

Aqua **Metrix** by Water Analytics

OPERATING INSTRUCTION MANUAL



60-Series Sensor Differential 5-Wire pH & ORP

N116-140 R3

AquaMetrix, by Water Analytics Inc.
100 School Street
Andover, MA 01810

Tel: (978) 749-9949
www.AquaMetrix.com

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1 GENERAL INFORMATION

This manual covers all AquaMetrix 60-series differential measurement 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.

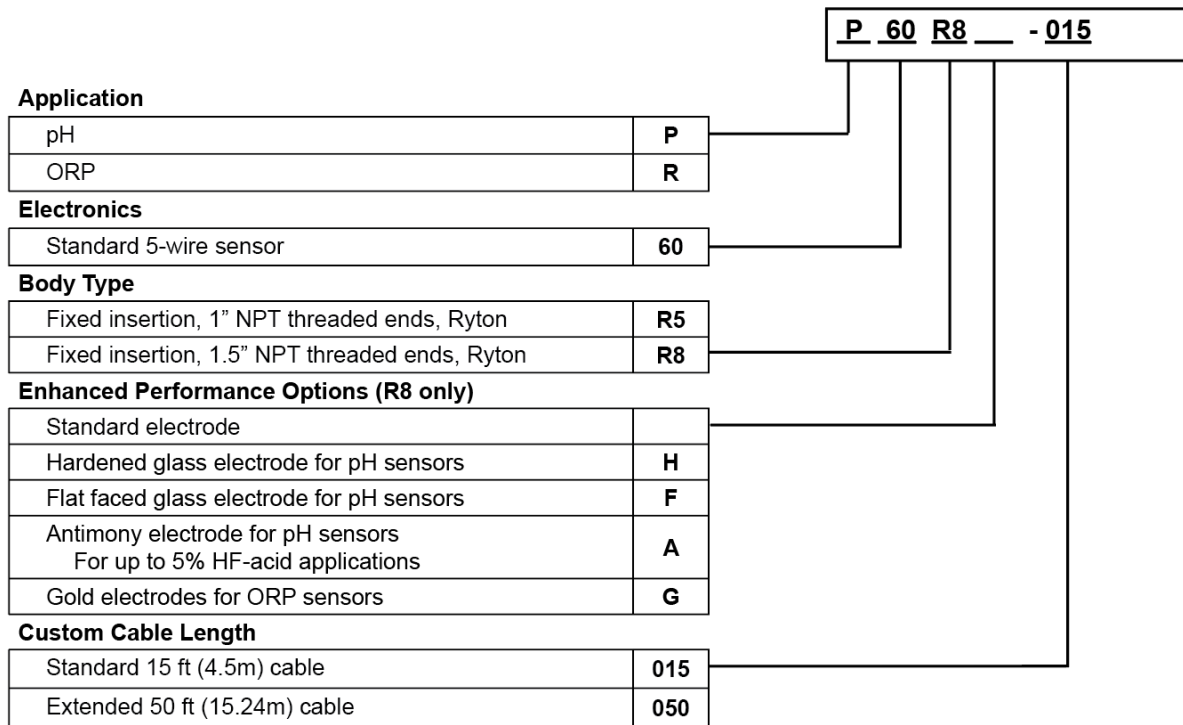


Figure 1 - Part number decoding for 60-series differential sensors

The 60-series sensors feature the AquaMetrix differential design 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 “P” prefix refers to the pH sensor while the “R” prefix refers to the ORP version. The sensor is a 5-wire (or 6-wire including shielding) device. It incorporates an encapsulated transmitter that outputs a voltage in accordance with the Nernst equation. The sensors can be connected to the AquaMetrix AM-2252, AM-2250 Controller or AM-2250TX transmitter as well as to most of the GLI/Hach controllers (e.g. P33, P53, P63, SC100, SC200 with analog pH/ORP inputs).

