



Advanced Instruments Inc.

Gas analysis solutions through advanced analyzer and sensor technology

GPR-2500 S

Oxygen Analyzer

Ambient Area Monitoring



Owner's Manual



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1 Introduction

Your new oxygen analyzer incorporates an advanced electrochemical sensor specific to oxygen along with state-of-the-art digital electronics designed to give you years of reliable precise oxygen measurements in variety of industrial oxygen applications.

The GPR-2500S is generally used to monitor the oxygen content of a confined space or control room occupied by humans for a deficiency of oxygen. This configuration requires the operator calibrate the monitor with a certified span gas from a cylinder and not the ambient air surrounding the monitor. Failure to heed this instruction may result in injury or death .

To obtain maximum performance from your new Ambient Oxygen Monitor, please read and follow the guidelines provided in this Owner's Manual.

Every effort has been made to select the most reliable state of the art materials and components, to design the monitor for superior performance and minimal cost of ownership. This monitor was tested thoroughly by the manufacturer prior to shipment for best performance.

However, modern electronic devices do require service from time to time. The warranty included herein plus a staff of trained professional technicians to quickly service your monitor is your assurance that we stand behind every monitor sold.

The serial number of this monitor may be found on the inside the monitor. You should note the serial number in the space provided and retains this Owner's Manual as a permanent record of your purchase, for future reference and for warranty considerations.

Serial Number: _____

Advanced Instruments Inc. appreciates your business and pledges to make every effort to maintain the highest possible quality standards with respect to product design, manufacturing and service.



2 Quality Control Certification

Date:	Customer:	Order No.:	<u>Pass</u>
Model	GPR-2500S Ambient Oxygen Monitor		_____
Sensor	() GPR-11-32-4 Oxygen Sensor () XLT-11-24-4 Oxygen Sensor () Other _____		_____
Serial Nos.:	Monitor:	Sensor:	_____
Accessories:	Owner's Manual () A-2344 Calibration Flow Adapter (GPR-2500S) () Remote sensor requires: A-2070 Bracket Mount, A-2781 Nut Retaining		_____
Configuration:	A-1151-E-L2 PCB Assembly Main / Display Software rev: Ranges: 0-1%, 0-5%, 0-10%, 0-25% Power: 12-36V DC two wire loop power NEMA 4 rated wall mount enclosure Barometric pressure compensation		_____
Test:	Default zero (without sensor) Default span @ 40uA Analog signal output 4-20mA full scale Calibrates with adequate span adjustment within 10-50% FS Baseline drift on zero gas < ± 2% FS over 24 hour period Noise level < ± 1.0% FS Span adjustment within 10-50% FS		_____
Final:	Overall inspection for physical defects		_____
Options:			_____
Notes:			_____



3 General Safety & Installation

General

This section summarizes the essential precautions applicable to the GPR-2500S Ambient Oxygen Monitor. Additional precautions specific to individual monitor are contained in the following sections of this manual. To operate the monitor safely and obtain maximum performance follow the basic guidelines outlined in this Owner's Manual.

Caution: This symbol is used throughout the Owner's Manual to CAUTION and alert the user to recommended safety and/or operating guidelines.

Danger: This symbol is used throughout the Owner's Manual to identify sources of immediate DANGER such as the presence of hazardous voltages.

Read Instructions: Before operating the monitor read the instructions.

Retain Instructions: The safety precautions and operating instructions found in the Owner's Manual should be retained for future reference.

Heed Warnings: Follow all warnings on the monitor, accessories (if any) and in this Owner's Manual.

Follow Instructions: Observe all precautions and operating instructions. Failure to do so may result in personal injury or damage to the monitor.

Heat: Situate and store the monitor away from sources of heat.

Liquid and Object Entry: The monitor should not be immersed in any liquid. Care should be taken so that liquids are not spilled into and objects do not fall into the inside of the monitor.

Handling: Do not use force when using the switches and knobs. Before moving your monitor be sure to disconnect the wiring/power cord and any cables connected to the output terminals located on the monitor.

Maintenance

Serviceability: Except for replacing the oxygen sensor, there are no parts inside the monitor for the operator to service.

Only trained personnel with the authorization of their supervisor should conduct maintenance.

Oxygen Sensor: DO NOT open the sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual appendix. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.

Troubleshooting: Consult the guidelines in Section 8 for advice on the common operating errors before concluding that your monitor is faulty.

Do not attempt to service the monitor beyond those means described in this Owner's Manual. Do not attempt to make repairs by yourself as this will void the warranty as per Section 10 and may result in electrical shock, injury or damage. All other servicing should be referred to qualified service personnel.

Cleaning: The monitor should be cleaned only as recommended by the manufacturer. Wipe off dust and dirt from the outside of the unit with a soft damp cloth then dry immediately. Do not use solvents or chemicals.

Nonuse Periods: If the monitor is equipped with a range switch advance the switch to the OFF position and disconnect the power when the monitor is left unused for a long period of time.



Installation

Gas Sample Stream: Ensure the gas stream composition of the application is consistent with the specifications and review the application conditions before initiating the installation. Consult the factory to ensure the sample is suitable for analysis. **Note:** In natural gas applications such as extraction and transmission, a low voltage current is applied to the pipeline itself to inhibit corrosion. As a result, electronic devices can be affected unless adequately grounded.

Contaminant Gases: A gas scrubber and flow indicator with integral metering valve are required upstream of the of the analyzer to remove interfering gases such as oxides of sulfur and nitrogen or hydrogen sulfide that can produce false readings, reduce the expected life of the sensor and void the sensor warranty if not identified at time of order placement. Installation of a suitable scrubber is required to remove the contaminant from the sample gas to prevent erroneous analysis readings and damage to the sensor or optional components. Consult the factory for recommendations concerning the proper selection and installation of components.

Expected Sensor Life: With reference to the publish specification located as the last page of this manual, the expected life of all oxygen sensors is predicated on oxygen concentration (< 1000 ppm or air), temperature (77°F/25°C) and pressure (1 atmosphere) in “normal” applications. Deviations are outside the specifications and will affect the life of the sensor. As a rule of thumb sensor life is inversely proportional to changes in the parameters.

Accuracy & Calibration: Refer to section 5 Operation.

Materials: Assemble the necessary zero, purge and span gases and optional components such as valves, coalescing or particulate filters, and, pumps as dictated by the application; stainless steel tubing is essential for maintaining the integrity of the gas stream for ppm and percentage range (above or below ambient air) analysis; hardware for mounting.

Operating Temperature: The sample must be sufficiently cooled before it enters the analyzer and any optional components. A coiled 10 foot length of ¼” stainless steel tubing is sufficient for cooling sample gases as high as 1,800°F to ambient. The maximum operating temperature is 45° C on an intermittent basis unless the user is willing to accept a reduction in expected sensor life – refer to analyzer specification - where expected sensor life is specified at an oxygen concentration less than 1000 ppm oxygen for ppm analyzers and air (20.9% oxygen) for percent analyzers, but in all instances at 25°C and 1 atmosphere of pressure. Expected sensor varies inversely with changes in these parameters.

Pressure & Flow: All electrochemical oxygen sensors respond to partial pressure changes in oxygen. The sensors are equally capable of analyzing the oxygen content of a flowing sample gas stream or monitoring the oxygen concentration in ambient air (such as a confined space such in a control room or an open area such as a landfill or bio-pond). The following is applicable to analyzers equipped with fuel cell type oxygen sensors. With respect to analyzers equipped with Pico-Ion UHP and MS oxygen sensors, refer to the analyzer’s specifications.

Inlet Pressure: The GPR-2500S is designed for in-situ ambient or area monitoring and has no sample system because the sensor is intended to be exposed directly to the surrounding ambient atmosphere which it is sampling and to operate at atmospheric pressure, however, slightly positive pressure has minimal effect on accuracy.

Further, applications situations may dictate that the sample be transported from a semi-sealed area to a safe area where the analyzer is located. In these cases the analyzer can be readily adapted to include optional pumps, tubing and connection fittings. Users interested in adding their own sample conditioning system should consult the factory.





Analyzers designed for flowing samples under positive pressure or pump vacuum (for samples at atmospheric or slightly negative atmospheres) that does not exceed 14" water column are equipped with bulkhead tube fitting connections on the side of the unit (unless otherwise indicated, either fitting can serve as inlet or vent) and are intended to operate at positive pressure regulated to between 5-30 psig although their particular rating is considerably higher.

Outlet Pressure: In positive pressure applications the vent pressure must be less than the inlet, preferably atmospheric.

Sample systems and flowing gas samples are generally required for applications involving oxygen measurements at a pressure other than ambient air. In these situations, the use of stainless steel tubing and fittings is critical to maintaining the integrity of the gas stream to be sampled and the inlet pressure must always be higher than the pressure at the outlet vent which is normally at atmospheric pressure. The sensor is exposed to sample gas that must flow or be drawn through metal tubing inside the analyzer. The internal sample system includes 1/8" compression inlet and vent fittings, a delrin (stainless steel is optional) sensor housing with an o-ring seal to prevent the leakage of air and stainless steel tubing.

Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate backpressure and erroneous oxygen readings because the diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate. The direction the sample gas flows is not important, thus either tube fitting can serve as the inlet or vent – just not simultaneously.

A flow indicator with an integral metering valve upstream of the sensor is provided as a means of controlling the flow rate of the sample gas. A flow rate of 2 SCFH or 1 liter per minute is recommended for optimum performance.

Caution: Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (voiding the sensor warranty). To avoid generating a vacuum on the sensor (as described above) during operation, always select and install the vent fitting first and remove the vent fitting last.

Application Pressure - Positive: A flow indicator with integral metering valve positioned upstream of the sensor is recommended for controlling the sample flow rate between 1-5 SCFH. If necessary, a pressure regulator (with a metallic diaphragm is recommended for optimum accuracy, the use of diaphragms of more permeable materials may result in erroneous readings) upstream of the flow control valve should be used to regulate the inlet pressure between 5-30 psig.

Application Pressure - Atmospheric or Slightly Negative: An optional external sampling pump should be positioned upstream of the sensor to draw the sample from the process, introduce it at a predetermined flow rate of 2 SCFH to the sensor and out to atmosphere. A flow meter is generally not necessary to obtain the recommended flow rate with most sampling pumps.

Caution: If the analyzer is equipped with an optional flow indicator with integral metering valve or a metering flow control valve upstream of the sensor - open the metering valve completely to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

If pump loading is a consideration, a second throttle valve on the pump's inlet side may be necessary to provide a bypass path so the sample flow rate is within the above parameters.

