

Instruction Manual



Model D200 & D400 OxyProbe® Series

Manufacturers of Sensors and Process Control Automation

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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, telephone (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, use qualified personnel to install, operate, update, 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.

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Tables

1	Oxygen Solubility in air-saturated pure water in mg O ₂ /L at an overall pressure of a water-vapor saturated atmosphere of 760 mm Hg	1=
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Chapter 1: Technical Data

1.0 Technical Data

Sensor body:	316L stainless steel
Membrane:	Teflon / silicone (steel-mesh reinforced)
Membrane cartridge:	High-temperature resistant plastic (PPS)
Cathode:	Platinum (Pt)
Anode:	Silver (Ag)
Electrolyte:	KOH / KCl solution, pH 13
Response time:	98% of readout in
@25°C	60 seconds
@37°C	20 seconds
Stability:	In water, under constant pressure and at a constant temperature drift amounts to less than 2% per week
Flow dependence:	Readings in stirred and unstirred solutions differ by approximately, 3 – 5 %.
Polarization voltage:	675 mV
Electrode current in ambient air:	Approximately 60×10^{-9} amps
Electrode current in N ₂ :	< 1% of current in ambient air
Temperature coefficient of membrane at constant O ₂ partial pressure:	Approximately 2.3% / K at 25°C
Temperature range:	Operation: 0 – 80°C Sterilization: maximum 130°C
Temperature compensation:	Automatic with built-in thermistor, 22K @ 25°C
Linearity:	< 0.3% of readout
Maximum pressure:	58 psig, 4 bar (atm)
Cable connection:	Standard 4-pin
Wetted materials:	All metal parts in contact with sample solution are made of 316L stainless steel.
O-ring seal:	Silicone Rubber

Chapter 2: OxyProbe Features

2.1 Sensor Construction

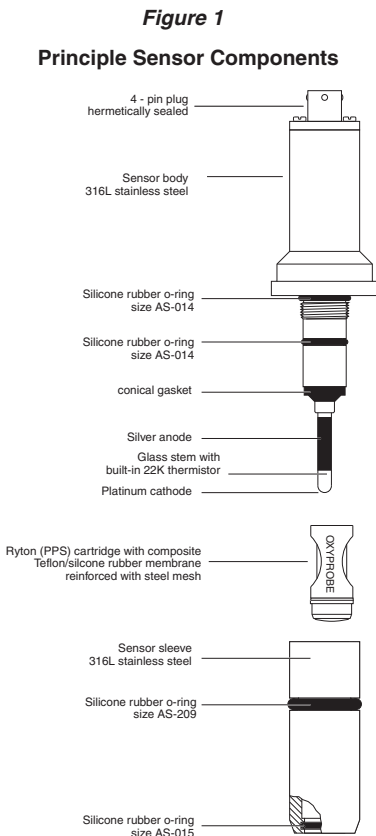
The principle components of the oxygen sensor are shown in Figure 1. All parts are made of heat resistant materials.

The sensing element is comprised of a glass tube that is sealed at one end with a fused Pt 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 is positioned over the glass tube. A thermistor for the temperature compensation of sensor current is also incorporated within the glass tube. The tube is then mounted and sealed into a stainless steel threaded holder. This comprises the anode/cathode assembly, which is easily threaded into the sensor housing with a simple tool.

The membrane cartridge, when filled with electrolyte, is gripped by the thumb and forefinger slots (which forces out any trapped air) and is slid over the end of the anode/cathode assembly. It is sealed at the lower end with a fixed, reinforced, gas-permeable membrane, and is surrounded by a flexible silicone sleeve. This enables the electrolyte to expand during sterilization operations. The stainless steel sensor sleeve forces the membrane cartridge against the conical silicone washer. At the same time optimum pressure of the gas-permeable membrane against the cathode is obtained.

IMPORTANT: EVEN AFTER ASSEMBLY, THE GLASS ROD EXTENDS A SLIGHT DEGREE BEYOND THE ENDCAP. THOUGH COVERED BY THE MEMBRANE, IT CAN BE DAMAGED BY SHARP BLOWS.





Chapter 3: Preparation

3.0 PREPARATION

3.1 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 4-pin connector. See Figure 2 for removal procedures for these protective caps.

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

Begin the sensor preparation by following the step by step procedures as shown in

Figures 2 through figure 7 inclusive.

After performing the steps for the removal of the protective caps, as shown in Figure 2, proceed with the MEMBRANE CARTRIDGE REFILL and INSTALLATION instructions as shown in Figure 3 and Figure 4.

The OxyProbe sensor is now ready to re-assemble by replacing the stainless steel sensor sleeve as shown in Figure 5.

Continue with the final assembly step of the OxyProbe sensor by installing the cap nut as shown in Figure 6.

The final step in the sensor preparation involves the POLARIZATION of the sensor which is accomplished as shown in Fig. 7.

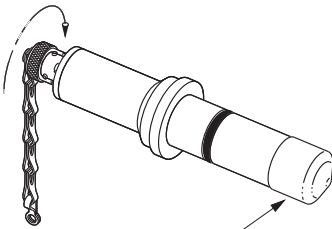


Figure 2

OxyProbe® Protective Cap Removal

Step 1

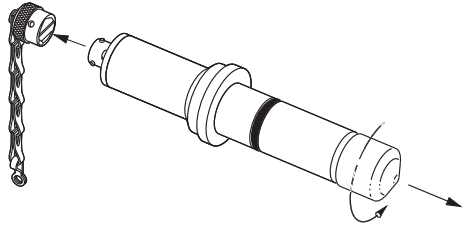
Remove moisture proof dust cap from 4-pin connector by applying a quarter-turn twist in the direction of the arrow as shown.



Cathode/Anode
Protective Boot

Step 2

Remove the protective boot from sensor body by twisting and pulling in the direction of the arrows as shown.



Step 3

Remove the optional moisture proof dust cap from cable connector by applying a quarter-turn twist in the direction of the arrows as shown.

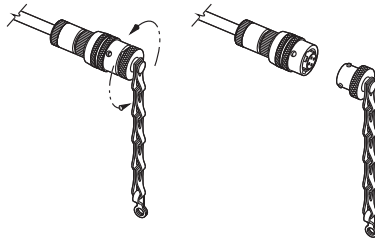
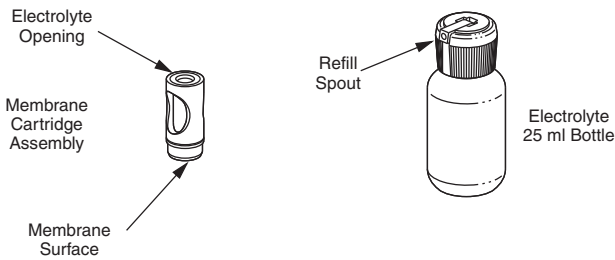