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 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 Specifications

	pH	ORP
Measurement Range	0 to 14	-2000 to +2000 mV depending on a controller
Wetted Materials	R8: PPS (Ryton®), CPVC, ceramic, titanium, Viton®, glass, *Dynaflex G7950-9001, *PVC R5: PPS (Ryton®), ceramic, titanium, Viton®, glass, *Santoprene 101-55, *PVC *when fully submerged	R8: PPS (Ryton®), CPVC, ceramic, titanium, Viton®, glass, platinum or gold, *Dynaflex G7950-9001, *PVC R5: PPS (Ryton®), ceramic, titanium, Viton®, glass, platinum, *Santoprene 101-55, *PVC *when fully submerged
Span	0 to 14 pH	-1000 to +1000 mV
Sensitivity	0.01 pH	0.1 mV
Stability	0.03 pH / day (non-cumulative)	2 mV / day (non-cumulative)
Mounting	R8: Fixed insertion 1-1/2" NPT. Threaded both ends R5: Fixed insertion 1" 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 a 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 15 ft. (4.6 m)	
Transmission Distance	Up to 2000 ft (610 m)	
Temperature Element	Pt1000RTD standard (300Ω NTC thermistor optional)	

3 INSTALLATION

3.1 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 (AquaMetrix Part No. AM-JB1). 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.

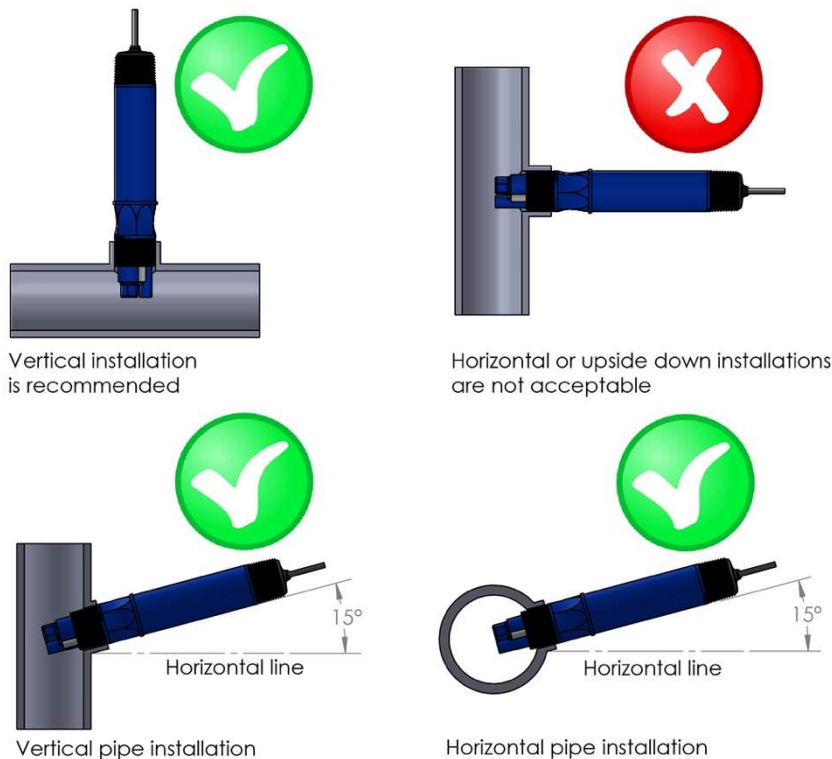


Figure 2 – General mounting instructions

3.2 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. Please follow these guidelines.

