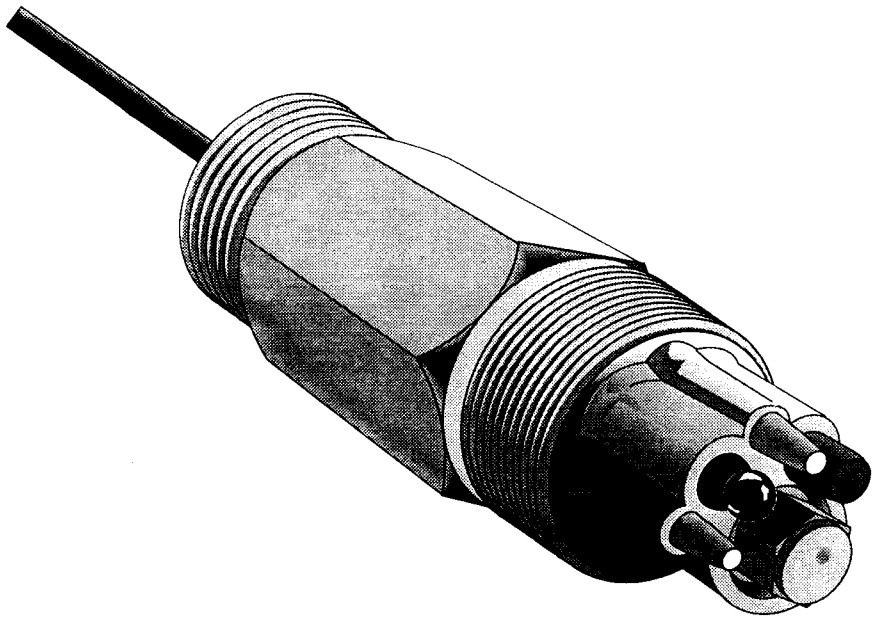
PHE-6028-PO

pH Differential Sensor



OMEGA®

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Operator's Manual

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ILLUSTRATIONS:

Unpacking

Remove the Packing List and verify that you have received all equipment. If you have any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

When you receive the shipment, inspect the container and equipment for any signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material in event reshipment is necessary.

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Description

Electronics

The liquid crystal polymer-encapsulated pH sensor has either an integral preamplifier (identified by its 5-wire cable) or two-wire transmitter (identified by its 2-wire cable) which provides a 4-20 mA output. Both sensor types also have an integral temperature-sensitive resistor to automatically compensate pH measurements for temperature variations.

Mounting Styles

The LCP-encapsulated pH sensor is available in two mounting styles. The "convertible" mounting style sensor has a distinctive hex-shaped body for easy installation and is threaded at both ends. This style enables the sensor to be threaded onto the end of a pipe for submersion applications or mounted into a standard 1-1/2 inch NPT pipe tee for flow-thru applications. The "union-mount" style sensor has a union adapter and requires a special 2-inch threaded mounting tee for installation.

1.2 Operating Precautions

1. The output of the 2-wire type sensor is **non-isolated and uncalibrated**. Consequently, the measuring system's indicating instrument must be able to provide 24 VDC where low is isolated from earth ground to power the sensor and have adjustment means to calibrate for offset and span. Refer to the calibration procedure in the instrument instruction manual for details.
2. The process electrode at the tip of the sensor is glass which can easily break. Do not subject it to impact or other mechanical abuse.

   Caution: A broken glass electrode can cause serious cuts if not handled carefully.
3. pH sensors with glass electrodes must not be used in hydrofluoric acid which dissolves the glass. A sensor with an antimony electrode is recommended in this case.
4. Before placing the sensor into operation, **remove the protective plastic caps** to expose the process electrode and hex-shaped "salt bridge". Save caps for future use.