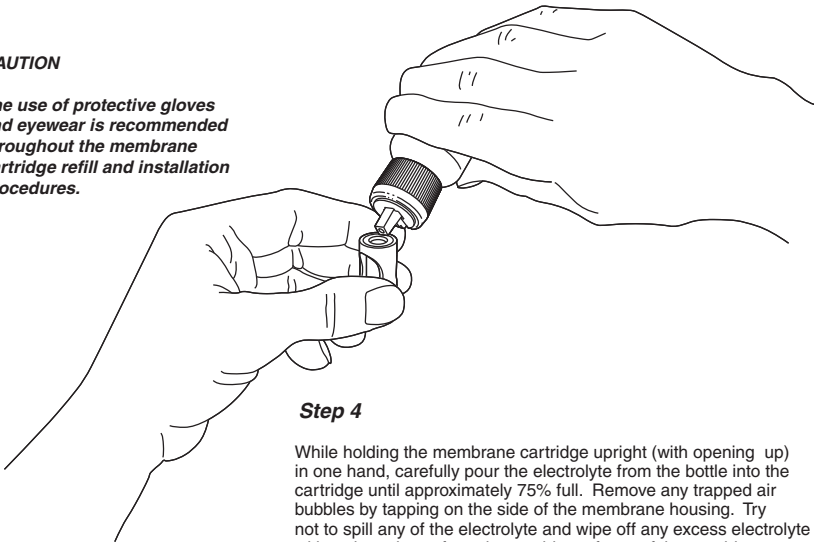
Figure 3

Membrane Cartridge Refill



CAUTION

The use of protective gloves and eyewear is recommended throughout the membrane cartridge refill and installation procedures.

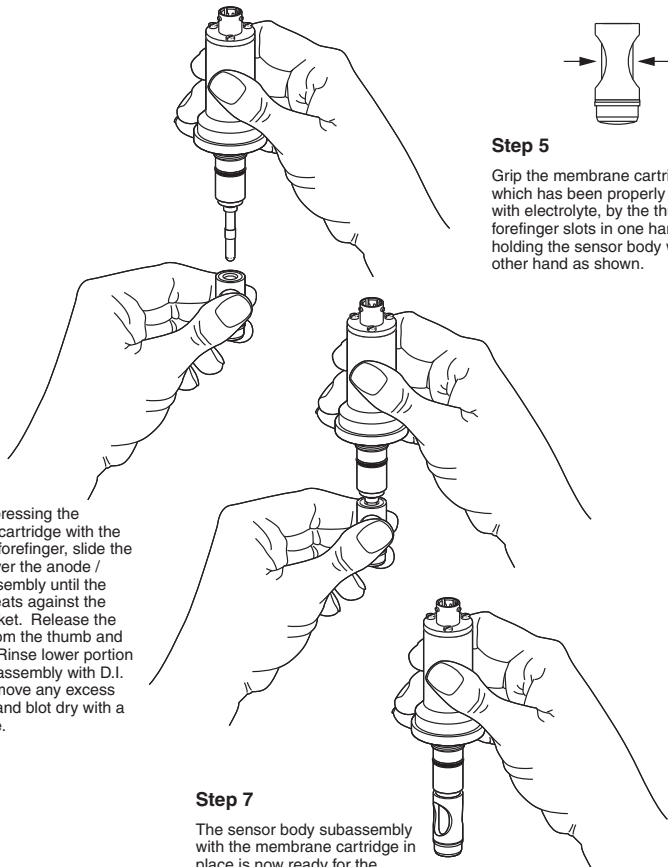


Step 4

While holding the membrane cartridge upright (with opening up) in one hand, carefully pour the electrolyte from the bottle into the cartridge until approximately 75% full. Remove any trapped air bubbles by tapping on the side of the membrane housing. Try not to spill any of the electrolyte and wipe off any excess electrolyte with a clean tissue from the outside surfaces of the cartridge.



Figure 4
Membrane Cartridge Installation



Step 5

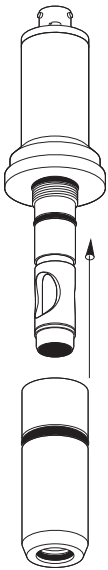
Grip the membrane cartridge, which has been properly filled with electrolyte, by the thumb and forefinger slots in one hand while holding the sensor body with the other hand as shown.

Step 6

While compressing the membrane cartridge with the thumb and forefinger, slide the cartridge over the anode / cathode assembly until the cartridge seats against the conical gasket. Release the pressure from the thumb and forefinger. Rinse lower portion of this sub-assembly with D.I. water to remove any excess electrolyte and blot dry with a clean tissue.

Step 7

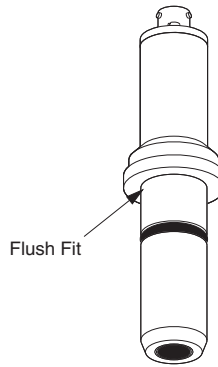
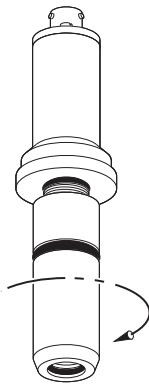
The sensor body subassembly with the membrane cartridge in place is now ready for the installation of the stainless steel sensor sleeve .

**Figure 5****Stainless Steel Sensor Sleeve Installation****Step 8**

Slide the stainless steel sensor sleeve over the membrane cartridge, being careful not to nick the o-rings. Be certain that the mating threads of the sleeve and sensor body are free of any dirt or debris.

Step 9

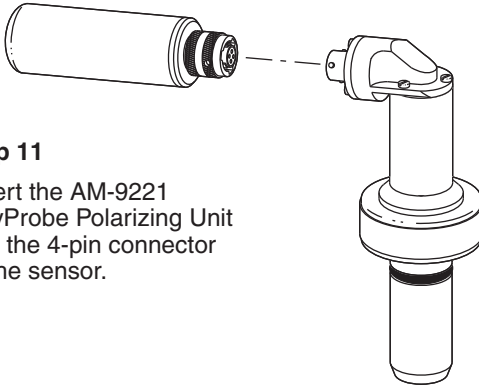
Thread the stainless steel sensor sleeve onto the sensor body in the direction shown by the arrow. Be certain that the sleeve is flush with the sensor body so that no o-rings are visible. **Do not overtighten.** Hand tight is all that is necessary.

**Note:**

Carefully inspect all O-rings and the conical gasket for any physical damage or excessive wear. Replace these items as needed or if there is any doubt as to their condition.

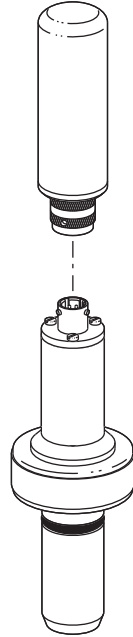


Sensor Polarization



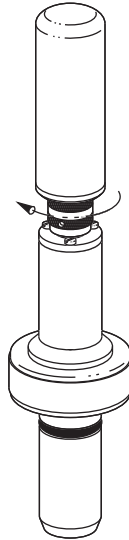
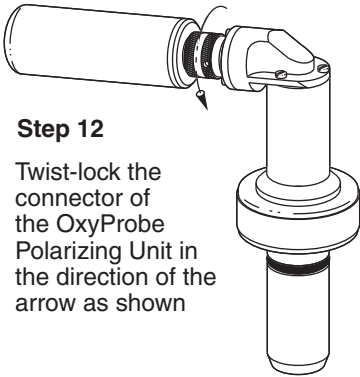
Step 11

Insert the AM-9221 OxyProbe Polarizing Unit into the 4-pin connector of the sensor.