Recommendations to avoid erroneous oxygen readings and damaging the sensor:

- Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (thus voiding the sensor warranty).
- Assure there are no restrictions in the sample or vent lines
- Avoid drawing a vacuum that exceeds 14" of water column pressure – unless done gradually
- Avoid excessive flow rates above 5 SCFH which generate backpressure on the sensor.
- Avoid sudden releases of backpressure that can severely damage the sensor.
- Avoid the collection of liquids or particulates on the sensor, they block the diffusion of oxygen into the sensor -



wipe away.

- If the analyzer is equipped with an optional integral sampling pump (positioned downstream of the sensor) and a flow control metering valve (positioned upstream of the sensor), completely open the flow control metering valve to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.
- Calibrate ambient area monitors with a certified span gas/
- Avoid calibration of ambient area monitors with the surrounding atmosphere unless assured the oxygen content is 20.9%.

Moisture & Particulates: Installation of a suitable coalescing or particulate filter is required to remove condensation, moisture and/or particulates from the sample gas to prevent erroneous analysis readings and damage to the sensor or optional components. Moisture and/or particulates do not necessarily damage the sensor, however, collection on the sensing surface can block or inhibit the diffusion of sample gas into the sensor resulting in a reduction of sensor signal output – and the appearance of a sensor failure when in fact the problem is easily remedied by blowing on the front of the sensor. Consult the factory for recommendations concerning the proper selection and installation of components.

Moisture and/or particulates generally can be removed from the sensor by opening the sensor housing and either blowing on the the sensing surface or gently wiping or brushing the sensing surface with damp cloth. **Caution:** Minimize the exposure of ppm sensors to air during this cleaning process. Air calibration followed by purging with zero or a gas with a low ppm oxygen concentration is recommended following the cleaning process. Moisture and/or particulates generally can be removed from the sample system by flowing the purge gas through the analyzer at a flow rate of 4.5-5 SCFH for an hour.

Mounting: The analyzer is approved for indoor use, outdoor use requires optional enclosures, consult factory. Mount as recommended by the manufacturer.

Gas Connections: Inlet and outlet vent gas lines for ppm analysis require 1/8" or 1/4" stainless steel compression fittings; hard plastic tubing with a low permeability factor can be used percentage range measurements. Oxygen analyzers designed for ambient area monitoring expose the sensor directly to the atmosphere being sampled and thus have no gas connections.

Power: Supply power to the analyzer only as rated by the specification or markings on the analyzer enclosure. The wiring that connects the analyzer to the power source should be installed in accordance with recognized electrical standards. Ensure that is properly grounded and meets the requirements for area classification. Never yank wiring to remove it from a terminal connection. AC powered analog analyzers consume 5 watts, digital analyzers 50 watts without optional heaters. Optional 110V and 220V heaters AC powered heaters consume an additional 100-150 watts; DC powered digital analyzers consume 30 watts, 40 watts with the optional DC powered heater.

4 Features & Specifications

See last page, left blank intentionally.



5 Operation

Principle of Operation

The GPR-2500S Ambient Oxygen Monitor incorporates a variety of advanced galvanic fuel cell type sensors. The monitor is configured in a general purpose NEMA 4X rated enclosure and meets the intrinsic safety standards required for use in Class 1, Division 1, Groups A, B, C, D hazardous areas when operated in conjunction with the manufacturer's recommended optional intrinsic safety barriers.

Advanced Galvanic Sensor Technology:

The sensors function on the same principle and are specific for oxygen. They measure the partial pressure of oxygen from low ppm to 100% levels in inert gases, gaseous hydrocarbons, helium, hydrogen, mixed gases, acid gas streams and ambient air. Oxygen, the fuel for this electrochemical transducer, diffusing into the sensor reacts chemically at the sensing electrode to produce an electrical current output proportional to the oxygen concentration in the gas phase. The sensor's signal output is linear over all ranges and remains virtually constant over its useful life. The sensor requires no maintenance and is easily and safely replaced at the end of its useful life.

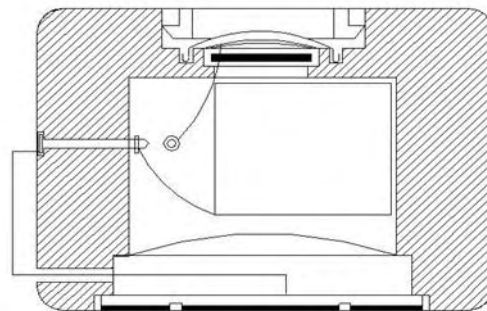
Proprietary advancements in design and chemistry add significant advantages to an extremely versatile oxygen sensing technology. Sensors for low ppm analysis recover from air to ppm levels in minutes, exhibit longer life and reliable quality. The expected life of our new generation of percentage range sensors now range to five and ten years with faster response times and greater stability. Another significant development involves expanding the operating temperature range for percentage range sensors from -30°C to 50°C.

Design Objectives

- Improve quality and reliability through a proprietary controlled manufacturing process . . .
- Comply with domestic and international quality standards
- Compact disposable dimensions
- No sensor maintenance
- Improve performance over replacement sensors - sensitivity, stability, response, recovery
- Longer operating and shelf life - translate into longer warranty period
- Low cost of ownership

% Oxygen Sensors

- Extend operating life to 10 years in air (20.9% O₂) . . .
24 months in continuous 100% O₂
- Extended operating range to -40° C/F to 50° C
- Excellent stability at elevated pressure . . .
Up to 10 atmospheres in hyperbaric chambers
- Superior compatibility with 0.5 - 100% CO₂ gas streams
24 month operating life in traditional dimensions
- Develop special sensor for fast response and long life
Large cathode with proprietary electrolytes and anodes



GPR/XLT 11 Series % Oxygen Sensor

Electronics:

The signal generated by the sensor is processed by state of the art low power micro-processor based digital circuitry. The first stage amplifies the signal. The second stage eliminates the low frequency noise. The third stage employs a high frequency filter and compensates for signal output variations caused by ambient temperature changes. The result is a very stable signal.



Sample oxygen is analyzed very accurately. Response time of 90% of full scale is less than 10 seconds (actual experience may vary due to the integrity of sample line connections, dead volume and flow rate selected) on all ranges under ambient monitoring conditions. Sensitivity is typically 0.5% of full scale low range. Oxygen readings may be recorded by an external device via the 0-1V signal output jack.

A 4-20mA signal output is provided from a two-wire 12-36VDC loop power source such as a PLC and is represented on full scale oxygen readings to an external device. When operated in conjunction with the manufacturer's recommended optional intrinsic safety barriers the GPR-2500S meets the intrinsic safety standards required for use in Class 1, Division 1, Groups A, B, C, D hazardous areas.

In compliance with OSHA specifications, the standard unit includes two oxygen alarms which have been set by the factory to energize audio and visual alarms when oxygen levels fall below CAUTION (20.0% O₂) and DANGER (19.5% O₂). Optionally, these alarms can be configured as HIGH O₂ and LOW O₂ based on customer requirements. The two-color alarm LED indicators display green for safe and red for alarm conditions. The alarms remain energized until the oxygen level rises above (and/or below with the optional high, low configuration) the alarm set points. Power interruptions do not interfere with the alarms of a unit installed and operated properly.

The GPR-35 is unique in that it automatically compensates the sensor output for pressure changes thereby eliminating the false alarms. Unlike competitive analyzers the GPR-35 is not affected by changes in the barometric pressure that can temporarily impact the sensor output and analyzer reading to the extent that most analyzers produce false alarms. In addition to being irritating, false alarms can be costly in terms of interrupting projects, tests or production processes.

Sample System:

The GPR-35 designed for in-situ ambient or area monitoring and has no sample system because the sensor is intended to be exposed directly to the surrounding ambient atmosphere which it is sampling and to operate at atmospheric pressure, however, slightly positive pressure has minimal effect on accuracy.

Further, applications situations may dictate that the sample be transported from a semi-sealed area to a safe area where the analyzer is located. In these cases the analyzer can be readily adapted to include optional pumps, tubing and connection fittings. Users interested in adding their own sample conditioning system should consult the factory. Contact us at 909-392-6900 or e-mail us at info@aii1.com with any questions.



Mounting the Analyzer

The GPR-2500S Ambient Oxygen Monitors has been calibrated at the factory prior to shipment and is fully operational from the shipping container. The enclosure's 4x9x3" configuration is designed to be mounted directly to any flat vertical surface, wall or bulkhead plate with the appropriate screws. To facilitate servicing the interior of the monitors, position it approximately 5 feet off the floor.

1. Remove the four (4) screws securing the top section of the enclosure, set them aside for reinstallation and raise the hinged top section 180° until it locks in place.
2. Locate the mounting holes cast into the bottom section of the enclosure and the black sensor. Orient the enclosure by locating the sensor at six (6) o'clock.
3. Secure the bottom section of the enclosure to a vertical surface approximately 5 feet from the floor or a level accessible to service personnel. This requires the user to supply four (4) additional proper size screws and anchors.
4. Caution: Do not remove or discard the gaskets from either the enclosure or junction box. Failure to reinstall either gasket will void the NEMA 4 rating and RFI protection.





5. The monitors design provides protection from RFI that is maintained by leaving specific mating areas of the enclosure unpainted to maintain conductivity the gasket, top and bottom sections of the enclosure. These unpainted areas are protected by gaskets and contribute to maintaining the NEMA 4 rating. Do not paint these areas. Painting will negate the RFI protection.
6. As described below the power connection is made through the junction box on the left side of the enclosure.

Gas Connections:

As described above, the sensor in the GPR-2500S ambient monitor configuration is exposed directly to ambient air through the bottom section of the enclosure and designed to continuously monitor the oxygen content in the atmosphere of the surrounding area, confined spaces and control rooms where the potential for a lethal deficiency of oxygen exists.

For calibration, the user is responsible for calibration gases and the required components, see Span Gas Preparation below, supplying an adequate amount of Tygon tubing to pipe the span gas to the flow through adaptor, regulating the pressure of the span gas between 5-30 psig and controlling the flow rate to approximately 2 SCFH or 1 liter per minute.

Caution: Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (voiding the sensor warranty).

