# Installation, Operation, and Maintenance Manual

# DPHX

## Differential 5-Wire Sensor

**⚠ WARNING**

**Read this Manual BEFORE using this equipment.**

**Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.**

**Keep this Manual for future reference.**

THINK SAFETY FIRST

HF scientific®
A WATTS Brand

## Table of Contents


**1. General Information ..... 2**
**2. Safety ..... 2**
**3. Specifications ..... 3**
**4. Installation ..... 3**
4.1 Mounting Instructions ..... 3
4.2 Wiring Instructions ..... 3
4.3 Mounting options for DPHX ..... 3
4.3.1. Submersion Mounting ..... 3
4.3.2. Flow-through mounting in a TEE ..... 3
4.3 Mounting options for DPHX ..... 4
**5. Sensor Calibration ..... 4**
5.1 pH Calibration ..... 4
5.1.1 About pH Calibration ..... 4
5.1.2 One-Point Calibration ..... 5
5.1.3 Two-Point Calibration ..... 5
5.1.3.1 Auto Calibration ..... 5
5.1.3.2 Manual Calibration ..... 6
5.1.4 3-Point Calibration ..... 6
5.1.5 Temperature Calibration ..... 6
**6. Service and Maintenance ..... 7**
6.1 Sensor Calibration ..... 7
6.2 Sensor Cleaning ..... 7
6.3 Replacement of Salt Bridge for Differential Sensors ..... 7
6.4 Storage ..... 7
**7. Troubleshooting and Service ..... 8**
7.1 pH Sensors ..... 8
7.2 Troubleshooting ..... 9
7.3 Warranty Information ..... 9
**Appendix A: Parts and Accessories ..... 9**
**HF scientific Municipal Market Products Limited Warranty ..... 12**


# 1. General Information

This manual covers pH and ORP sensors. Figure 1 shows available configurations. If you can't find your part number here, it may have been obsoleted or replaced with a newer model—please contact your distributor for information.

The sensors differential is designed for long lifetime, user serviceability and more accurate readings. In typical installations, these sensors will last for years whereas the more common combination sensor lasts only months.

The sensors are designed to work with the MPX Controller.

***Note:*** Do not discard the protective cap(s) that came with the sensor. If the sensor is removed from the process for an extended period of time, thoroughly clean the sensor, put a piece of cotton ball with a few drops of water into the protective cap and replace it on the sensor. This keeps the junction from drying out which causes slow response when put back into operation or causes permanent damage to the sensor. **Sensors should not be left in dry lines or empty tanks for extended periods.**

Do not store the sensors in a dry or humid location. When storing, check the protective cap(s) regularly to make sure the cotton ball remains moist. Improper storage of sensors voids the warranty.

# 2. Safety

**⚠ WARNING**

**Electrical hazard:** Do not install the probe unless you have electrical training and you have read the instruction manual. The probe uses a 8-36V power supply and improper installation and handling can result in injury or damage to surrounding equipment including this probe.

***NOTICE***

**The probe should only be installed, stored and serviced in the manner described in this manual. Improper handling may result in damage to the unit and surrounding equipment and may void the warranty.**

# 3. Specifications

Call customer service if you need assistance with technical details.

| | |
|---|---|
| Measurement Range | 1 to 12 pH |
| | Response at pH<1 or >12 is non-linear (<59.2 mV/pH @ 25°C) |
| Wetted Materials | PPS (Ryton®), CPVC, ceramic, titanium, Viton®, glass, *Dynaflex G7950-9001, *PVC (*when fully submerged) |
| Span | 0-12 pH |
| Sensitivity | 0.01 pH |
| Mounting | Fixed insertion 1-1/2" NPT. Threaded both ends |
| Flow Rate | 10 ft/sec (3 m/sec). Flow should be as low as possible in water with low conductivity or in water with suspended solids. |
| Temperature Limits | -5 to 75°C (23 to 167°F) |
| Pressure Limits | 100 psig @ 65°C, 40 psig @ 75°C |
| Power Input | -3...-12 VDC |
| Sensor Cable | 5 conductor, shielded. Default length 50 ft. (15.24 m). |
| Transmission Distance | Up to 2000 ft (610 m) |
| Temperature Element | Pt1000RTD |

