ROSEMOUNT ANALYTICAL

MODEL 7003D
OXYGEN MONITOR

INSTRUCTION MANUAL

748054-K

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Rosemount Analytical Inc.
4125 East La Palma Avenue
Anaheim, California 92807-1802 USA

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PREFACE

SAFETY SUMMARY

To avoid explosion, loss of life, personal injury and damage to this equipment and on-site property, all personnel authorized to install, operate and service the Model 7003D Oxygen Monitor should be thoroughly familiar with and strictly follow the instructions in this manual. **Save these instructions.**

If this equipment is used in a manner not specified in these instructions, protective systems may be impaired.

DANGER is used to indicate the presence of a hazard which **will** cause **severe** personal injury, death, or substantial property damage if the warning is ignored.

WARNING is used to indicate the presence of a hazard which **can** cause **severe** personal injury, death, or substantial property damage if the warning is ignored.

CAUTION is used to indicate the presence of a hazard which **will or can** cause **minor** personal injury or property damage if the warning is ignored.

NOTE is used to indicate installation, operation or maintenance information which is important but not hazard-related.

WARNING: ELECTRICAL SHOCK HAZARD

Do not operate without doors and internal circuit panel secure. Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.

For safety and proper performance this instrument must be connected to a properly grounded three-wire source of power. Electrical installation must be made in accordance with any applicable national or local codes.

Alarm switching relay contacts wired to separate power source must be disconnected before servicing.

WARNING: PARTS INTEGRITY

Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair.

WARNING: HIGH PRESSURE GAS CYLINDERS

This analyzer requires periodic calibration with known zero and standard gases. Refer to General Precautions for Handling and Storing High Pressure Cylinders, at the rear of this manual.

WARNING: ENCLOSURE INTEGRITY

Unused cable conduit entries must be securely sealed by flameproof closures to provide enclosure integrity in compliance with personnel safety and environmental protection requirements. The plastic closures provided are for shipping protection only. When installing instrument, observe all notes on drawing 622617 (in rear of this manual).

WARNING: ELECTRICAL SHOCK HAZARD

To avoid shock hazard and AC pickup, do not route potentiometric output or current output cables through the same conduit as power cable or alarm output cable.

WARNING: CORROSIVE MATERIAL

Concentrated nitric acid is used in rejuvenating the sensor cathode (Section 6.1.2). This material is highly corrosive.

⚠ *CAUTION: CONDUIT GROUNDING*

The non-metallic enclosure does not provide grounding between conduit connections. Use grounding-type bushings and jumper wires.

SPECIFICATIONS - PERFORMANCE

OPERATING RANGE

0 - 19.99% to 0 to 25% oxygen by volume

SAMPLE TEMPERATURE

32°F to 110°F (0°C to 44°C)

AMBIENT TEMPERATURE

-20°F to 122°F (-29°C to 50°C) for instrument

AMBIENT HUMIDITY

Up to 95% relative humidity, non-condensing

SYSTEM LINEARITY

For constant sample temperature after correction for sensor zero offset: ±1% of fullscale

SPECIFICATIONS - ELECTRICAL

POWER REQUIREMENTS

107 to 127 VAC, 50/60 Hz, 0.2 A or 214 to 254 VAC, 50/60 Hz, 0.1

POTENTIOMETRIC OUTPUT

Selectable: 0-25%, 0-10%, 0-5% or 0-1% oxygen fullscale

Minimum load: 2K ohms

VOLTAGE OUTPUT

Selectable: 0-10V, 0-5V, or 0-1V fullscale

CURRENT OUTPUT (OPTION)

Isolated 0-20mA or 4-20mA over same range as potentiometric output. Minimum load: 600 ohms.

SPECIFICATIONS - ALARM

RANGE

Selectable: 0-25%, 0-10%, 0-5%, or 0-1% oxygen fullscale

CONTACTS

Two independently adjustable SPDT relay contact actuations

CONTACT RATING (RESISTIVE LOAD)

Maximum switching voltage: 250 VAC, 30 VDC

Maximum switching current: 3A

DEADBAND

Adjustable from less than 2% to 20% of range at any setpoint

REPEATABILITY

±0.1% of range

SPECIFICATIONS - PHYSICAL

MOUNTING

Standard: Panel mount

Optional: Surface mount, pipe mount

DIMENSIONS

10.4 x 8.9 x 8.3 inches (265 x 225 x 210 mm) HxWxD

WEIGHT

4.2 lbs (1.9 kg)

ENCLOSURE

NEMA-4X general purpose.

Optional air purge designed to NFPA-496 Type Z.[1]

SENSOR CABLE

1000 ft (305 m) Maximum length between instrument and sensor.

[1] The optional air purge, when installed along with user supplied components, is designed to equip the instrument enclosure with Type Z purge protection per Standard ANSI/NFPA 496-1986. This reduces the classification within the enclosure from Class I, Division 2 (normally non-hazardous) to non-hazardous, thus permitting installation in a location classified Class I, Groups A, B, C, D, Division 2. This method of protection is recognized in Article 500-1 of the National Electrical Code (NEC)< ANSI/NFPA 70.

SPECIFICATIONS - SENSOR

TYPE

Rechargeable, non-rechargeable (disposable)

STABILITY

±1% of fullscale at any given temperature per 24 hours, for an equilibrated sensor

TEMPERATURE COMPENSATIONS

32°F to 110°F (0°C to 44°C) ±6% of reading

60°F to 90°F (15°C to 32°C) ±3% of reading

For any other 30°F (16°C) ±4% of reading

RESPONSE TIME

90% in 20 seconds for a step change, using an equilibrated sensor at 25°C

SAMPLE PRESSURE

0 to 50 psig (0 to 345 kPa)

CUSTOMER SERVICE, TECHNICAL ASSISTANCE AND FIELD SERVICE

For order administration, replacement Parts, application assistance, on-site or factory repair, service or maintenance contract information, contact:

Rosemount Analytical Inc.
Process Analytical Division
Customer Service Center
1-800-433-6076

RETURNING PARTS TO THE FACTORY

Before returning parts, contact the Customer Service Center and request a Returned Materials Authorization (RMA) number. Please have the following information when you call: *Model Number, Serial Number, and Purchase Order Number or Sales Order Number.*

Prior authorization by the factory must be obtained before returned materials will be accepted. Unauthorized returns will be returned to the sender, freight collect.

When returning any product or component that has been exposed to a toxic, corrosive or other hazardous material or used in such a hazardous environment, the user must attach an appropriate Material Safety Data Sheet (M.S.D.S.) or a written certification that the material has been decontaminated, disinfected and/or detoxified.

Return to:

Rosemount Analytical Inc.
4125 East La Palma Avenue
Anaheim, California 92807-1802
USA

TRAINING

A comprehensive Factory Training Program of operator and service classes is available. For a copy of the *Current Operator and Service Training Schedule* contact the Technical Services Department at:

Rosemount Analytical Inc.
Phone: 1-714-986-7600
FAX: 1-714-577-8006

DOCUMENTATION

The following Model 7003D Oxygen Monitor instruction materials are available. Contact Customer Service or the local representative to order.

748054 Instruction Manual (this document)

COMPLIANCES

The Model 7003D Oxygen Monitor is designed to comply with applicable American standards for protection against electrical shock, mechanical and fire hazards in non-hazardous (ordinary) locations. The instrument must be installed in accordance with the provisions of the National Electrical Code (NEC), ANSI/NFPA 70, and/or any applicable national or local code(s), and operated and maintained in the recommended manner.

The oxygen sensors and interconnecting cable used with the Model 7003D Oxygen Monitor are non-incendive in normal operation and comply with the requirements of Articles 501-3 (b)(1) c and 501-4 (b), Exception, of the National Electrical Code, ANSI/NFPA 70-1987, for installations in Class I, Groups A, B, C, D Division 2 classified locations.

1 INTRODUCTION

The Model 7003D Oxygen Monitor (Figure 1-1) automatically and continuously measures the oxygen concentration in gaseous samples. The determination is based on measurement of the electrical current developed by an amperometric sensor in contact with the sample.

The monitor provides direct readout of concentration in % by volume. Alarms and a potentiometric output are provided as standard. The fullscale range of the alarms and the potentiometric output are each independently selectable. Thus, the range of the potentiometric output may be changed without the need to readjust alarm setpoints.

The Model 7003D is used with a sensor which is housed in a submersion assembly or flow assembly and is connected to the monitor by a multi-conductor shielded cable.

1.1 OXYGEN MONITOR

The oxygen monitor conditions the sensor output signal to provide direct readout of oxygen in % by volume. It also contains current-measuring circuitry, operating controls, digital display, alarms, and signal outputs provisions.

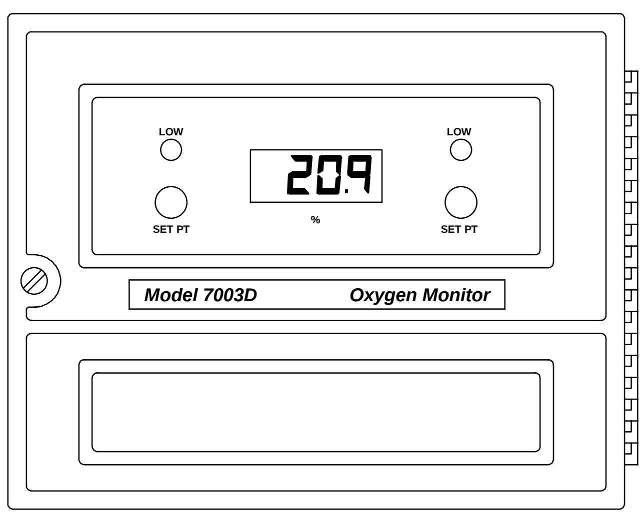


FIGURE 1-1. MODEL 7003D OXYGEN MONITOR

The monitor is designed for panel mounting. Accessory Pipe Mounting Kit permits the oxygen monitor to be mounted on a vertical or horizontal pipe. Accessory Wall Mounting Kit permits wall (surface) mounting. An optional air purge kit is designed to meet requirements for NFPA-496 Type Z air purge (see specifications) .

An accessory Isolated Current Output Board provides a field-selectable 0 to 20 mA, or 4 to 20 mA isolated current output.

1.2 SENSORS

Rosemount Analytical offers rechargeable and disposable oxygen sensors which can be used with the Model 7003D. See Figures 1-2 and 1-3. These sensors are supplied alone or in kits: Submersion, in-line flow, and fast response.. Sensors are available constructed of polypropylene or Ryton. See Sections 2.4 - Sensors, Rechargeable, 2.5 - Sensors - Non-Rechargeable and 7.3 - Sensors, Replacement Parts for additional information.

RECHARGEABLE - FAST-RESPONSE FLOW

The fast-response flow assembly allows minimum volume gas flow that permits mounting the sensor in a flowing gas stream. Sample is supplied at slightly above atmospheric pressure, flows through the assembly and discharges to atmospheric pressure. Internal volume of the assembly is low to minimize system response time.

RECHARGEABLE - IN-LINE FLOW

The in-line pressure compensated flow assembly permits mounting the sensor in a variable pressure gas stream at pressures up to 50 psig (345 kPa). The typical application is in-line monitoring with the flow assembly connected directly into the process stream pipeline. An alternative application involves discharge to atmospheric pressure where discharge rates are high.

RECHARGEABLE - SUBMERSION ASSEMBLY

The submersion assembly permits placing the sensor at depth, in an open or closed vessel, at a maximum pressure of 50 psig (345 kPa). The submersion assembly provides a convenient means of mounting the sensor, and also affords protection for the sensor cable connection a feature particularly desirable in high humidity environments.

NON-RECHARGEABLE - IN-LINE FLOW

The in-line flow assembly permits mounting the sensor in a flowing gas stream. Also included is a universal mounting bracket and a cable assembly for connecting the disposable oxygen sensor to the monitor.

NON-RECHARGEABLE - SUBMERSION

The submersion assembly adapts the oxygen sensor so that it may be inserted through the wall of a vessel or pipe to monitor the oxygen concentration existing in the vessel or pipe.

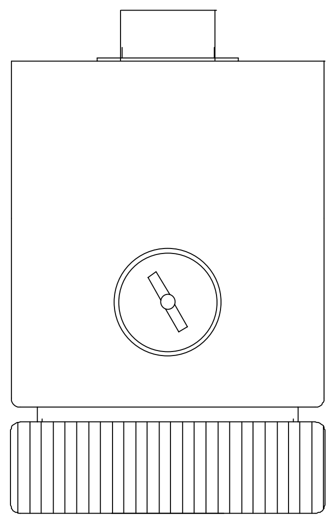


FIGURE 1-2. RECHARGEABLE SENSOR

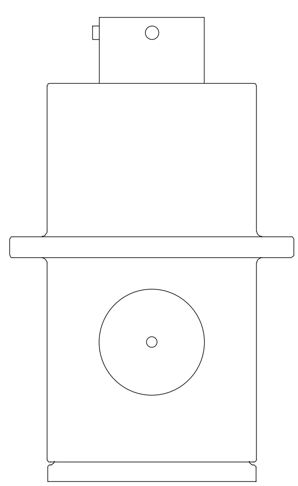


FIGURE 1-3. NON-RECHARGEABLE SENSOR

NOTES

3 STARTUP AND CALIBRATION

2.1 UNPACKING AND FACILITY PREPARATION

Carefully examine the shipping carton and contents for signs of damage. Immediately notify the shipping carrier if the carton or contents is damaged. Retain the carton and packing material until all components associated with the Model 7003D Oxygen Monitor are operational.