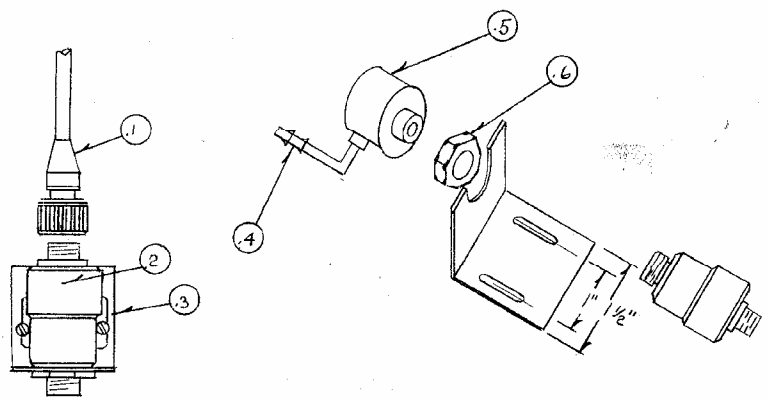


Calibration Gas Connections – Integral and Remote Sensor:

1. **Caution:** Do not change the factory setting until instructed to do in this manual.
2. Review the illustration below and locate Item A-2344 Calibration Flow Through Adapter and the installed Item FITN-1029 Connector, Barbed Tubing.
3. Review Span Gas Preparation section below – regulate the pressure and control the flow rate as directed.
4. **Caution:** When configured for ambient monitoring of oxygen deficiency in a confined space or room do not calibrate the unit in the atmosphere to be monitored. Use a certified span gas of a known oxygen concentration approximating 20.9% oxygen balance nitrogen or clean compressed air.
5. Apply a little lubricant to the o-ring, a dry o-ring can make insertion difficult, of the Calibration Flow Through Adapter Assembly, A-2344.
6. Insert the flow through adapter into the throat of the sensor.
7. Connect the 1/8" ID Tygon tubing from the flow meter vent to Item #4 Connector, Barbed Tubing.
8. Proceed to Span Calibration section.

Legend:

1. CONN-1014 Sensor Cable
2. GPR-11-32-4R Oxygen Sensor
3. A-2079 Bracket Sensor Mounting





4. FITN-1029 Connector, Barbed Tubing
5. A-2344 Calibration Flow Through Adapter
(Calibration use only)
6. A-2781 Nut Sensor Retaining

Electrical Connections

Remove the front cover of the junction box located on left side of the monitors by removing the four (4) screws securing the cover and set them aside for reinstallation.

To assure proper grounding, connect the 4-20mA signal output to the external device (PLC, DCS, etc.) before attempting any zero or span adjustments.

Power requirements consist of a two wire shielded cable and a 12-36V DC with negative ground power supply.

Procedure:

1. Loosen the nut on the cable gland.
2. Separate the shielding from the wires of the cable.
3. Thread the wires through the cable gland into the inside of the junction box.
4. Connect the two wires to the two (2) screw type terminals of the barrier strip inside the junction box.
5. Ensure the positive and negative terminals of the power supply are connected to the appropriate terminals of the barrier strip as marked.
6. Connect the shielding of the cable to the copper ground screw inside the junction box.
7. Replace the junction box cover ensuring the gaskets are in place and tighten the four (4) screws.
8. Tighten the cable gland to maintain NEMA 4 rating.



Hazardous Area Installation:

The GPR-2500S monitors may be installed in a hazardous area with specific intrinsic safety barriers and a barrier enclosure approved for use with the safety barrier selected.

MTL 702 type barriers and a 24VDC power supply with two (2) wire shielded cable are recommended. Requirements include a 4-20mADC two (2) wire signal and a power requirement of 20mADC per channel at 24VDC minimum.

The following chart identifies the required wire based on the distance from the safety barriers to the two wire monitors.

- 4,500 ft. – 22 AWG
- 7,200 ft. – 20 AWG
- 11,500 ft. – 18 AWG



18,500 ft. – 16 AWG

29,500 ft. – 14 AWG

Connections – Optional Intrinsic Safety Barrier:

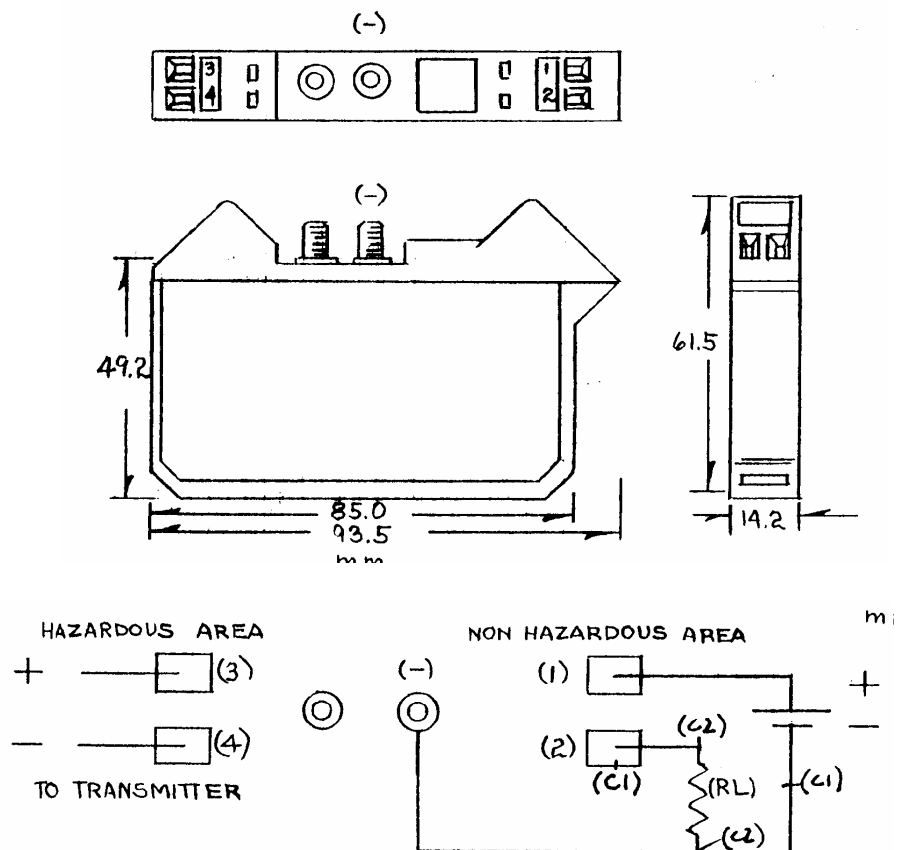
Non-hazardous area: Barrier terminals (1), (2)

Hazardous area: Barrier terminals (3), (4)

Direct measurement of 4-20mA: Reference (C1), connect the current measuring device at terminal (2) of the barrier and the negative (-) terminal from the power source as shown below.

Convert 4-20mA current to voltage: Reference (C2), connect a resistor (RL) maximum value 850Ω between terminal (2) of the barrier and the negative (-) terminal from the power source and measure the voltage across the resistor.

Example: To convert the 4-20mA current for output to a PLC requiring 1-5V, follow the above procedure using a 250Ω resistor (RL).



Hazardous Area Operation:



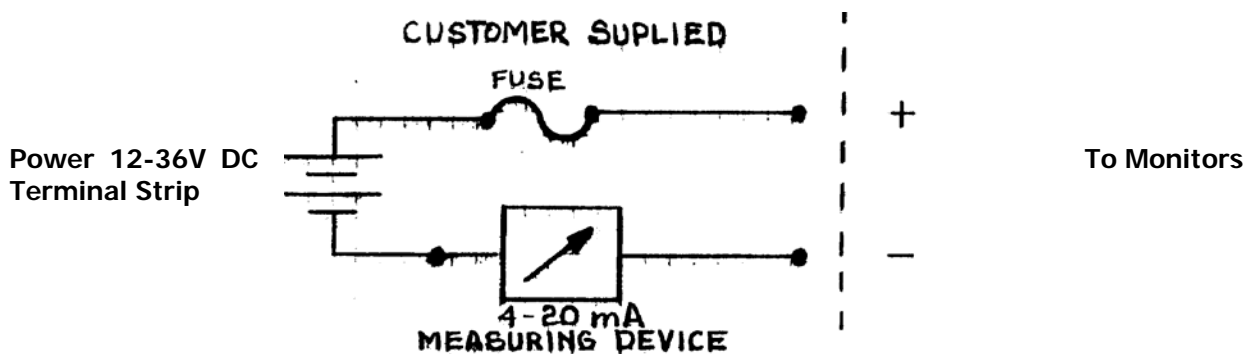
When used in conjunction with the optional MTL 702, third party certified, intrinsic safety barriers, the design of the GPR-2500S Ambient Oxygen Monitors meet recognized standards as intrinsically safe for operation in Class I, II, III; Division I, II; Groups A-G hazardous areas.

Note: Locate the optional intrinsic safety barrier as close to the power source in the non-hazardous area as possible.

Output connection:

The 4-20mA current output is obtained by connecting the current measuring device between the negative terminal of power source and the negative terminal, marked (-), located in the junction box of the monitors. The positive current flow is from pin 1 to pin 2 and from pin 2 to ground through the external load.

To check the signal output of the 4-20mA E/I integrated circuit connect an ammeter, as illustrated below, as the measuring device and confirm the output is within ± 0.1 mA of 4mA.



Caution: To assure proper grounding, connect the 4-20mA signal output to the external device (PLC, DCS, etc.) before attempting any zero or span adjustments.



Installing the Oxygen Sensor

The GPR-2500S ppm Ambient Oxygen Monitor is normally equipped with an integral oxygen sensor. It has been tested and calibrated by the manufacturer prior to shipment and are fully operational from the shipping container. However, when the application requires a remote sensor (external to the electronics enclosure) or other special circumstances, the oxygen sensor will be packaged separately and must be installed prior to operating the monitor. If the sensor has not been installed at the factory, it will be necessary to install the sensor in the field.

Caution: All monitors must be calibrated once the installation has been completed and periodically thereafter as described below. Following the initial installation and calibration, allow the monitors to stabilize for 24 hours and calibrate with certified span gas.

Caution: DO NOT open the oxygen sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual appendix. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in manner similar to that of a common battery in accordance with local regulations.

Caution: Do not change the factory settings until instructed to do in this manual.

