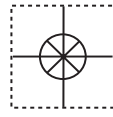


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User's Guide



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The information contained in this document is believed to be correct, but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

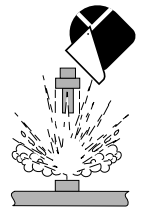
OMEGA PHE/ORE Series pH/ORP Electrode Instructions

WARNING!



SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.



1. Technical Data

1.1 General

Compatibility: OMEGA PH-2720-PA Twist-Lock Pre-amplifier

Pipe Size Range:

- 1/2 in. and up.
 - Use OMEGA installation fittings to 4 in.
 - Use pipe adapter in pipes over 4 in.
 - Submersion with PH-2720-PA pre-amplifier requires 3/4 in. NPT or ISO 7-R 3/4 in. male threaded extensions

Efficiency: >97% @ 25°C (77° F)

Wetted Materials:
 CPVC Body
 Glass
 FPM O-rings
 Porous UHMW Polyethylene reference junctions
 ORP: Platinum sensing surface

Primary Functions:
 PHE-3271, ORE-2715: Flat surface resists fouling
 PHE-2716, ORE-2717: Bulb surface for general use
 PHE-3271-HF: Extended use in applications with trace hydrofluoric acid (<2%)
 PHE-2716-DI: Extended use in pure waters (<100 µS)

Secondary Junction: Nylon Filament
 Element: Ag/AgCl
 Shipping Weight: 0.2 kg (0.4 lb)

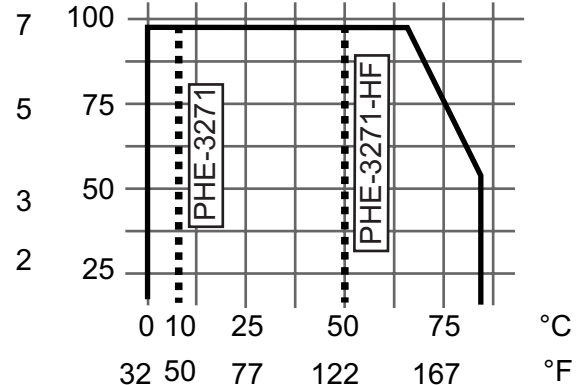
1.2 PHE-3271 and PHE-2716 pH Electrodes

Operating Range: 0 to 14 pH (PHE-3271-HF: 0 to 12 pH)
 Reference: Electrolyte: Solidified Acrylamide Gel
 3.5M KCl (PHE-3271, PHE-3271-HF, PHE-2716)
 0.1 M KCl (PHE-2716-DI)
 Temperature Sensor: 3KΩ Balco (3000Ω = 25°C)
 Response Time: <5 s for 95% of signal change
 Response Time, τ: 140 s (PHE-3271), 196 s (PHE-2716)

1.3 ORE-2715/ORE-2717 ORP Electrodes

Operating Range: -999 to +999 mV
 Reference: Electrolyte: Solidified Acrylamide Gel
 3.5M KCL
 Response Time: Application dependent

BAR PSI



1.4 Temperature and pressure specifications

ORP electrode operating Temperature/Pressure

- 6.89 bar @ 0°C to 65°C (100 psi @ 32° to 149° F)
- 4.00 bar @ 66°C to 85°C (58 psi @ 150° to 185° F)

PHE-2716 and PHE-2716-DI pH electrode operating Temperature/Pressure

- 6.89 bar @ 0°C to 65°C (100 psi @ 32° to 149° F)
- 4.00 bar @ 66°C to 85°C (58 psi @ 150° to 185° F)