Outline and mounting dimensions for the oxygen monitor are given in the outline and mounting drawing 622617.

2.2 LOCATION AND MOUNTING

Mount the sensor in an environment within the permissible range of 32°F to 110°F (0°C to 44°C) The sensor is supplied, as ordered, in a kit that includes a submersion assembly or flow chamber.

Sensor and amplifier are interconnected by a multi-conductor shielded cable. It is supplied in the standard 10 foot length, or in any length specified by customer, up to 1000 feet (305 m). See Section 7.

The oxygen monitor is designed to meet NEMA-4X requirements, and may be mounted outdoors Permissible ambient temperature range is -20°F to +122°F (-29°C to +50°C).

Panel mount the amplifier, or use the accessory wall mount kit or accessory pipe mount kit as desired.

2.3 ELECTRICAL CONNECTIONS

WARNING: ELECTRICAL SHOCK HAZARD

Do not operate without doors and internal circuit panel secure. Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.

For safety and proper performance this instrument must be connected to a properly grounded three-wire source of power. Electrical installation must be made in accordance with any applicable national or local codes.

2.3.1 LINE POWER CONNECTION

The Model 7003D provides switch-selectable operation on either 107 VAC to 127 VAC or 214 VAC to 254 VAC, 50/60 Hz.

Electrical power is supplied to the monitor via a customer-supplied three-conductor cable, type SJT. minimum wire size 18 AWG. Route power cable through conduit and into appropriate opening in monitor enclosure. Connect power cable leads to terminal strip TB5 on the power supply board, as shown in Figure 2-1 and drawing 622228.

VOLTAGE SELECT

1. Open the monitor door.
2. Loosen the retainer screw which holds the display board and pivot the display board to access the power supply board.
3. Verify that the line voltage selector switch S1 is set to indicate the nominal line voltage: either 115 or 230 (Figure 2-1).

2.3.2 SYSTEM GROUNDING CONNECTION

A ground terminal (TB5-GND) is provided on the power supply board. Refer to Figure 2-1. This terminal must be connected, via the ground lead of the three-conductor power cable to a good earth ground.

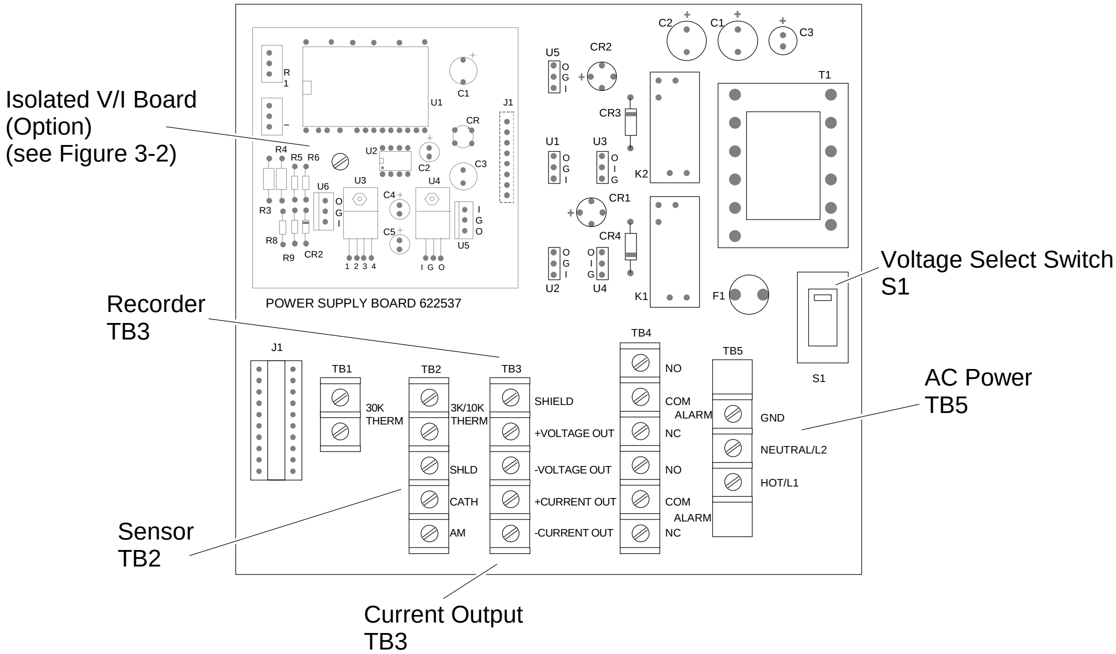


FIGURE 2-1. POWER SUPPLY BOARD

2.3.3 SENSOR CABLE CONNECTION

If a long cable is used, it should be routed to the amplifier through appropriate conduit. Connect the amplifier end of the cable to terminal strip TB2 on the power supply board, as shown in Figure 2-1 and drawing 622228.

Connect the cable to the sensor when installation of the sensor is complete.

2.3.4 OUTPUT CABLE CONNECTION

WARNING: ELECTRICAL SHOCK HAZARD

To avoid shock hazard and AC pickup, do not route potentiometric output or current output cables through the same conduit as power cable or alarm output cable.

If a recorder, controller, or other output device is used, connect it via number 22 or number 24 AWG two-conductor shielded cable. Route the output cable through conduit to the oxygen monitor, and into the case through the appropriate opening shown in drawing 622617.

POTENTIOMETRIC OUTPUT

1. Connect leads of shielded recorder cable to VOLTOUT + and VOLTOUT - terminals of TB3 on power supply board (Figure 2-1). Connect shield to SHD terminal.
2. Connect other end of output cable to appropriate terminals of recorder or other potentiometric device.
   a. For devices with spans of 0 to 1.0 to 5, or 0 to 10 volts connect cable directly to input terminals of the device, making sure polarity is correct.
   b. For devices with intermediate spans. i.e., between the specified values, connect cable to device via a suitable external voltage divider. as shown in Figure 2-2.

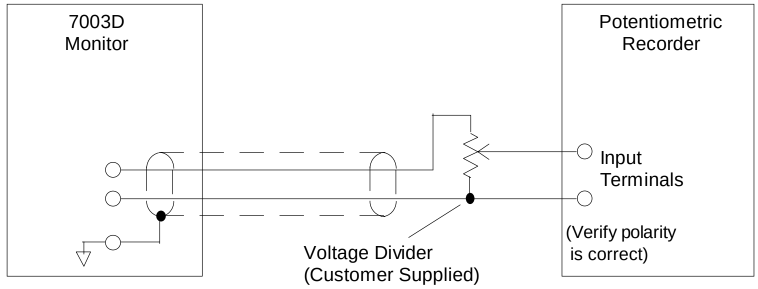
ISOLATED CURRENT OUTPUT ACCESSORY

1. Verify that the current output board (Isolated V/I Board) is properly mounted on the power supply board in connector J2. See Figure 2-1. If originally ordered with the oxygen monitor, the board is factory installed.
2. Connect leads of shielded cable to CURRENT OUT + and CURRENT OUT - terminals of TB3 on power supply board. Connect shield to SHD terminal.
3. Connect other end of output cable to input terminals of recorder or other current-actuated device, making sure polarity is correct. If two or more current-actuated devices are used, they must be connected in series. Refer to Figure 2-2.

Note

Total resistance of all output devices and associated interconnection cable must not exceed 600 ohms.

4. Since neither the CUROUT + nor CUROUT - output terminal is grounded, the current loop should be grounded at some point within the circuit. The ground point should be chosen to minimize noise or other undesirable interactions.



Position of Recorder Output Selector Plug	Minimum Permissible Resistance for R1 + R2
10 mV	1K Ohm
100 mV	10K Ohm
1 V	100K Ohm
5 V	2K Ohm

FIGURE 2-2. CONNECTIONS FOR POTENTIOMETRIC RECORDER WITH NON-STANDARD SPAN

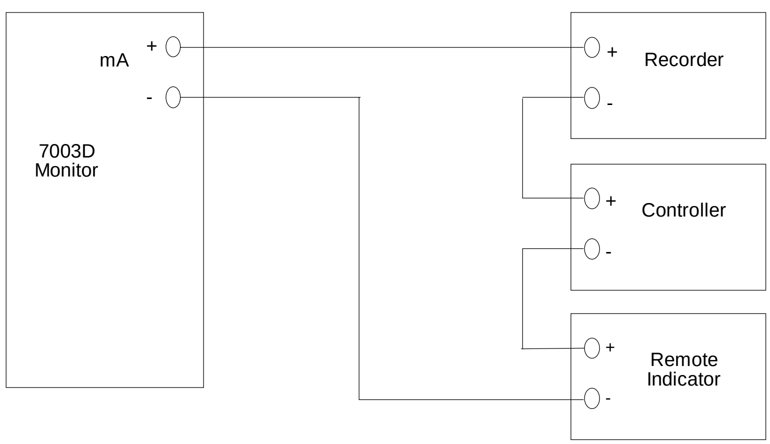


FIGURE 2-3. TYPICAL EXAMPLE OF OXYGEN MONITOR CONNECTED IN SERIES WITH SEVERAL CURRENT ACTUATED DEVICES

2.3.5 OUTPUT CONNECTIONS FOR ALARMS

ALARM OUTPUT CONNECTIONS

The alarm output provides two sets of relay contacts for actuation of alarm and/or process-control functions. Leads from the customer-supplied external alarm system connect to terminal block TB4 on the power supply board. See Figure 2-1 and drawing 622228.

If the alarm contacts are connected to any device that produces radio frequency interference (RFI), it should be arc-suppressed. Accessory Arc Suppressor is recommended. When possible, the oxygen monitor should operate on a different AC power source, to minimize RFI.

ALARM RELAY CHARACTERISTICS

The HI ALARM and LO ALARM outputs are provided by two identical single-pole double-throw relays. Relay contacts are rated at (resistive load):

3 A, 250 VAC

3 A, 30 VDC

Removal of AC power from the analyzer, as in a power failure, de-energizes both relays.

HI ALARM RELAY

The HI ALARM relay coil is energized when the display moves upscale through the value that corresponds to the setpoint plus deadband. This relay coil is de-energized when display moves downscale through the value that corresponds to setpoint minus deadband.

LO ALARM RELAY

The LO ALARM relay coil is energized when the display moves downscale through the value that corresponds to setpoint minus deadband. This relay coil is de-energized when the display moves upscale through the value that corresponds to setpoint plus deadband.

ALARM RESET

The HI ALARM and LO ALARM functions both incorporate automatic reset. When the meter reading goes beyond the pre-selected limits, the corresponding relay is energized; when the meter reading returns within the acceptable range, the relay is automatically de-energized.

FAIL SAFE APPLICATIONS

By appropriate connection to the double-throw relay contacts, it is possible to obtain either a contact closure or a contact opening for an energized relay. The de-energized relay then provides a contact opening or contact closure, respectively. It is important for failsafe applications that the user understand what circuit conditions are desired in event of power failure and the resultant relay de-energization. Relay contacts should then be connected accordingly.

2.4 SENSORS - RECHARGEABLE

This section provides instructions on installation and gas connections of the sensors in the three available mounting configurations. Refer to Section 2.6 for electrical connections to sensor. Refer to Section 7 for part numbers of sensors, sensor kits, and accessories. The sensor is shipped assembled, charged, and ready for use.

2.4.1 INSTALLATION OF SENSOR AND FAST-RESPONSE FLOW KIT

The Fast-Response Flow Assembly is used to mount the sensor in a gaseous sample flow stream. It is used when the sample is supplied at slightly above atmospheric pressure. Internal volume is low to minimize system response time.

MOUNTING FLOW CHAMBER

The flow chamber has two .2 diameter clearance holes for mounting screws (screws supplied by user). See Figure 2-4.

Mount the flow chamber as shown in Figure 2-6. Preferably, mount the flow chamber so that the sensor is vertical as shown in Figure 2-6A. Horizontal mounting, Figure 2-6B, is acceptable provided the sample enters the lower port of the chamber and discharges from the upper port.

INSTALLING SENSOR

1. Refer to Figure 2-5. Remove the sensor cap from the sensor. Slide the stainless steel ring clamp onto the threads for the sensor cap until stops against sensor body. Replace the sensor cap. The ring clamp is held between the cap and body of the sensor.
2. Insert the o-ring and cap end of the sensor into the flow chamber.
3. Slide the flow chamber nut down the body of the sensor and tighten onto flow chamber.

The o-ring between the bottom of the chamber and the sensor cap now effects a seal.

