GPR-2500A
% Oxygen Analyzer

Owner's Manual

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1. Introduction

Your new oxygen transmitter incorporated 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 a variety of industrial oxygen applications.

To obtain maximum performance from your new oxygen transmitter, 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 transmitter for superior performance and minimal cost of ownership. This transmitter was tested thoroughly by the manufacturer prior to shipment for best performance.

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

The serial number of this transmitter may be found on the inside the transmitter. You should note the serial number in the space provided below and retain 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

Quality Control & Calibration Certification

Customer: _____ **Date:** _____

Order No.: _____

Model:		GPR-2500 A Oxygen Analyzer	**S/N:**	
Configuration:	( )	A-1161-AIS-2-I Rev C4 PCB Assembly, Main 4-20 mA Signal Output	**Batch:**	
	( )	A-1161-AIS-2-V Rev C4 PCB Assembly, Main 1-5 V Signal Output		
	( )	A-1166-AIS-I-2 Rev J2 PCB Assembly, Interconnection (12-28 VDC), 4-20 mA	**Batch:**	
	( )	A-1166-AIS-V-2 Rev J2 PCB Assembly, Interconnection (12-28 VDC), 1-5 VDC	**Batch:**	
		Ranges: 0-1%, 0-5%, 0-10%, 0-25%	**Software Ver:**	
		Barometric pressure and temperature compensation		
		A-2221 Flow Housing, 1/8" SS tubing, connections		
		Wall mount fiberglass NEMA 4X enclosure, 1/8" SS tube connections		
Sensor:	( )	GPR-11-32-4 Oxygen Sensor		
	( )	XLT-11-24-4 Oxygen Sensor	**S/N:**	
Accessories:		Owner's Manual		

		Expected Value	Observed Value	Pass
Test & Verify:	Default zero	.00 ± .05 low range		
	Default span in air @ 40 µA	19.0% to 23.0%		
	Span calibration upper limit in air @ 55 uA	20.5% to 21.3%		
	Span calibration lower limit in air @ 35 uA	20.5% to 21.3%		
	Reading after air (20.9%) calibration	20.5% to 21.3%		
	Baseline drift over 1 hour period (+5% FS) on 1% range	± 0.05% of reading		
	Noise level (+1% FS) on 1% range	± 0.01% of reading		
	Analog signal output 4-20 mA full scale			
		Alarm 1	**Alarm 2**	
	SETPOINT - Set alarm thresholds			
	MODE - Verify activation mode HIGH / LOW relative to setpoint			
	ENABLED - Verify alarms do not activate and OFF replaces SETPOINT			
	DELAY - Verify setpoint must be exceeded before activation			
	LATCHING - Verify alarms latching and non-latching modes			
	SILENCE/BYPASS - Verify main menu option de-activates alarm			
	FAIL SAFE - Verify relay opens (de-energizes) during alarm condition			
	Overall inspection for physical defects			

Options:	NA
Other:	NA

3. Safety

General

This section summarizes the essential precautions applicable to the GPR-2500A Oxygen Transmitter. Additional precautions specific to individual transmitter are contained in the following sections of this manual. To operate the transmitter 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 transmitter 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 transmitter, 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 transmitter.

Pressure and Flow

Inlet Pressure: GPR-2500A Oxygen Transmitters are designed for flowing samples, equipped with 1/8" 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 sample pressure regulated between 5-30 psig.

Caution: If equipped with a H2S scrubber as part of an optional sample conditioning system, inlet pressure must not exceed 30 psig.

Outlet Pressure: The sample gas must be vented to atmosphere or vent pipe with atmospheric pressure.

Installation

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.

Mounting of the Transmitter: The transmitter is approved for indoor or outdoor use. Mount the transmitter on a flat surface.

Power Requirement: Supply power to the transmitter only as rated by the specification or markings on the transmitter enclosure. The wiring that connects the transmitter to the power source should be installed in accordance with recognized electrical standards and so they are not pinched particularly near the power source and the point where they attach to the transmitter. Never yank wiring to remove it from an outlet or from the transmitter.

Operating Temperature: The maximum operating temperature is between 0^0C to 45º C.

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

Liquid and Object Entry: The transmitter 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 transmitter.

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

Maintenance

Serviceability: Except for replacing the oxygen sensor, there are no parts inside the transmitter 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 transmitter is faulty.

Do not attempt to service the transmitter 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 transmitter 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 transmitter is equipped with a range switch advance the switch to the OFF position and disconnect the power when the transmitter is left unused for a long period of time.

4. Features and Specification

Advanced Instruments Inc.