PHE-3271 pH electrode operating Temperature/Pressure

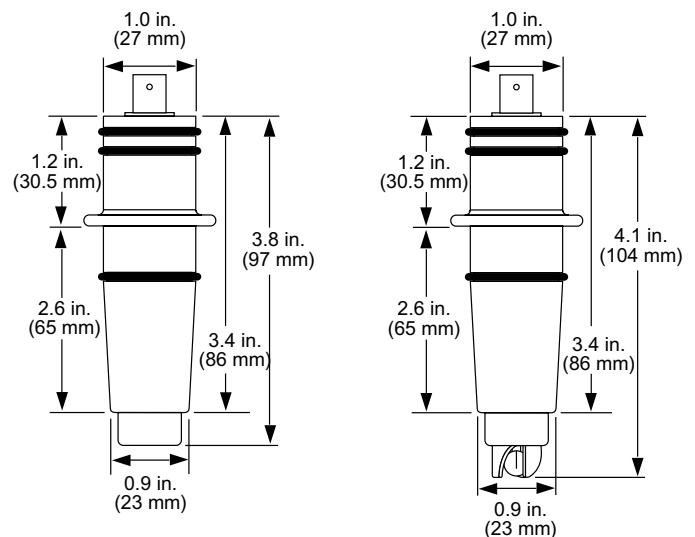
- 6.89 bar @ 10°C to 65°C (100 psi @ 50° to 149° F)
- 4.00 bar @ 66°C to 85°C (58 psi @ 150° to 185° F)

PHE-3271-HF pH electrode operating Temperature/Pressure

- 6.89 bar @ 0°C to 50°C (100 psi @ 32° to 122° F)

Storage Temperature: > -12° C (11° F)

1.5 Dimensions



Flat electrode

Bulb electrode

2. Electrode care and application

pH/ORP electrodes are similar to batteries; they age with time and usage. The following information will help maximize electrode life.

2.1 Conditions to Avoid:

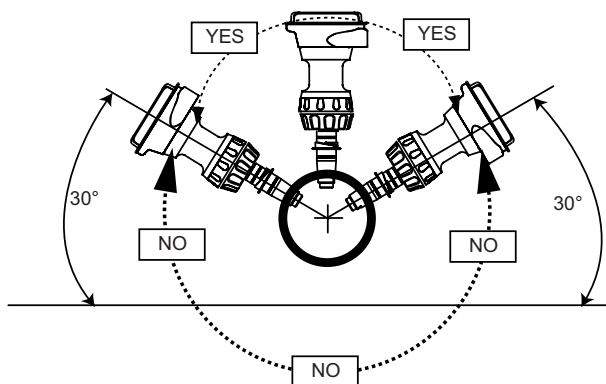
- High temperatures, strong acids or caustics will elevate electrochemical reactions and speed electrode aging.
- Coatings on the glass or junction surfaces (i.e. proteins) cause extended response time and inaccurate measurement.
- Never store the electrode tip in deionized (DI) water.
- Never expose electrode to temperatures below -12 °C (10 °F) or allow it to dehydrate. These conditions will damage the electrode.
- Never scrape or sand the glass electrode surface.
- Treat glass electrode surfaces with care. The glass is very thin and requires care to prevent accidental breakage.

2.2 Submersible Installation Tips:

- Mount electrodes in a location with ample clearance for removal for periodic cleaning and recalibration. Choose a location that keeps the electrode glass completely submerged at all times.
- Place the electrode tip in pH 4 buffer during system maintenance or storage to avoid dehydration.
- Mount the electrode near tank outlet away from reagent addition areas.

2.3 In-Line Installation Tips:

- pH and ORP electrodes respond best in moving fluids.
- The internal measuring electrode chamber contains a wire within a liquid and a slight amount of air. The electrode must be mounted at least 30° from horizontal to ensure proper sensing. Mounting angles less than 30° will impede performance.



3. pH Electrode Calibration

All pH electrodes are designed to ensure linearity during their lifespan. The following sections define proper electrode operation.

3.1 Offset (STD)

Electrode offsets occur due to:

- Clogged reference junction
- Aged or contaminated reference solution/wire

Check offsets in a pH 7 buffer @ 25 °C. The theoretical output is 0 mV. Any deviation from 0 mV is the pH electrode offset.

pH Electrode Offset pH 7 buffer @ 25°C	Theoretical:	7.0 pH (0.0 mV)
	New:	pH 7 ± 0.25 pH (±15 mV)
	Reliable:	pH 7 ± 0.85 pH (± 50 mV)

Theoretical mV Values @ 25°C	
pH	mV
2	+ 295 mV
3	+ 236 mV
4	+177 mV
5	+118 mV
6	+ 59 mV
7	0 mV
8	- 59 mV
9	- 118 mV
10	- 177 mV
11	- 236 mV
12	- 295 mV

Electrode offsets greater than 0.85 pH (50 mV) indicate the electrode requires cleaning or replacement. See section 5: Maintenance and cleaning.