Step 12

Twist-lock the connector of the OxyProbe Polarizing Unit in the direction of the arrow as shown



NOTE: SENSOR POLARIZATION MAY ALSO BE ACHIEVED BY CONNECTING THE SENSOR TO THE HOST DO TRANSMITTER WHICH IS POWERED.

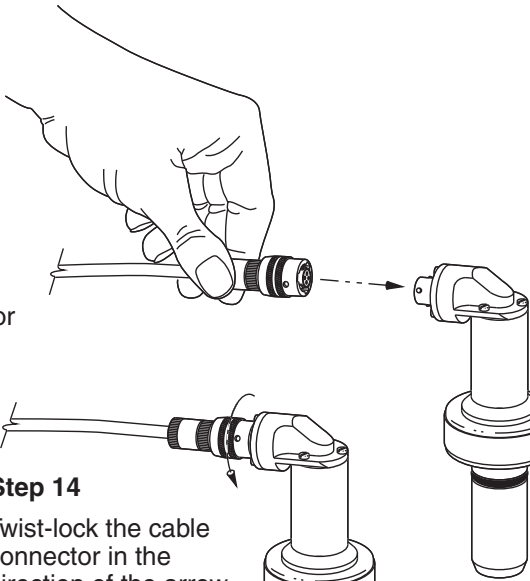


Figure 8

AX-5000 Cable Connection to Sensor

Step 13

Insert the 4-pin cable connector into the mating 4-pin connector of the sensor.



Step 14

Twist-lock the cable connector in the direction of the arrow as shown.

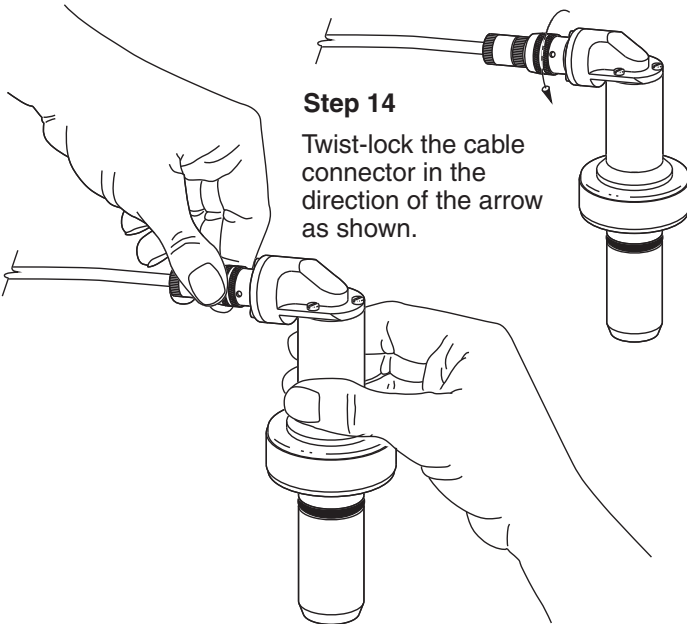


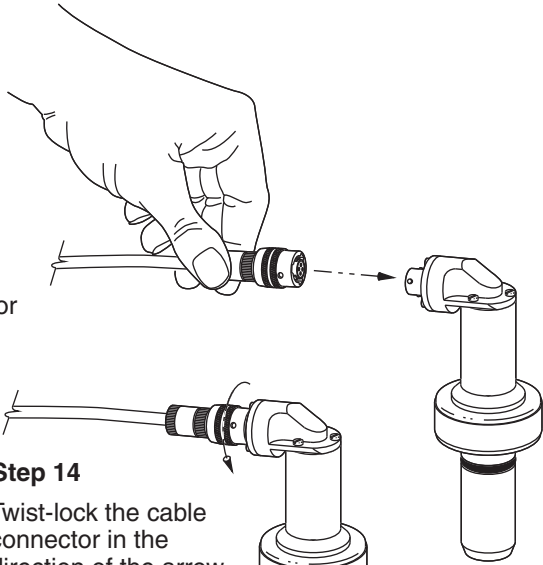


Figure 8

AX-5000 Cable Connection to Sensor

Step 13

Insert the 4-pin cable connector into the mating 4-pin connector of the sensor.



Step 14

Twist-lock the cable connector in the direction of the arrow as shown.

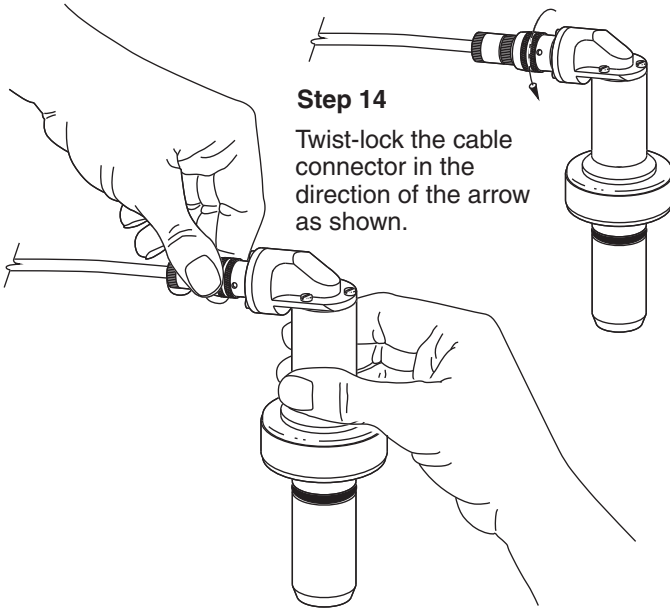
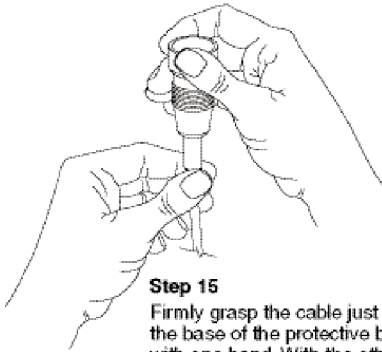


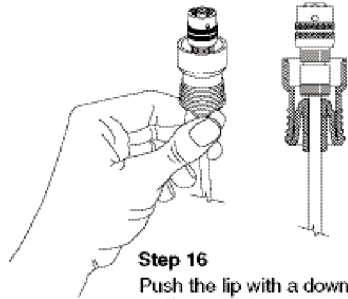


Figure 8b
AX-5100 Cable Connection to Sensor



Step 15

Firmly grasp the cable just below the base of the protective boot with one hand. With the other hand grasp the lip of the protective boot.

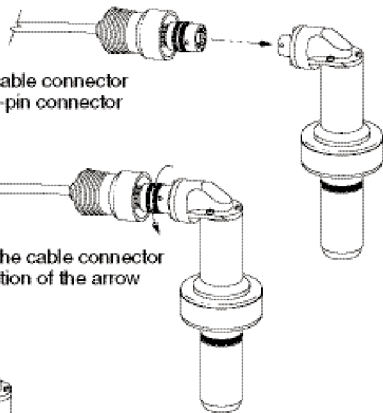


Step 16

Push the lip with a downward motion until the protective boot folds over the base of the boot exposing the 4-pin cable connector as shown.