   NOTE: *If sensor is to be out of solution for more than a day or two, put a few drops of water in each cap and replace them on the sensor. This keeps the pH sensitive glass and salt bridge moist and avoids slow response when the sensor is put back into operation. This should be done every 2-4 weeks (depending on environmental conditions) for extended storage.*

SECTION 2 - SPECIFICATIONS

Min. Temperature.....-5°C (23°F)

Max. Temperature:

In Flow-Thru Tee.....PVC: 60°C at 50 psig or 50°C at 100 psig
Steel: 95°C at 100 psig
CPVC: 95°C at 40 psig or 65°C at 100 psig

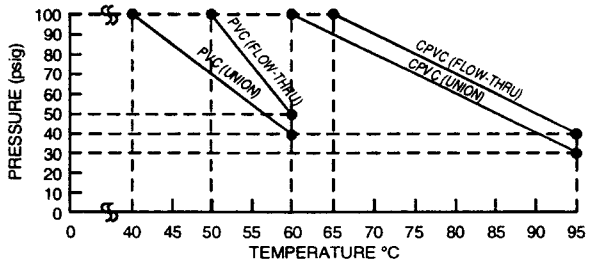
In Union Tee.....PVC: 60°C at 40 psig or 40°C at 100 psig
Steel: 95°C at 100 psig
CPVC: 95°C at 30 psig or 60°C at 100 psig

Maximum Pressure:

In Flow-Thru Tee.....PVC: 100 psig at 50°C or 50 psig at 60°C
Steel: 100 psig at 95°C
CPVC: 100 psig at 65°C or 40 psig at 95°C

In Union Tee.....PVC: 100 psig at 40°C or 40 psig at 60°C
Steel: 100 psig at 95°C
CPVC: 100 psig at 60°C or 30 psig at 95°C

Plastic Mounting Hardware Ratings



Maximum Flow Rate .....10 feet per second

NOTE: *If possible, flow rate should be minimal for low conductivity water or solutions high in suspended solids.*

Wetted Materials.....Liquid crystal polymer body, liquid crystal polymer and PVDF (or ceramic) salt bridge, glass process electrode, titanium ground electrode and RTV sealant. Union-mount style sensor also has liquid crystal polymer adapter and Viton O-ring process seals. For pH sensors with an antimony process electrode, stainless steel replaces the titanium ground electrode.

Measuring Range .....0-14 pH

NOTE: *Most pH applications fall in the 2.5 - 12.5 pH range. General purpose pH glass electrodes perform well in this range. Some industrial applications require accurate measurements and control at pH values below 2 or above 12.*

Repeatability and speed of response for pH sensors with an antimony process electrode is not as good as those with a glass process electrode. Antimony electrodes are only linear between 3 and 8 pH and should only be specified when process conditions, such as the presence of hydrofluoric acid, dictate their use.

Performance:

- Sensitivity ..... Less than 0.005 pH
- Stability ..... 0.03 pH units per 24 hrs., non-cumulative
- For Sensor w/Two-wire Transmitter:
  - Output Span..... 0.95 mA per pH
  - Output Offset ..... 12 mA occurs at 7.0 pH (+) or (-) 0.88 pH
  - Load at 20 mA..... 450 ohms

Sensor Cable:

- Sensor w/ Preamplifier ..... 5 conductor (plus shield), 10 ft. (3 m) length
- Sensor w/ Two-wire Transmitter..... 2 conductor (twisted pair), 10 ft. (3 m) length

Transmission Distance:

- Sensor w/ Preamplifier ..... 3000 ft. (914 m) maximum
- Sensor w/ Two-wire Transmitter..... Limited by wire resistance and power supply voltage

Dimensions ..... Refer to Figure 2-2 or 2-3

PART TWO - INSTALLATION

SECTION 1 - LOCATION REQUIREMENTS

1. Mount the sensor vertically, electrodes down. If the sensor must be installed on an angle, it should be **at least 15° above horizontal**. Other mounting angles may cause erratic readings.
2. Use Teflon tape on sensor and mounting hardware threads to avoid leaks. Do not use pipe sealant.