3.2 Slope (SLP)

Electrode slope is the number of mV per pH unit. At 25°C the theoretical slope is 59.16 mV per pH. Temperature has an appreciable affect on electrode slope. Reliable instrumentation includes temperature compensation. The graph below illustrates potential pH error when a temperature compensated instrument is not used.

°C	pH Error										
	2	3	4	5	6	7	8	9	10	11	12
15	0.15	0.12	0.09	0.06	0.03	0	0.03	0.06	0.09	0.12	0.15
25	0	0	0	0	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

Recommendations:

- Calibrate temperature before calibrating the standard and slope.
- The mV offset will track across the entire pH range. The slope is usually not affected by offset changes. (i.e. pH 7= +10 mV, pH 4= +187 mV); slope = 59 mV
- Coatings on the glass may affect sensor slopes. See section 5 maintenance and cleaning.
- A constant output near 0 mV in all buffer solutions indicates a shorted electrode that must be replaced.

3.3 Response Time/Stability

Response time and stability are affected by the condition of the pH electrode's glass surface (ORP electrode - Platinum surface), reference junction, and reference solution. Restoration to acceptable levels can often be accomplished by cleaning the electrode's glass surface (ORP electrode - Platinum surface) and reference junction.

Electrode mV values should remain stable ±3 mV. Conditions that may cause fluctuations are:

1. Electrode coating
2. Ground fault: If proper operation is observed in the beaker, but is unstable in the application, a ground fault probably exists.
 - Using instrumentation with isolated inputs and outputs may restore stable operation.
 - Solution grounding may also restore stable operation.

4. ORP Electrode Calibration

All ORP electrodes are designed to ensure linearity during their lifespan. The following sections define proper electrode operation.

4.1 Offset (STD)

Electrode offsets occur due to:

- Clogged reference junction
- Aged or contaminated reference solution/wire

Offsets are easily checked in pH 7 buffer saturated with quinhydrone @ 25 °C; since the theoretical output is +87 mV. Any deviation from +87 mV is the ORP electrode offset (i.e. +90 mV). Quinhydrone is the oxidizer measured by the ORP electrode and is required for calibration. To guarantee buffer saturation, mix 1/8g quinhydrone per 50 mL of pH buffer.

ORP Electrode Offset:

Solution: pH 7 or pH 4 buffer saturated with Quinhydrone @ 25 °C

	<u>pH 7 + Quinhydrone</u>	<u>pH 4 + Quinhydrone</u>
Theoretical mV:	+ 87 mV	+ 264 mV
New:	87 ± 15 mV	+264 ± 15 mV
Reliable:	87 ± 50 mV	+264 ± 50 mV

Electrode offsets greater than ±50 mV indicate the electrode requires cleaning or replacement, see section 5.2.

4.2 Slope (SLP)

ORP slope errors are generally caused by contamination of the platinum electrode surface. Cleaning the electrode surface will usually restore proper values, response time, and stability.

Common ORP Values

<u>Reaction</u>	<u>mV</u>
Cr → Cr ²⁺ + 2e ⁻	- 913
Fe → Fe ²⁺ + 2e ⁻	- 440
Cr ²⁺ → Cr ³⁺ + e ⁻	- 407
4OH ⁻ → O ₂ + 2H ₂ O + 4e ⁻	- 401
2I ⁻ → I ₂ + 2e ⁻	- 400
Ti ²⁺ → Ti ³⁺ + e ⁻	- 370
Ni → Ni ²⁺ + 2e ⁻	- 250
Pb → Pb ²⁺ + 2e ⁻	- 126
Fe → Fe ³⁺ + 3e ⁻	- 37
H ₂ → 2H ⁺ + 2e ⁻	0
Fe ²⁺ → Fe ³⁺ + e ⁻	+ 771
Ag → Ag ⁺ + e ⁻	+ 799
Pb → Pb ⁴⁺ + 4e ⁻	+ 800
3Br ⁻ → Br ₃ ⁻ + e ⁻	+ 1060
2Br ⁻ → Br ₂ + 2e ⁻	+ 1066
ClO ₂ ⁻ → ClO ₂ + e ⁻	+ 1160
Pt → Pt ²⁺ + 2e ⁻	+ 1188
Ag → Ag ²⁺ + 2e ⁻	+ 1369