Integral Oxygen Sensor:

1. Remove the four (4) screws securing the top section of the enclosure, set them aside for reinstallation and raise the hinged top section 180° until it locks in place.
2. **Caution:** Do not remove or discard the gaskets from either the enclosure or junction box. Failure to reinstall either gasket will void the NEMA 4 rating and RFI protection.
3. The monitors design provides protection from RFI that is maintained by leaving specific mating areas of the enclosure unpainted to maintain conductivity the gasket, top and bottom sections of the enclosure. These unpainted areas are protected by gaskets and contribute to maintaining the NEMA 4 rating. Do not paint these areas. Painting will negate the RFI protection.
4. Remove the oxygen sensor from the bag.
5. Screw the oxygen sensor into the threaded hole tapped in the bottom of the enclosure and finger tighten plus one half (1/2) turn to ensure a good seal from the o-ring affixed to the sensor.
6. Remove the shorting device (looped wire) from the receptacle located at the rear of the sensor. Minimize the time the sensor is exposed to ambient air.





7. Assure the keyway registration of the female plug on the cable and male receptacle on the sensor match up.
8. Push the female plug (including the knurled lock nut) molded to the cable into the male receptacle attached to the new sensor.
9. Screw the knurled lock nut attached the cable onto to the male connector attached to the sensor, tighten finger tight plus $\frac{1}{4}$ turn.
10. Replace the front cover of the monitor and ensure that the gasket is replaced as well to maintain CE approval and NEMA 4 rating.
11. Tighten the four (4) screws to secure the front cover.
12. Connect the gas lines, vent line first, as previously described.
13. Proceed to calibration.

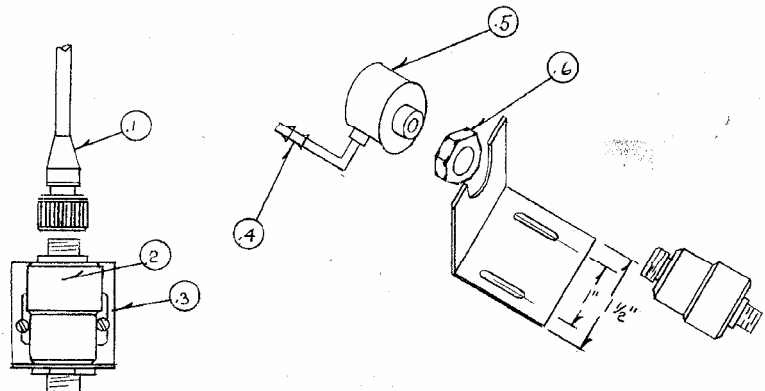
Remote Oxygen Sensor:

Applications requiring the sensor to be located remotely from the electronics dictate the separate packaging and shipment of the electronics enclosure, oxygen sensor and sensor flow housing. The appropriate length of cable to connect the sensor to the electronics is supplied and connected to the electronics. To install the remote sensor:

1. Locate Item #3 sensor mounting bracket, note the through holes and identify the surface for installation.
2. Using two (2) 6/32 screws of the appropriate type and length secure the sensor mounting bracket to a flat surface, the position illustrated below left is recommended for optimum performance.
3. Remove the oxygen sensor from the bag. Do not remove the shorting device (wire loop) from the sensor.
4. Position the threaded end of the sensor into the U-shaped opening of the sensor mounting bracket.
5. Screw Item #6 sensor retaining nut onto the threaded end of the oxygen sensor, finger tighten to secure.
6. Remove the shorting device (wire loop) from the receptacle located at the rear of the sensor. Minimize the time the sensor is exposed to ambient air.
7. Assure the keyway registration of the female plug on the cable and male receptacle on the sensor match up.
8. Push the female plug (including the knurled lock nut) molded to the cable into the male receptacle attached to the new sensor.
9. Screw the knurled lock nut attached the cable onto to the male connector attached to the sensor, tighten finger tight plus $\frac{1}{4}$ turn..
10. Refer to the Calibration Gas Connections above and proceed to calibration.

Legend:

1. CONN-1014 Sensor Cable
2. GPR-11-32-4R Oxygen Sensor
3. A-2079 Bracket Sensor Mounting
4. FITN-1029 Connector, Barbed Tubing
5. A-2344 Calibration Flow Through Adapter
(Calibration use only)
6. A-2781 Nut Sensor Retaining





Span Gas Preparation

Caution: Do not contaminate the span gas cylinder when connecting the regulator. Bleed the air filled regulator (faster and more reliable than simply flowing the span gas) before attempting the initial calibration of the instrument.

Required components:

- Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range above the intended measuring range.
- Regulator to reduce pressure to between 5 and 30 psig.
- Flow meter to set the flow between 1-5 SCFH,
- 2 lengths of 1/8" dia. Tygon tubing measuring 4-6 ft. in length.
- Suitable fittings and 1/8" dia. Tygon tubing to connect the regulator to the flow meter inlet
- Suitable fitting and 1/8" dia. Tygon tubing to connect from the flow meter vent to Item FITN-1029 Connector, Barbed Tubing attached to Item A-2344 Flow Through Adapter.

Procedure:

1. With the span gas cylinder valve closed, install the regulator on the cylinder.
2. Open the regulator's exit valve and partially open the pressure regulator's control knob.
3. Open slightly the cylinder valve.
4. Loosen the nut connecting the regulator to the cylinder and bleed the pressure regulator.
5. Retighten the nut connecting the regulator to the cylinder
6. Adjust the regulator exit valve and slowly bleed the pressure regulator.
7. Open the cylinder valve completely.
8. Set the pressure between 5-30 psig using the pressure regulator's control knob.
9. Set the flow rate to approximately 2 SCFH or 1 liter per minute.

Caution: Do not exceed the recommended flow rate. Excessive flow rate could cause the backpressure on the sensor and may result in erroneous readings and permanent damage to the sensor.

10. Proceed to Span Calibration section.

Calibration Gas Connections – Integral and Remote Sensor:

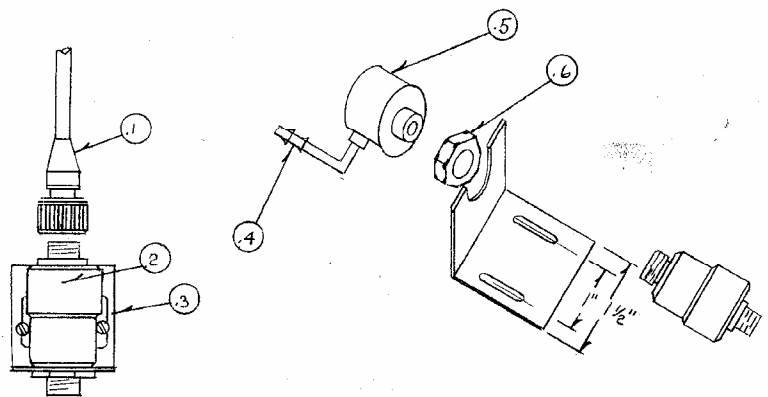
1. **Caution:** Do not change the factory setting until instructed to do in this manual.
2. Review the illustration below and locate Item A-2344 Calibration Flow Through Adapter and the installed Item FITN-1029 Connector, Barbed Tubing.



3. Review Span Gas Preparation section below – regulate the pressure and control the flow rate as directed.
4. **Caution:** When ambient monitoring of oxygen deficiency in a confined space or room do not calibrate the unit in the atmosphere to be monitored. Use a certified span gas of a known oxygen concentration approximating 20.9% oxygen balance nitrogen or clean compressed air.
5. Apply a little lubricant to the o-ring, a dry o-ring can make insertion difficult, of the Calibration Flow Through Adapter Assembly, A-2344.
6. Insert the flow through adapter into the throat of the sensor.
7. Connect the 1/8" ID Tygon tubing from the flow meter vent to Item #4 Connector, Barbed Tubing.
8. Proceed to Span Calibration section.

Legend:

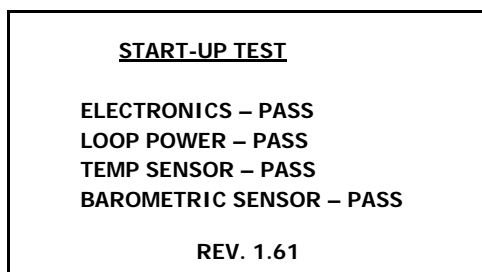
1. CONN-1014 Sensor Cable
2. GPR-11-32-4R Oxygen Sensor
3. A-2079 Bracket Sensor Mounting
4. FITN-1029 Connector, Barbed Tubing
5. A-2344 Calibration Flow Through Adapter
(Calibration use only)
6. A-2781 Nut Sensor Retaining



Establishing Power to the Electronics

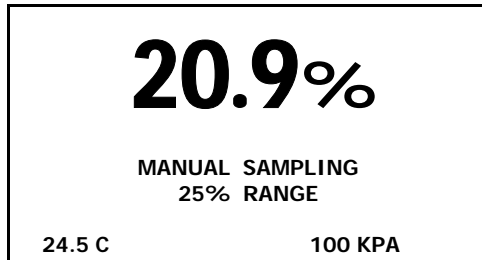
Once the two wires of the shielded cable are properly connected to the terminals inside the junction box as described above, connect the other end of the two wires to a suitable 12-36V DC power supply with negative ground such as a PLC, DCS, etc.

The digital display responds instantaneously. When power is applied, the monitor performs several diagnostic system status checks termed "START-UP TEST" as illustrated below:





Note: The monitor display defaults to the sampling mode when 30 seconds elapses without user interface.



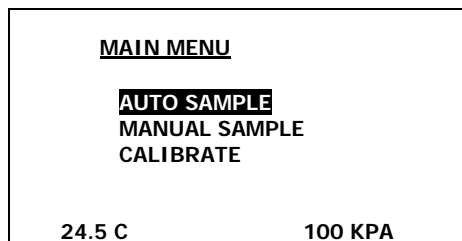
Menu Navigation

The four (4) pushbuttons located on the front of the monitor operate the micro-processor:

- green ENTER (select)
- yellow UP ARROW
- yellow DOWN ARROW
- blue MENU (escape)

Main Menu

Access the MAIN MENU by pressing the MENU key:



Range Selection

The GPR-2500S Ambient Oxygen Monitor is equipped with four (4) standard measuring ranges (see specification) and provides users with a choice of sampling modes. By accessing the MAIN MENU, users may select either the AUTO SAMPLING (ranging) or MANUAL SAMPLING (to lock on a single range) mode.

Caution: For ambient monitoring, the user must use the MANUAL SAMPLE option to lock on to the 0-25% range. Also, when ambient monitoring for oxygen deficiency in a confined space or room do not calibrate the unit in the atmosphere to be monitored. Use a certified span gas of a known oxygen concentration approximating 20.9% oxygen balance nitrogen or clean compressed air.

