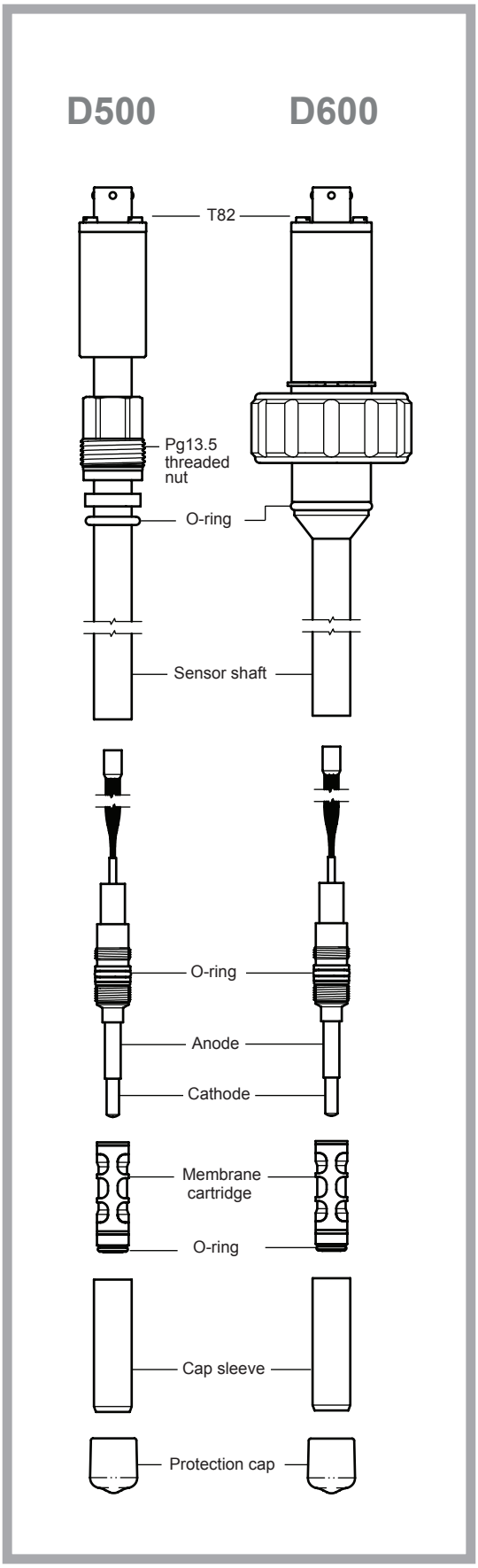
Broadley® James


# OxyProbe® II
# Instruction Manual




## Essential Instructions Read this Page Before Proceeding

This product has been designed, manufactured, and tested to meet national and international standards. Because these sensors are sophisticated technical products, proper installation, use, and maintenance ensures they continue to operate within their normal specifications.

The following instructions are provided for integration into your safety program when installing, using, and maintaining these products. Failure to follow the proper instructions may cause any one of the following situations to occur: loss of life, personal injury, damage to property, damage to the sensor, and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this instruction manual is not the correct manual, call 949.829.5555 to request the correct manual. Save this manual for future reference.
- If you do not understand any of the instructions, contact Broadley-James for clarification.
- Follow all warnings, cautions, and instructions supplied with the product. Inform and educate your personnel on the proper installation, operation, and maintenance of the product. Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes.
- To ensure proper performance, only allow qualified personnel to install, operate, calibrate, and maintain the product.
- When replacement parts are required, ensure qualified personnel use replacement parts specified by Broadley-James. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in improper operation.

## Section 1: Sensor Construction

### 1.1 Sensing Element

The sensing element is comprised of a glass tube sealed at one end with a fused platinum wire. This sealed end is ground to a precise hemispherical curve. Since the geometrical configuration and roughness of the ground surface have an important effect on sensor performance, they should not be modified. A silver anode tube covers the large annular surface of the glass tube. A thermistor for the temperature compensation of sensor current is also incorporated within the glass tube. The tube assembly in turn is mounted and sealed into a stainless steel threaded holder. This is the anode/cathode assembly.

### 1.2 Membrane Cartridge

The membrane cartridge, when filled with electrolyte, is placed over the anode/cathode assembly and threaded onto the stainless steel body. The membrane cartridge is sealed at the lower end with a fixed, reinforced, gas permeable membrane, and is surrounded by a stainless steel sleeve. This seals the cartridge to the sensor body with a precision tolerance o-ring seal.

When fully seated, the cartridge sleeve properly positions the tip of the cathode to the inner membrane surface. At the same time, optimum pressure of the gas permeable membrane against the cathode is obtained.

**Important:** After assembly, the anode/cathode assembly extends a slight degree beyond the endcap. Though covered by the membrane, it can be damaged by physical impact.