# 4. Installation

## 4.1 Mounting Instructions

Specific instructions for each type of sensor are given in the following pages. Common to all sensors are the following instructions:

1. If the distance between the sensor and the instrument is such that a direct connection is not possible, the sensor cable should be routed to a junction box with a terminal strip. The box should be well sealed and away from corrosion danger. Be sure that you have sufficient slack cable to allow for sensor removal for calibration and servicing.
2. Route the interconnect cable from the junction box to the instrument, preferably in metal conduit. Do not run the power cable or control cables in the same conduit with the sensor interconnect cable.
3. Remove the protective plastic caps from the end of the sensor before placing in service.
4. For best results, sensor should always be mounted vertically with electrodes down. If this is not possible, the sensor must be at least 15° above horizontal and never upside down.

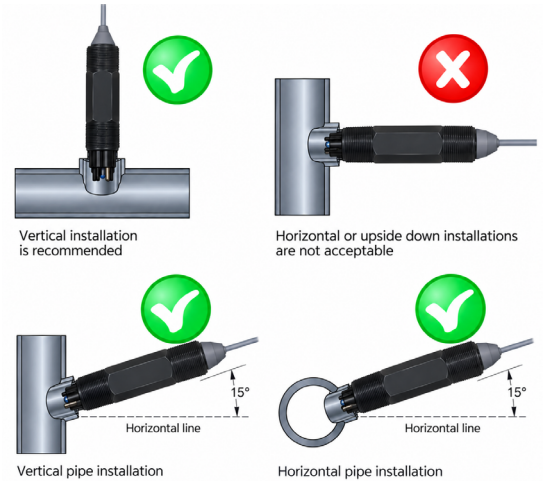
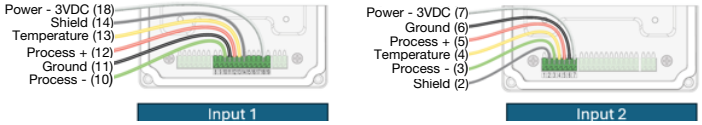



*Figure 2 - General mounting instructions*

## 4.2 Wiring Instructions

Always power down the controller/transmitter BEFORE connecting the sensor cable. Check the wiring. Use the diagrams below to ensure that you've made the correct connections. Remember: Unplug it, wire it, check it and power it.

**Improper wiring of the sensor cable to the controller/ transmitter will destroy the sensor and/or controller. Please follow these guidelines.**




## 4.3 Mounting options for DPHX

### 4.3.1. Submersion Mounting

This sensor is fully submersible. It should be installed with an arm or other mounting accessories to protect the sensor and its cable, depending on the application. An optional protective shroud, Part No. 1000003934 should be used on the electrode end of the sensor to protect the electrodes from accidental contact with the tank bottom, sides or objects in the process (See Figure 5 below).

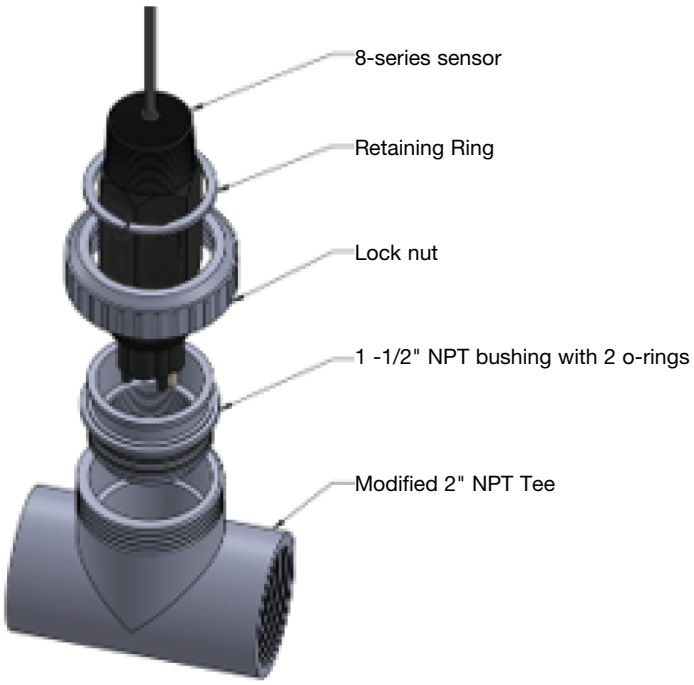
*Figure 5 - Electrode protector installation*