Procedure - Auto Sampling:

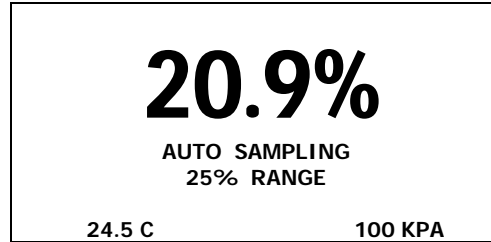
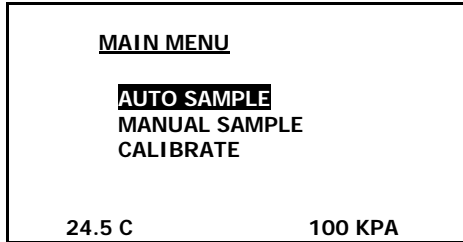
Access the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight AUTO SAMPLE.



Press the ENTER key to select the highlighted menu option.

The display returns to the sampling mode WHEN THE SENSOR IS EXPOSED TO AMBIENT AIR:



The display will shift to the next higher range when the oxygen reading (actually the sensor's signal output) exceeds 99.9% of the upper limit of the current range. The display will shift to the next lower range when the oxygen reading drops to 85% of the upper limit of the next lower range.

For example, if the monitor is reading 1% on the 0-10% range and an upset occurs, the display will shift to the 0-25% range when the oxygen reading exceeds 9.9%. Conversely, once the upset condition is corrected, the display will shift back to the 0-10% range when the oxygen reading drops to 8.5%.

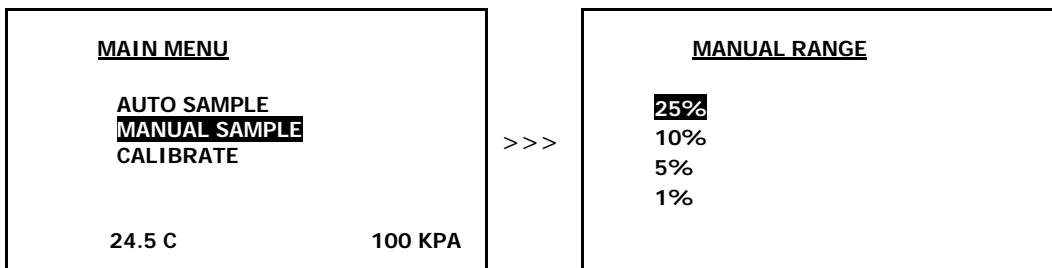
Procedure - Manual Sampling:

Access the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.

Press the ENTER key to select the highlighted menu option.

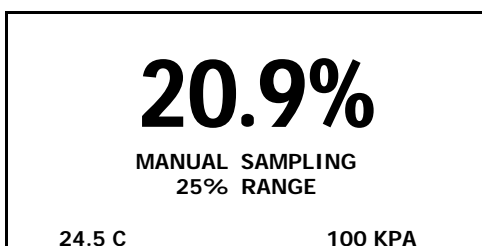
The following display appears:



Advance the reverse shade cursor using the ARROW keys to highlight the desired RANGE.

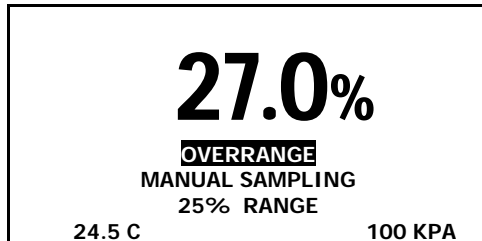
Press the ENTER key to select the highlighted menu option.

The following display appears with the range selected and oxygen concentration of the sample gas:





The display will not shift automatically. Instead, when the oxygen reading (actually the sensor's signal output) exceeds 110% of the upper limit of the current range an OVER RANGE warning will be displayed.



Once the OVER RANGE warning appears the user must correct the source of the problem or advance the monitor to the next higher range via the menu and keypad Press MENU, select MANUAL SAMPLING, press ENTER, select the appropriate MANUAL RANGE and press ENTER again.

An over range condition on a 0-25% range indicates an error introduced during the previous calibration. An over range condition GPR-2500 monitors equipped with a 0-25% range indicates an error introduced during the previous calibration. If the over range condition is less than 25.9%, the OVERRANGE warning is not displayed

If the over range condition exceeds 26.0%, the LCD displays the "OVERRANGE" warning in a reversed black background. This condition indicates an error introduced during the previous calibration, at this point the monitor should be calibrated.

Note: To enhance viewing the LCD display, all monitors and monitors are equipped with a backlit LCD display. Due to the limited power availability of the GPR-2500 series of two wire loop powered monitors, the backlit LCD feature does not operate when the signal output is less than 10mA – should not be a consideration with the GPR-2500S as its intended use at 20.9% oxygen will produce approximately a 17.9mA output.

Installation is complete ...



Zero Calibration

In theory, the oxygen sensor produces no signal output when exposed to an oxygen free sample gas. However, the monitor will generate an oxygen reading when sampling oxygen free sample gas due to:

- Contamination or quality of the zero gas
- Minor leakage in the sample line connections
- Residual oxygen dissolved in the sensor's electrolyte
- Tolerances of the electronic components

Recommendation: Zero calibration is recommended for measurements below 1% on the 0-1% range, as it is not practical on higher ranges as described below. This recommendation is applicable to the GPR-2500S, however, this section is provided for users discretion.

Procedure:

Zero calibration should precede the span calibration and once performed should not have to be repeated with subsequent span calibrations. Normally, zero calibrations are performed when a new sensor is installed or changes are made in the sample system connections.

Refer to Span Calibration below for the detailed procedure. Differences include the displays illustrated below, substituting a suitable zero gas for the span gas and allowing the monitor 24 hours with flowing zero gas to determine the true zero offset (a stable reading evidenced by a horizontal trend on an external recording device) of the system before conducting the zero calibration. **Note:** 24 hours is required for the sensor to consume the oxygen that has dissolved into the electrolyte inside the sensor (while exposed to air or percentage levels of oxygen).

Thus, for the reasons above, it is not practical to zero a percent monitor. Finding the true zero offset is not always necessary particularly in the case of applications requiring higher level oxygen measurements because of the low offset value, normally < 0.1 ppm, is not material to the accuracy of higher level measurements.

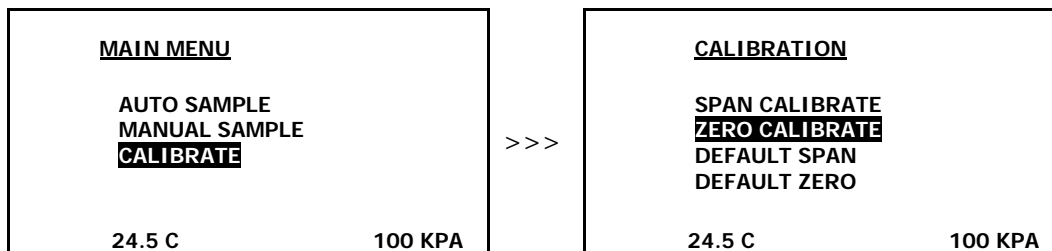
Note: Prematurely zeroing the monitor can cause a negative reading in both the ZERO and SAMPLE modes.

Access the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATE.

Press the ENTER key to select the highlighted menu option.

Repeat to select ZERO CALIBRATE and the following displays appear:





Press the ENTER key to calibrate or MENU key to abort and return to SAMPLING mode.

0.000 PPM

ZERO
CALIBRTION
ENTER TO CALIBRATE
MENU TO ABORT

Allow approximately 60 seconds for the calibration process while the processor determines whether the signal output or reading has stabilized within 60% of the full scale low range.

Both the Zero Calibrate and Span Calibrate functions result in the following displays:

PASSED
CALIBRATION

OR

FAILED
CALIBRATION

Satisfying users that the zero offset is reasonably acceptable for their application can be accomplished much quicker. Unless the zero gas is contaminated or there is a significant leak in the sample connections, the monitor should read less than 100 ppm oxygen within 5 minutes after being placed on zero gas.

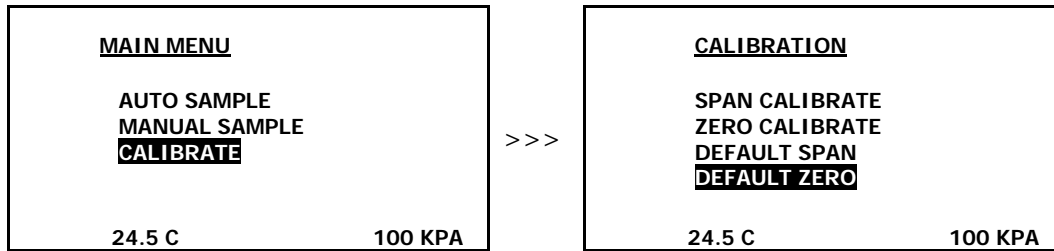
The maximum zero calibration adjustment permitted is 60% of the lowest full scale range available, which normally is 1 ppm. Thus the maximum zero calibration adjustment or zero offset is 6 ppm oxygen. Accordingly, the monitor's ZERO has not been adjusted prior to shipment because the factory conditions are different from the application condition at the user's installation.

The maximum zero calibration adjustment permitted is 60% of the lowest full scale range available, which normally is 1%. Thus the maximum zero calibration adjustment or zero offset is 0.6% oxygen. Accordingly, the monitors' ZERO has not been adjusted prior to shipment because the factory conditions are different from the application condition at the user's installation.

Accuracy due to manufacturer tolerances may result in a slight difference between the LCD display and the analog output of the 4-20mA integrated circuit. However, the difference is less than 0.25% of range and falls well below the specified accuracy of the monitors.

Factory Default Zero:

The software will eliminate any previous zero calibration adjustment and display the actual the signal output of the sensor at a specified oxygen concentration. For example, assuming a zero gas is introduced, the display will reflect an oxygen reading representing basically the zero calibration adjustment as described above. This feature allows the user to test the sensor's signal output without removing it from the sensor housing.



Span Calibration

Maximum drift from calibration temperature is approximately 0.11% of reading per °C. The monitor has been calibrated at the factory. However, in order to obtain reliable data, the monitor must be calibrated at the initial start-up and periodically thereafter. The maximum calibration interval recommended is approximately 3 months, or as determined by the user's application.