## Section 2: Preparation

### 2.1 Sensor

The sensor is shipped with a removable boot that protects the anode/cathode assembly and membrane cartridge during shipment and long-term storage. A moisture-proof dust cap is provided to protect the 4-pin connector.

**Note:** Save the moisture proof dust cap to protect the 4-pin connector during autoclave or out of service conditions.



After removing the protective caps, proceed with the **Membrane Cartridge Refill and Installation Instructions** (see separate document). Observe the cautions regarding handling the electrolyte. Rinse lower portion of sensor in deionized water (DI) water and blot dry. When the dissolved oxygen (DO) transmitter is switched on, a polarization voltage is applied between the anode and cathode, resulting in a sensor current that is initially high but drops to a steady state after a few minutes. Because the polarization period is long, the sensor should be kept connected to a powered transmitter or polarizing unit when not in use. The life of the sensor is not shortened under these conditions. If for any reason the sensor has to be disconnected (or the transmitter power switched off) for an extended period, it will have to be repolarized before it is ready for further use.

During the polarization period, the sensor current will also fall off even in oxygen-free solutions. For this reason, an excessive zero current may indicate incomplete polarization.

### 2.2 Transmitter

The transmitter to be used with OxyProbe sensors must be properly matched with the sensor. Oxygen sensors differ from other sensors in their output current, polarization voltage, and temperature compensation technique. Therefore, the sterilizable DO sensor requires a transmitter with precisely defined characteristics. The transmitter specifications must be carefully examined to verify compatibility. Contact Broadley-James Corporation for questions on sensor and transmitter capability.

### 2.3 Remote Recording and Control Devices

The signal circuits of all remote instruments must be isolated from ground. If this cannot be accomplished, an isolation device must be placed between the oxygen transmitter and the remote instrument. For safety reasons, the chassis of all component units must be well grounded. We recommend the ground terminals of all ancillary instruments be connected together and taken to a known ground point.

## Section 3: Calibration

### 3.1 Calibration Comments

The DO measuring system should be recalibrated prior to each process. If work is performed under sterile conditions, the system can be calibrated with the sensor in place after sterilization, but prior to inoculation. If the sensor is employed to monitor a process that extends over several days or weeks with no possibility of changing, check the electrical zero point of the sensor prior to insertion. The sensor should be fitted into the bioreactor only if the zero point of the sensor is less than the desired measuring accuracy (i.e. 2–5% of full scale).

### 3.2 Transmitter Zero Point

The electrical zero point of the transmitter should first be set to correct for the nonzero background of the oxygen sensor (see the operating instructions for the host DO transmitter located on the documentation page of the Broadley-James websites). It is critical that the sensor zero point be checked and corrective if the sensor zero current exceeds the desired measuring accuracy (i.e. 2–5% of full scale).

### 3.3 Sensor Zero Point

The zero current of the DO sensor (at 0% saturation) is usually negligibly small and almost identical with the transmitter zero point. However, the sensor zero point should be periodically checked as some sensor faults are detectable as an excessive zero current.

Zero point calibration may be carried out in pure nitrogen or in water saturated with nitrogen.

An alternative to pure nitrogen or water saturated with nitrogen is using a freshly prepared 2% bisulfite solution. The complete saturation of water with nitrogen takes approximately 30 minutes. Calibration with pure nitrogen gas is faster and more reliable. The zero point can be read after five minutes.

### 3.4 Calibration: Air Calibration

**Note: Zero point adjustment must precede air calibration.** Sensor calibration is usually performed using saturated air. Place the sensor in saturated air, and adjust the instrument's reading to 100% saturation.



### 3.5 Temperature Compensation

The Negative Temperature Coefficient (NTC) thermistor incorporated within the glass tube of the anode/cathode assembly can compensate for the effect of temperature on membrane permeability.

### 3.6 Calibration: % Saturation

A solution saturated with air is defined as 100% saturated. In large size aerated bioreactors, the sensor is usually calibrated in place after sterilization. Calibration should be carried out under flow, aeration and pressure conditions approximating as closely as possible to the expected conditions of the measurement period. During measurement, the temperature and pressure in the bioreactor should remain constant.

## Section 4: Functional Check/ Maintenance/Troubleshooting

### 4.1 Functional Check of Transmitter

The DO simulator (Part Number: AM-9222) is suitable for checking the transmitter and connecting cable for proper operation. See simulator instructions for methods.

### 4.2 Functional Check of DO Sensor

a) Place sensor in an oxygen-free atmosphere (e.g. pure nitrogen). After approximately five minutes the reading should drop below 2–5% of the air value previously set. Failing this test indicates that the zero current is too high.

b) Place sensor in the air and set the transmitter reading to 100% saturation.

c) When changing from nitrogen to ambient air, 98% of the reading should be obtained within 45 to 90 seconds.