SECTION 2 - MOUNTING

2.1 Submersion

The sensor may be submersion or tank mounted by threading it onto the end of a pipe of an appropriate length (Figure 2-1).

1. Screw a 1-1/2 inch x 1 inch NPT reducer coupling onto cable end of sensor. Route sensor cable through an appropriate length of 1-inch mounting pipe. Screw pipe into reducer coupling.
2. Run sensor cable into unilet junction box. Screw unilet box onto mounting pipe.
3. Run interconnect cable into unilet. Connect sensor and interconnect cable wires, by matching colors, to terminal strip in unilet. Fasten cover onto unilet.
4. Route interconnect cable to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2" or larger flexible, metal conduit for protection against moisture and mechanical damage. Flexible conduit

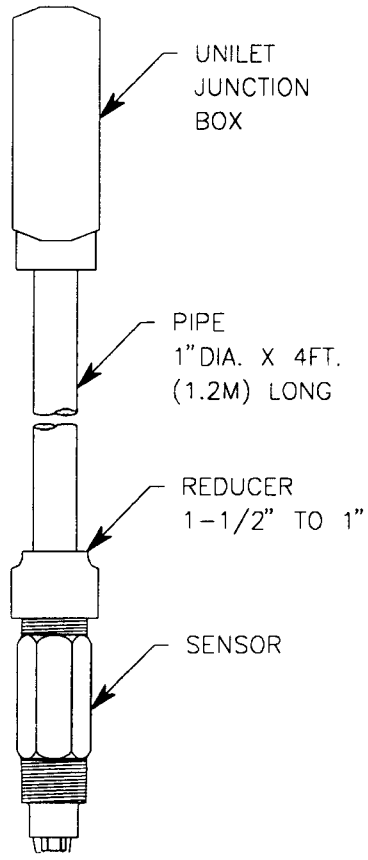


FIGURE 2-1
Submersion Mounting Details

must be long enough to allow removal of the sensor from the process for maintenance and calibration.

NOTE: *Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).*

5. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.
6. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor/hardware assembly into the process.
7. Fasten electrode protector onto end of sensor. Mount sensor/hardware assembly by suitable means. This completes the submersion installation.

2.2 Flow Thru (Pipe Tee)

The sensor may be tee mounted by threading it into a standard 1-1/2-inch NPT pipe tee (Figure 2-2).

1. Install a standard 1-1/2 inch NPT pipe tee into the process line.
2. Electrically connect the sensor directly to the instrument or indirectly with a junction box and interconnect cable.
   A. Direct Hook-Up
      a. Route sensor cable to instrument. Use a watertight connector, such as a cable feed-thru fitting, in the instrument's cable entry hole.
      b. Connect sensor cable wires to instrument in accordance with instrument hook-up instructions.
   B. Indirect Hookup With Junction Box
      a. Mount junction box (with terminal strip) on a flat surface such that its cover is removable when installed.
      b. Route sensor cable to junction box through a watertight connector such as a cable feed-thru fitting.

         NOTE: *Keep terminal strip dry to prevent problems caused by wet and/or corroded terminals.*

      c. Route interconnect cable from junction box to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2 inch or larger metal conduit for protection against moisture and mechanical damage. Use conduit

hubs where cable enters the junction box and instrument enclosure.

NOTE: *Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).*

d. Connect sensor and interconnect cable wires, by matching colors, to junction box terminal strip. Fasten cover onto junction box.

e. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.

3. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.

4. Purposely pre-twist the sensor cable by turning the sensor counterclockwise (left) 4 to 5 turns. Now place sensor into tee and hand tighten. Use a large crescent or open-end wrench on the flat sides of the sensor body to carefully snug the connection to prevent leaks. **Do not overtighten!**

   This completes the pipe tee installation.