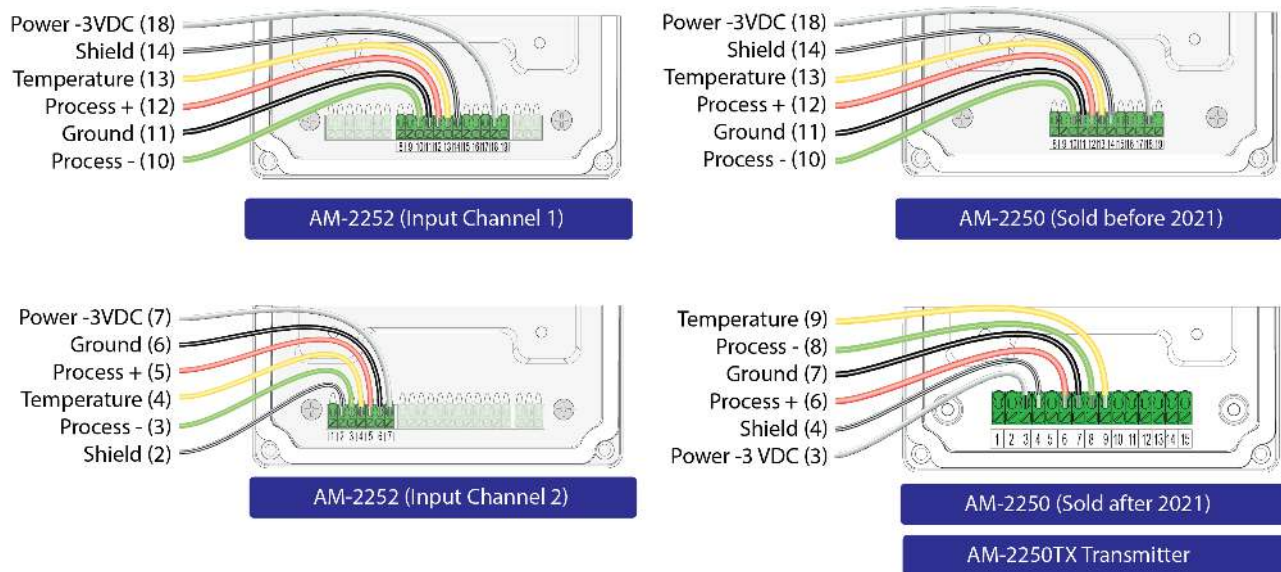


Figure 3 - Wiring of probes to 2250-series controllers

3.3 Mounting options for R8-sensors (P60R8, R60R8)

3.3.1 Submersion mounting

Refer to Figure 4 below.

1. A submersion mounting kit, AM-ARM-8, is available from Water Analytics which includes 4 ft. of 1" CPVC pipe, 1-1/2" x 1" reducer, a strain relief fitting and wire mounting bracket. Proceed as follows, either with the kit or with your own hardware.
2. Route the sensor cable through a pipe. Apply a thread sealant to the thread on the cable end of the sensor and screw it into a 1-1/2" fitting. Tight the strain relief. The cable end of the sensor should not be exposed to the process. A cable strain relief fitting should be used on the upper end of the pipe. In the kits a wire bracket is provided to aid in supporting the assembly.

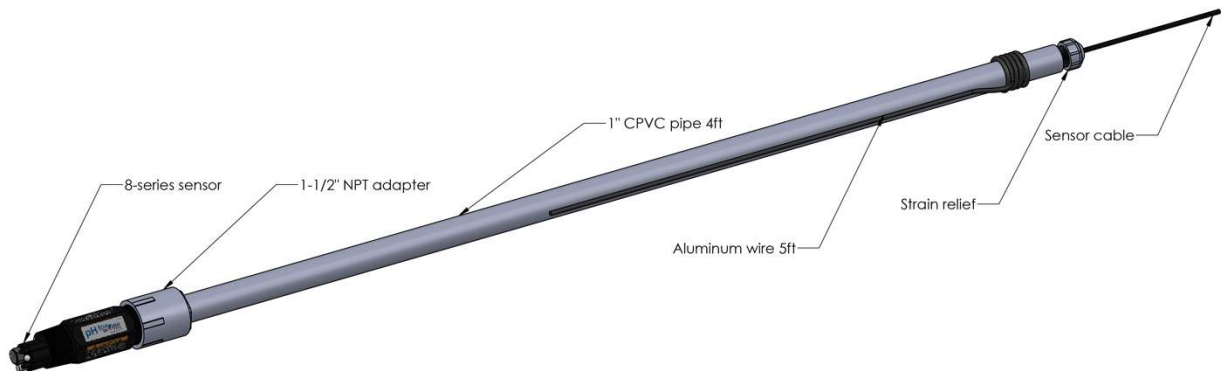


Figure 4 - Submersion mounting using AM-ARM-8

An optional protective shroud, Part No. AM-PTR-8 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 AM-PTR-8 installation