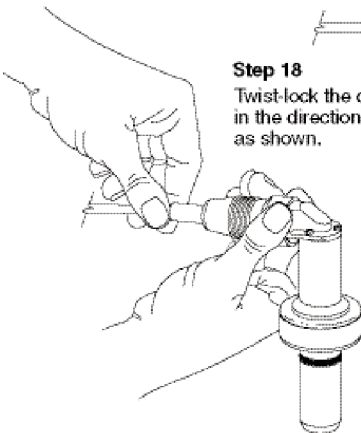
Step 17

Insert the 4-pin cable connector into the mating 4-pin connector of the sensor.



Step 18

Twist-lock the cable connector in the direction of the arrow as shown.



Step 19

While firmly holding the cable at the base of the protective boot, slide the folded portion of the boot in the direction of the sensor until the protective boot is secured in place as shown.



When the 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 steady state after a few hours. Since this polarization period is relatively long, the sensor should be kept connected to a powered transmitter or polarizing unit (Part Number: AM-9221) 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 (See Section 4.2) may indicate incomplete polarization.

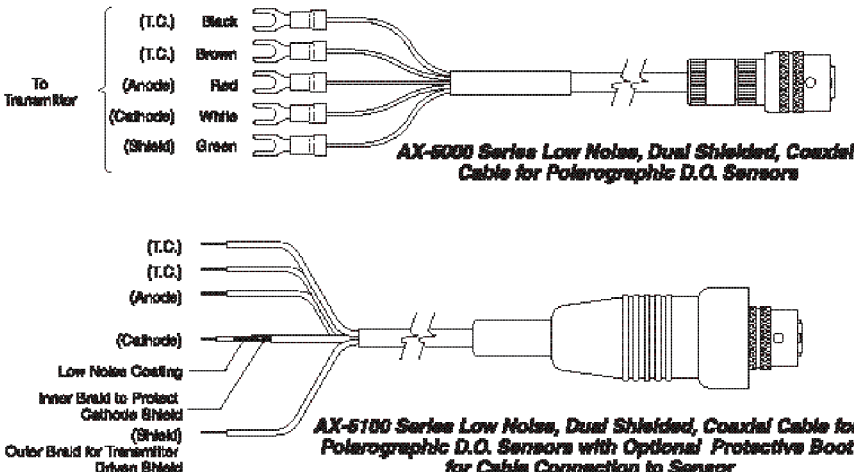
3.2 Sensor Cable

The oxygen sensor cable is provided in two configurations: (1) the AX-5100 with a protective connector boot; or (2) the AX-5000 without the boot. See Figures 6 – 8 for cable to sensor connections and descriptions.

Refer to the wiring diagram of the DO transmitter selected for use with the OxyProbe for proper connection of the sensor.

Figure 9

OxyProbe® Sensor Cables





3.3 Transmitter

The transmitter to be used with OxyProbe DO 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 DO 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.

3.4 Remote Recording and Control Devices

The signal circuits of all such 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.



Chapter 4: Calibration

4.1 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). If the zero point of the sensor is greater than this threshold consult the recommendations in Section 5.4 (Troubleshooting) for corrective action.

4.2 Transmitter Zero Point

The electrical zero point of the transmitter should first be set to correct for the non-zero background of the oxygen sensor (see the operating instructions for the host DO 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).

4.3 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.

4.4 Calibration at Air Calibration

Zero point adjustment (Section 4.3) must precede calibration at air saturation. In comparison to zero point calibration, the aqueous phase is preferred for saturation calibration. The following problems arise with calibration air:

Calibration in a fermenter should be performed only after sterilization as sterilization may alter the sensor's membrane tension. This alteration may be comparatively large, particularly when a membrane cartridge is used for the first time.

After cooling, the fermenter is aerated. Depending on the host instrument's calibration method, the calculated oxygen concentration is set in units of mg O₂ /L (ppm), or % saturation.

Calibration is usually performed at air saturation since it is convenient and simple. If this method is chosen, the reading is adjusted to 100% saturation. As partial pressure of oxygen is dependent on total applied pressure, the 100% adjustment should be done under actual operating pressure.



See Figures 13 through 15 for exploded-view drawings and itemized parts lists of the OxyProbe 12 mm sensors.

4.5 Measurement with and without 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. This temperature measurement provides the necessary input for the algorithm calculation of the ppm read-out.

4.6 Calibration: % of Atmospheric Oxygen

A solution saturated with air is defined as 100% saturated. In large-size aerated fermenters the sensor should be 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.

4.7 Calibration : mg O₂ / L

TABLE 1

Oxygen solubility in air-saturated pure water in mg O₂ /L at an overall pressure of a water-vapor saturated atmosphere of 760 mm Hg

Temp. °C	Solubility in mg O ₂ /L	Temp. °C	Solubility in mg O ₂ /L
0	14.57	20	9.06
2	13.79	22	8.71
4	13.08	24	8.39
6	12.42	26	8.09
8	11.81	28	7.81
10	11.26	30	7.55
12	10.74	32	7.30
14	10.27	34	7.07
16	9.83	36	6.84
18	9.43	38	6.63
		40	6.42



In determining oxygen concentration, the O₂ content of the calibrating solution must be accurately known. The values applying to pure water are known and shown in Table 1. These solubilities need only be adjusted to the prevailing barometric pressure P_B.

Solubility(P_B) = solubility(at 760 mm Hg) x

P_B / 760

This calibration is reliable only if measurements are affected by dilute aqueous solutions. In concentrated solutions the oxygen solubility must first be determined by a Winkler titration.



Chapter 5: Functional Check/ Maintenance/Trouble Shooting

5.1 Functional Check of Transmitter

The DO Simulator (Part number AM-9222) is suitable for checking the transmitter and connecting cable for proper operation.

5.2 Functional Check of DO Sensor

a) Place sensor in air-saturated water and set transmitter reading to 100% saturation.

b) 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. See Section 5.4 for troubleshooting such a problem.

c) Response time: when changing from nitrogen to ambient air, 98% of the reading should be obtained within 45 to 90 seconds. If this is not the case, consult Section 5.4 for appropriate action.

5.3 Replacement of Membrane Cartridge

OxyProbe DO sensors are supplied with an installed membrane cartridge which has been checked for proper function at the factory. 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 needed.

If the membrane fails to operate (sluggish response, mechanical damage, etc.) it must be replaced. In so doing, observe the following instructions (Refer to Figures 3 through Fig. 5 inclusive):

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

b) Compress thumb and forefinger recesses of the membrane cartridge carefully pulling it with a slight twisting action from the anode/cathode and sensor body assembly. (If the membrane cartridge remains in the stainless steel sensor sleeve, it may be dislodged by pressing on the end of the membrane. Use a tissue to avoid direct contact with the membrane surface).

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

d) Check all o-rings and the conical gasket visually for mechanical defects and replace if necessary.

e) Fill the new membrane cartridge to 75% full with dissolved oxygen electrolyte solution (P/N: AS-3140-C30-0025). Gently tap the cap until the remaining air bubbles have been removed from the electrolyte. Remove all excess air from the membrane cartridge by



compressing the thumb and forefinger recesses of the membrane cartridge. Slide the cartridge over the anode/cathode assembly until the cartridge seats against the conical gasket. Release the pressure from thumb and forefinger to draw electrolyte into the space between the body of the membrane cartridge and the silicone sleeve.