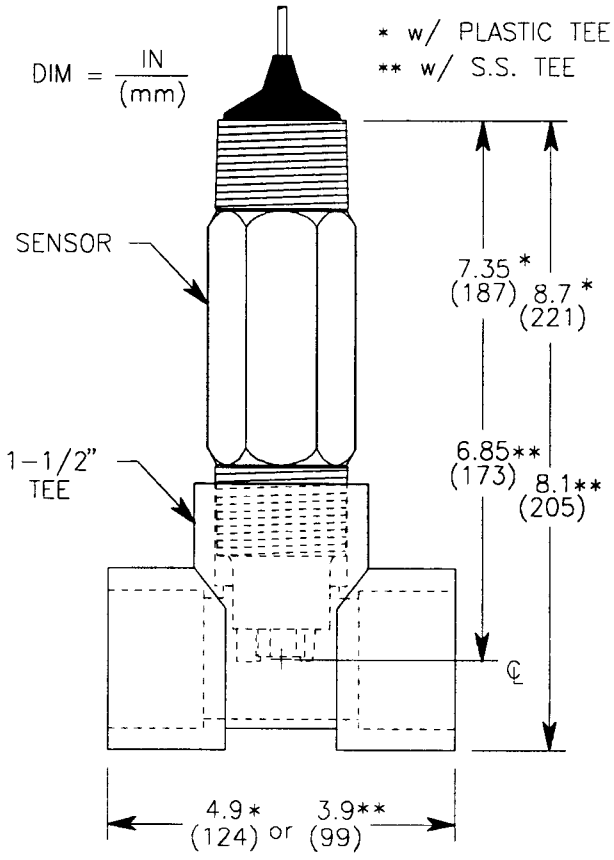


FIGURE 2-2 Tee Mounting Details

2.3 Union

The union-mount style sensor is installed by using a special 2-inch threaded mounting tee (Figure 2-3).

1. Install the special 2-inch threaded mounting tee into the process line.
2. Remove retaining ring from top portion of adapter.
3. Place lock ring onto adapter as shown in Figure 2-3 (threads on lock ring toward O-rings). Slip retaining ring over top of lock ring to hold it in place.
4. Electrically connect sensor to instrument as described in Section 2.2, step 2A or 2B.
5. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.
6. Lubricate adapter O-rings with water to ease sensor insertion into tee and carefully place sensor into special tee. Hand tighten lock ring onto tee. This completes the union-mount installation.

