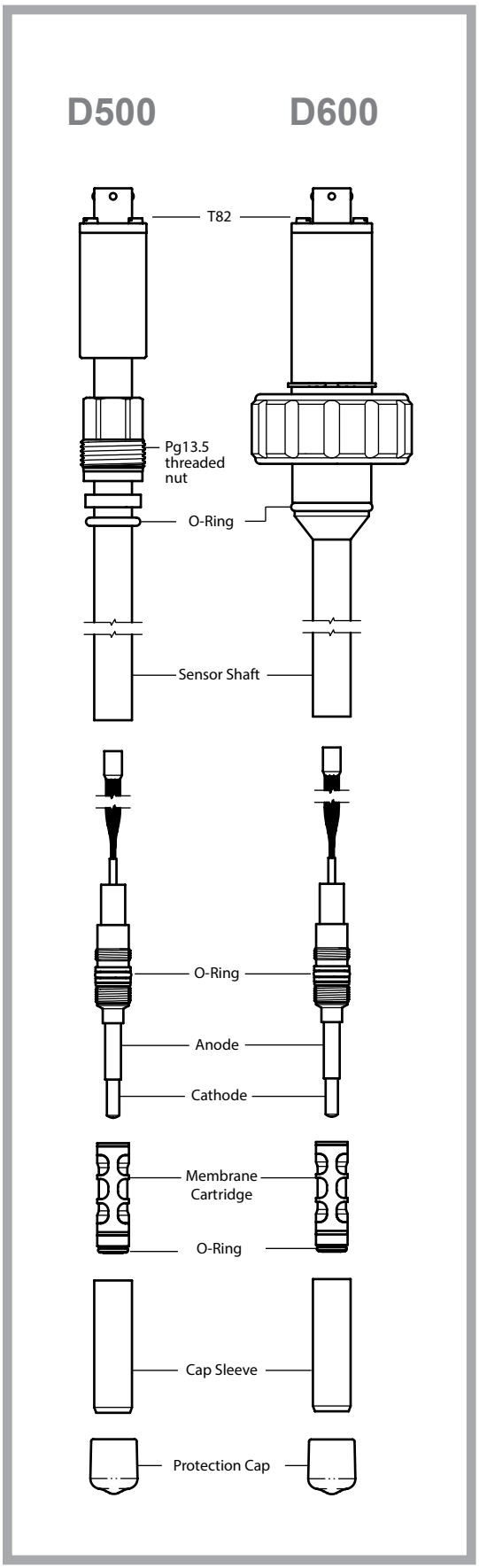
Broadley James®

OxyProbe® II
Instruction Manual



ESSENTIAL INSTRUCTIONS: READ THIS PAGE BEFORE PROCEEDING!

This product has been designed, manufactured, and tested to meet many 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; property damage; damage to this 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 us at (949) 829-5555 and the requested manual will be provided. 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 marked on and supplied with the product. Inform and educate your personnel in 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, please allow only qualified personnel to install, operate, calibrate, and maintain the product.

- When replacement parts are required, ensure that qualified people 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

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, no attempt should be made to modify them. 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.

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 by means of a precision tolerance o-ring seal.

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

IMPORTANT: EVEN 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

2.0 Sensor

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

NOTE: Save the moisture proof dust cap to protect the 4pin 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 DI water and blot dry. When the D.O. transmitter is switched on, a polarization voltage is applied between the anode and cathode. The sensor current is initially very high, but then falls off exponentially and settles down to a steady state after a few minutes. Since this polarization period is relatively long, the sensor should be kept connected to a powered transmitter or polarizing unit when not in use. Owing to the very small current flowing through the sensor under these conditions, its life will not be shortened. 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.

2.1 Transmitter

The transmitter to be used with OxyProbe D.O. sensors must be properly matched with the sensor. Oxygen sensors differ in regard to output current, polarization voltage, and temperature compensation technique. Therefore, the sterilizable D.O. sensor requires a transmitter with precisely defined characteristics. The transmitter specifications must be carefully examined to verify compatibility. If there is any question regarding sensor and transmitter compatibility, contact your Broadley-James representative or call 949-829-5555 for factory assistance.

2.2 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 that the ground terminals of all ancillary instruments be connected together and taken to a known good ground point.

Section 3: Calibration

3.0 Calibration Comments
The dissolved oxygen measuring system should be recalibrated prior to each fermentation. 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 fermentation process that extends over several days (or weeks) with no possibility of changing it, the electrical zero point of the sensor should be checked before insertion. The sensor should be fitted into the fermenter only if the zero point of the sensor is less than the desired measuring accuracy (i.e. 2–5% of full scale).

