refill before installation if necessary.



#### WARNING!

Wear appropriate eye, face, hand, body, and respiratory protection when using chemicals or solvents.

## Ordering Information

### Mfr. Part No. Code Description

#### Signet 275X Series Wet-Tap DryLoc pH and ORP Electrodes

##### pH Electrode

|              |             |   |
|--------------|-------------|---|
| 3-2756-WTP   | 159 001 390 | Bulb pH electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, Pt1000 RTD for connection to the 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics |
| 3-2756-WTP-1 | 159 001 384 | Bulb pH electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, 3 KΩ Balco RTD  |

##### ORP Electrode

|            |             |  |
|------------|-------------|--|
| 3-2757-WTP | 159 001 391 | ORP electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, to use with 2751 Smart Sensor Electronics or 2760 Preamplifier |
|------------|-------------|--|

#### Signet 276X Series Differential DryLoc pH and ORP Electrodes

##### pH Electrode

|          |             |  |
|----------|-------------|--|
| 3-2764-1 | 159 000 943 | Flat surface pH differential electrode, DryLoc connector, 3 KΩ Balco RTD   |
| 3-2764-2 | 159 000 944 | Flat surface pH differential electrode, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics              |
| 3-2766-1 | 159 000 949 | Bulb pH differential electrode with bulb protection, DryLoc connector, 3 KΩ Balco RTD  |
| 3-2766-2 | 159 000 950 | Bulb pH differential electrode with bulb protection, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics |

##### ORP Electrode

|          |             |   |
|----------|-------------|---|
| 3-2765-1 | 159 000 946 | Flat surface ORP differential electrode, DryLoc connector, 10 KΩ ID resistor for connection to 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics              |
| 3-2767-1 | 159 000 952 | Bulb ORP differential electrode with bulb protection, DryLoc connector, 10 KΩ ID resistor for connection to 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics |

#### Signet 277X Series Threaded DryLoc pH and ORP Electrodes

##### pH Electrode

|               |             |   |
|---------------|-------------|---|
| 3-2774        | 159 000 955 | Flat surface pH electrode, DryLoc connector, 3 KΩ Balco RTD   |
| 3-2774-1      | 159 000 956 | Flat surface pH electrode, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics  |
| 3-2774-HT     | 159 001 796 | Flat surface pH electrode, DryLoc connector, 3KΩ Balco RTD, High Temperature (110 °C, 230 °F), in-line install only.  |
| 3-2774-HT-C   | 159 001 795 | Flat surface pH electrode, DryLoc connector, BNC connector, 3KΩ Balco RTD, NPT, High Temperature (110 °C, 230 °F), NPT, 15 ft cable, no memory chip, for submersible installations, can only be connected to the 2751 or 2760 sensor electronics if used with the 3-2722 BNC adapter. |
| 3-2774-HT-ISO | 159 001 794 | Flat surface pH electrode, DryLoc connector, 3 KΩ Balco RTD, High Temperature (110 °C, 230 °F), 3/4" ISO, 3KΩ Balco RTD, in-line install only.  |
| 3-2776        | 159 000 959 | Bulb pH electrode with bulb protection, DryLoc connector, 3 KΩ Balco RTD  |
| 3-2776-1      | 159 000 960 | Bulb pH electrode with bulb protection, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics   |

#### Signet 277X Series Threaded DryLoc pH and ORP Electrodes

##### ORP Electrodes

|        |             |  |
|--------|-------------|--|
| 3-2775 | 159 000 957 | Flat surface ORP electrode, DryLoc connector, 10 KΩ ID resistor for connection to the 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics              |
| 3-2777 | 159 000 961 | Bulb ORP electrode with bulb protection, DryLoc connector, 10 KΩ ID resistor for connection to the 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics |

## Ordering Information cont.

### Special Order Options - Please consult the factory

| Mfr. Part No.    | Code          | Description   |
|------------------|---------------|---|
| <b>Electrode</b> |               |   |
| 3-2774-HF        | Special Order | Flat glass pH electrode for hydrofluoric acid applications <2%, DryLoc connector, in-line sensor, NPT                               |
| 3-2775-HT        | Special Order | Flat surface ORP electrode, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ RTD, in-line install only              |
| 3-2775-AU        | Special Order | Flat surface ORP electrode, gold measuring electrode, DryLoc connector, NPT, in-line sensor   |
| 3-2776-HT        | Special Order | Bulb glass pH electrode with protection, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ RTD, in-line install only |
| 3-2776-HF        | Special Order | Bulb glass pH electrode with protection, hydrofluoric acid applications <2%, DryLoc connector, in-line sensor, NPT                  |
| 3-2777-HT        | Special Order | Bulb ORP electrode with protection, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ TRD, in-line install only      |
| 3-2777-AU        | Special Order | Bulb ORP electrode with protection, gold measuring electrode, DryLoc connector, in-line sensor, NPT                                 |

### Special Order Options- Please consult the factory

### Accessories and Replacement Parts for all pH

| Mfr. Part No.      | Code        | Description  |
|--------------------|-------------|--|
| <b>Calibration</b> |             |  |
| 3-2759             | 159 000 762 | pH/ORP System Tester   |
| 3-2759.391         | 159 000 764 | Adapter Cable for use with 2751, 2760  |
| 3-0700.390         | 198 864 403 | pH Buffer Kit (includes 4.0, 7.0, and 10.0 buffer powder)                                      |
| 3-2700.395         | 159 001 605 | Calibration Kit: includes 3 PP cups, cups stand, 1 pint pH 4.01, 1 pint pH 7.00                |
| 3822-7115          | 157 001 606 | 20 g bottle Quinhydrone for ORP calibration (must use pH 4.01 and/or pH 7.00 buffer solutions) |
| 3822-7004          | 159 001 581 | pH 4 buffer solution, 1 pint (473 ml) bottle   |
| 3822-7007          | 159 001 582 | pH 7 buffer solution, 1 pint (473 ml) bottle   |
| 3822-7010          | 159 001 583 | pH 10 buffer solution, 1 pint (473 ml) bottle  |
| 3800-5000          | 159 838 107 | 3.0M KCl storage solution for pH and ORP, 1 pint (473 ml) bottle                               |
| 3-2700.398         | 159 001 886 | O-ring lubricant kit (5 packs of Super Lube, 1cc each)   |

### Accessories and Replacement Parts for 275X

|           |             |                    |
|-----------|-------------|--------------------|
| 1224-0205 | 159 000 836 | O-ring, EPR (EPDM) |
|-----------|-------------|--------------------|

### Accessories and Replacement Parts for 276X

|           |             |  |
|-----------|-------------|--|
| 3864-0001 | 159 001 007 | Replacement salt bridge (2764-2767)                |
| 3864-0002 | 159 001 008 | Replacement reference electrolyte solution, 500 ml |
| 2120-0015 | 159 001 009 | CPVC adapter: 1½ in. to 1 in.                      |
| 2122-0015 | 159 001 010 | PVDF adapter: 1½ in. to 1 in.                      |



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