### 4.3.2. Flow-through mounting in a TEE

Refer to Figure 6.

1. 1. Apply pipe sealant to the electrode end of the sensor and screw it into the 1-1/2" NPT bushing.
2. Slide bushing into modified Tee.
3. Secure sensor by tightening the lock nut.
4. Install retaining ring

## 4.3 Mounting options for DPHX




NPT

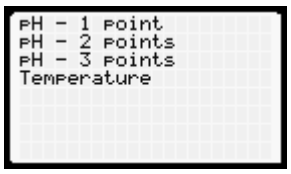
*Figure 6 - Flow through installation using a TEE*

# 5. Sensor Calibration

The Calibration menu automatically presents choices appropriate for the probe chosen. If the menu choices for calibration appear wrong, you probably chose the wrong probe.

Note: If you select the probe type and wish to immediately calibrate you must put the controller in Run mode first. You can press the Run button while in any menu.

## 5.1 pH Calibration

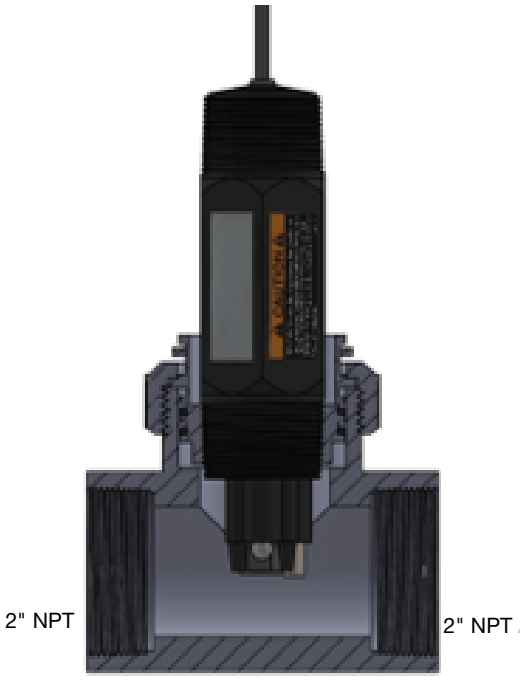



### 5.1.1 About pH Calibration

Most pH analyzers allow the user to calibrate a probe with only two points, using two of the three standard calibration solutions: pH 4, 7 and 10. For two-point calibration use the tow standards that are closest to your expected process values. For example, if your process is mostly acidic (< pH 7) then calibrate using standards pH 4 and pH 7.

For the pH readings that span a wide range encompassing neutral (7pH) the MPX controller offers the option of three-point calibration. An algorithm uses linear least squares to calculate the slope and offset, as a result error will be spread across the full pH range.

A pH probe that operates according to theory outputs 59,16 mV at 25°C for every unit change in pH. The actual change in output for a real probe is likely to be different and is the **slope** for that probe. An ideal probe in pH 7 solution (at 25°C) outputs 0 volts. The actual output is likely to be different and is the **offset**. The slope yields the **efficiency** of the probe. A probe that outputs 59.16 mV at 25°C is 100% efficient. If the probe outputs, say, 57.34 mVthen the efficiency 57.34mV/59.16mV ≈ 96.9% efficient.