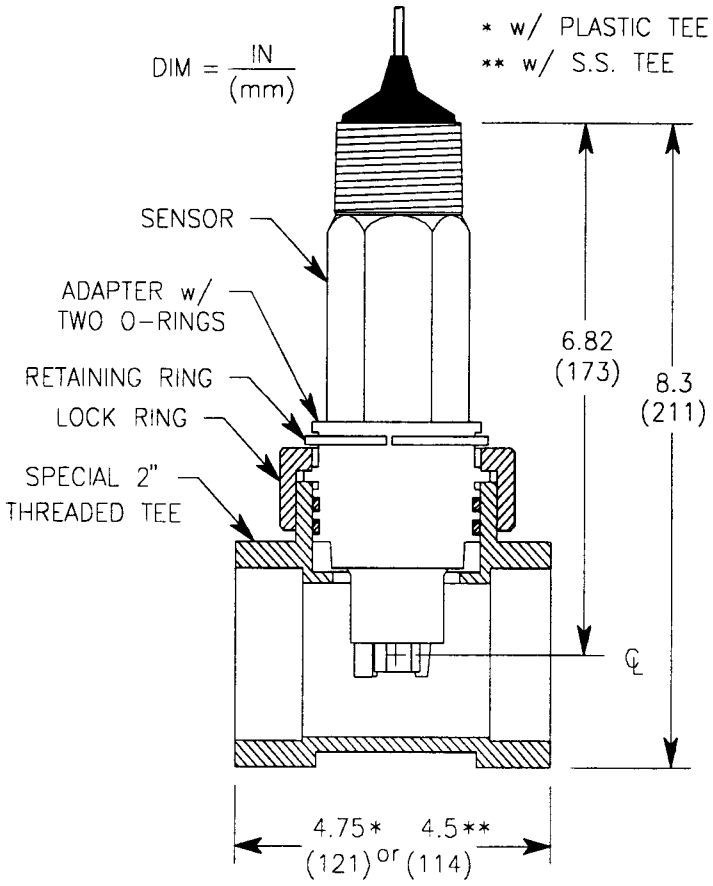


FIGURE 2-3 Union Mounting Details

PART THREE - PRINCIPLE OF OPERATION

The sensor operates in principle as if it contained two "batteries" whose voltages are measured and transmitted by electronic amplifiers. One battery is formed by the ground electrode and the glass process electrode. The voltage of this battery is a function of the solution pH. The other battery is formed by the same ground electrode and the standard electrode which contains a pH electrode in a chemical standard of fixed pH value (see Figure 4-1). The voltage of the second battery is subtracted from the voltage of the first battery. The result is a differential pH measurement, the final signal being that of a pH electrode in the process compared to a pH electrode in a chemical standard solution.

A temperature sensitive resistor inside of the sensor automatically compensates the pH measurement for temperature variations by adjusting the output of the sensor.

PART FOUR - SERVICE AND MAINTENANCE

SECTION 1 - RECOMMENDED CLEANING PROCEDURE

The sensor must be kept reasonably clean to maintain measurement accuracy. The time period between cleanings (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in waste water that contains oil and/or grease may require more frequent cleaning.

1. Rinse the sensor with clean, warm water.
2. Prepare a mild soap solution. Use warm water and dishwashing detergent or other non-abrasive soaps that do not contain lanolin which will coat the glass process electrode.
3. Soak the sensor for 2 to 3 minutes in the soap solution.
4. Using a **soft** bristle brush, scrub the entire measuring end of the sensor (glass process electrode, salt bridge and ground electrode).

   CAUTION: Performance can be degraded by scratching the glass electrode. Do not use a cleaning brush that can cause scratches.

5. Before cleaning with acid, determine if any hazardous reaction products could form. For example, a sensor used in a cyanide bath should not be put directly into a strong acid for cleaning because poisonous cyanide gas could be produced. Acids are hazardous and appropriate eye protection and clothing should be worn in accordance with Material Safety Data Sheet recommendations.

   Muriatic or other **dilute** acids may be used to clean the sensor. The acid should be as dilute as possible, but yet strong enough to clean. Experience will help to determine which acid to use and how dilute it can be. Some stubborn coatings may require a different cleaning agent. Contact the factory for assistance in these difficult cases.

   Soak the sensor in dilute acid for no more than 5 minutes. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize the acid.

6. Rinse the sensor in clean, warm water.
7. Calibrate the sensor and instrument with pH buffers (refer to instrument instruction manual). If calibration cannot be accomplished, replace the sensor's standard cell buffer and salt bridge (Part Four, Section 2). If calibration is still not possible, troubleshoot the sensor in accordance with Part Four, Section 3.

SPECIAL CASE

Sensors which have an antimony (instead of glass) process electrode that still cannot be calibrated after normal cleaning and replacement of the standard cell buffer and salt bridge may require additional electrode cleaning. The antimony electrode is brittle and can easily break. Use care when cleaning it. **Very carefully** file the **tip** of the antimony electrode and lightly scrape its rounded sides to remove any process coating.

WARNING: ANTIMONY IS TOXIC! CAREFULLY DISPOSE ALL FILINGS IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS. WHEN FINISHED, WASH HANDS THOROUGHLY.