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

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. Use of eye protection and rubber gloves is recommended.

g) Carefully slip the stainless steel sensor sleeve over the fitted membrane cartridge and thread it back onto the anode/cathode and sensor body assembly. Be certain that the mating threads are clean and free of any debris.

h) Perform a functional check as per Section 5.2 after each membrane replacement.

5.4 Troubleshooting

A) CONDITION – Sensor is non-responsive, i.e. sensor current equals zero.

POSSIBLE CAUSES

- **Cable Interruption:**

See functional check Section 5.1. Subsequently check measuring cable for continuity using an ohmmeter.

- **Heavily contaminated or defective membrane:**

Gently clean membrane surface with a clean tissue wetted with distilled or DI water or replace membrane cartridge.

- **No internal electrolyte:**

Disassemble and refill with fresh electrolyte.

B) CONDITION – Zero current of sensor too high:

POSSIBLE CAUSES

- **Partial short-circuit in sensor cable:**

Disconnect cable from sensor and set the transmitter in the nA mode, the reading should be < 1.0 nA. If not, there is either a short-circuit in the sensor cable, in which case the cable must be replaced.

- **Partial short-circuit or moisture in interior of sensor body:**

Remove the stainless steel membrane cartridge assembly from the sensor housing. Carefully clean the anode/cathode area of the inner sensor body with acetone and allow to dry. Do not allow the acetone to come in contact with the o-rings.

Connect sensor to the cable and the cable to the transmitter and set the transmitter in the nA mode. The reading should be < 1.0 nA. If not, there is either a short-circuit in the anode/cathode subassembly or in the sensor connector. The defective component must be replaced.

C) CONDITION – Excessive response time:



POSSIBLE CAUSE

• **Deposits on membrane:**

Perform a careful mechanical cleaning using moist tissue or soft cloth, or change membrane.

D) CONDITION – Reading is much too high in all measuring ranges:

POSSIBLE CAUSES

• Interruption of temperature compensating measurement circuit:

Remove thermistor leads (black & brown) from the transmitter and test with ohmmeter. The resistance across these leads at room temperature should be between 20 and 30 K ohms.

• In case of large and rapid pressure changes (or total pressure above 58 psig, 4 bar) the pressure of the gas-permeable membrane against the glass body may affect the thin electrolyte film behind the membrane and consequently the sensor output current. This often generates a high and unstable current which settles down again after a matter of hours. Avoid large and rapid pressure changes, particularly after sterilization.



Chapter 6: Effects on Oxygen Sensor Performance

6.1 Flow Dependence

With most oxygen sensors the sensor current level is smaller in a stagnant solution than in agitated ones. The consumption of oxygen by the sensor results in extraction of oxygen from the test solution in the close proximity of 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 would correspond to 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 (i.e. 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 (i.e. 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.

6.2 Oxygen Partial Pressure vs. Oxygen Concentration

The sensor current depends on the oxygen partial pressure and the O₂ permeability of the membrane — but not on the O₂ solubility in the solution of interest. Without a prior knowledge of the oxygen solubility in the solution of interest, the oxygen concentration in mg O₂ / L (C_L) cannot be determined directly with a sensor.

Medium saturated with air	Solubility at 20°C 760 mm Hg (ppm)	% Saturation
Water	9.1 mg O ₂ / L	100%
4 mol/KCl	2.0 mg O ₂ / L	100%
50% Methanol-water	21.9 mg O ₂ / L	100%



According to Henry's law the oxygen concentration is proportional to its partial pressure (PO_2).

$$C_L = (\text{PO}_2) (a)$$

a = solubility factor

If a is constant and either C_L or a values are known, the oxygen concentration can be determined by means of the sensor. This methodology only applies at constant temperature and with dilute aqueous solutions such as drinking water.

The solubility factor is strongly influenced not only by the temperature, but also by the com-

position of the solution.

Although the solubilities vary widely, the oxygen sensor gives the same reading in all three solutions.

This determination of the oxygen concentration is only possible with constant and known solubility factors a .

Solubility may be determined by a Winkler titration or the method developed by Kappeli and Fiechter.



Chapter 7: Sensor Installation & Maintenance

7.1 Insertion of the OxyProbe DO Sensors

Most fermentation vessels and bioreactors are fitted with either 19mm or 25mm ports for installation of dissolved oxygen sensors. Insert and secure the oxygen sensor as shown in Figure 11 and Figure 12.

Carefully inspect the large o-ring on the sensor sleeve for any physical damage or excessive wear. Replace as needed or if there is any doubt about the condition of this o-ring. The cost of o-ring replacement is usually quite small when compared to the cost of the media in the vessel.

7.2 Preventative Maintenance

The OxyProbe sensors are designed to provide a proper seal with the mating weld-in port on the vessel/reactor when the cap nut is hand tightened. Over-tightening of the cap nut with tools will not improve this seal and may in fact damage the sensor and/or the weld-in port. The perceived need for over tightening is usually a good indication that there is a problem with the concentricity, roundness, or surface finish of the ID surface of the mating weld-in port.

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 less than 75% full, 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 surface area Ag anode. If a large portion of it is tarnished or discolored; e.g. grey, purple/grey, or black; clean with 12 MICRON 3M IMPERIAL® LAPPING FILM (aluminum oxide sheets) or toothpaste and soft paper towel until the Ag 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 tooth-paste and a soft paper towel.

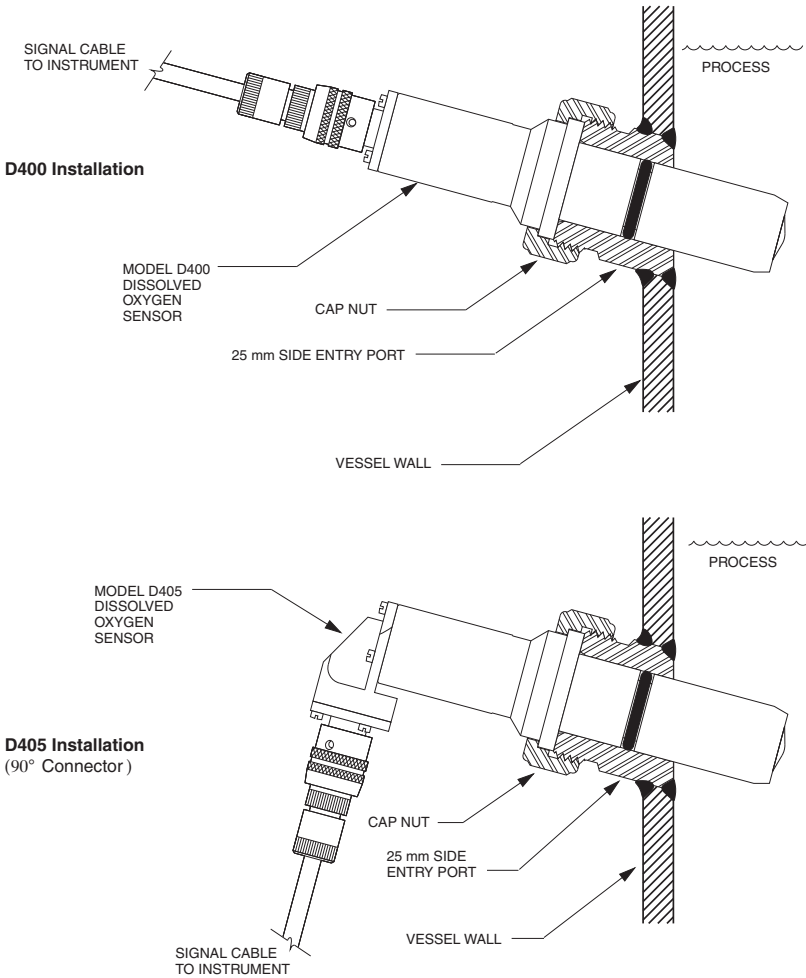
If a grease film is observed, clean with acetone. In the event of an inorganic deposit, clean by suspending the tip portion only of the cathode in 0.1M H₂SO₄ for up to 24 hours.