GAS CONNECTIONS

Sample inlet and outlet connections are 1/8 inch NPT (Figure 2-4). Normally, sample is supplied to the flow chamber via a customer supplied needle valve which provides flow adjustment.

PRESSURE AND FLOW

The flow chamber is designed for discharge at atmospheric pressure. Maximum recommended flow is 2 liters per minute. Minimum acceptable flow rate depends on required rate of system response, which is dependent on length of the sample line, and in some cases, the volume of gas sample that can be wasted.

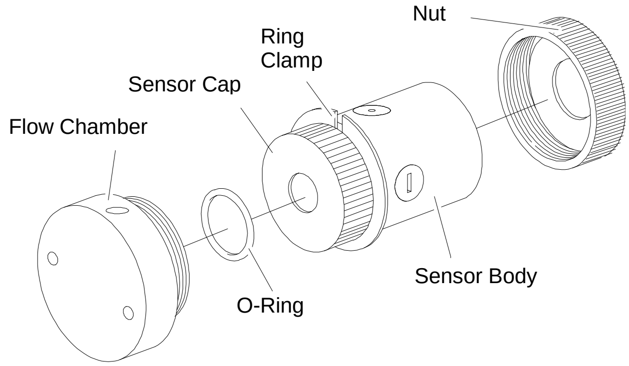


FIGURE 2-4. RECHARGEABLE SENSOR WITH FAST RESPONSE FLOW ASSEMBLY

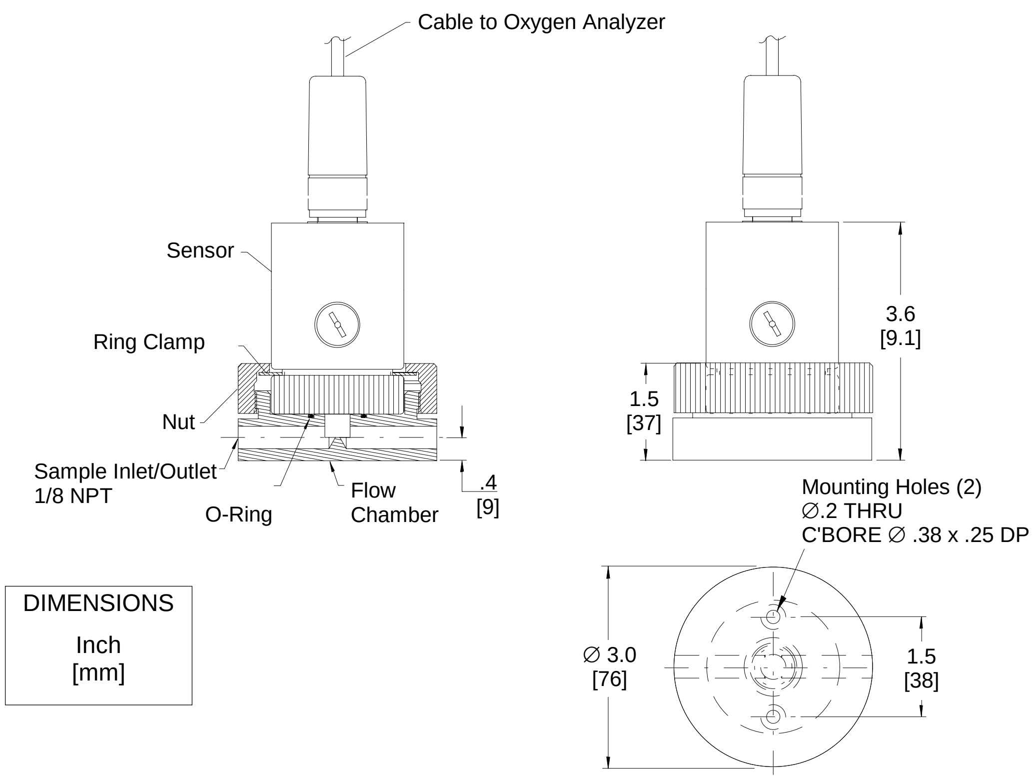


FIGURE 2-5. MOUNTING RECHARGEABLE SENSOR IN FAST RESPONSE FLOW ASSEMBLY

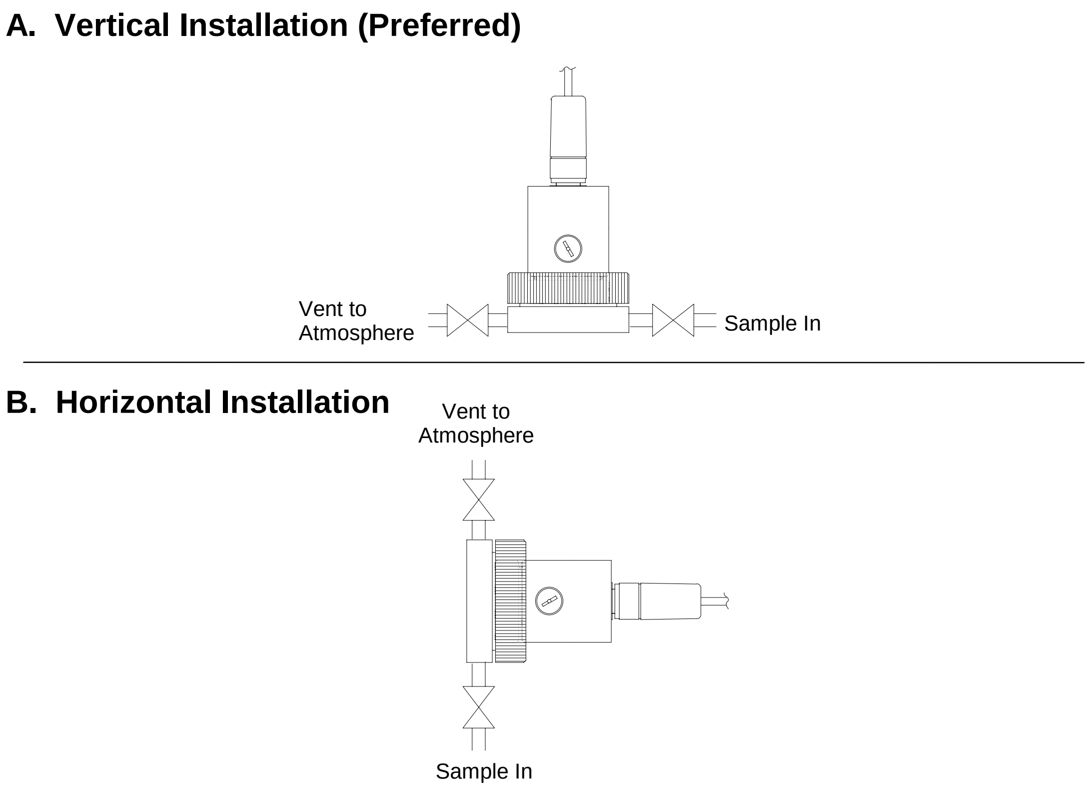


FIGURE 2-6. TYPICAL INSTALLATION ORIENTATION OF RECHARGEABLE SENSOR AND FAST RESPONSE FLOW ASSEMBLY

2.4.2 INSTALLATION OF SENSOR AND IN-LINE FLOW KIT

The In-Line Flow Assembly is used to mount the sensor in a variable-pressure gaseous or liquid sample stream, at pressures up to 50 psig (345 kPa).

The typical application is in-line monitoring, with the flow assembly connected directly into the process-stream pipeline. An alternative application involves discharge to atmospheric pressure where high discharge rates are desired.

Note that the sensor responds to partial pressure of oxygen in the sample. If total pressure changes, the oxygen responds accordingly.

For liquid sample streams, it is recommended that the assembly be mounted so the sensor is in the vertical position, as shown in Figure 2-8. In this orientation the sample enters the lower port of the assembly and discharges to the upper port. The horizontal arrangement ensures that during setup there will be immediate discharge of any gas in the flow chamber or any entrained gases in the sample stream.

For gaseous sample streams, the assembly may be mounted with the sensor horizontal, if desired.

MOUNTING FLOW CHAMBER

Outline and mounting dimensions are given in Figure 2-7. The flow chamber has two .22 diameter clearance holes for mounting screws (screws supplied by user). The sample inlet and sample outlet are 1/2 FPT. Mount the flow chamber as shown in Figure 2-8.

INSTALLING SENSOR

1. Remove the clamp and adapter ring from the flow chamber.
2. Insert the sensor (with gland) into the flow chamber.
3. Replace the adapter ring and clamp.

GAS CONNECTIONS

Sample inlet and sample outlet connections are 1/2 FPT.

PRESSURE AND FLOW

	GAS STREAM	LIQUID STREAM
MAXIMUM PRESSURE	50 psig (345 kPa)	50 psig (345 kPa)
MAXIMUM FLOW	2 cfm (60 L/min)	5 gal/min (6 L/min)
MINIMUM FLOW	dependent on desired response time	1.5 gal/min (6 L/min)

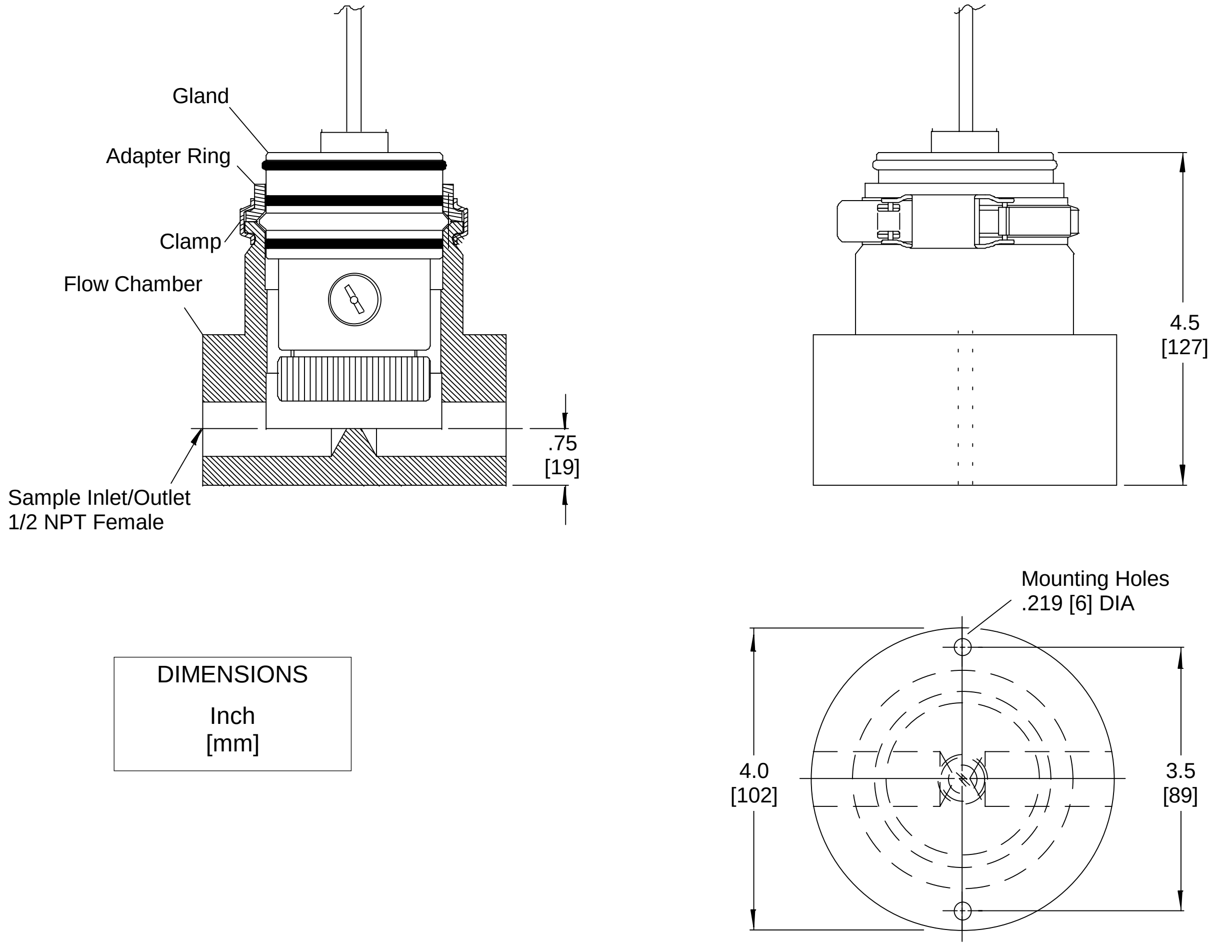


FIGURE 2-7 RECHARGEABLE SENSOR WITH GLAND AND IN-LINE FLOW ASSEMBLY

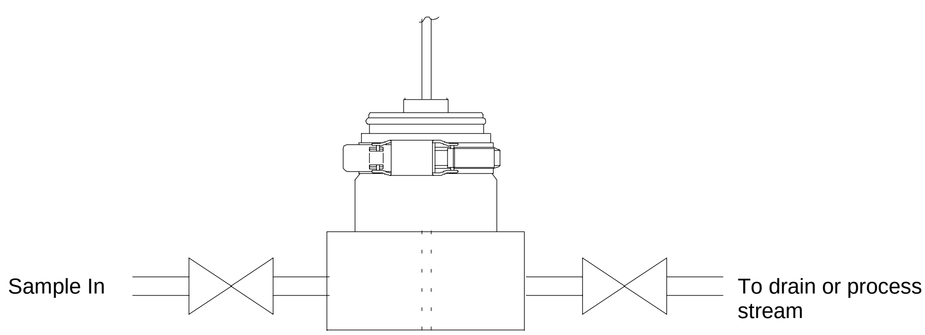


FIGURE 2-8. PREFERRED INSTALLATION ORIENTATION OF RECHARGEABLE SENSOR AND IN-LINE FLOW ASSEMBLY

2.4.3 INSTALLATION OF SENSOR AND SUBMERSION KIT

The Submersion Assembly permits placing the sensor at depth in an open or closed vessel. The Submersion Assembly provides a convenient means of mounting the sensor, and also affords protection for the sensor cable connection, a feature particularly desirable in high-humidity environments.