# 5. Sensor Calibration (Cont.)

When a probe leaves the HF Scientific factory it is tested three times to ensure that its offset and efficiency are within acceptable tolerance (±50 mV and >90% slope, respectively). As probes age their efficiency decreases. Note that a probe with low efficiency will still be accurate but it will not be precise, i.e. its reading will have a large uncertainty. We recommend cleaning or replacing a sensor when its efficiency drops below 80%. Before discarding a probe showing low efficiency, make sure to clean it according to the probe manual's instructions. A large offset usually indicates that the reference solution is contaminated and should be replaced.

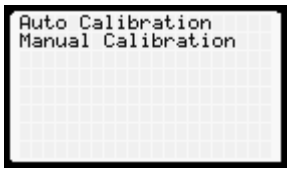
#### 5.1.2 One-Point Calibration

While one-point calibration is offered as an option, it is not recommended if accuracy is desired. One-point calibration can be used as a correction for sensor error by introducing an offset. It will compare a tested sample to the desired value. It can be implemented when removing the probe is not practical or possible.

#### 5.1.3 Two-Point Calibration

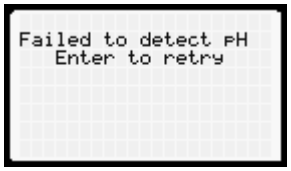
As stated above, use the two calibration standards that encompass the pH range of your process. If target reading is around pH7, then it is recommended to use pH4 and pH7 buffer standards.

There is a choice between auto and manual calibration.




#### 5.1.3.1 Auto Calibration

In auto calibration the AM-2252 reads the probe output when it is in a buffer and decides whether the buffer is pH 4, 7 or 10. Ideal voltages for these buffers are 177, 0 and -177 mV respectfully. If the output of the probe is within 59.16 mV (1 pH unit) from any of these values auto calibration assumes it “knows” the calibration standard in which the probe is immersed. If the output is greater than 59.16 mV auto calibration will fail.

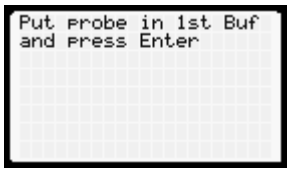



There are several reasons why this can happen:

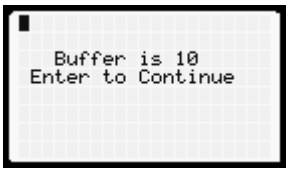
1. The offset of the probe is greater than 59 mV.
2. The efficiency of the probe is less than 67%
3. The buffer is non-standard (i.e. neither 4, 7 or 10).
4. The buffer has aged and is no longer at its nominal pH value.

To initiate auto calibration:

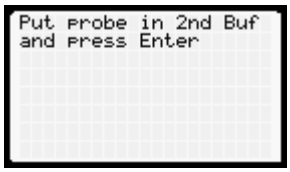
1. Select **Auto Calibration**
2. Follow the directions on the next screen and immerse the probe in the first calibration standard.




Press **Enter**. Allow at least one minute for the probe reading to settle down. It helps to swirl the probe around in the solution. After a minute or longer press the **Enter** key as instructed. (If you press the **Enter** key too soon the analyzer will accept an inaccurate probe reading and the efficiency is likely to be lower than it should.)

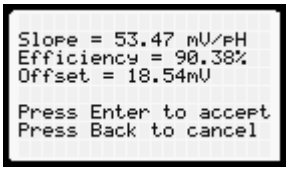



3. The screen will display **Calibrating** for a few seconds as it reads the probe output and stores the probe output value. The next screen will appear and will direct you to immerse the probe in the second calibration standard. (*Always rinse the probe in clean tap water before immersing it in a new buffer.)* As before, wait at least one minute before pressing **Enter** to record the probe output value of the second calibration solution.



# 5. Sensor Calibration (Cont.)

4. The screen will again display **Calibrating** for a few seconds and will display the results of the calibration—the efficiency and offset. An example is:

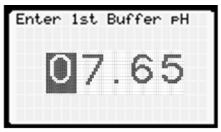



If you are satisfied with the measured efficiency and offset, press **Enter** to accept the calibration. If not press **Back** to repeat calibration. Pressing **Menu** brings you back to the top menu.