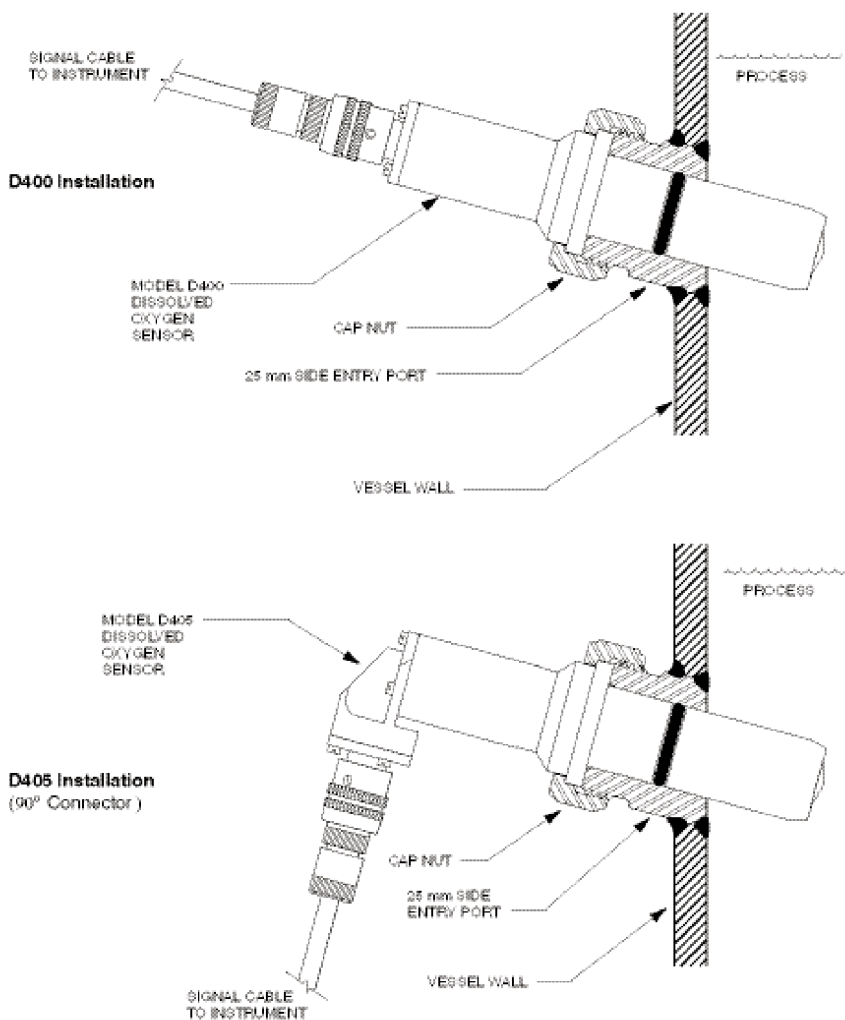
The cathode tip should be free of any deposit or film before being returned to service.