3.1 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 D.O. transmitter). It is critical that the sensor zero point be checked and corrective actions taken if the sensor zero current exceeds the desired measuring accuracy (i.e. 2–5% of full scale).

3.2 Sensor Zero Point
The zero current of the D.O. sensor (reading at 0% saturation) is usually negligibly small and almost identical with the transmitter zero point. Nonetheless the sensor zero point should be periodically checked as some sensor faults, which may compromise sensor performance, are detectable as an excessive zero current.

Zero point calibration may be carried out in both pure nitrogen or in water saturated with nitrogen. A further alternative is the use of 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 5 minutes.

3.3 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.

3.4 Temperature Compensation
The NTC thermistor incorporated within the glass tube of the anode/cathode assembly can automatically provide for temperature compensation relating to the effect of temperature on membrane permeability.

3.5 Calibration: % Saturation
A solution saturated with air is defined as 100% saturated. In large size aerated fermenters 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 those conditions expected to be encountered during the required measurement period. During measurement, the temperature and pressure in the fermenter should remain constant.

Section 4: Functional Check/Maintenance/Troubleshooting

4.0 Functional Check of Transmitter
The D.O. Simulator (Part number AM-9222) is suitable for checking the transmitter and connecting cable for proper operation. See simulator instructions for methods.

4.1 Functional Check of D.O. Sensor
a) Place sensor in an oxygen-free atmosphere (e.g. pure nitrogen). After approximately 5 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 air and set transmitter reading to 100% saturation.

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

4.2 Replacement of Membrane Cartridge
OxyProbe D.O. sensors are supplied with an installed membrane cartridge which has been checked for proper function at the factory. Should sensors with fitted membrane cartridges be stored for several months after delivery, the electrolyte should be renewed before use and the proper sensor operation verified by checking the sensor zero point and calibration in room air. Failure to pass these steps may indicate that a change of the membrane cartridge is in order.

If the membrane fails to operate (e.g. sluggish response, mechanical damage, etc.) it must be replaced. In doing so, observe the following instructions:

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

b) Use of thumb and forefinger for removal of the membrane cartridge is all that should be required. The use of tools is not recommended.

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

d) Visually inspect the surface of the silver anode to see that it is still bright and not very tarnished.

e) Check the cartridge o-ring(s) visually for any mechanical defects such as scratches, cracks, or perforations. Replace it if necessary.

f) Fill the new membrane cartridge to within approximately 1/8" (3 mm) of the top edge of the cartridge with dissolved oxygen electrolyte solution. Gently tap the cartridge until any large air bubbles have been removed from the electrolyte. 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 can no longer be seen. It should be a flush fit between the membrane cartridge sleeve and the outer body of the sensor.

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

h) Perform a functional check after each membrane replacement.

CAUTION: THE D.O. 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. USE OF EYE PROTECTION AND RUBBER GLOVES IS RECOMMENDED.

Section 5: Effects on Oxygen Sensor Performance

5.0 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 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 sensor current weaker than the corresponding conditions in the solution. In agitated solutions the oxygen is transported to the surface membrane not only by diffusion but additionally by the flow (convection). In that case 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 D.O. sensors, the thin Teflon membrane which determines the sensor current (the actual measuring signal) is separated from the sample solution by a relatively thick reinforced silicone membrane. This layer is highly permeable to oxygen molecules and thus acts as an oxygen reservoir. The double Teflon/silicone membrane therefore acts as an effective buffer against disturbances due to hydrodynamic flow. Combined with the OxyProbe sensor's small cathode surface area and resulting 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

6.0 Insertion of the OxyProbe D.O. Sensors

Many small scale fermentation vessels and bioreactors are fitted with a variety of compression fittings and 12 mm ports in the headplates for 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 replacement is usually quite small when compared to the cost of the media in the vessel.

6.1 Preventative Maintenance

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

Inspect the large silver anode. If a large portion of it is tarnished or discolored (e.g. grey, purple/grey, or black), clean with the D.O. 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 better) loop for the presence of any organic/inorganic contamination/coating.

- In the case of an organic deposit, clean the tip of the cathode with nonabrasive detergent paste and a soft paper towel.
- If a grease film is observed, clean the tip with acetone.
- In the event of an inorganic deposit, clean by suspending the tip portion only of the cathode in 0.1M H_2SO_4 for up to 24 hours. The cathode tip should be free of any deposit or film before being returned to service.

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