#### 5.1.3.2 Manual Calibration

As explained above, manual calibration can be used if the probe has a very large offset, has low efficiency or is being calibrated with non-standard buffer solutions.

1. Select **Manual Calibration**
2. Place the probe in the first buffer. As opposed to auto calibration, it is okay to press Enter without waiting for the probe output to settle down. The next screen will display the current output reading of the probe.
3. When the reading settles down press Enter. The next screen allows you to change the value of the displayed pH value to correspond to the actual pH of the calibration solution. Use the ↑and ↓arrow buttons to change the value and the ← or → button to change the cursor position. Press the **Enter** key to lock in the correct value.




4. The results of the calibration (identical to the one shown for auto calibration) will display.
5. Place the probe in the second buffer. Again, there is no need to wait for the probe reading to settle down prior to pressing **Enter**.
6. When the reading settles down press **Enter**. Change the pH value display to equal the pH of the calibration standard.

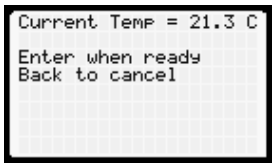
#### 5.1.4 3-Point Calibration

The instructions for 3-point calibration are the same as for 2-point calibration with the obvious exception that three standards are used instead of two.

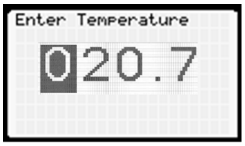
#### 5.1.5 Temperature Calibration

Since all pH readings are temperature compensated, an accurate pH readings depend on an accurate temperature.

1. Select **Temperature**.




2. The screen displays the current temperature reading. Make sure the temperature reading has settled down. Keep in mind that most temperature elements in pH probes are encapsulated inside the probe, which results in a temperature lag of several minutes for the element to equilibrate with the temperature of the solution.
3. The temperature calibration procedure is analogous that for manual pH calibration. It's not necessary to immerse the probe in solution. Knowing room temperature enables you to calibrate the probe in air. As with manual pH calibration, ensure that the temperature reading settles down prior to pressing **Enter**. The next screen allows you to change the temperature reading to match the actual temperature. Press **Enter** when done or Menu to go back to the top menu.



# 6. Service and Maintenance

## 6.1 Sensor Calibration

1. All pH sensors must be calibrated when first connected to a controller. Refer to the controller manual for the specific instructions.
2. As pH or ORP sensor drifts over time, a periodical re-calibration is required. Intervals between calibrations depends on the application and desired accuracy, and usually don't exceed 1-2 months.

## 6.2 Sensor Cleaning

1. The sensor should be kept reasonably clean to avoid measurement errors. Frequency of cleaning can only be determined by experience. To clean proceed as follows:
2. Rinse with clean warm water.
3. Soak the end of the sensor in warm water and dish detergent for 3 or 4 minutes.
4. Brush the end of the sensor, particularly the three electrodes with a soft bristle brush such as a toothbrush. Take care not to scratch the glass electrode.
5. If the sensor is still not clean, it may have to be cleaned with acid. ***CAUTION:*** *Do not acid clean sensors used in processes containing cyanide solutions*. Some experimentation may be required to determine the most suitable acid for your process. Use the most dilute acid, which is effective. Normally 10 parts water to one part muriatic acid is sufficient. *Do not use hydrofluoric acid.*
6. Soak the sensor for not more than 5 minutes in the chosen acid; then rinse thoroughly with clean warm water and soak in water for 3-5 minutes.

Calibrate the system in accordance with the instrument instruction manual.

## 6.3 Replacement of Salt Bridge for Differential Sensors

If the system can't be calibrated after cleaning the sensor, it may be necessary to replace the standard cell solution and/or the salt bridge. A salt bridge kit is available for this purpose (Part No. 1000003933 for a 3-pack)

Proceed as follows:

1. Hold the sensor vertically electrodes up. Remove the used salt bridge. For the sensor the salt bridge is a hexagonal-shaped capsule that can be removed using a 9/16" socket wrench. Discard the used salt bridge.
2. Dispose of the used solution inside the bridge chamber and flush with pH 7 solution or distilled water.
3. Refill the chamber with 7pH buffer solution, up to the tip of the electrode, inside the chamber. DO NOT OVERFILL. It is important to leave space for the salt bridge thread and a small amount of air.
4. Screw the new salt bridge into the cavity until finger tight. Now perform a 1/4 turn with a 9/16" socket wrench. The salt bridge edges should be flush with the front of the sensor face.