Figure 11

OxyProbe® Sensor Typical Installation Diagrams



**Figure 12****OxyProbe® Sensor Typical Installation Diagrams**

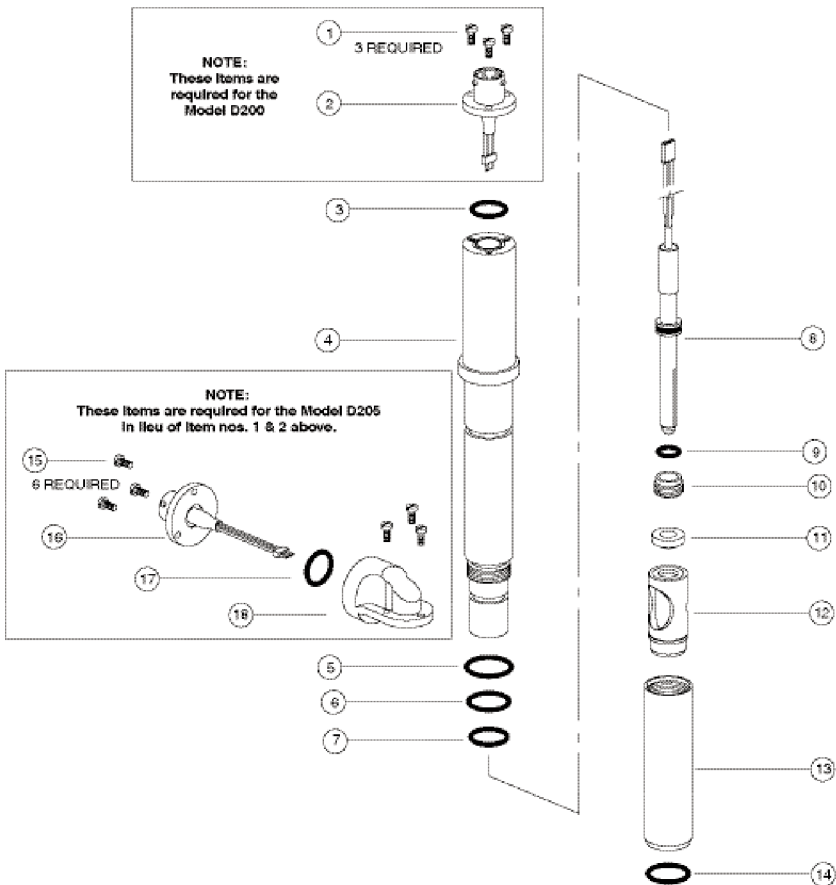


Chapter 8: Replacement and Spare Parts

Figure 13

D200 & D205 OxyProbe® Sensor Assembly

See Itemized List for Part Number & Description





D200/D205 OxyProbe® Sensor Assembly

EXPLODED VIEW, ITEMIZED PART NUMBER & DESCRIPTIONS

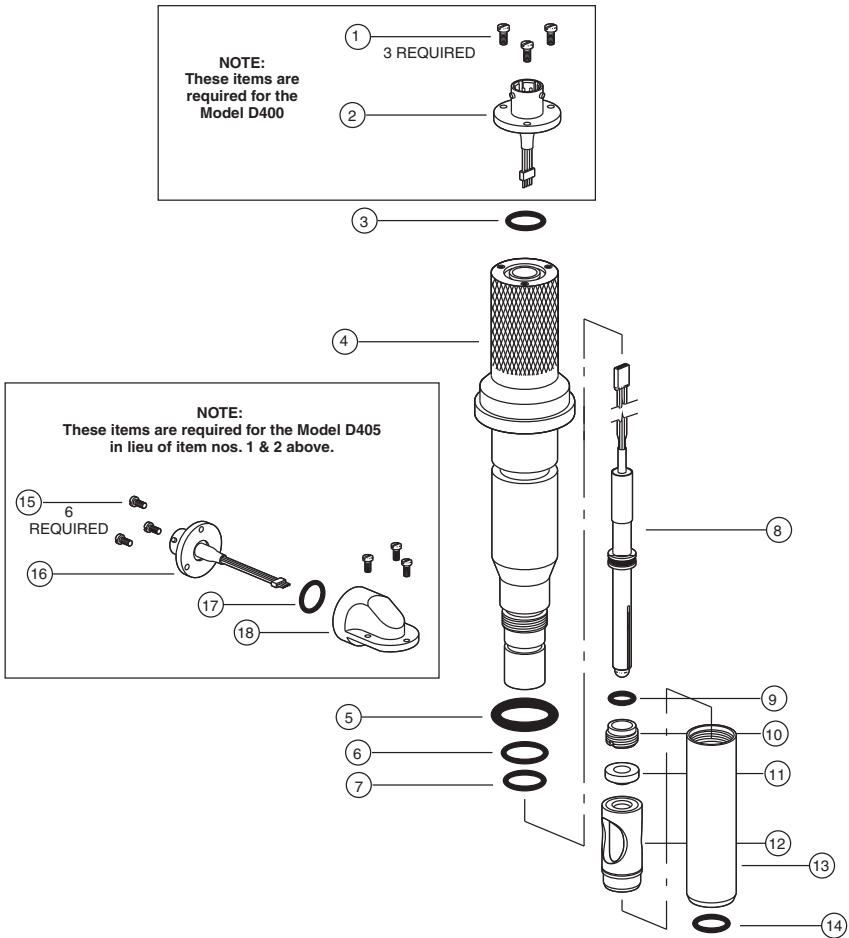
Item	Part Number	Description
1	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3
2	AM-9203	4-Pin Connector, glass to metal seal with ribbon/micro cable disconnect
3	AM-9316	O-ring, EPDM, size: 10.4 x 1.0 for use w/AM-9203 4-Pin Connector
4a	AM-9341	Sensor Body, 316L stainless steel, for B=150 mm D200/205 sensors
4b	AM-9342	Sensor Body, 316L stainless steel, for B=220 mm D200/205 sensors
4c	AM-9343	Sensor Body, 316L stainless steel, for B=320 mm D200/205 sensors
4d	AM-9344	Sensor Body, 316L stainless steel, for B=420 mm D200/205 sensors
5	AM-9345	O-ring, Silicone, size: AS-016
6	AM-9231	O-ring, Silicone, size: AS-014
7	AM-9231	O-ring, Silicone, size: AS-014
8a	CT25-PT-130MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=150 mm D200/205 sensors
8b	CT25-PT-130MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=220 mm D200/205 sensors
8c	CT25-PT-130MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=230 mm D200/205 sensors
8d	CT25-PT-130MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=420 mm D200/205 sensors
9	AM-9307	O-ring, EPDM, size: AS-011
10	AM-9210	Retainer Ring Nut, 316L SST for CT25 Cathode/Anode assembly
11	AM-9233	Conical Gasket, silicone
12	AM-9234	Membrane Cartridge for D200 and D400 Series sensors
13	AM-9239	Sensor Sleeve, 316L SST, D200 / D205 sensors
14	AM-9236	O-ring, Silicone, size: AS-015
15	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3 (2 sets required)
16	AM-9347	4-Pin Connector, glass to metal seal w/ribbon/micro cable disconnect
17	AM-9315	O-ring, EPDM, size: AS-014
18	AM-9348	Right Angle connector / Adapter assembly



Figure 15

D400-B150 & D405-B150 OxyProbe® Sensor Assembly

See Itemized List for Part Number & Description





D100/D105 OxyProbe® Sensor Assembly ITEMIZED PART NUMBER & DESCRIPTIONS

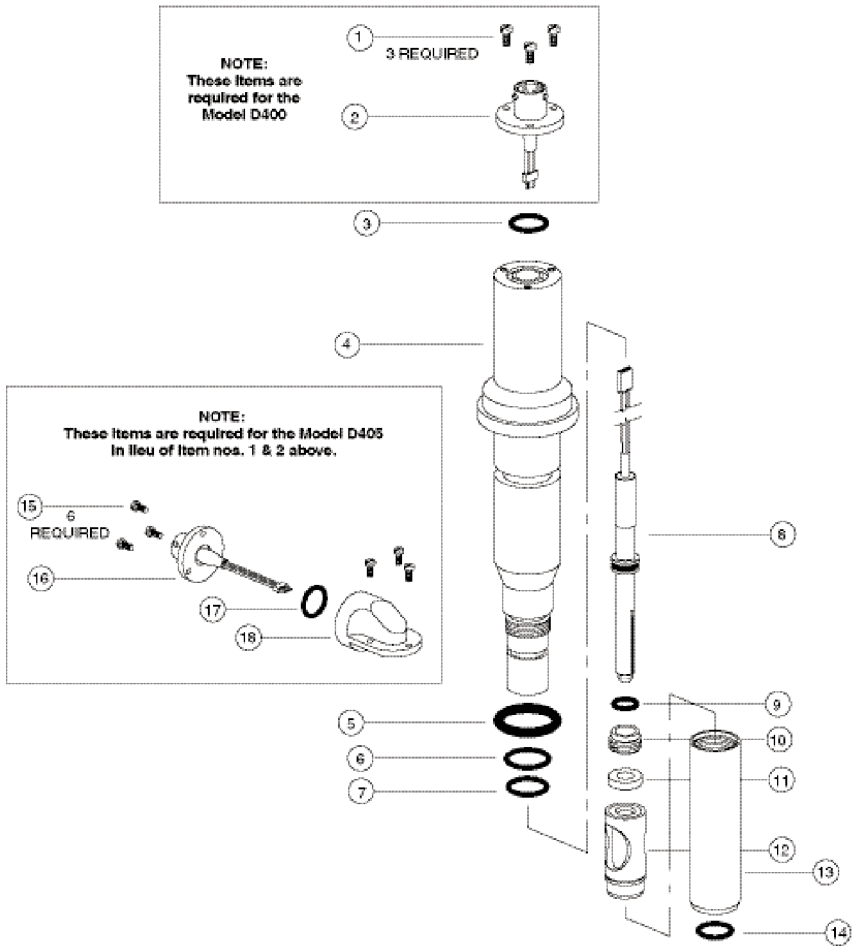
Item	Part Number	Description
1	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3
2	AM-9202	4-Pin Connector, glass to metal seal with ribbon/micro cable disconnect
3	AM-9315	O-ring, EPDM, size: AS-014
4	AM-9232	Sensor Body, 316L stainless steel, for B=070 mm D400/405 sensors
5	AM-9231	O-ring, Silicone, size: AS-014
5	AM-9231	O-ring, Silicone, size: AS-014
7	CT25-PT-050MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=070 mm D400/405
8	AM-9307	O-ring, EPDM, size: AS-011
9	AM-9210	Retainer Ring Nut, 316L SST for CT25 Cathode/Anode assembly
10	AM-9233	Conical Gasket, silicone
11	AM-9234	Membrane Cartridge for D200 and D400 Series sensors
12	AM-9235	Sensor Sleeve, 316L SST, for B=070 mm D400/405 sensors
13	AM-9237	O-ring, Silicone, size: AS-209
14	AM-9236	O-ring, Silicone, size: AS-015
15	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3 (2 sets required)
16	AM-9349	4-Pin Connector, glass to metal seal with ribbon/micro cable disconnect
17	AM-9315	O-ring, EPDM, size: AS-014
18	AM-9238	Right Angle Connector/Adapter assembly for D405 Sensors