For liquid sample stream, it is recommended that the submersion assembly be mounted in horizontal position, as shown in Figure 2-10. This arrangement prevents entrapment on the membrane of gas bubbles which could cause erroneous oxygen readings.

For installation made during plant construction, a swing-arm piping arrangement installed in the side of the tank has proved most satisfactory. The sensor cable is led from the sensor through the supporting pipe. A junction box located in a manhole on the deck beside the aeration vessel may be included optionally to facilitate pulling of the cable. Permanently installed conduit carries the sensor cable to the amplifier, which may be located in any convenient building or protective enclosure. Figures 2-11 and 2-12 illustrate typical installations.

MOUNTING IN GASEOUS SAMPLE STREAM

For gaseous samples, the submersion assembly may be oriented horizontally or vertically.

OPERATING PRESSURE

Maximum permissible operating pressure is 50 psig (345 kPa), equivalent to a water depth of approximately 100 feet (approximately 30 m).

LIQUID SAMPLE FLOW

For liquid sample streams, velocity of the liquid past the sensor tip must be at least 1.5 feet per second (45 cm/sec) for flow-independent oxygen readout.

MOUNTING CHAMBER

The chamber is mounted to 3/4 inch pipe (customer supplied), which the sensor cable is fed through. See Figures 2-9 and 2-10.

INSTALLING SENSOR

1. Remove the clamp and adapter ring from the flow chamber.
2. Insert the sensor (with gland) into the flow chamber.
3. Replace the adapter ring and clamp.

SENSOR CABLE

In a permanent installation, the sensor cable is normally routed through a customer-supplied conduit, which screws into the 3/4 inch NPT connection on the submersion assembly.

In applications where the sensor cable is not housed in conduit, the cable connector accessory (PN 856832) may be used. This separately ordered item provides watertight sealing to prevent leakage around the cable. The connector is constructed of aluminum and includes a inner sealing grommet and compression nut.

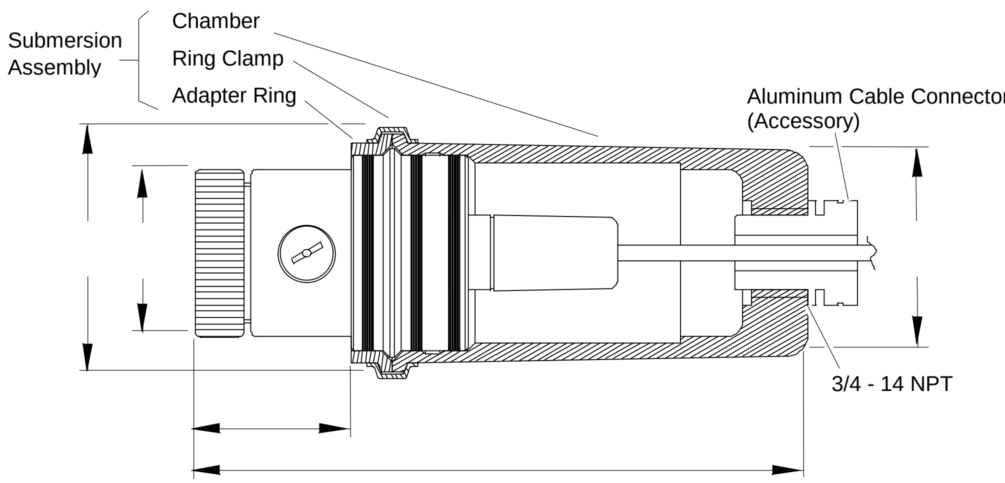
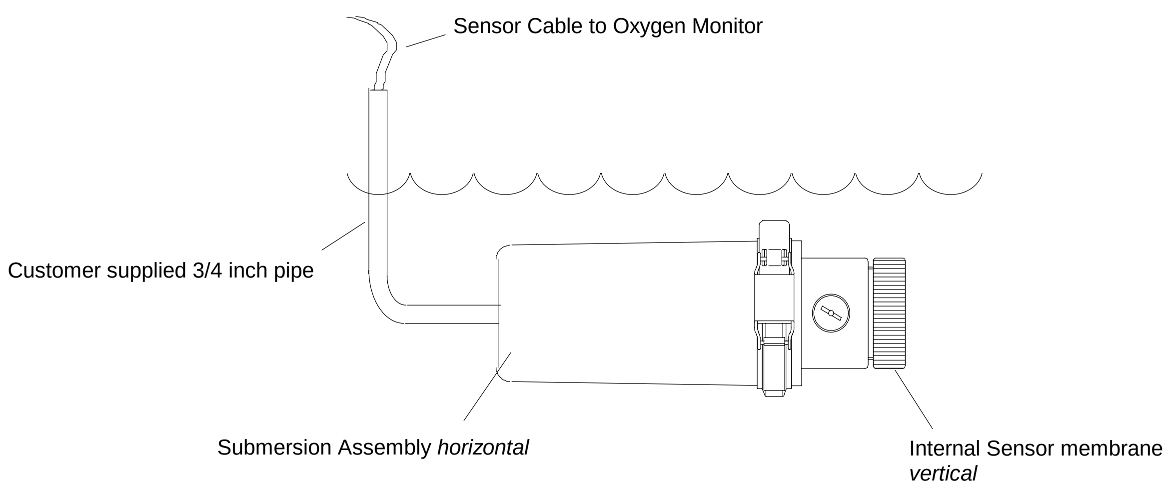


FIGURE 2-9. RECHARGEABLE SENSOR WITH SUBMERSION ASSEMBLY



1. Preferred orientation in liquid sample stream.
2. Orientation in gaseous sample may be either horizontal *or* vertical.

FIGURE 2-10. TYPICAL INSTALLATION OF RECHARGEABLE SENSOR AND SUBMERSION ASSEMBLY

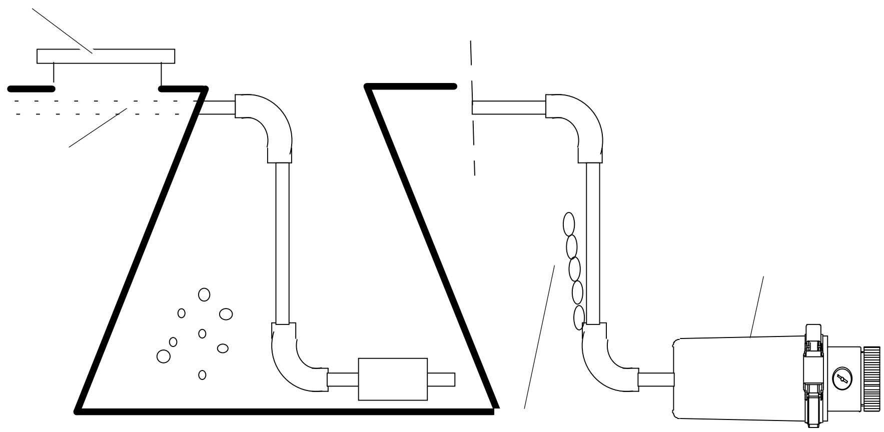


FIGURE 2-11. TYPICAL PERMANENT INSTALLATION OF RECHARGEABLE SENSOR WITH SUBMERSION ASSEMBLY DURING PLANT CONSTRUCTION

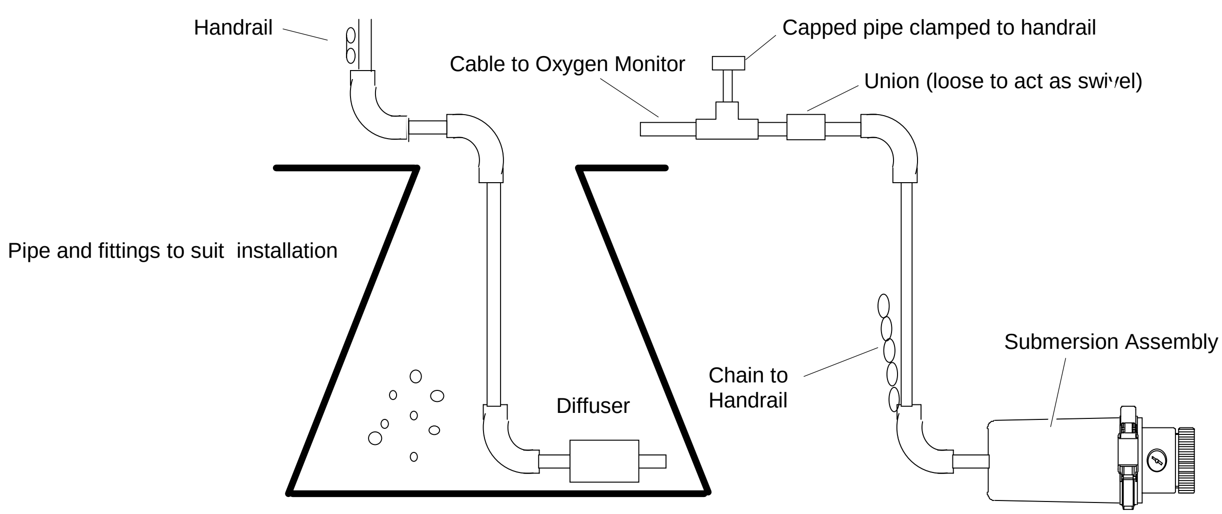


FIGURE 2-12. TYPICAL INSTALLATION OF SENSOR/SUBMERSION ASSEMBLY IN AN EXISTING PLANT

2.5 SENSORS - NON-RECHARGEABLE

2.5.1 CONVERSION OF OXYGEN MONITOR FROM USE WITH RECHARGEABLE SENSOR TO USE WITH NON-RECHARGEABLE SENSOR

The 7003D monitor is shipped from the factory configured for use with a rechargeable sensor. To convert the instrument for use with a non-rechargeable sensor, a Non-Rechargeable Sensor Conversion Kit must be installed. The Conversion Kit changes the gain of the monitor to match the output current available from the non-rechargeable sensor. Follow the instructions supplied in the kit.

2.5.2 INSTALLATION OF SENSOR AND IN-LINE FLOW ASSEMBLY

This kit consists of a non-rechargeable oxygen sensor designed for analysis of gaseous oxygen samples, a flow chamber and associated nut, a universal mounting bracket, a connecting cable to connect the monitor to the sensor, and appropriate loose hardware (see Figure 2-13). The PVC flow chamber is designed for use with a non-rechargeable oxygen sensor when a flowing gas stream with discharge of the effluent from the flow chamber at atmospheric pressure is being measured. This requirement means that upstream sample pressure reduction must be performed on the process sample from a pressurized source before it is presented to the flow chamber for analysis by the sensor. Sample input flow rate should be selected in the range of 50 to 100 cc/min and care must be taken with downstream pressure drops to prevent back pressurization of the sensor.

MOUNTING THE FLOW CHAMBER

Refer to Figure 2-15. The preferred mounting configuration of the sensor is with the electrical connector at the top of the flow chamber/sensor assembly. Operation in the horizontal plane is also possible. To facilitate mounting the flow chamber to a bench surface, wall or pipe, employ the universal mounting bracket included as part of the kit. The flow chamber has one port which should be capped off with the fitting cap supplied in the kit. The port to be capped is determined by the user, depending on the particular application.

INSTALLING THE SENSOR

The sensor is inserted into the flow chamber to form a face seal on the front of the sensor with the O-ring present in the bottom of the flow chamber. The nut is then placed over the connector end of the sensor and tightened hand tight to form a seal on the face of the sensor.

GAS CONNECTIONS

Sample inlet and outlet connections are 1/8-inch NPT. Normally, sample is supplied at slightly above ambient pressure by use of a customer supplied needle valve which provides the necessary pressure and flow adjustment to the desired 50 to 100 cc/min flow rate level.