## 6.4 Storage

1. Do not discard the protective cap(s) that came with the sensor. If the sensor is removed from the process for an extended period of time, thoroughly clean the sensor, put a piece of cotton ball with a few drops of water into the protective cap and replace it on the sensor. This keeps the junction from drying out which causes slow response when put back into operation or causes permanent damage to the sensor. **Sensors should not be left in dry lines or empty tanks for extended periods.**
2. Do not store the sensors in a dry or humid location. When storing, check the protective cap(s) regularly to make sure the cotton ball remains moist. Improper storage of sensors voids the warranty.

# 7. Troubleshooting and Service

A pH or ORP sensor is a potentiometric device. It outputs a voltage in response to a change in pH or ORP. A pH sensor that is not functioning properly will output a voltage that is out of range of the specifications listed in Section 5.1.

The ORP sensor is unique in that the voltage is the ORP reading. There is no span between readings of two calibration solutions. However, mV readings should be within the ranges stated in Section 5.2.

The sensor can be checked by a few simple measurements. The directions below allow a voltmeter to be used for diagnostics. The MPX has a diagnostic tool build in, that allows quick and easy troubleshooting (Menu → Diagnostics → Sensor output). Shark-120 and Shark-TX also have diagnostic tool (Menu → Diagnostics → Sensor Input).

## 7.1 pH Sensors

To diagnose pH sensor at least two pH buffer solutions (pH 7 and either pH 4 or pH 10) and a controller (or high precision voltmeter) are required. pH buffer solutions can be purchased from Water Analytics, see part numbers in Appendix A.

1. Clean the sensor as described in Section 4.1. If the system cannot be calibrated, replace the salt bridge and pH 7 buffer solution as described in 4.3 or 4.4. If system still can't be calibrated check the sensor as follows.
2. If sensor is used - use diagnostic tool:
    a. Menu → Diagnostics → Sensor Output
    b. Check "Temperature" output, the resistance should be between 1050 Ω and 1150 Ω at 25°C (77°F). If the resistance is within specifications the sensor's thermistor is functioning correctly.
    c. Place the sensor in pH 7 buffer solution and allow enough time for the temperature of the sensor and buffer to stabilize at room temperature.
    d. Check "Sensor" output, the measured voltage in pH 7 buffer should be -50...+50mV. If the voltage is within this range proceed to the next step.
    e. Rinse the sensor and place it in pH 4 (or pH 10) buffer. Allow it to stabilize then check the reading again. Measured voltage in pH 4 should be 170...230mV higher (lower for pH10) compared to the pH 7 output. Table 1 summarizes these acceptance criteria.
3. If sensor connected to a controller without diagnostic tool:
    a. Disconnect red green, yellow and black wires at the junction box. If you are not using a junction box, disconnect at the instrument after shutting off the power.
    b. Place sensor in pH 7 buffer. Allow enough time for the temperature of the sensor and buffer to stabilize at room temperature.
    c. Measure the resistance between the yellow and black wires to check the sensor's temperature compensator. The resistance should be between 1050 Ω and 1150 Ω at 25°C. If the resistance is within specifications the sensor's thermistor is functioning correctly
    c. Measure the resistance between the yellow and black wires to check the sensor's temperature compensator. The resistance should be between 1050 Ω and 1150 Ω at 25°C. If the resistance is within specifications the sensor's thermistor is functioning correctly
    d. Reconnect the yellow and black wires and restore power to the instrument.
    e. Measure the voltage between the red and green wires, If it is within -50 to +50 mV the sensor is defective. If the voltage is within this range proceed to the next step.
    f. Rinse the sensor and place it in pH 4 or pH 10 buffer. Allow it to stabilize then check the voltage again between the red and green wires. Measure the voltage and then change in voltage from the pH 7 output. If the change in voltage is between 170 and 230 millivolts (negative in 10 pH buffer, positive in 4 pH buffer) the sensor is within specifications. Table 1 summarizes these acceptance criteria.