3.3.2 Flow-through mounting in a TEE

Refer to Figure 6 below

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 tighten the lock nut
4. Install retaining ring

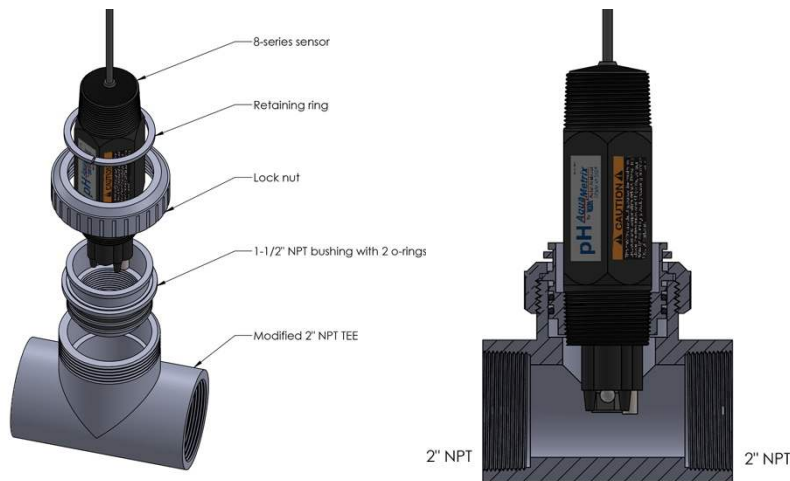


Figure 6 - Flow through installation using AM-TEE-8

3.3.3 Sanitary fitting for R8-series

The R8-series can be installed in 2" sanitary fitting using sanitary flange (part AM-SFL-8). Refer to Figure 7 below.

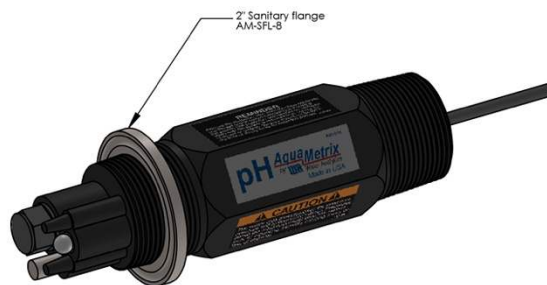


Figure 7 - Installation of AM-SFL-8 sanitary fitting

Please note that the sanitary fitting doesn't make sensor suitable for sanitary application.

3.4 Mounting options for R5-series sensor (P60R5, R60R5)

3.4.1 Submersion mounting

Refer to Figure 8 below

1. A submersion mounting kit, AM-ARM-5, is available from Water Analytics which includes 4 ft. of 1" CPVC pipe, 1" adapter, a strain relief fitting and wire mounting bracket. Proceed as follows, either with the kit or with your own hardware.
2. Route the sensor cable through a pipe. Apply a thread sealant to the thread on the cable end of the sensor and screw it into a 1" fitting. Tight the strain relief. The cable end of the sensor should not be exposed to the process. A cable strain relief fitting should be used on the upper end of the pipe. In the kits a wire bracket is provided to aid in supporting the assembly.