2.5.3 INSTALLATION OF SENSOR WITH SUBMERSION ASSEMBLY

This kit consists of a non-rechargeable oxygen sensor for gas phase oxygen measurements, a head space submersion assembly, and assorted required loose hardware (see Figure 2-15). It is intended for use when the gas phase sensor is to be inserted through a vessel wall as in the monitoring of a process vessel head space or when a large diameter process is being monitored directly by insertion of the sensor through the pipe.

MOUNTING THE SUBMERSION ASSEMBLY

Refer to Figure 2-15. The sensor installs in the submersion assembly by placing the doughnut shaped thin rubber gasket on the connector side of flange of the oxygen sensor by gently slipping it over the sensor body and then connecting the cable to the cable sensor using the mating connectors. The end of the cable emerging from the threaded portion of the submersion assembly should then be gently pulled to seat the sensor within the receiving cavity of the submersion assembly. At this point, the cap should be placed over the front end of the submersion assembly and then screwed down snugly. At this point the blue silicone rubber plug has moved with the cable and is now no longer seated in the threaded portion of the submersion assembly. Hold the cable securely and move the plug back into the submersion assembly until it is firmly seated.

The submersion assembly is now ready to be connected to the 3/4-inch pipe in a manner dictated by the local installation requirements. See Figure 2-16.

SENSOR CABLE

In permanent installations the sensor cable is normally routed through a customer supplied conduit, which screws into the 3/4-inch NPT connection at the end of the submersion assembly.

OPERATING PRESSURE

Maximum operating pressure is 50 psig (345 kPa).

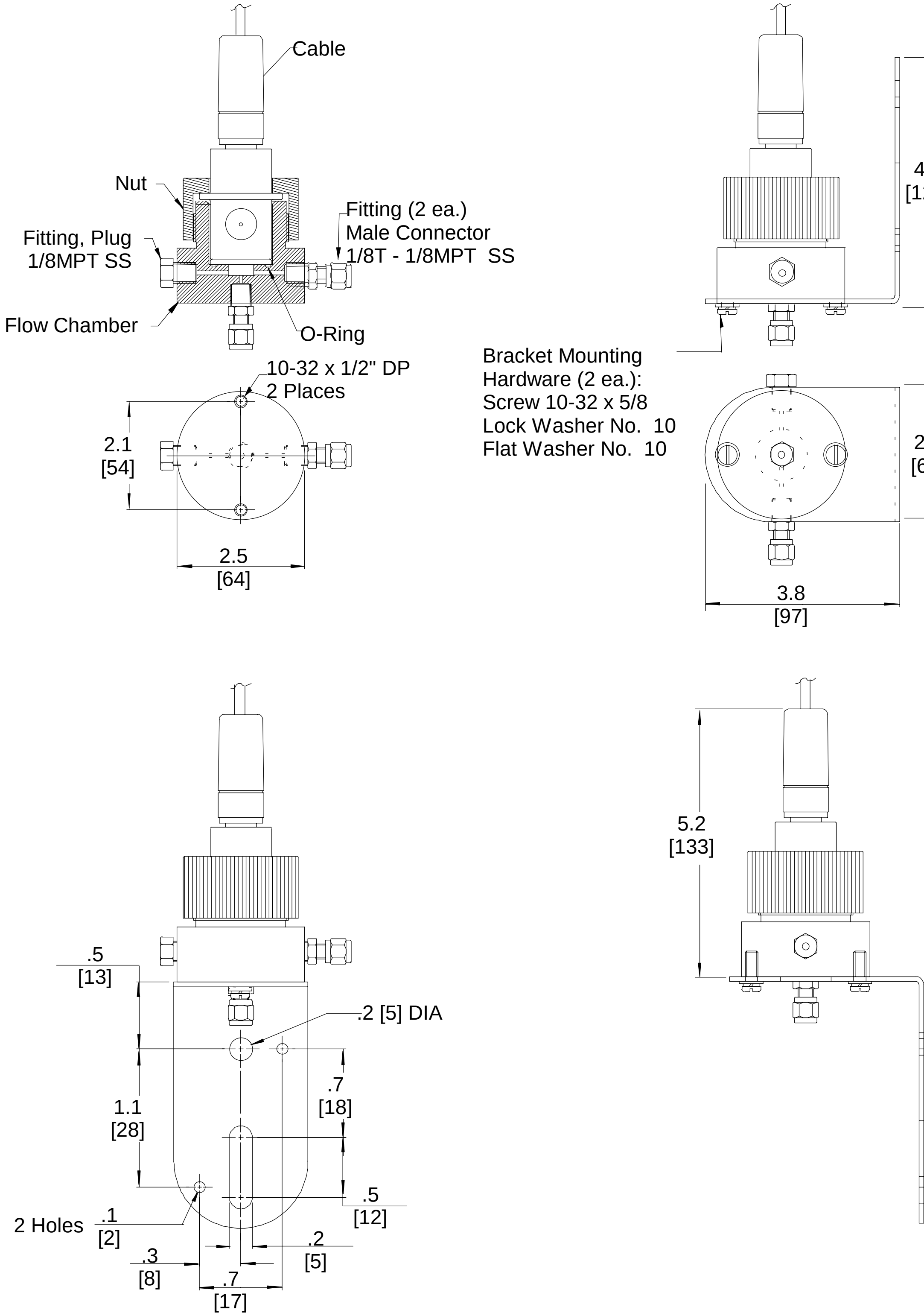


FIGURE 2-13. DIMENSIONS AND COMPONENTS OF NON-RECHARGEABLE SENSOR WITH IN-LINE FLOW KIT

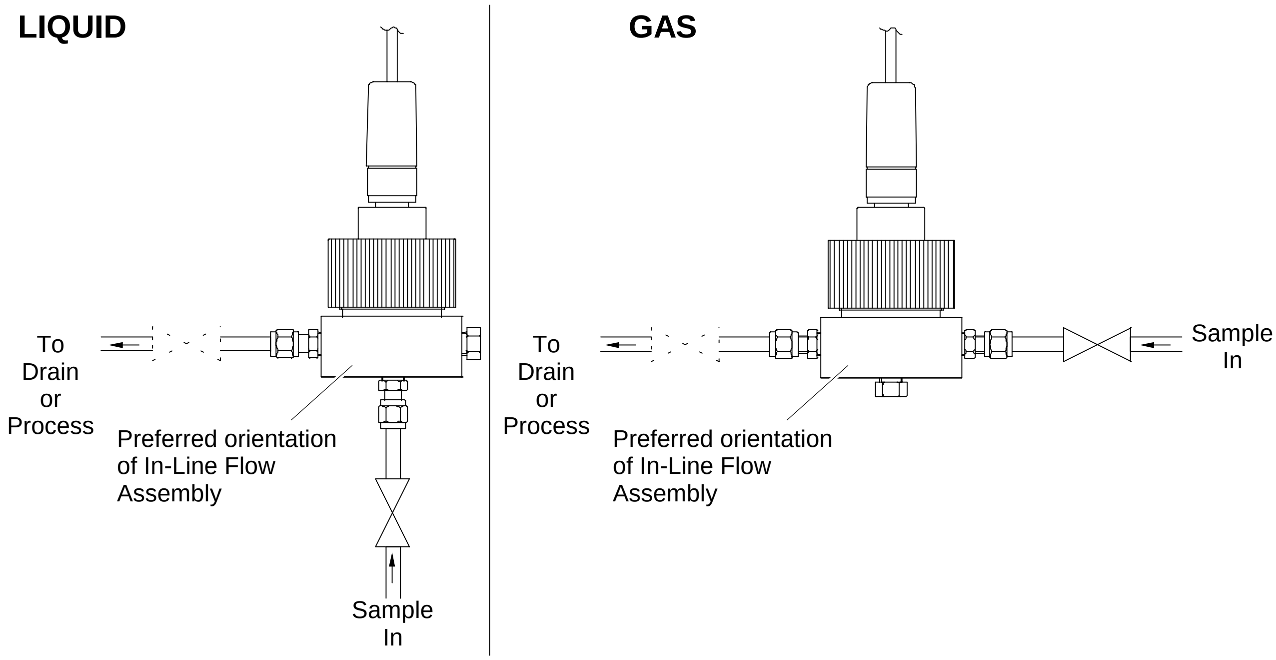


FIGURE 2-14. TYPICAL INSTALLATION OF NON-RECHARGEABLE SENSOR WITH IN-LINE FLOW KIT

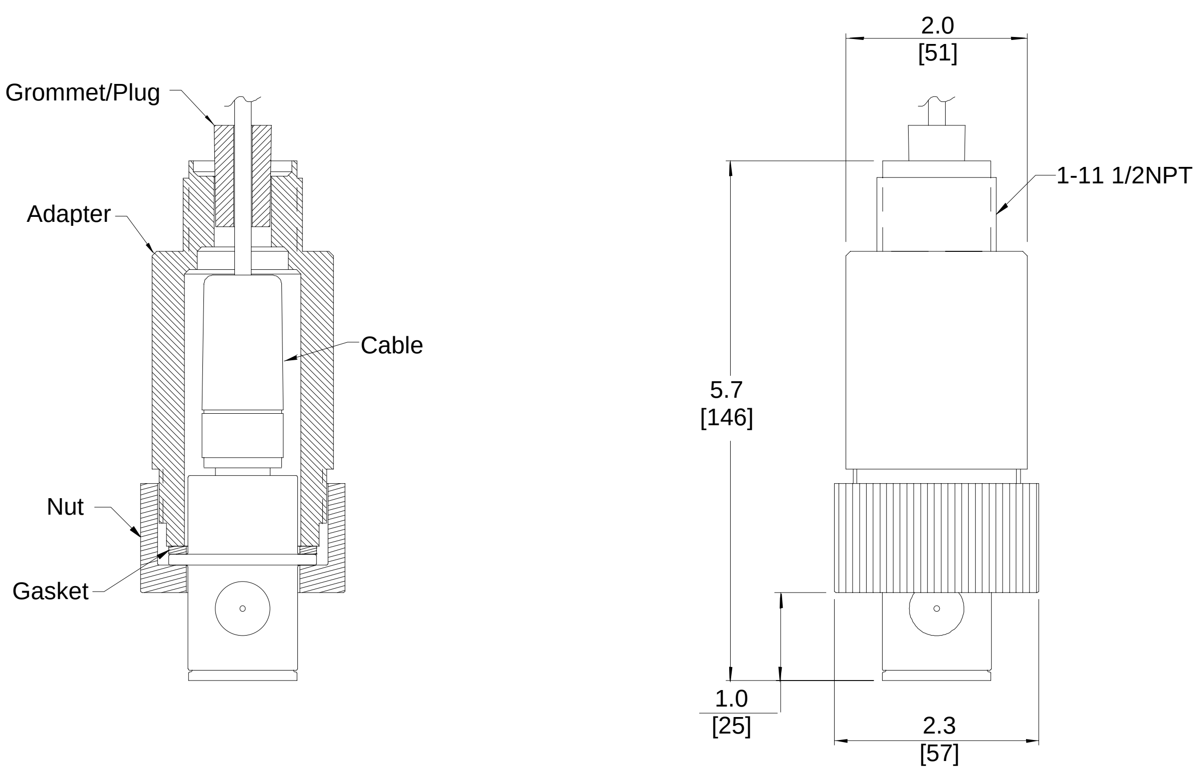
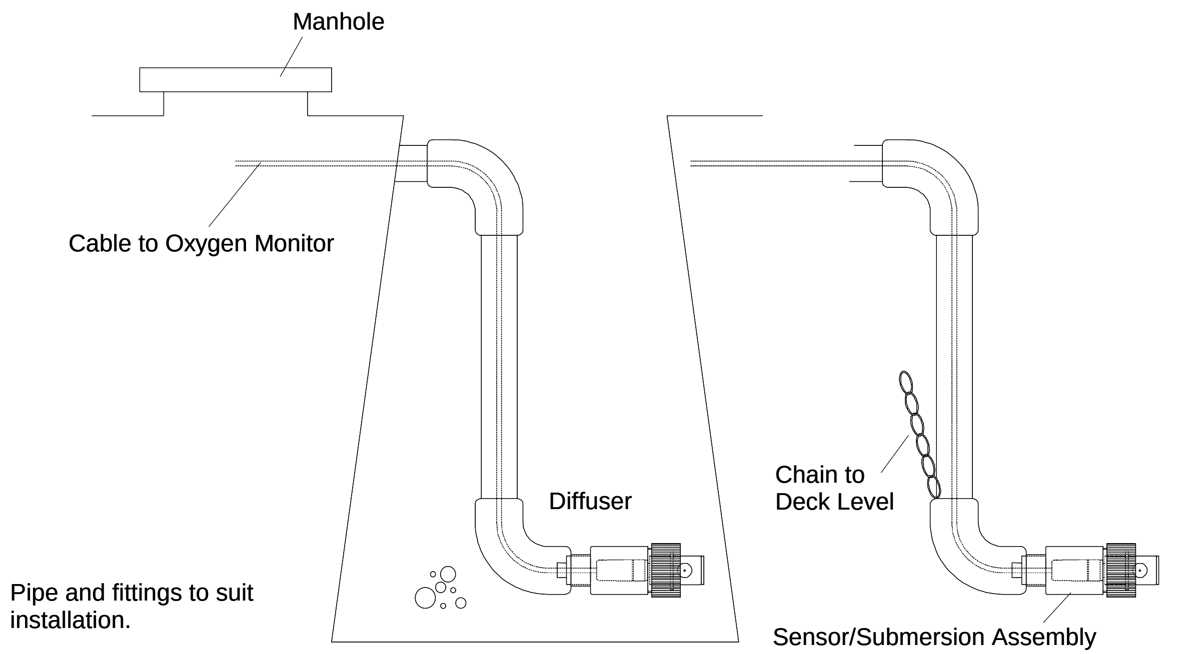