SECTION 2 - REPLACING STANDARD CELL BUFFER/SALT BRIDGE

The sensor's standard cell buffer and salt bridge should be replaced if calibration cannot be accomplished after cleaning the sensor. To do so:

1. Hold sensor in upright position and remove the hex-shaped salt bridge (Figure 4-1) by turning it counterclockwise with a 9/16" socket or nut driver to initially loosen it. Take care not to damage the protruding process electrode. Discard the old salt bridge.
2. Replace the standard cell buffer in the chamber of the standard cell. The buffer may be a solution or a gel.
   A. For Solution-Filled Chamber
      a. Pour out the aged standard cell buffer. Thoroughly flush standard electrode chamber with distilled water.
      b. Fill standard electrode chamber with fresh standard cell buffer (p/n 25M1A1001-115).
   B. For Gel-Filled Chamber:
      a. Remove aged standard cell buffer using a jet of water from a "water pik" type device. Thoroughly flush standard electrode chamber with distilled water after removing the gel.
      b. Place one level bottle cap (1/8 level teaspoon) of gel powder (p/n 25M8A1002-101) into chamber. Then add fresh standard cell buffer (p/n 25M1A1001-115). Mix together until a gel consistency is attained. Continue this procedure until

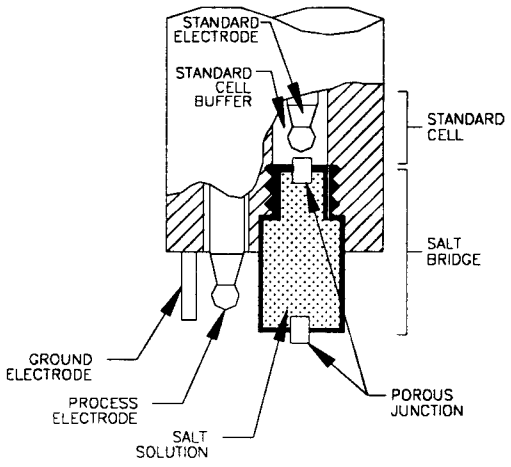


FIGURE 4-1 Sensor Electrode Details

level of gel is sufficient to contact the salt bridge when it is installed. To check for proper level, replace and remove the salt bridge. A formed impression of the salt bridge should appear in the gel surface.

3. Install the new salt bridge (see Part Five for part number). Inspect O-ring for imperfections and replace if necessary. Turn salt bridge clockwise until finger tight. Then tighten with a 9/16" socket or nut driver (approximately 1/4 turn). **Do not overtighten!**

SECTION 3 - TROUBLESHOOTING

A few simple measurements can determine if the sensor is operating properly. A multimeter and two pH buffer solutions (pH 7 and pH 4 or 10) are required.

Clean the sensor in accordance with Part Four, Section 1. If the instrument and sensor cannot be calibrated, replace the standard cell buffer and salt bridge as described in Part Four, Section 2. If the measuring system still cannot be calibrated after replacing the standard cell buffer and salt bridge, perform the appropriate test in this section (3.1 or 3.2) that applies to your sensor type.

3.1 Sensors With 5-Wire Cable (Integral Preamplifier)

1. Disconnect sensor's red, green, yellow and black wires from the instrument (at junction box, if used) and place sensor in pH 7 buffer. Before performing steps 2 through 5, allow temperature of sensor and buffer solution to equalize at approximately 25°C (room temperature).
2. To verify that the sensor's temperature compensator is operating properly, measure the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25°C.
3. Reconnect the yellow and black wires.
4. Place multimeter (+) lead on red wire and (-) lead on green wire. Measure the DC millivolts with the sensor in pH 7 buffer. This reading is called "offset" and it should be between (-)50 and (+)50 mV. If it is, the sensor "offset" is within factory-specified limits. Note the millivolt value and perform step 5. If not, discontinue this test.
5. Check the sensor "span" by measuring the millivolts with the sensor in either pH 4 or pH 10 buffer. Keep the millivolt meter connected as described in step 4.