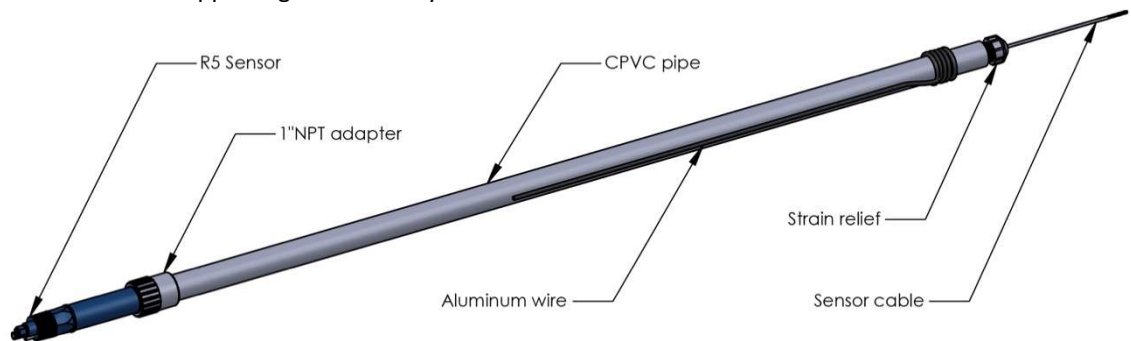


Figure 8 - Submersion mounting using AM-ARM-5

An optional protective shroud, Part No. AM-PTR-5 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 9 below.

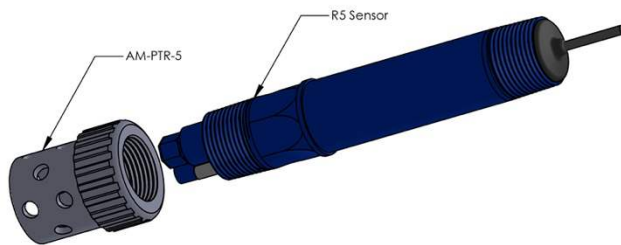


Figure 9 - Electrode protector AM-PTR-5 installation

3.4.2 Flow-through tee mounting R8-series Differential Sensors

Refer to Figure 10 below

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

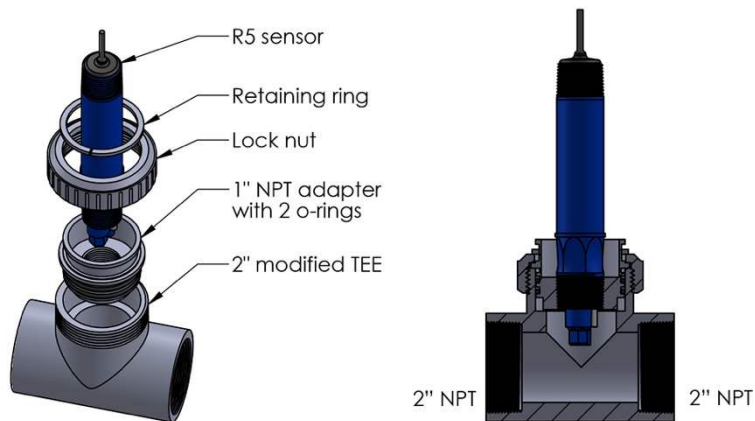


Figure 10 - Flow through installation using AM-TEE-5

3.4.3 Sanitary fitting

The R5-series can be installed in 2" sanitary fitting using sanitary flange (part AM-SFL-5). Refer to Figure 11 below.



Figure 11 - 2in sanitary flange AM-SFL-5

Please note that the sanitary fitting doesn't make sensor suitable for sanitary application.

3.4.4 Variable insertion (R5-series only)

Refer to Figure 12 below.

1. Mount the attachment on the sensor from the cable side.
2. Take the compression fitting apart. Apply pipe sealant to the 1-1/2" NPT thread and screw this part into a 1-1/2" tee or nipple. A larger fitting with an appropriate reducer may be used.
3. Put the compression fitting components on the sensor in the order shown in the figure below.
4. Remove the protective cap from the sensor and place the sensor in the tee. The sensor must be in such a position that the electrodes will be in the pipe stream but not touching the opposite side of the tee.
5. Now tighten the nut by hand as much as possible, then turn 1/2 turn with a wrench.