### 4.3 Replacement of Membrane Cartridge

OxyProbe DO sensors are supplied with an installed membrane cartridge which has been checked for proper function at the factory. If sensors with fitted membrane cartridges are stored for several months after delivery, renew the electrolyte before use and verify the sensor is operational by calibrating it. Failure to pass these steps may indicate that a change of the membrane cartridge is in order.

Replace the membrane if it fails to operate properly (sluggish response, mechanical damage, etc.). Follow the instructions below to replace the membrane:

a) Unscrew the stainless steel cartridge sleeve from sensor body and pull it away from the sensor body.

   **Note:** The use of the your thumb and forefinger is all that is required for membrane cartridge removal. The use of tools is not recommended.

b) Rinse the anode/cathode assembly with DI water and dry with a clean piece of tissue paper.

c) Visually inspect the surface of the silver anode for tarnishing.

d) Check the cartridge o-rings visually for any mechanical defects such as scratches, cracks, or perforations and replace as necessary.

e) Fill the new membrane cartridge to approximately 1/8 inches (3 mm) of the top edge of the cartridge with dissolved oxygen electrolyte solution. Gently tap the cartridge to remove any large air bubble from the solution. While holding the membrane cartridge in the upright position, slide the cartridge over the anode/cathode assembly until the cartridge sleeve engages near the housing's threads. Thread the parts together until the o-ring is no longer visible. It should be a flush fit between the membrane cartridge sleeve and the outer body of the sensor.

f) Rinse all parts with DI water and wipe dry with a clean paper towel or tissue.

g) Perform a functional check after each membrane replacement.

**Caution:** The DO electrolyte is an alkaline solution with a pH of 13. Avoid contact of electrolyte with skin, mucous membrane, or eyes. If contact occurs flush all affected areas with plenty of water. We recommend the use of eye protection and rubber gloves.



## Section 5: Effects on Oxygen Sensor Performance

### 5.1 Flow Dependence

With most oxygen sensors, the sensor current level is smaller in stagnant solutions than in agitated ones. The consumption of oxygen by the sensor results in the extraction of oxygen from the test solution in close proximity to the cathode. The oxygen is replaced through diffusion. If the sensor current is large, the solution cannot fully restore the oxygen by diffusion. This results in a weaker current in the sensor than the corresponding conditions in the solution. In agitated solutions, the oxygen is transported to the surface membrane by diffusion and the flow (convection). In such cases, no oxygen depletion occurs at the membrane surface.

A high degree of flow dependence occurs mainly with large cathodes or thin and highly permeable membranes where sensor current levels are large. The problem of flow dependence is often solved by specifying a minimum flow rate.

In OxyProbe DO sensors, the thin Teflon membrane which determines the sensor current (the measuring signal) is separated from the sample solution by a thick reinforced silicone membrane. This layer is highly permeable to oxygen molecules and acts as an oxygen reservoir. The double Teflon/silicone membrane acts as an effective buffer against disturbances due to hydrodynamic flow. Combined with the OxyProbe sensor's small cathode surface area and low oxygen consumption rate, the membrane configuration makes this system ideal for use in variable flow conditions or applications of extended duration.

## Section 6: Sensor Installation and Maintenance

### 6.1 Insertion of the OxyProbe DO Sensors

Many small-scale vessels and bioreactors are fitted with a variety of compression fittings and 12 mm ports in the headplates for the installation of dissolved oxygen sensors. Insert and secure the oxygen sensor into the available fitting. Consult Broadley-James Corporation for additional assistance regarding the available fitting(s) in your vessel.

Carefully inspect all o-ring, grommet, or gasket seals for any physical damage or excessive wear. Replace if there is any doubt about the condition of any of the sealing devices. The cost of o-ring, grommet, or gasket replacements is usually quite small when compared to the cost of the media in the vessel.

### 6.2 Preventative Maintenance

OxyProbe sensors are designed for easy maintenance. Remove the membrane cartridge sleeve and observe the condition and amount of electrolyte liquid. If the sensor is dirty or the liquid level is less than 1/8 inches (3 mm) from the top, flush with DI water and refill with fresh electrolyte. Use a 40x power scope to inspect the surface of the membrane for any scratches or perforations. If any are found, replace the membrane cartridge.

Inspect the large silver anode. If a large portion is tarnished or discolored (e.g. grey, purple, grey, or black), clean it with the DO cleaning kit (Part Number: AM-9389) until the silver surface is free of most discoloration.

Visually inspect the tip of the cathode with a 10x power or higher loop for the presence of any organic/inorganic contamination/coating.

- In the case of an organic deposit, clean the tip of the cathode with a nonabrasive detergent paste and a soft paper towel.
- If a grease film is observed, clean the tip with acetone.

In there are inorganic deposits, suspend the tip of the cathode in 0.1M $H_2SO_4$ for up to 24 hours. Make sure the cathode tip is free of any deposit or film before returning to service.

This completes the instructions for this manual.

Broadley® James

Manufacturers of Sensors for Science and Industry

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