FIGURE 2-15. DIMENSIONS AND COMPONENTS OF NON-RECHARGEABLE SENSOR WITH SUBMERSION KIT

A. INSTALLATION DURING PLANT CONSTRUCTION



B. INSTALLATION IN EXISTING PLANT

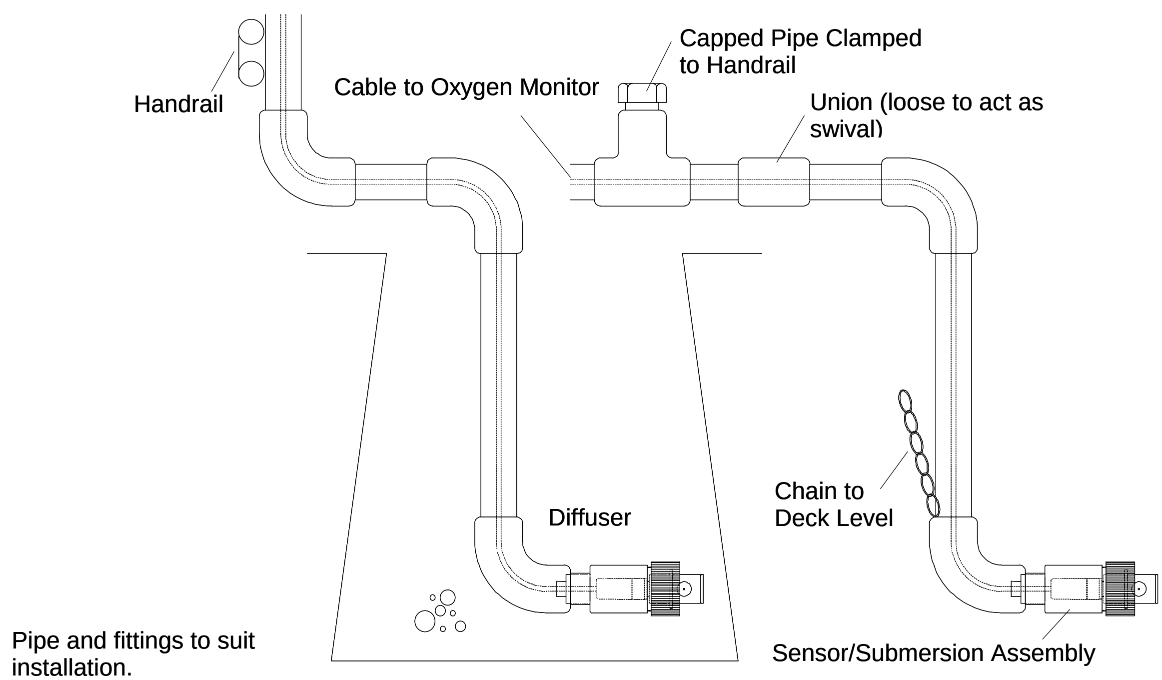


FIGURE 2-16. TYPICAL INSTALLATION OF NON-RECHARGEABLE SENSOR WITH SUBMERSION KIT

3 STARTUP AND CALIBRATION

Prior to startup and calibration, familiarization with Figure 3-1 is recommended. This figure gives locations and brief descriptions of operating controls and adjustments on the display board.

3.1 SYSTEM STARTUP

After completing the installation per Section 2, proceed as follows:

1. On the Display Board (refer to diagram inside door and Figure 3-1):
   a. Select potentiometric output fullscale range by placing output/alarm switch S3 in ON position. Choices are 0 to 25%, 0 to 10%, 0 to 5%, and 0 to 1% oxygen.
   b. Select potentiometric output fullscale voltage by placing output volts switch S2 in ON position. Choices are 0 to 1, 0 to 5, and 0 to 10 volts, fullscale.
   c. Set alarm switches S4 and S5 to OFF position, to avoid activating either alarm before setpoints and deadbands have been adjusted (Section 3.3).
2. Turn on line power.
3. Wait for a suitably stable reading on the digital display. The time required by the user for stabilization of the sensor to levels of performance where the stability of the sensor meets the requirement of a particular user is defined as the equilibration time, that is, the time when the sensor is said to be equilibrated. Normal operation of the analyzer involves adjustments of only the front-panel controls: ZERO and SPAN, and RANGE Switch, if provided. See Figure 1-1.

3.2 CALIBRATION

SENSOR - RESIDUAL CURRENT ZEROING

Each sensor has an individual residual current that must be zeroed out by adjustment of R52 on the Display Board. The sensor is purged with nitrogen gas until a stable reading is obtained. Adjust R52 for a zero reading. This adjustment is required each time a new or recharged sensor is installed.

After the sensor has stabilized, the instrument is ready for calibration. Perform the procedure in Section 3.2.1 or 3.2.2, as appropriate.

3.2.1 CALIBRATION WITH AIR

Calibration with dry air is the preferred method, applicable in all situations. The most convenient source of dry air, when available, is a cylinder of compressed air. It is important, however, to know the actual oxygen content of the cylinder. Cylinder compressed air is frequently a prepared blend of O_2 and N_2, and is not necessarily labeled as such. U.S. Government standards require only that cylinders labeled "air" contain between 19% and 23% oxygen.

To determine oxygen content, request an analysis when purchasing the cylinder air. Another way to determine oxygen content is to pass ambient outdoor air through an efficient drier on the way to the analyzer, preferably using a diaphragm-type pump. The concentration of oxygen will then be very close to 21%.

1. On the Display Board, set RANGE switch S7 at 25%, expose sensor to suitable dry air at ambient atmospheric pressure.
2. Change RANGE switch to CAL position, wait for display reading to stabilize. Then adjust CAL control (disregard decimal point) to bring display reading to:

$$760 \times \frac{\%\ O_2 \text{ in sample}}{20.95}$$

In most situations. ambient air may be used in place of the recommended dry air. Only in instances where temperature and relative humidity are high will significant errors be introduced through the use of ambient air. At a near-sea-level barometric pressure, errors are less than 2% for relative humidity under 40% and temperatures below 95°F (35°C). At 60% relative humidity, ambient air temperatures as high as 82°F (27.8°C) produce a maximum error of 2%. As a rule-of-thumb. dry air should be used for calibration where ambient temperature exceeds 80°F (26.7°C) and/or relative humidity exceeds 60%. For calibration with ambient air, the procedure is the same, except that the sensor is exposed to ambient air instead of dry air.

3.2.2 CALIBRATION WITH SPAN GAS

1. Set RANGE switch S7 to 25% or 19.99%, depending upon concentration of span gas, and expose sensor to span gas, exhausting to ambient pressure.
2. Wait for reading to stabilize, then adjust CAL control to bring display reading to known concentration of span gas.

3.3 SELECTION OF ALARM RANGE, SETPOINT, AND DEADBANDS

1. Select alarm fullscale range by placing one slide of output/alarm switch S3 in ON position. Choices are 0 to 25%. 0 to 10%, 0 to 5% and 0 to 1% oxygen. Refer to diagram on inside of door.
2. The HI ALARM and LO ALARM setpoint potentiometers are adjustable from 0% to 100% of the fullscale span. The potentiometers are graduated from 0 to 100.

Required potentiometer setting for either setpoint adjustment is determined from the equation:

required potentiometer setting = desired alarm reading x 100 fullscale span

EXAMPLE:

Alarm range, 0 to 25%; desired Hi Alarm setpoint, 20%; desired Lo Alarm setpoint, 15%

required Hi ALARM setting = $\frac{20}{25} \times 100 = 80$

required LO ALARM setting = $\frac{15}{25} \times 100 = 60$

3. Select the desired deadband. The HI ALARM and LO ALARM deadband potentiometers are adjustable from 1% of fullscale (counterclockwise limit) to 20% of fullscale (clockwise limit). Deadband is essentially symmetrical with respect to the setpoint.
4. When setpoints and deadbands have been selected, set alarm switches S4 and SS to the AUTO position, to activate the alarms.
5. To test external alarm devices, temporarily set alarm switch S4 or S5 in the ON position. The associated alarm is then unconditionally on.

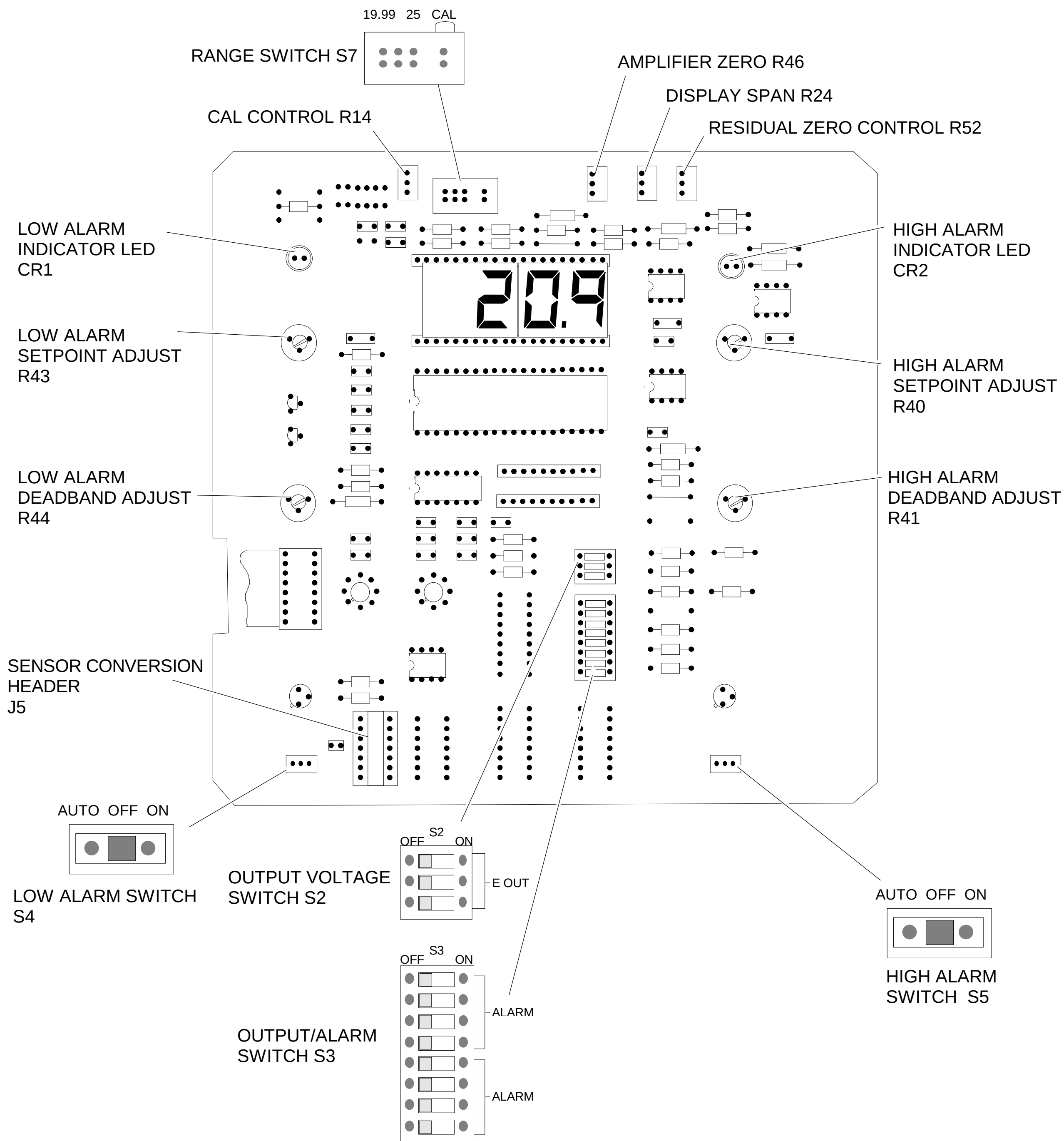


FIGURE 3-1. DISPLAY BOARD

3.4 CURRENT OUTPUT RANGE

Select 0 to 20 or 4 to 20 milliamperes to be minimum current for isolated current output (if present).