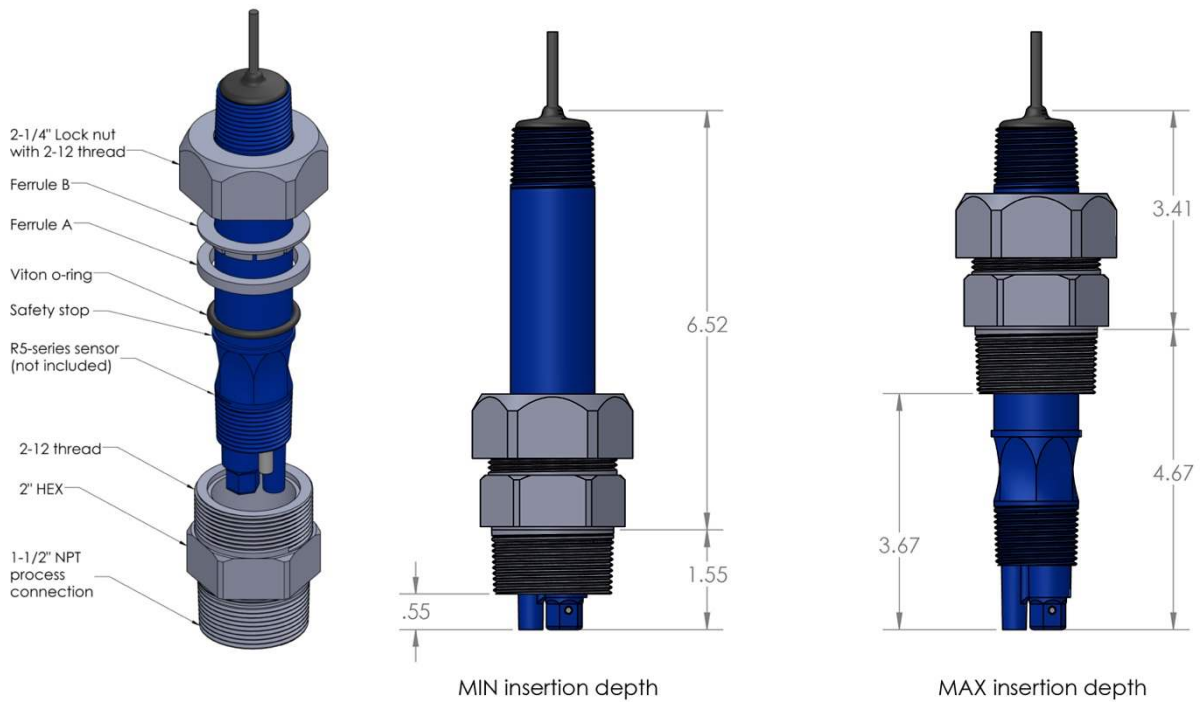


Figure 12 - Variable insertion using AM-CFT-R5 compression fitting

Using attachment AM-CFT-R5 the standard R5 series sensor can be used in applications that require variable insertion. AM-CFT-R5 has 1-1/2" NPT process connection and allow to vary insertion depth from .55" to 3.67"