Many systems require both pH and ORP calibration. To conserve calibration reference solutions, use pH 7 and 4 buffers for pH calibration first. ORP calibration can be performed with the same buffers by adding quinhydrone.

5. Maintenance and Cleaning

5.1 Maintenance

Variables can affect long term pH or ORP electrode life. For this reason, a maintenance log is recommended for trend analysis. When storing boxed sensors, lay the sensor flat to maximize hydration of the glass surface. Keep the glass surface wet at all times. Soak the sensor tip in pH 4.0 buffer during system maintenance intervals. In-line applications should be plumbed with a depression (trap) so liquid is maintained around the sensor tip. If the sensor dehydrates, soak the sensor tip in pH 4 buffer for 24 to 48 hours, then visually inspect the electrode for surface cracks, swelling, or discoloration. Severely dehydrated electrodes cannot be restored to normal operation.

5.2 Cleaning

Cleaning techniques vary depending on the type of coating present on the glass electrode surface or reference junction.

- Soft coatings can be removed by vigorous stirring, or with directed spray of an applicable detergent or solvent onto the glass electrode surface. Chlorine bleach or mild detergent may be used to remove soft coatings. Always rinse electrode tip in clean water after cleaning.
- Hard coatings can be chemically removed. Use the least harsh chemical which will remove the contaminant within two (2) minutes without attacking the materials of construction. e.g. calcium carbonate may be removed with a 5% HCL (muriatic acid) solution.
- Oily or organic coatings can be removed with detergents or an appropriate solvent that does not attack the materials of construction e.g. isopropyl alcohol may be used but acetone must be avoided to prevent damage to the CPVC sensor body.
- ORP electrode surface (platinum rod) can be gently sanded with 600 grit wet and dry silicone or carbide sandpaper, jewelers rouge, crocus cloth, or very fine steel wool.



WARNING!

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

6. Replacement parts and accessories

Mfr. Part No.	Description
PHE-3271	Flat pH Electrode
PHE-3271-HF	Flat pH Electrode, HF Resistant
ORE-2715	Flat ORP Electrode
PHE-2716	Bulb pH Electrode
PHE-2716-DI	Bulb pH Electrode, DI Resistant
ORE-2717	Bulb ORP Electrode
PH-270-PA	Preamplifier, 3/4 in. NPT
P31515-0V200	PVDF Pipe Adapter
FPP-1220-0021	O-ring, FPM (standard)
FPP-1224-0021	O-ring, EPR
FPP-1228-0021	O-ring, Kalrez

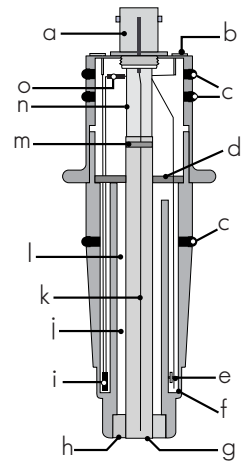


CAUTION!

Apply O-ring lubricant to sensor O-rings prior to assembly.
Unlubricated O-rings may score the sealing surface in the 2720.

Technical Features

- | | |
|--|--|
| a) Male BNC connector | i) 3K Balco thermistor |
| b) Keyed for a simple sure fit | j) Solidified acrylamide reference electrolyte |
| c) Viton® O-rings | k) Ag/AgCl measuring element |
| d) Silicone-bushing seal | l) Large reference volume |
| e) Double junction | m) Epoxy seal |
| f) Ag/AgCl reference element | n) Shielding |
| g) Platinum sensing surface (ORP) or flat pH glass | o) 10KΩ I.D. resistor for ORP sensor |
| h) Porous UHMW polyethylene reference junction | |





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