1. On the Display Board (Figure 3-1), set RANGE switch S7 to CAL position.
2. With power OFF, disconnect anode and cathode leads from terminal strip TB2 on the Power Supply Board (Figure 2-1). Secure the leads so that they will not contact any board or component.
3. Turn power ON. On the Display Board (Figure 3-1), adjust residual ZERO control R52 until potentiometric output device indicates 0 volt.
4. On the Isolated Current Output Board, adjust ZERO control R1 (Figure 3-2) so that current output device indicates the low range-limit desired for the output range: 0 milliamperes or 4 milliamperes.
5. Turn power OFF. If sensor is rechargeable, connect a 10K ohm resistor between the anode and the cathode terminals on the Power Supply Board terminal strip TB2 (Figure 2-1). If sensor is non-rechargeable, connect a 320K ohm resistor across TB2. This resistor permits the polarizing voltage supply to provide a small current that simulates the sensor output signal.
6. Turn power ON. On front panel controls, adjust CAL clockwise to produce a fullscale reading on the potentiometric output device.
7. On the Isolated Current Output Board (Figure 3-2), adjust SPAN control R2 for reading of 20 milliamps on current output device.

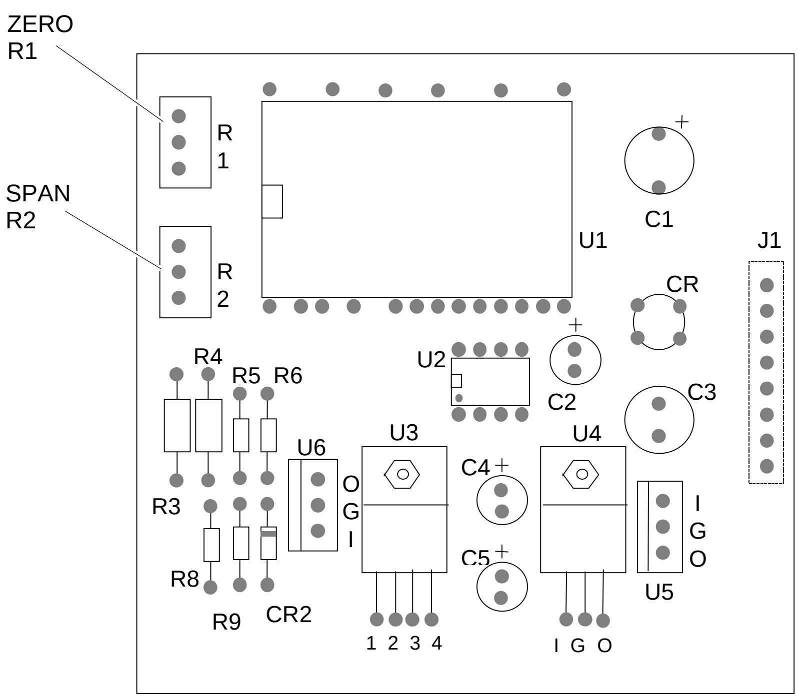


FIGURE 3-2. ISOLATED CURRENT OUTPUT BOARD

NOTES

4 OPERATION

4.1 ROUTINE OPERATION

After startup and calibration (Section 3) the monitor will automatically and continuously indicate the oxygen concentration of the sample.

If potentiometric output or alarms are used on the 0% to 1% oxygen range after calibration at 20.95% oxygen, an appropriate interval is needed to permit the sensor to equilibrate to a low concentration of oxygen. The time required for equilibration depends upon how long the sensor was operated at the higher oxygen level. Thus, a sensor which has been in operation on air for 24 hours prior to calibration will typically show a reading of 0.05% oxygen, or less within one hour after exposure to pure nitrogen. This reading will decrease to 0.01% or so within the next few hours.

Inability to obtain a low-level oxygen reading in a gas of known low-level oxygen content usually indicates a leak in the sample system. To check this possibility, increase sample flow rate, block off the flow of gas into and out of the flow chamber, and note the response of the oxygen monitor. An increase in reading, with time, indicates a leak in the system. If there is no leak in the system, another possibility is that a rechargeable sensor should be rejuvenated or that a disposable sensor should be replaced. The procedure for sensor rejuvenation, which is outlined in Section Six, must be followed carefully if satisfactory results are to be achieved.

4.2 RECOMMENDED CALIBRATION FREQUENCY

For the first few days of operation the instrument should be calibrated daily to compensate for initial stabilization of the membrane in the sensor.

After the sensor has stabilized, an instrument in continuous operation should be calibrated at least once a week until the appropriate calibration interval is determined. A log of periodic calibrations helps establish desired calibration intervals for given applications.

4.3 FREQUENCY OF SENSOR RECHARGING

Nominal useful life of a sensor charge is approximately three to six months; after this time, the sensor should be removed from the installation and recharged. Refer to Section 6.1.1. Physical damage to the membrane is the most frequent cause of failure for service periods less than three months. Proper handling and installation of the sensor into the sample system are essential.

The service life of a disposable 0xygen sensor is application-dependent and no rejuvenation or recharging is possible. It is difficult to determine the prospective shelf life of the disposable oxygen sensor, since no time related failure mechanisms are apparent at this time.

5 THEORY

The Model 7003D Oxygen Monitor system consists of an amperometric oxygen sensor and an amplifier unit interconnected by a multi-conductor shielded cable. The sensor responds to the partial pressure of oxygen. The amplifier conditions the sensor signal, providing a readout of oxygen in percent by volume.

The following Sections detail the major principles of operation. Section 5.2 describes variables that influence the oxygen measurement.

5.1 ELECTROCHEMICAL THEORY

With the sensor placed in the process stream, a voltage is applied across the cathode and anode (see Figure 5-1). Oxygen in the process stream diffuses through the membrane and is reduced at the cathode. The reduction of oxygen results in a current flow proportional to the partial pressure of oxygen in the sample.

When oxygen is not present, no electrical current flows in the sensor. When oxygen is present, electrical current flows in the sensor according to the characteristic curve for the particular potential applied to the electrodes. The magnitude of the current depends upon the partial pressure of the dissolved oxygen in the sample.

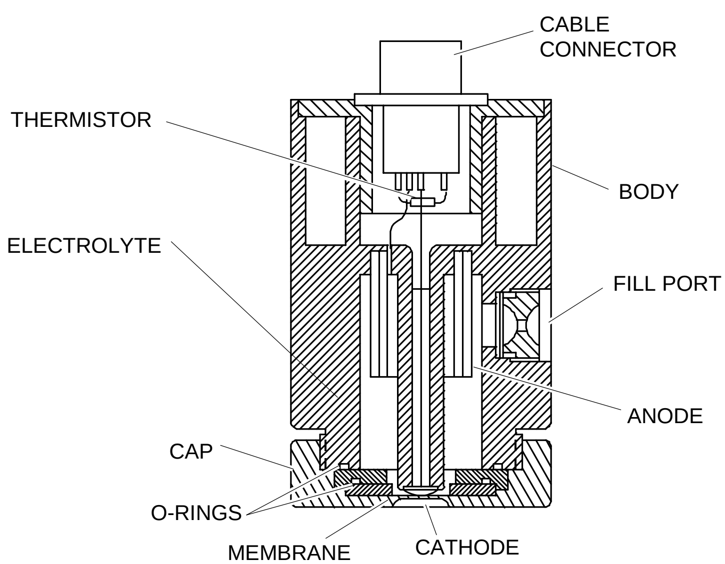


FIGURE 5-1. RECHARGEABLE OXYGEN SENSOR - SECTIONAL VIEW

5.2 VARIABLES INFLUENCING OXYGEN MEASUREMENT

Since the amperometric oxygen sensor responds to the partial pressure of oxygen, any variable that affects that partial pressure should be taken into account to ensure accurate measurement in the desired units. The two basic variables involved are barometric pressure and relative humidity.

Since dry air contains 20.95% oxygen by volume, regardless of barometric pressure, the partial pressure of oxygen is directly proportional to the total barometric pressure, according to Dalton's law of partial pressures. Thus for dry air, if the total barometric pressure is known, the partial pressure of oxygen can be computed. However, the procedure is valid only for dry air. Humid air has the effect of reducing the partial pressure of oxygen and the other gases in the air without affecting the total barometric pressure. Another way of expressing this relationship is by the following equation:

P (atm) = P (gas)+ P (oxygen) + P (water)

where:

P (atm) = total barometric pressure

P (gas) = partial pressure of all gases other than oxygen and water vapor

P (oxygen) = partial pressure of oxygen

P (water) = partial pressure of water vapor

Thus, for constant barometric pressure, if the humidity in the air is not zero, the partial pressure of oxygen is less than the value for dry air. For most measurements taken below 80°F (26.7°C) and below 60% RH, the effect of water vapor may be ignored.

At a barometric pressure of 760 mm Hg (101 kPa), the partial pressure of oxygen in dry air is approximately 160 mm Hg (21.1 kPa).

To determine the partial pressure of oxygen in air at various levels of humidity and barometric pressure. the partial pressure of water is subtracted from the total barometric pressure: this difference is then multiplied by 20.95%.

EXAMPLE

barometric pressure = 740 mm Hg (98.5 kPa)

partial pressure H_20 = 20 mm Hg (2.7 kPa)

partial pressure O_2 = (740-20) x 0.2095 mm Hg = 151 mm Hg (20.1 kPa)

6 ROUTINE SERVICE AND TROUBLESHOOTING

Most service and maintenance problems involve the sensor. Failures within the amplifier unit are less frequent. In system checkout, the recommended procedure is first to isolate the amplifier from the sensor, then perform a few simple tests to determine if the amplifier is performing satisfactorily. The sensor can be checked and then recharged, rejuvenated, or replaced, as necessary.

6.1 RECHARGEABLE SENSORS

Most routine maintenance involves the sensor. Sensor maintenance consists of periodic recharging and cleaning, or rejuvenating the sensor cathode. The usual indication that the sensor requires rejuvenation and recharging is that, during calibration. the correct upscale reading is unobtainable by adjustment of the CAL control. Normally, the inability to calibrate is preceded by a gradual, day-to-day reduction in sensor output, with a resultant lower instrument indication. The rate of reduction increases with the increase in internal resistance of the sensor. Other indicators of need for rejuvenation may be sluggish response or the presence of an appreciable residual signal when the sensor is exposed to a zero reference sample.

Note

If sensor is disassembled for inspection, it must be recharged utilizing a new membrane.

Normally, the sensor should be recharged with fresh electrolyte at three-month intervals. However, the interval may be extended, depending upon the application in which the sensor is used. In general, correcting a low output can be accomplished by recharging with fresh electrolyte, as described in Section 6.1.1. If output still remains low, or the other symptoms exist, the gold cathode should be rejuvenated as described in Section 6.1.2.

In event of "spiking," i.e., non-oxygen-related transient response, the accessory Cell Separator Kit is recommended. Refer to Section 6.1.3.

6.1.1 RECHARGING SENSOR

The sensor must be removed from the process installation and disconnected from the sensor cable for recharging.

The recharging kit consist of electrolyte, membranes, pressure-compensating rubber diaphragms, O-rings for the membrane retainer, O-rings for the sensor body, and washers for the diaphragms.

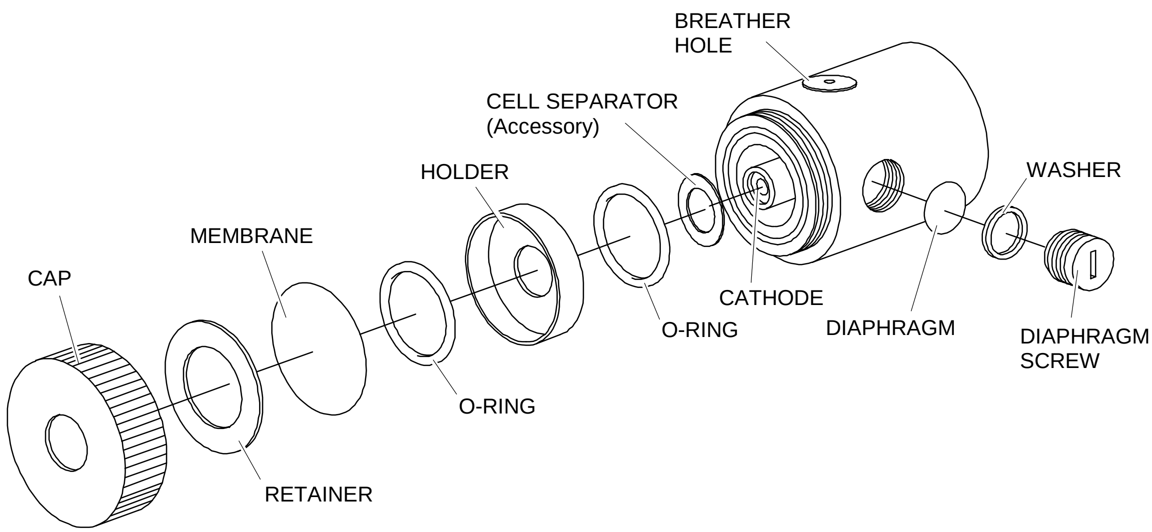


FIGURE 6-1. RECHARGEABLE SENSOR - EXPLODED VIEW

RECHARGEING PROCEDURE

For this procedure refer to Figure 6-1.