3.4.5 Hot Tap (Wet Tap) insertion mounting (R5-series only)

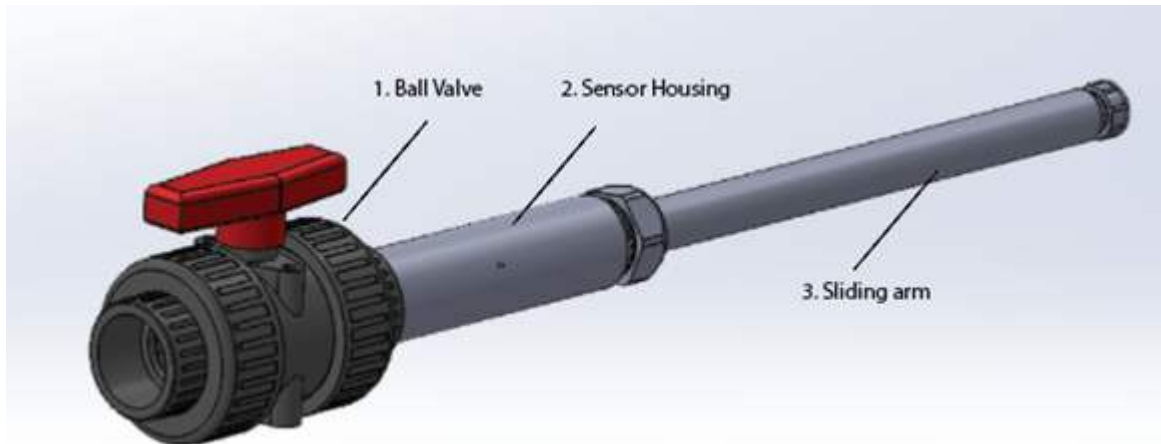


Figure 13 - AM-HTA-R5 Hot Tap assembly

1. A ball valve assembly, AM-HTA-R5, is available from AquaMetrix which includes the 2" ball valve, sensor housing, and a sliding arm with cable compression fitting.
2. Mount the ball valve assembly in a desirable location. The assembly comes with a field selectable, 2" FNPT or socket adaptor. Make sure valve is in the close position before mounting.
3. Remove the union body by turning the union nut counter clockwise. Take the compression fitting apart.
4. Insert sensor cable into the sliding arm from the adaptor side and run it through cable gland.
5. Apply sealant to the back end of the R5-series probe and screw the sensor into the 1" sensor adaptor.

6. Slide the sensor into the sensor's housing fully.
7. Place the union body, with the probe attached, back into the ball valve assembly and tighten union nut. Open ball valve & slide the probe into the process.
8. Tighten the compression fitting nut of the sensor housing by hand as much as possible, then turn 1/2 turn with a wrench to keep probe in place.

4 SERVICE AND MAINTENANCE

4.1 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.

4.2 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 of 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.

4.3 Replacement of Salt Bridge for R5 Series Differential Sensor

If the system cannot be calibrated after cleaning the sensor, it may be necessary to replace the standard cell solution. Two kit is available from Water Analytics for this purpose (Part No. AM-SBK3-R5 for a 3-pack, and AM-SBK10-R5 for a 10-pack).

Proceed as follows:

1. Hold the sensor vertically with the sensor face up. Using Phillips #3 or 1/2" wrench turn salt bridge counter-clockwise taking care not to damage the glass electrode. Discard the used salt bridge.
2. Up-end the sensor and pour out the contents of the standard electrode chamber. Flush the chamber with a small amount of pH 7 buffer or clean 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 turn 1/4 turn with Phillips #3 or 1/2" wrench. The salt bridge edges should be flush with the front of the sensor face.

4.4 Replacement of Salt Bridge for R8-series 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 from Water Analytics for this purpose (Part No. AM-SBK3-R8 for a 3-pack and AM-SBK10-R8 for a 10-pack).

Proceed as follows:

1. Hold the sensor vertically electrodes up. Remove the used salt bridge. For the -R8 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.

4.5 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 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.

5 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 AM-2250 has a diagnostic tool build in, that allow quick and easy troubleshooting (Menu → Diagnostics → Sensor output). Shark-120 and Shark-TX also have diagnostic tool (Menu → Diagnostics → Sensor Input)

5.1 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 the system still can't be calibrated check the sensor as follows.
2. If sensor is used with 2250-series analyzer - 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 pH7 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 pH7 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 the 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.
- 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 not 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 the 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.

Table 1 - Acceptable Voltage Output for pH Sensors

Part number	Buffer pH value	Color	Acceptable Output
AM-PH7-1P	pH 7	Yellow	-50 to +50 mV
AM-PH4-1P	pH 4	Pink	pH 7 + (160 to 190 mV)
AM-PH10-1P	pH 10	Blue	pH 7 - (160 to 190 mV)