Calibration involves adjusting the monitor electronics to the sensor's signal output at a given oxygen standard, e.g. a certified span gas with an oxygen content (balance nitrogen) approximating 80% of the next higher full scale range above the intended measuring range is recommended for optimum accuracy, see Calibration and Accuracy. Calibration with ambient or instrument air (20.9% or 209,000 ppm) is recommended when installing a new sensor or when a certified gas is not available.

Ambient Monitor GPR-2500S: When configured for ambient monitoring of oxygen deficiency in a confined space or room do not calibrate the unit in the atmosphere to be monitored. Use a certified span gas of a known oxygen concentration approximating 20.9% oxygen balance nitrogen or clean compressed air. Refer to the illustration below and locate Item #5 to identify the Flow Through Adapter used to calibrate a GPR-2500 configured for ambient monitoring or equipped with a remotely located sensor. The user is responsible for supplying an adequate amount of Tygon tubing to pipe the span gas to the adaptor.

General Service:

In standard configuration, the GPR-2500 can be calibrated by exposing the sensor to the readily available cost effective and reliable 20.9% (209,000 ppm) oxygen concentration of ordinary atmospheric air or a certified span gas with an oxygen concentration of 80-100% of full scale range balance nitrogen. For example, for a 0-25% range, the span gas should be a certified grade between 19-23% oxygen preferably approximately 20.9% oxygen.

Caution: Regardless of configuration to assure proper grounding, connect the 4-20mA signal output to the external device (PLC, DCS, etc.) before attempting any zero or span adjustments.

Factory Default Span

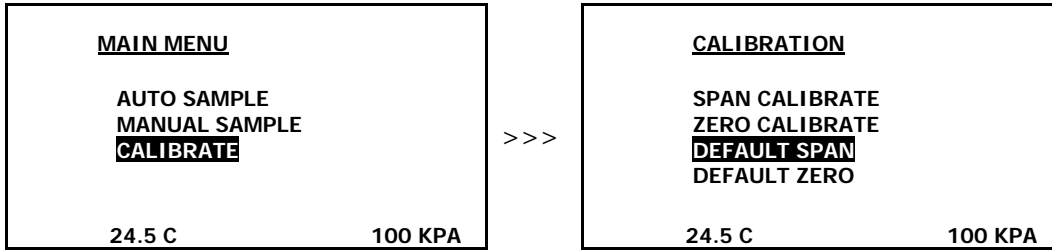
The software will set the SPAN adjustment based on the average oxygen reading (actually the sensor's signal output) at a specified oxygen concentration. For example, when a span gas is introduced, the micro-processor will display an oxygen reading within $\pm 50\%$ of the span gas value. This feature allows the user to test the sensor's signal output without removing it from the sensor housing.

Access the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.

Press the ENTER key to select the highlighted menu option.

The following displays appears:



Manual Span

The user must ascertain that the oxygen reading (actually the sensor's signal output) has reached a stable value within the limits entered below before entering the span adjustment. Failure to do so will result in an error.

Preparation - Required components: Refer to Installing Span Gas section above.

Procedure – Integral and Remote Sensor:

Caution: Do not change the factory setting until instructed to do in this manual.

Connect the calibration gas lines - review the illustration below and locate Item A-2344 Calibration Flow Through Adapter and the installed Item FITN-1029 Connector, Barbed Tubing.

Review Span Gas Preparation section above – regulate the pressure and control the flow rate as directed.

Caution: When ambient monitoring of oxygen deficiency in a confined space or room do not calibrate the unit in the atmosphere to be monitored. Use a certified span gas of a known oxygen concentration approximating 20.9% oxygen balance nitrogen or clean compressed air.

Apply a little lubricant to the o-ring, a dry o-ring can make insertion difficult, of the Calibration Flow Through Adapter Assembly, A-2344.

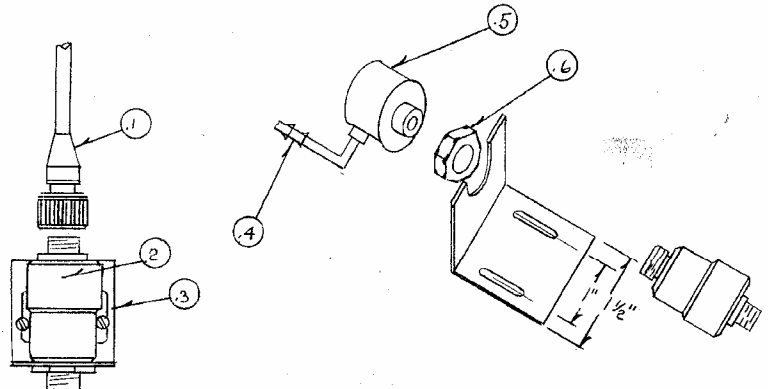
Insert the flow through adapter into the throat of the sensor.

Connect the 1/8" ID Tygon tubing from the flow meter vent to Item #4 Connector, Barbed Tubing.

Proceed to Span Calibration section.

Legend:

1. CONN-1014 Sensor Cable
2. GPR-11-32-4R Oxygen Sensor
3. A-2079 Bracket Sensor Mounting
4. FITN-1029 Connector, Barbed Tubing
5. A-2344 Calibration Flow Through Adapter
(Calibration use only)
6. A-2781 Nut Sensor Retaining



Confirm the monitor is in the MANUAL SAMPLE mode –

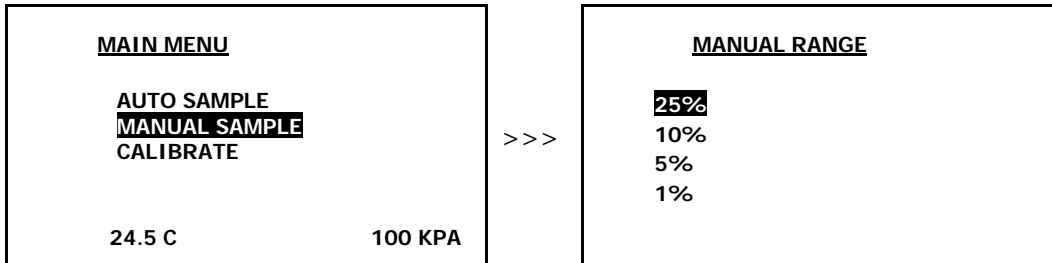
Access the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.



Press the ENTER key to select the highlighted menu option.

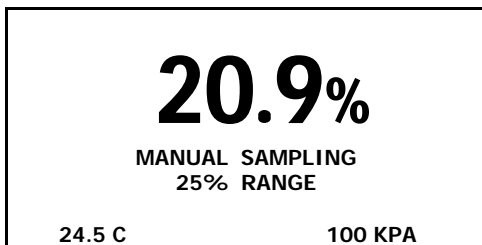
The following displays appears:



Advance the reverse shade cursor using the ARROW keys to highlight the desired RANGE.

Press the ENTER key to select the highlighted menu option.

The following display appears with the range selected and oxygen concentration of the sample gas:



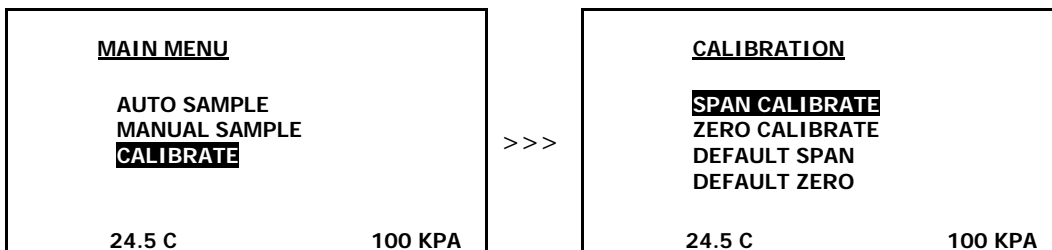
Return to the MAIN MENU by pressing the MENU key.

Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATE.

Press the ENTER key to select the highlighted menu option.

Repeat to select SPAN CALIBRATE

The following displays appear:



Assure there are no restrictions in vent line.

Regulate the pressure and control the flow rate as described above at 5-30 psig and a 2 SCFH flow rate.

Caution: Allow the span gas to flow and wait until the reading is stable before proceeding with calibration. The wait time will vary depending on the amount oxygen introduced to the sensor when the gas lines were switched.

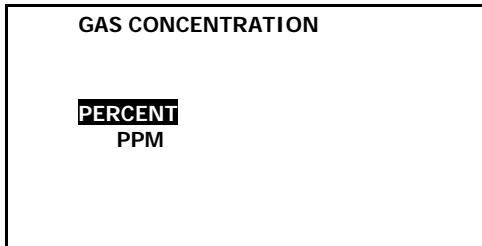


Press the ENTER key to select the SPAN CALIBRATE option.

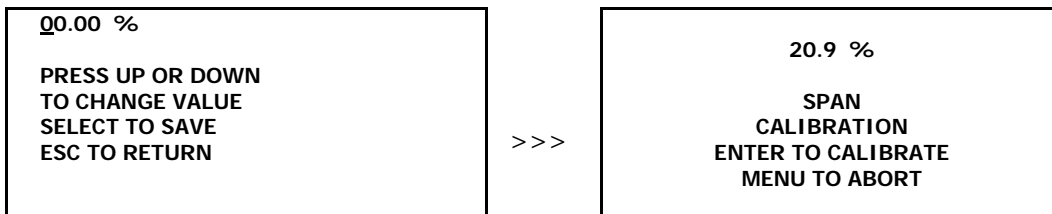
Note: A span gas concentration above 1000 ppm dictates the selection of the PERCENT option.

Advance the reverse shade cursor using the ARROW keys to highlight the desired GAS CONCENTRATION.

Press the ENTER key to select the highlighted menu option.



The following displays appear:



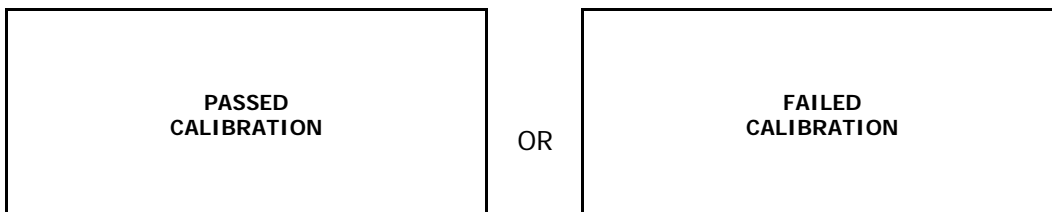
Press the ENTER key to advance the underline cursor right to the second digit of the span value. Press the MENU key to advance the underline cursor left to the previous digit.