A. Span Check In pH 4 Buffer

Rinse sensor with water and place in pH 4 buffer. The "span" reading should be at least (+)160 mV more than the noted "offset" reading in step 4. Examples of typical readings are:

"Offset" Reading In pH 7 Buffer	"Span" Reading In pH 4 Buffer
(-)50 mV	(+)110 mV
(-)25 mV	(+)135 mV
0 mV	(+)160 mV
(+)25 mV	(+)185 mV
(+)50 mV	(+)210 mV

B. Span Check In pH 10 Buffer

Rinse sensor with water and place in pH 10 buffer. The "span" reading should be at least (-)160 mV less than the noted "offset" reading in step 4. Examples of typical readings are:

"Offset" Reading In pH 7 Buffer	"Span" Reading In pH 10 Buffer
(-)50 mV	(-)210 mV
(-)25 mV	(-)185 mV
0 mV	(-)160 mV
(+)25 mV	(-)135 mV
(+)50 mV	(-)110 mV

If the "span" reading complies with A or B of this step, the sensor is within factory-specified limits.

3.2 Sensors With 2-Wire Cable (Integral Two-Wire Transmitter)

1. Connect a DC milliammeter in series with the sensor and the instrument (or +24 VDC source):
   A. Disconnect the sensor's red (+) wire from instrument and connect it to milliammeter (+) input.
   B. Connect the milliammeter (-) input to instrument's (+) input terminal.
2. Place sensor in pH 7 buffer. Allow temperature of sensor and buffer solution to equalize at approximately 25°C (room temperature). Read and note the mA value. This reading is called the "offset" and it should be between 11 and 13 mA. If it is, the sensor "offset" is within factory-specified limits and the sensor "span" should now be checked using step 3. If not, discontinue this test.

3. Check the sensor "span" by measuring the mA value with the sensor in either pH 4 or pH 10 buffer. Keep the milliammeter connected as described in step 1.

   A. Span Check in pH 4 buffer

      Rinse sensor with water and place in pH 4 buffer. Allow temperature of sensor and buffer solution to equalize at 25°C (room temperature). The "span" reading should be 2.37 to 3.10 mA **lower than** the noted "offset" reading in step 2.

      Example: Suppose "offset" reading in pH 7 buffer is 11.50 mA. Then the "span" reading in pH 4 buffer must be between 8.40 and 9.13 mA to be within factory-specified limits.

   B. Span Check In pH 10 buffer

      Rinse sensor with water and place in pH 10 buffer. Allow temperature of sensor and buffer solution to equalize at 25°C (room temperature). The "span" reading should be 2.37 to 3.10 mA **higher than** the noted "offset" reading in step 2.

      Example: Suppose "offset" reading in pH 7 buffer is 11.50 mA. Then the "span" reading in pH 10 buffer must be between 13.87 and 14.60 mA to be within factory-specified limits.

   If the calculated "span" reading conforms with the limits in A or B of this step, the sensor is operating properly.

PART FIVE - SPARE PARTS AND ACCESSORIES

	Description	Part Number
Sensor Accessories	Protector (for submersion applications)	60A2F1278
	Union Adapter Assembly (includes two Viton O-rings and a retaining ring)	60M2G9753-101
	Replacement Viton O-rings (two, for union adapter ass'y)	99X5H1233
Standard Cell Supplies	Standard Cell Buffer (1 pint)	25M1A1001-115
	Gel Powder (for gelling standard cell buffer, 2 grams)	25M8A1002-101
	Salt Bridge (includes O-ring)	60-9765-000*
	Salt Bridge O-ring	99X5H1261

*Some applications require a special salt bridge (identified with a different dash number). When ordering, specify the complete salt bridge number including the dash number.

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3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS OR **CALIBRATION,** consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contacting OMEGA:

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3. Repair instructions and/or specific problems relative to the product.

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