5.2 ORP sensors

For ORP sensors two calibration solutions (200 and 600 mV) are required. ORP solutions may be $\pm 20\%$ of nominal value. The actual value is noted on the bottle. ORP calibration 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 the system still can't be calibrated check the sensor as follows.
2. If sensor is used with 2250-series analyzer - use diagnostic tool:
 - a. Menu \rightarrow Diagnostics \rightarrow Sensor Output
 - b. Check "Temperature" output, the resistance should be between 250 Ω and 350 Ω at 25°C (77°F). If the resistance is within specifications the sensor's thermistor is functioning correctly.
 - c. Place the sensor in 200mV calibration 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 should be within $\pm 50\text{mV}$ from the ORP value listed on the bottle. If the voltage is within this range proceed to the next step
 - e. Rinse the sensor and place it in 600mV calibration solution. Allow it to stabilize then check the reading again. Measured voltage should be within $\pm 50\text{mV}$ from the ORP value listed on the bottle. Table 2 summarizes these acceptance criteria.
3. If ORP sensor is 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 the sensor in 200 mV solution. Allow enough time for the temperature of the sensor and solution 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 250 and 350 Ω at 25°C. If the resistance is within specifications the sensors 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. The reading should be within $\pm 50\text{mV}$ from the ORP value listed on the bottle; otherwise, the sensor is defective. If the voltage is OK proceed to the next step.
- g. Rinse the sensor and place it in 600 mV solution. Allow it to stabilize then check the voltage again between the red and green wires. If the voltage within $\pm 50\text{mV}$ from the ORP value listed on the bottle, the sensor is within specifications. Table 2 summarizes these acceptance criteria.

Table 2 – Acceptable voltage output for ORP sensor

Part number	Listed ORP value	Color	Acceptable Output
AM-R200-1P	200 $\pm 20\text{mV}$	Green	$\pm 50\text{ mV}$ from listed ORP value
AM-R600-1P	600 $\pm 20\text{ mV}$	Brown	$\pm 50\text{ mV}$ from listed ORP value

5.3 Troubleshooting

If pH or ORP sensor output does not fall within the ranges listed in Table 1 and Table 2, 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 Sections 5.1 - 5.2.
 - Possible reason:
The reference solution has been contaminated with the process to the point that it is no longer pH 7
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 (i.e. -500mV or 500 mV)
 - 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 HF (Hydrofluoric) Acid) and became inoperable.
Remedy:
Damages due to a use in not appropriate applications are not covered by AquaMetrix warranty. Sensor cannot be fixed or restored, replacement of failed sensor is required. AquaMetrix 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.

5.4 Warranty information

The warranty information is available on our website: www.wateranalytics.net or www.aquamatrix.com



5.5 Customer Service

If a problem has not been resolved with the above procedures, a telephone consultation with your AquaMetric representative, or directly with Water Analytics will provide the answer.

Water Analytics
100 School Street
Andover, MA 01810
978-749-9949
support@WaterAnalytics.net

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 . Water Analytics cannot be responsible for shipping damage nor for damage due to frozen electrodes. For safety reasons, Water Analytics cannot accept sensors which have not been thoroughly cleaned to remove all process material.

Appendix A: Parts and Accessories

<p>Salt Bridge Kit (3 pack) For R5-series: AM-SBK3-R5 For R8-series: AM-SBK3-R8</p>		<p>Junction box, NEMA 4X AM-JB2</p>	
<p>pH Buffer Solutions (1 pint ≈ 500ml) pH4: AM-PH4-1P pH7: AM-PH7-1P pH10: AM-PH10-1P (1 gal ≈ 4L) pH4: AM-PH4-1G pH7: AM-PH7-1G pH10: AM-PH10-1G</p>		<p>ORP Calibration Solutions (1 pint ≈ 500ml) 200 mV: AM-R200-1P 600 mV: AM-R600-1P (1 gal ≈ 4L) 200 mV: AM-R200-1G 600 mV: AM-R600-1G</p>	
<p>Submersion Hardware For R5-series sensor: AM-ARM-5 For R8-series sensor: AM-ARM-8</p>		<p>Protector For R5-series sensor: AM-PTR-5 For R8-series sensor: AM-PTR-8</p>	
<p>Union Tee with Adapter For R5-series sensor: AM-TEE-5 For R8-series sensor: AM-TEE-8</p>		<p>Jet Cleaner For R5-series sensor: AM-JET-5 For R8-series sensor: AM-JET-8</p>	
<p>Hot Tap Assembly For R5-series: AM-HTA-R5</p>		<p>Sanitary Flange, 2" For R5-series: AM-SFL-5 For R8-series: AM-SFL-8</p>	



Water Analytics Inc.
100 School Street
Andover, MA 01810
Tel: (978) 749-9949
www.AquaMetrix.com