Press the ARROW keys to enter the second digit of the span value.

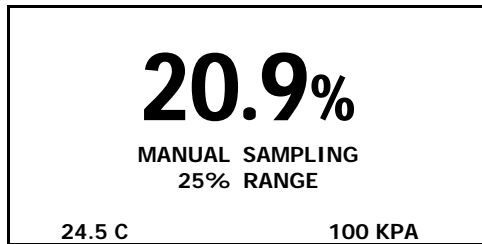
Repeat steps 30 and 31 until the complete span value has been entered.

Allow approximately 60 seconds for the calibration process while the processor determines whether the signal output or reading has stabilized within 60% of the full scale low range.

Both the Zero Calibrate and Span Calibrate functions result in the following displays:



If the calibration is successful, the monitor returns to the SAMPLING mode after 30 seconds.



If the calibration is unsuccessful, return to the SAMPLING mode with span gas flowing through the monitor, make sure the reading stabilizes and repeat the calibration before concluding the equipment is defective.

If the calibration is successful, remove the flow through adapter to expose the sensor to the ambient air.

Wait 5 minutes to ensure the reading is stable and proceed to sampling.

Sampling

Following calibration the monitor returns to the SAMPLE mode after 30 seconds as illustrated above.

To avoid erroneous oxygen readings and damaging the sensor:

- Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (voiding the sensor warranty).
- Assure there are no restrictions in the sample or vent lines
- Avoid drawing a vacuum that exceeds 14" of water column pressure – unless done gradually
- Avoid excessive flow rates above 5 SCFH which generate backpressure on the sensor.
- Avoid sudden releases of backpressure that can severely damage the sensor.
- Avoid the collection of particulates, liquids or condensation collect on the sensor that could block the diffusion of oxygen into the sensor.
- If the monitor is equipped with an optional integral sampling pump (positioned downstream of the sensor) and a flow control metering valve (positioned upstream of the sensor), completely open the flow control metering valve to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

Standby

The monitor has no special storage requirements.

The sensor should remain connected during storage periods.

Store the monitor with the power OFF.

If storing for an extended period of time, charge before operating.



6 Maintenance

Generally, cleaning the electrical contacts or replacing filter elements is the extent of the maintenance requirements of this monitor.

Sensor Replacement

Periodically, the oxygen sensor will require replacement. The operating life is determined by a number of factors that are influenced by the user and therefore difficult to predict. The Features & Specifications define the normal operating conditions and expected life of the standard sensor utilized by the GPR-2500S monitor. Expected sensor life is inversely proportional to changes in oxygen concentration, pressure and temperature.

Serviceability: Except for replacing the oxygen sensor, there are no parts inside the monitor for the operator to service. Only trained personnel with the authorization of their supervisor should conduct maintenance.

Caution: DO NOT open the oxygen sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.

Procedure Integral Oxygen Sensor:

1. Remove the four (4) screws securing the top section of the enclosure, set them aside for reinstallation and raise the hinged top section 180° until it locks in place.
2. **Caution:** Do not remove or discard the gaskets from either the enclosure or junction box. Failure to reinstall either gasket will void the NEMA 4 rating and RFI protection.
3. The monitors design provides protection from RFI that is maintained by leaving specific mating areas of the enclosure unpainted to maintain conductivity the gasket, top and bottom sections of the enclosure. These unpainted areas are protected by gaskets and contribute to maintaining the NEMA 4 rating. Do not paint these areas. Painting will negate the RFI protection.
4. Remove the oxygen sensor from the bag.
5. Screw the oxygen sensor into the threaded hole tapped in the bottom of the enclosure and finger tighten plus one half (1/2) turn to ensure a good seal from the o-ring affixed to the sensor.
6. Remove the shorting device (looped wire) from the receptacle located at the rear of the sensor. Minimize the time the sensor is exposed to ambient air.
7. Assure the keyway registration of the female plug on the cable and male receptacle on the sensor match up.
8. Push the female plug (including the knurled lock nut) molded to the cable into the male receptacle attached to the new sensor.
9. Screw the knurled lock nut attached the cable onto to the male connector attached to the sensor, tighten finger tight plus ¼ turn.





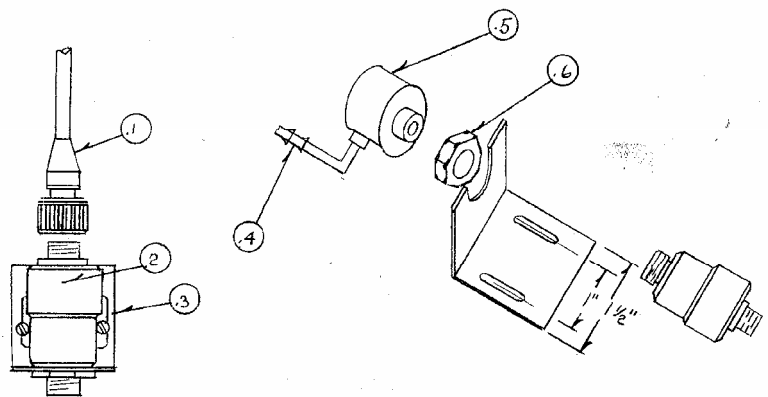
10. Replace the front cover of the monitor and ensure that the gasket is replaced as well to maintain CE approval and NEMA 4 rating.
11. Tighten the four (4) screws to secure the front cover.
12. Connect the gas lines, vent line first, as previously described.
13. Proceed to calibration.

Procedure - Remote Oxygen Sensor:

1. Locate Item #1 sensor cable.
2. Loosen the knurled lock nut attached to the sensor cable and pull the attached female plug out of the male connector attached to the sensor.
3. Locate Item #6 sensor retaining nut.
4. Unscrew the retaining nut from the sensor and remove the sensor.
5. Discard the old sensor in accordance with local regulations for disposing of a battery.
6. Remove the oxygen sensor from the bag. Do not remove the shorting device (wire loop) from the sensor.
7. Position the threaded end of the sensor into the U-shaped opening of the sensor mounting bracket.
8. Screw Item #6 sensor retaining nut onto the threaded end of the oxygen sensor, finger tighten to secure.
9. Remove the shorting device (wire loop) from the receptacle located at the rear of the sensor. Minimize the time the sensor is exposed to ambient air.
10. Assure the keyway registration of the female plug on the cable and male receptacle on the sensor match up.
11. Push the female plug (including the knurled lock nut) molded to the cable into the male receptacle attached to the new sensor.
12. Screw the knurled lock nut attached the cable onto to the male connector attached to the sensor, tighten finger tight plus $\frac{1}{4}$ turn..
13. Refer to the Calibration Gas Connections above and proceed to calibration.

Legend:

1. CONN-1014 Sensor Cable
2. GPR-11-32-4R Oxygen Sensor
3. A-2079 Bracket Sensor Mounting
4. FITN-1029 Connector, Barbed Tubing
5. A-2344 Calibration Flow Through Adapter
(Calibration use only)
6. A-2781 Nut Sensor Retaining





7 Spare Parts

Recommended spare parts for the GPR-2500S Ambient Oxygen Monitor:

Item No.	Description
GPR-11-32-4	Oxygen Sensor

Other spare parts:

Item No.	Description
A-2079	Bracket Sensor Mounting
CONN-1014	Cable Sensor with Female Socket
A-2344	Calibration Flow Through Adapter
FITN-1018	Connector SS 1/8" MNPT to 1/8" Tube
FITN_1029	Connector Barbed Tubing
FITN-1039	Elbow SS 1/8"
A-3051	Housing Flow Adaptor
MTR-1011	Meter Digital Panel LCD Backlight
A-2781	Nut Sensor Retaining
A-1151-E-L2	PCB Assembly Main / Display (GPR-2500S)



8 Troubleshooting

Symptom	Possible Cause	Recommended Action
Reading does not reflect expected values	Sensor was not calibrated at the pressure, flow rate and temperature anticipated in the sample gas stream	Recalibrate the monitor
Oxygen reading drifts toward zero or significant drifts number of turns of the span control adjustment is required to calibrate the monitor.	Indication sensor is nearing the end of its useful life	Replace sensor, see Section 6 - Maintenance.
<p>Slow response time</p> <p>Erratic oxygen reading</p> <p>No oxygen reading</p>	<p>Liquid covering sensing membrane</p> <p>Presence of interference gases.</p> <p>Unauthorized maintenance</p> <p>Defective electrical connection</p> <p>Sensor failure</p>	<p>Gently remove with alcohol and lint free towel.</p> <p>Consult factory, replace sensor, and see Section 6 - Maintenance.</p> <p>Use voltmeter and determine μA or mV output and contact factory.</p>
High oxygen reading	<p>Inadequate control of pressure and flow rate</p> <p>Abnormality in span gas</p>	<p>See Section 5 - Operation, Getting Started, Control of Pressure and Flow</p> <p>Qualify source</p>



9 Warranty Policy

What is covered:

Any defect in material and workmanship from normal use in accordance with the Owner's Manual.

This warranty applies to all monitor purchased worldwide. Advanced Instruments Inc. reserves the right in its sole discretion to invalidate this warranty if the serial number does not appear on the monitor.

For how long:

One year from shipment by manufacturer or purchase from a distributor with proof of purchase.

Who is warranted:

This warranty is limited to the first customer who submits a claim. Under no circumstances will the warranty extend to more than one customer.

What we will do:

If your Advanced Instruments Inc. monitor is defective with respect to material and workmanship, we will repair it or, at our option, replace it at no charge to you.

If we choose to replace your Advanced Instruments Inc. monitor, we may use new or reconditioned replacement parts.

If we choose to replace your Advanced Instruments Inc. monitor, we may replace it with a new or reconditioned one of the same or upgraded design.

Limitations:

Implied warranties, including those of fitness for a particular purpose and merchantability (an unwritten warranty that the product is fit for ordinary use), are limited to one year from the date of shipment by manufacturer or purchase from a distributor with proof of purchase.

Advanced Instruments Inc. will not pay for: loss of time; inconvenience; loss of use of your Advanced Instruments Inc. monitor or property damage caused by your Advanced Instruments Inc. monitor or its failure to work; any special, incidental or consequential damages; or any damage resulting from alterations, misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the monitor; affixing of any attachment not provided with the monitor or other failure to follow the Owner's Manual.