Figure 15

D400-B150 & D405-B150 OxyProbe® Sensor Assembly

See Itemized List for Part Number & Description





D400-B105 & D405-B150 OxyProbe® Sensor Assembly EXPLODED VIEW, ITEMIZED PART NUMBER & DESCRIPTIONS

Item	Part Number	Description
1	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3
2	AM-9202	4-Pin Connector, glass to metal seal with ribbon/micro cable disconnect
3	AM-9315	O-ring, EPDM, size: AS-014
4	AM-9346	Sensor Body, 316L stainless steel, for B=150 mm D400/405 sensors
5	AM-9237	O-ring, Silicone, size: AS-209
6	AM-9231	O-ring, Silicone, size: AS-014
8	CT25-PT-130MP	Cathode/Anode ass'y w/dual EPDM, AS-011 O-rings for B=150 mm D400/405
9	AM-9307	O-ring, EPDM, size: AS-011
10	AM-9210	Retainer Ring Nut, 316L SST for CT25 Cathode/Anode assembly
11	AM-9233	Conical Gasket, silicone
12	AM-9234	Membrane Cartridge for D200 and D400 Series sensors
13	AM-9239	Sensor Sleeve, 316L SST, for B=150 mm D400/405 sensors
14	AM-9236	O-ring, Silicone, size: AS-015
15	AM-9230	M2.5 x 0.45 x 1/4" Stainless Steel Screw, set of 3 (2 sets required)
16	AM-9349	4-Pin Connector, glass to metal seal with ribbon/micro cable disconnect
17	AM-9315	O-ring, EPDM, size: AS-014
18	AM-9238	Right Angle Connector/Adapter assembly for D405 Sensors



Chapter 9: Return of Materials

9.1 GENERAL

To expedite the repair and return of sensors, proper communication between the customer and the factory is important. A return material authorization (RGM number) is required. Call (949) 829-5555, (800) 288-2833 or FAX (949) 829-5560. The “Return Goods Memo” form is provided for you to copy and use in case the situation arises. The accuracy and completeness of this form will help to expedite the processing time of your materials.

9.2 WARRANTY REPAIR

The following is the procedure for returning products still under warranty.

1. Contact the factory for authorization.
2. Complete a copy of the “Return Goods Memo” form as completely and accurately as possible.
3. To verify warranty, supply the factory sales ordernumber or the original purchase order number.
4. Carefully package the materials and enclose the completed copy of the “Return Goods Memo” form. If possible, pack the materials in the same manner as received.

IMPORTANT

Please see second section of the “Return

Goods Memo” form. Compliance to the OSHA requirements is mandatory for the safety of all personnel. MSDS forms and a certification that the sensors have been disinfected or detoxified are requested.

5. Send the package prepaid to:

Broadley-James Corporation

19 Thomas

Irvine, CA 92618

Attn: Factory Repair

Mark the package:

Returned for Repair RGM

No. _____

Model No. _____

9.3 NON-WARRANTY REPAIR

1. Contact the factory for authorization.
2. Fill out a copy of the “Return Goods Memo” form as completely and accurately as possible.
3. Include a purchase order number and make sure to include the name and telephone number of the right individual to be contacted should additional information be needed.
4. Perform Steps 4 and 5 of Section 9.2.

NOTE:

Consult the factory for additional information regarding service or repair.



Return of Materials Request

NOTICE TO SENDER

CUSTOMER/USER MUST SUBMIT MATERIAL SAFETY SHEET (MSDS) OR COMPLETE STREAM COMPOSITION, AND/OR LETTER CERTIFYING THE MATERIALS HAVE BEEN DISINFECTED AND/OR DETOXIFIED WHEN RETURNING ANY PRODUCT, SAMPLE OR MATERIAL THAT HAS BEEN EXPOSED TO OR USED IN AN ENVIRONMENT OR PROCESS THAT CONTAINS A HAZARDOUS MATERIAL. ANY OF THE BELOW THAT IS SUBMITTED TO BROADLEY-JAMES CORPORATION WITHOUT THE MSDS WILL BE RETURNED TO SENDER C.O.D. FOR THE SAFETY AND HEALTH OF OUR EMPLOYEES. WE THANK YOU IN ADVANCE FOR COMPLIANCE WITH THIS SUBJECT.

CUSTOMER CONTACT INFORMATION

Name: _____
Phone: _____
Ship to: _____

REASON FOR RETURN — PLEASE CHECK APPROPRIATE BOX(ES):

- Wrong part received
- Duplicate shipment
- Repair and calibrate
- Evaluation
- Replacement Required
- Warranty request
- Non-warranty
(Customer PO# _____)
- Other (Explain)

Description of Problem: _____

RETURN TO:

Broadley-James Corporation

19 Thomas, Irvine, CA 92618 USA

Tel: (949) 829-5555 (800) 288-2833 Fax: (949) 829-5560

Call for RGM NUMBER before sending (RGM #) _____







Chapter 10: Warranty

Subject to the limitations contained in Section 6 of Seller's (Broadley-James Corporation) Terms & Conditions of Sale, and except as otherwise expressly provided herein, Seller warrants that the licensed firmware will execute the programming instructions provided by Seller, and that the Goods manufactured or Services provided by Seller will be free from defects in materials or workmanship under normal use and care until the expiration of the applicable warranty period.

Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller, whichever period expires first.

Dissolved Oxygen sensors are warranted for (24) months from the date of shipment by Seller.

Consumables and Services are warranted for a period of 90 days from the date of shipment or completion of the Services.

Products produced by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products.

If Buyer discovers any warranty defects and notifies Seller thereof in writing during the applicable warranty period, Seller shall, at its option, promptly correct any errors that are found by Seller in the firmware or Services, or repair or replace F.O.B. point of manufacture that portion of the Goods or

firmware found by Seller to be defective, or refund the purchase price of the defective portion of the Goods/Services.

All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources, unsuitable environmental conditions, accident, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense.

Seller shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by an Officer of Broadley-James Corporation. All costs of dismantling, reinstallation and freight and the time and expenses of Seller's personnel for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Seller.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer.

This limited warranty is the only warranty made by Seller and can be amended only in writing signed by an Officer of Broadley-James Corporation. Except as otherwise expressly provided in this Agreement, **THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES.**