## 7.2 Troubleshooting

If pH sensor output does not fall within the ranges listed in Table 1, then see possible reasons and ways to fix it below:

1. The sensor reacts to changes in calibration solutions but does not fit in ranges specified in Section 5.1 - 5.2.
   - **Possible reason:**
     The reference solution has been contaminated with the process to the point that it is no longer pH7.
     **Remedy:**
     Refilling reference solution inside the sensor with fresh pH 7 and replacing salt bridge as described in Section 4.
   - **Possible reason:**
     The salt bridge has fouled to the point that reference solution cannot pass through that is needed to complete the potentiometric circuit.
     **Remedy:**
     Replacing salt bridge as described in Section 4.
   - **Possible reason:**
     The process electrode (glass bulb) is coated with scaling or biofouling.
     Remedy:
     If the coating is from scaling, then soaking the sensor in a weak acid (e.g. vinegar or 0.1 M HCl) will remove the scale. If the coating is from fouling, then soaking the sensor in bleach will clear it.
2. The sensor does not react to changes in calibration standards, the output is stuck at a value that is way out of specs.
   - **Possible reason:**
     The process electrode is broken.
     **Remedy:**
     Mechanical damage to a sensor excluded from a warranty. Sensor cannot be fixed or restored, replacement of failed sensor is required. The protectors can be used to prevent electrode damage, see Appendix A for ordering information.
   - **Possible reason:**
     Sensor had been exposed to a glass etching agent (for example Hydrofluoric H(F) Acid) and became inoperable.
     **Remedy:**
     Damages due to a use in not appropriate applications are not covered by HF Scientific warranty. Sensor cannot be fixed or restored., replacement of failed sensor is required. HF Scientific offers glass-less pH sensors with antimony electrode, that would be the best option to use in applications where glass etching chemicals presented, see Figure 1 for ordering information.

## 7.3 Warranty Information

The warranty information is available on our website:
https://www.watts.com/our-story/brands/hf-scientific
HF Scientific
16260 Airport Park Dr.
Suite 140
Fort Myers, FL 3391

If you are returning a sensor for inspection, enclose description of the problem. Pack the sensor adequately to avoid damage to the glass electrode and ensure that it will not be exposed to temperatures below -5°C. HF Scientific cannot be responsible for shipping damage nor for damage due to frozen electrodes. For safety reason, HF Scientific cannot accept sensors which have not been thoroughly cleaned to remove all process material

# Appendix A: Parts and Accessories

| | | |
|---|---|---|
| **Salt Bridge Kit (3 pack)**<br>**1000003933** | | |
| **Protector**<br>**1000003934** | | |
| **Union Tee with Adapter** | | |
| **1000003721**<br>**1000003611**<br>**1000003622** | **2" NPT Connection**<br>**2" Socket Connection**<br>**3" Socket Connection** | |

# Notes

# Notes

# HF scientific Municipal Market Products Limited Warranty

The online warranty for this product is located on the Watts website (https://www.watts.com/resources/warranty-information), and in the event that the terms or conditions of this manual conflict with the online warranty, the terms and conditions of the online warranty shall control. HF scientific, LLC (the "Company") warrants each municipal market instrument product to be free from defects in material and workmanship under normal usage for a period of one (1) year from first use or two (2) years from date of the Company's invoice from the original sale of the product, whichever occurs first. In the event of such defects within the warranty period, the Company will, at its option, replace or recondition the product without charge. Parts which by their nature are normally required to be replaced periodically, consistent with normal maintenance, specifically reagents, desiccant, sensors, electrodes and fuses, are excluded. Also excluded are accessories and supply-type items.

Proof of purchase from the Company (Company invoice or paid order confirmation) and/or first use (commissioning) must be provided when making a product warranty claim.

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