Some states and provinces do not allow limitations on how an implied warranty lasts or the exclusion of incidental or consequential damages, so the above exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state and province to province.



What is not covered:

This warranty does not cover installation; defects resulting from accidents; damage while in transit to our service location; damage resulting from alterations, misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the monitor; affixing of any attachment not provided with the monitor; fire, flood, or acts of God; or other failure to follow the Owner's Manual.

Sole Warranty

This warranty is the only one we will give on your Advanced Instruments Inc. monitor, and it sets forth all our responsibilities regarding your Advanced Instruments Inc. monitor.

There are no other express warranties.

How to obtain warranty service:

Do-It-Yourself-Service:

Call Advanced Instruments Inc. at 909-392-6900 between 8:00am and 5:00pm Pacific Time weekdays. Trained technicians will assist you in diagnosing the problem and arrange to supply you with the required parts.

Service from Distributors:

If warranty service is provided by a distributor, Advanced Instruments Inc. will provide all required parts under warranty at no charge to you, but the distributor is an independent business and may render a service charge for their services. Advanced Instruments Inc. will not reimburse you or otherwise be responsible for those charges.

Return to Advanced Instruments Inc.:

You may obtain warranty service by returning you monitor, postage prepaid to:

Advanced Instruments Inc.
2855 Metropolitan Place
Pomona, Ca 91767 USA

Be sure to pack the monitor securely. Include your name, address, telephone number, proof of date of purchase and a description of the operating problem. After repairing or, at our option, replacing your Advanced Instruments Inc. monitor, we will ship it to you at no cost for parts and labor.

Your choice of any one of the service options described above is your exclusive remedy under this warranty.



10 Material Safety Data Sheet (MSDS)

Product Identification

Product Name	Oxygen Sensor Models CAD, GPR, PSR, SAF, 67013
Synonyms	Galvanic Fuel Cell, Electrochemical Transducer
Manufacturer	Analytical Industries Inc. 2855 Metropolitan Place, Pomona, CA 91767 USA
Emergency Phone Number	909-392-6900
Preparation / Revision Date	January 1, 1995
Notes	Oxygen sensors are sealed, contain protective coverings and in normal conditions do not present a health hazard. Information applies to electrolyte unless otherwise noted.

Specific Generic Ingredients

Carcinogens at levels > 0.1%	None
Others at levels > 1.0%	Potassium Hydroxide, Lead
CAS Number	Potassium Hydroxide = KOH 1310-58-3, Lead = Pb 7439-92-1
Chemical (Synonym) and Family	Potassium Hydroxide (KOH) - Base, Lead (Pb) - Metal

Physical Properties

Boiling Point Range	100 to 115° C
Melting Point Range	KOH -10 to 0° C, Lead 327° C
Freezing Point	-40 to 0° C
Molecular Weight	KOH = 56, Lead = 207
Specific Gravity	1.09 @ 20° C
Vapor Pressure	Not applicable
Vapor Density	Not applicable
pH	> 14
Solubility in H ₂ O	Complete
% Volatiles by Volume	None
Evaporation Rate	Similar to water
Appearance and Odor	Colorless, odorless aqueous solution



General Requirements

Use	Potassium Hydroxide - electrolyte, Lead - anode
Handling	Rubber or latex gloves and safety glasses
Storage	Indefinitely

Fire and Explosion Data

Flash and Fire Points	Not applicable
Flammable Limits	Not flammable
Extinguishing Method	Not applicable
Special Fire Fighting Procedures	Not applicable
Unusual Fire and Explosion Hazards	Not applicable

Reactivity Data

Stability	Stable
Conditions Contributing to Instability	None
Incompatibility	Avoid contact with strong acids
Hazardous Decomposition Products	None
Conditions to Avoid	None

Spill or Leak

Steps if material is released	<p>Sensor is packaged in a sealed protective plastic bag, check the sensor inside for electrolyte leakage.</p> <p>If the sensor leaks inside the protective plastic bag or inside the monitor sensor housing do not remove it without rubber or latex gloves and safety glasses and a source of water.</p> <p>Flush or wipe all surfaces repeatedly with water or wet paper towel. Use a fresh towel each time.</p>
Waste Disposal Method	In accordance with federal, state and local regulations for battery disposal

Health Hazard Information

Primary Route(s) of Entry	Ingestion, eye and skin contact
Exposure Limits	Potassium Hydroxide - ACGIH TLV 2 mg/cubic meter; Lead - OSHA PEL .05 mg/cubic meter
Effects of Exposure -	
Ingestion	Electrolyte could be harmful or fatal if swallowed. Oral LD50 (RAT) = 2433 mg/kg
Eye	Electrolyte is corrosive and eye contact could result in permanent loss of vision.



Skin	Electrolyte is corrosive and skin contact could result in a chemical burn.
Inhalation	Liquid inhalation is unlikely.
Symptoms	Eye contact - burning sensation; Skin contact - soapy slick feeling.
Medical Conditions Aggravated	None
Carcinogenic Reference Data	NTP Annual Report on Carcinogens - not listed; LARC Monographs - not listed; OSHA - not listed
Other	Lead is listed as a chemical known to the State of California to cause birth defects or other reproductive harm.

Emergency First Aid

Ingestion	Do not induce vomiting; Give plenty of cold water; Seek medical attention immediately.
Skin Contact	Wash affected area repeatedly with plenty of water; Remove contaminated clothing; If burning persists, seek medical attention.
Eye Contact	Flush repeatedly with plenty of water for at least 15 minutes; Seek medical attention immediately.
Inhalation	Liquid inhalation is unlikely.

Special Protection Information

Ventilation Requirements	None
Eye	Safety glasses
Hand	Rubber or latex gloves
Respirator Type	Not applicable
Other Protective Equipment	None

Special Precautions

Precautions	Do not remove the sensor's protective Teflon and PCB coverings; Do not probe the sensor with sharp objects; Wash hands thoroughly after handling; Avoid contact with eyes, skin and clothing; Empty sensor body may contain hazardous residue.
Transportation	Not applicable



Product Identification

Product Name	Oxygen Sensor Models XLT
Synonyms	Galvanic Fuel Cell, Electrochemical Transducer
Manufacturer	Analytical Industries Inc. 2855 Metropolitan Place, Pomona, CA 91767 USA
Emergency Phone Number	909-392-6900
Preparation / Revision Date	January 1, 1995
Notes	Oxygen sensors are sealed, contain protective coverings and in normal conditions do not present a health hazard. Information applies to electrolyte unless otherwise noted.

Specific Generic Ingredients

Carcinogens at levels > 0.1%	None
Others at levels > 1.0%	Acetic Acid, Lead
CAS Number	Acetic Acid = 64-19-7, Lead = Pb 7439-92-1
Chemical (Synonym) and Family	Acetic Acid (CH ₃ CO ₂ H) - Acid, Lead (Pb) - Metal

Physical Properties

Boiling Point Range	100 to 117° C
Melting Point Range	Acetic Acid = not applicable, Lead 327° C
Freezing Point	-40 to -10° C
Molecular Weight	Acetic Acid = not applicable, Lead = 207
Specific Gravity	1.05 @ 20° C
Vapor Pressure	11.4 @ 20° C
Vapor Density (air = 1)	2.07
pH	2-3
Solubility in H ₂ O	Complete
% Volatiles by Volume	None
Evaporation Rate	Similar to water
Appearance and Odor	Colorless, vinegar-like odor aqueous solution

General Requirements

Use	Acetic Acid - electrolyte, Lead - anode
Handling	Rubber or latex gloves; Safety glasses
Storage	Indefinitely



Fire and Explosion Data

Flash and Fire Points	Not applicable
Flammable Limits	Not flammable
Extinguishing Method	Not applicable
Special Fire Fighting Procedures	Not applicable
Unusual Fire and Explosion Hazards	Not applicable

Reactivity Data

Stability	Stable
Conditions Contributing to Instability	None
Incompatibility	Avoid contact with strong bases
Hazardous Decomposition Products	Emits toxic fumes when heated
Conditions to Avoid	Heat

Spill or Leak

Steps if material is released	Sensor is packaged in a sealed protective plastic bag, check the sensor inside for electrolyte leakage. If the sensor leaks inside the protective plastic bag or inside the monitor sensor housing do not remove it without rubber or latex gloves, safety glasses and a source of water. Flush or wipe all surfaces repeatedly with water or wet paper towel. Use a fresh towel each time.
Waste Disposal Method	In accordance with federal, state and local regulations for battery disposal.

Health Hazard Information

Primary Route(s) of Entry	Ingestion, eye and skin contact
Exposure Limits	Acetic Acid - ACGIH TLV / OSHA PEL 10 ppm (TWA); Lead - OSHA PEL .05 mg/cubic meter
Effects of Exposure -	
Ingestion	Electrolyte could be harmful or fatal if swallowed; Oral LD50 (RAT) = 6620 mg/kg
Eye	Electrolyte is corrosive and eye contact could result in permanent loss of vision.
Skin	Electrolyte is corrosive and skin contact could result in a chemical burn.
Inhalation	Liquid inhalation is unlikely.
Symptoms	Eye contact - burning sensation; Skin contact - burning sensation.
Medical Conditions Aggravated	None
Carcinogenic Reference Data	NTP Annual Report on Carcinogens - not listed; LARC Monographs - not listed; OSHA - not listed
Other	Lead is listed as a chemical known to the State of California to cause birth defects or other reproductive harm. Lead acetate formed as the sensor is used is listed as a chemical known to the State of California to cause cancer.



Emergency First Aid

Ingestion	Do not induce vomiting; Give plenty of cold water or if available milk; Seek medical attention immediately.
Skin Contact	Wash affected area repeatedly with plenty of water; Remove contaminated clothing; If burning persists, seek medical attention.
Eye Contact	Flush repeatedly with plenty of water for at least 15 minutes; Seek medical attention immediately.
Inhalation	Liquid inhalation is unlikely.

Special Protection Information

Ventilation Requirements	None
Eye	Safety glasses
Hand	Rubber or latex gloves
Respirator Type	Not applicable
Other Protective Equipment	None

Special Precautions

Precautions	Do not remove the sensor's protective Teflon and PCB coverings; Do not probe the sensor with sharp objects; Wash hands thoroughly after handling; Avoid contact with eyes, skin and clothing; Empty sensor body may contain hazardous residue.
Transportation	Not applicable