1. Unscrew knurled cap from end of sensor body. Remove membrane assembly, consisting of membrane fixed between holder and retainer. Empty all electrolyte from sensor. Flush sensor with distilled or deionized water to remove all particulate matter.

2. Place a piece of adhesive tape over the breather hole in the pressure compensation diaphragm port (not the slotted fill plug).

3. Examine cathode for:

   a. Staining or uneven coloration. which indicates that the cathode should be rejuvenated as described in Section 6.1.2.

b. Any deposited material, typically white to gray. present in or around the grooves in the plastic surrounding the cathode. This must be removed to ensure best operation. Most of these deposits are water-soluble and may be removed by a water jet from a squeeze bottle. Any insoluble deposits in the annular and channel grooves may be removed with a toothpick; however, care must be used to avoid deforming the grooves.

4. Disassemble the membrane assembly. This consists of a plastic membrane, a holder, a retainer, and an O-ring. Remove retainer from holder by placing finger into center hole of holder and pressing fingernail against inner edge of retainer. Remove and discard the old membrane.

5. Verify that O-ring is properly positioned in associated groove in holder.

6. Holding a single membrane by the edges only, place it across membrane holder and snap retainer in place. Membrane is now fixed in proper position, between holder and retainer.

CAUTION: MEMBRANE CONTAMINATION

Never touch center area of membrane with fingers. Membranes are easily contaminated with foreign substances. Contaminated membranes cause drifting or erratic readings.

7. Using a sharp razor blade, carefully trim away excess membrane around edge of membrane assembly. Take care that razor blade does not cut into edges of membrane assembly.

8. Set sensor body on a flat surface, with cathode facing upward. Verify that O-ring in groove at end of sensor body is properly positioned around cathode. Pour the electrolyte over the cathode/central post assembly so that it runs down into the sensor electrolyte well. Fill the well to a level flush with the top of the sidewall.

   Put the membrane assembly directly onto the cathode so that the face of the holder (i.e., the part with the larger-diameter central hole) fits against the O-ring in the end of the sensor body.

   The membrane is now in place. It will spread any electrolyte remaining on the cathode into a thin film that wets the entire surface. The membrane assembly should now be centered over the cathode.

9. Taking care not to disturb the central orientation of the membrane assembly, carefully place the cap on the sensor body. Screw the cap on, fingertight only. Then lay the sensor on its side, with the side port up. Remove side port screw, rubber pressure-compensating diaphragm, and washer. Add electrolyte, if necessary, to bring the level into the side port and then rock the sensor from end to end to remove any air pockets. Add

electrolyte, if necessary, to bring the level even with the shoulder. With the side port still facing up, tighten the cap further until it is snug, and the membrane is stretched taut across the cathode. Any excess electrolyte displaced from the electrolyte well into the side port may now be removed by blotting with a tissue.

10. Insert new rubber diaphragm into side port, place new washer over diaphragm, and secure with side port screw. Do not overtighten screw.
11. Inspect sensor for possible leaks or damage to membrane.
12. Remove the adhesive tape installed in Step 2 from the pressure compensation port.

Sensor is ready for operation. Connect cable. If sensor does not operate properly refer to Section 6.3.

If normal operation is not obtained with the specified recharging procedure, perform rejuvenation, as detailed in Section 6.1.2.

6.1.2 REJUVENATING CATHODE

If simple recharging does not correct symptoms of low output, clean and/or rejuvenate the cathode as follows:

WARNING: CORROSIVE MATERIAL

Concentrated nitric acid is used in the following procedure. This material is highly corrosive. Avoid contact with skin, eyes, clothing, and precision instrument parts. Use rubber gloves and eye protection. If body contact occurs, flush copiously with water and seek medical attention.

1. Disassemble sensor. Remove cap and membrane assembly. Discard the used electrolyte. Flush the sensor with distilled or deionized water to remove all particulate material.

2. Over a sink, use a cotton swab to treat the cathode with concentrated reagent grade nitric acid, obtainable from a laboratory supply house. Submerge the tip of the swab in the nitric acid. Press the swab against the side of the nitric acid container to remove excess acid. Swab the cathode area lightly for five minutes.

3. Take care to confine the nitric acid to the button area. Only a thin film of nitric acid should be present on the surface of the cathode during the cleaning operation. Excessive application may result in the destruction of the epoxy annulus surrounding the button, with resultant sensor failure.

4. Rinse the button and sensor cavity thoroughly with distilled or deionized water. Then rinse the sensor with electrolyte by pouring it over the cathode into the sensor cavity until it is filled. Discard this electrolyte.

5. Recharge the sensor in the normal fashion.

If normal operation is not obtained with the specified rejuvenation procedure, the sensor is depleted and must be replaced.

6.1.3 CELL SEPARATOR KIT

The cell separator is used to eliminate "spiking," i.e., non-oxygen-related transient response on the analyzer output.

This condition is usually caused by reaction products which slough off the anode and are transported to the cathode surface, where they are reduced. During reduction, the anode accepts electrons, resulting in the undesired transient response.

The condition may be corrected by installing a separator disk which mechanically separates the cathode and anode (see Figure 6-1). The kit contains ten disks.

To install the separator in an oxygen sensor, remove the cap and membrane holder. pour out the electrolyte, and position the hole in the separator over the cathode post. Then gently push the separator down into the sensor body until it rests on top of the anode. Fill the sensor with fresh electrolyte and reassemble in the conventional manner.

6.2 NON-RECHARGEABLE SENSORS

The non-rechargeable sensor has no user accessible internal parts. No sensor maintenance is possible other than gentle brushing to remove deposits on the face of the sensor to restore its sensitivity and response time.

If the performance of the sensor has degraded beyond acceptable limits, it must be replaced.

6.3 TROUBLESHOOTING

The most frequent fault is a progressive development of insensitivity of the sensor. During calibration, the CAL control must be turned farther and farther clockwise to set the meter to the desired calibration value. Finally, after several months of operation, rotating the CAL control to its clockwise limit fails to bring the meter to the desired calibration setting.

The cause of this characteristic change is the gradual exhaustion or occlusion of the sensor. Accordingly, the sensor must be maintained as described in Section 6.

System problems can be isolated to the sensor or the amplifier by the following procedure:

1. Disconnect AC power from the instrument.
2. Set alarm switches S4 and S5 (Figure 3-1) to OFF position.
3. On TB2 (Figure 2-1) make following connections:
   a. Disconnect all leads of sensor cable.
   b. Connect a 10K ohm resistor across the three l0K THMS terminals. This resistor simulates the resistance of the thermistor at 25°C.
   c. If the sensor is rechargeable, connect a 10 K ohm resistor across terminals marked AN (for anode) and CATH (for cathode). If the sensor is non-rechargeable, connect a 320 K ohm resistor across the terminals. This resistor permits the polarizing voltage supply to provide a small current that simulates the sensor output signal.
4. Set RANGE switch to CAL (Figure 3-1).
5. Rotate CAL control throughout its range to verify that the outputs of the instrument respond from near zero to above fullscale.

If test yields correct results, amplifier is operational. The fault is in sensor or cable. Remove 10 K ohm resistors from TB2 and proceed to tests given in Section 6.3.1 or 6.3.2.

If these tests do not yield correct results, contact a factory authorized service representative.

6.3.1 CHECKING RECHARGEABLE SENSOR AND CABLE

For convenience, the sensor cable may be regarded as part of the sensor. Accordingly, electrical checks are made at the terminal ends of the cable, disconnected from the amplifier at TB2. Verification of electrical integrity of the sensor is determined by making the following checks with an ohmmeter:

1. Resistance between white and green leads should be 10 ohms +1% at 25°C (approximately 30 ohms at 0°C, and 4 ohms at 50°C). Readings from white or green lead to any other lead of the sensor cable should indicate open circuit, or at least 100M ohms. Readings less than this indicate a shunt resistance path which produces an error in the measurement.
2. The black and white lead is connected to the grounding shield. Readings from this lead to any other lead of the sensor cable should be at least 100M ohms.

3. If checks in Steps I or 2 indicate trouble, or if other symptoms indicate the sensor to be faulty, determine the probable cause by reference to the appropriate symptom(s) in Table 6-1. This table is a compilation of the most common sensor problems.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Abnormally high oxygen readings (unable to calibrate)	Hole in sensor membrane	Replace membrane
	Gold cathode loose	Replace sensor
	Open thermistor	Replace sensor
Abnormally low oxygen readings (unable to calibrate)	High internal cell resistance	Rejuvenate/recharge sensor
	Membrane too loose	Tighten cap or replace membrane
	Contaminated electrolyte[2]	Clean/recharge sensor
	Thermistor shorted	Replace sensor
Sensor noisy (motion sensitive)	Membrane loose	Replace membrane
	Low electrolyte level	Fill properly
	Cathode contaminated[2]	Rejuvenate/recharge sensor
Upscale reading with known oxygen-free sample	Gold cathode loose	Replace sensor
Slow response (sluggish)	Contaminated electrolyte[2]	Rejuvenate/recharge sensor

TABLE 6-1. RECHARGEABLE SENSOR TROUBLESHOOTING GUIDE

[2] "Contamination" may be the normal accumulation resulting from long-term operation, indicative that the standard cell-rejuvenation procedure is required.

6.3.2 CHECKING NON-RECHARGEABLE SENSOR AND CABLE

To check the cable disconnect it from the monitor and the sensor. The resistance between any two leads should be at least 100 M ohms. A continuity check on any lead should produce a reading of less than 15 ohms per thousand feet.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Abnormally high oxygen readings	Hole in sensor membrane	Replace sensor
(unable to calibrate)	Open thermistor	Replace sensor
	Cell contaminated	Replace sensor
Abnormally low oxygen readings	Thermistor shorted	Replace sensor
(unable to calibrate)	Membrane surface dirty	Clean front surface
Upscale reading with known oxygen-free sample (greater than 0.1% O_2 or equivalent)	Sensor contaminated	Adjust sensor zero control Check linearity with standards
Slow response (sluggish)	Contaminated electrolyte[2]	Replace sensor

TABLE 6-2. NON-RECHARGEABLE SENSOR TROUBLESHOOTING GUIDE

7 REPLACEMENT PARTS

WARNING: PARTS INTEGRITY

Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair.

7.1 CIRCUIT BOARD REPLACEMENT POLICY

In most situations involving a malfunction of a circuit board, it is more practical to replace the board than to attempt isolation and replacement of the individual component, as the cost of test and replacement will exceed the cost of a rebuilt assembly. As standard policy, rebuilt boards are available on an exchange basis.

Because of the exchange policy covering circuit boards, the following list does not include individual electronic components. If circumstances necessitate replacement of an individual component, which can be identified by inspection or from the schematic diagrams, obtain the replacement component from a local source of supply.

7.2 REPLACEMENT PARTS

858728	Arc Suppressor
637358	Cell Separator Kit (10 separator disks)
622529	Display Board
777156	Fuse, 1/4 A - 120 VAC (Package of 5)
777360	Fuse, 1/8 A - 240 VAC (Package of 5)
620433	Isolated Current Output Board (Option)
622621	Pipe Mounting Kit
622537	Power Supply Board
193265	Sensor Cable[3]
191748	Sensor Cable 10'
856831	Sensor Cable Connector Accessory
191755	Sensor Recharge Kit (10 recharges)
652117	Wall Mounting Kit

[3] Length specified by customer, any length up to 1000'.

7.3 REPLACEMENT PARTS - SENSORS

7.3.1 RECHARGEABLE SENSORS

SENSOR:

MATERIAL	PART NUMBER
Polypropylene	623371
Polypropylene	623370 (use with Fast Response Kit)
Ryton	190408
Ryton	190409 (use with Fast Response Kit)

SENSOR KITS (SENSOR *NOT* INCLUDED):

DESCRIPTION	PART NUMBER	USE WITH SENSOR
Submersion, Polypropylene	639904	623371
In-Line Flow, Polypropylene	639905	623371
Fast Response, Polypropylene	639906	623370
Submersion, Ryton	646628	190408
In-Line Flow, Ryton	646629	190408
Fast Response, Ryton	646630	190409

SENSOR KITS (SENSOR INCLUDED):

DESCRIPTION	PART NUMBER
Submersion, Polypropylene	400011
In-Line Flow, Polypropylene	400012
Fast Response, Polypropylene	400013
Submersion, Ryton	400021
In-Line Flow, Ryton	400022
Fast Response, Ryton	400023

7.3.2 NON-RECHARGEABLE SENSORS

SENSOR:

MATERIAL	PART NUMBER
Polypropylene	623742

SENSOR KITS (SENSOR *NOT* INCLUDED):

DESCRIPTION	PART NUMBER	USE WITH SENSOR
Submersion, Polypropylene	623716	623742
In-Line Flow, Polypropylene	623715	623742

SENSOR KITS (SENSOR INCLUDED):

DESCRIPTION	PART NUMBER
Submersion, Polypropylene	500011
In-Line Flow, Polypropylene	500012

NOTES