Technical Specifications

Accuracy:	< 2% of FS range under constant conditions
Analysis:	0-1%, 0-5%, 0-10%, 0-25% FS ranges; auto or fixed ranging
Application:	Oxygen analysis in inert, hydrocarbon, helium, hydrogen, mixed and acid (CO_2) gas streams
Area Classification:	General purpose
Alarms:	Two user configurable alarms relays rated 3A at 100 VAC, field programmable alarm time delays, alarm bypass for calibration and system fail alarm
Calibration:	Air or certified span gas
Compensation:	Barometric pressure and temperature
Connections:	Sample IN and Sample Vent 1/8" compression tube fittings
Controls:	Menu driven options of range selection, calibration and system functions
Display:	Graphical LCD 2.75" x 1.375"; resolution 0.001%; displays real time ambient temperature and pressure
Enclosure:	Fiberglass NEMA 4X, 14"x10"x5", 8 lbs.
Flow Sensitivity:	None between 0.5-5 SCFH, 1-2 SCFH recommended
Linearity:	±1% of full scale
Pressure:	Inlet - regulate to 5-30 psig to deliver 1-2 SCFH flow to transmitter; vent to atmospheric
Power:	12-24 VDC
Response Time:	90% of final reading in 10 seconds
Sample System:	None
Sensitivity:	< 0.5% of FS range
Sensor Model:	GPR-11-32-4 for inert gases; XLT-11-24-4 for gases containing > 0.5% CO2
Sensor Life:	36 months (GPR), 24 months (XLT) at 25ºC and 1 atm.
Signal Output:	4-20mA
Operating Range:	Recommended -10 ºC to 45ºC (GPR sensor), -20° to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

Optional Equipment

Sample conditioning system - Contact factory.

GPR-2500 A
Oxygen Analyzer

12-24 VDC
2 Field Selectable Alarm Set Points
Advanced Sensor Technology
Sensitivity < 0.5% FS Range
36 or 24 Month Life
No Maintenance
Compatible with gas streams containing 0-100% CO_2
4 Standard Analysis Ranges
Auto or Fixed Ranging
4-20mA Signal Output
Stainless Steel Wetted Parts

ISO 9001:2008 QA System

2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, www.aii1.com, e-mail: info@aii1.com Rev 10/10

5. Operation

Principle of Operation

The GPR-2500A oxygen transmitter incorporates a variety of advanced galvanic fuel cell type sensors. The transmitter is a compact efficient package configured with the oxygen sensor and separate circuit boards for signal processing and terminals for incoming power, power supply, signal output and alarm relay contacts housed in a general purpose NEMA 4X rated enclosure.

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.

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.

The circuit for the 4-20mA signal output and two adjustable alarms is powered by a DC/DC transformer that requires a 12-24VDC power source and separate wiring for the signal outputs.

Caution: A loop power source is not sufficient to power this transmitter. Further, the 4-20mA signal output does not require any external power (applying power to 4-20 mA terminal will permanently damage the transmitter and void transmitter warranty).

Sample System

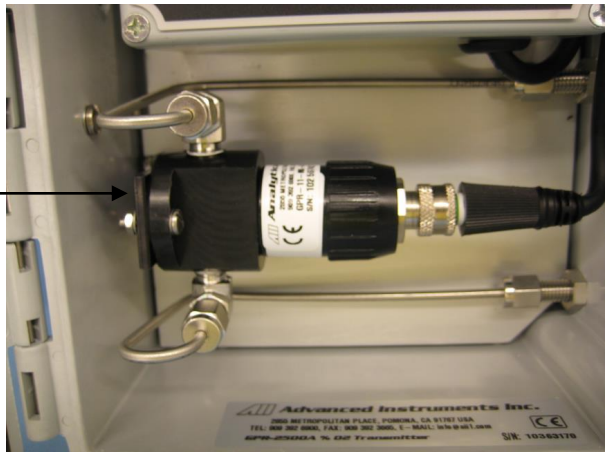
The GPR-2500A is supplied without a sample conditioning system thereby giving users the option of adding their own or purchasing a factory designed sample conditioning system. Whatever the choice, the sample must be properly presented to the sensor to ensure an accurate measurement. Users interested in adding their own sample conditioning system should consult the factory. Advanced Instruments Inc. offers a full line of sample handling, conditioning and expertise to meet your application requirements. Contact us at 909-392-6900 or e-mail us at aii2@earthlink.net

Pressure and Flow Consideration

All electrochemical oxygen sensors respond to partial pressure changes in oxygen. The inlet pressure must always be higher than the pressure at the outlet vent which is normally at atmospheric pressure.

Flow-Through Configuration

The sensor is exposed to sample gas that must flow or be drawn through the sensor housing inside the transmitter. The GPR-2500A internal sample system includes 1/8" compression tube sample inlet and vent fittings, a Delrin or optional stainless steel sensor housing.



Delrin Senor Housing with sensor installed.

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 of the two tube fitting connectors can serve as the inlet or vent.

A flow indicator with an integral metering valve upstream of the sensor is recommended as a means of controlling the flow rate of the sample gas. A flow rate of 1-2 SCFH or 0.4-1 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).

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 (pressure regulator with a metallic diaphragm is recommended for optimum accuracy, the use 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.

Caution: If equipped with a H2S scrubber as part of an optional sample conditioning system, inlet pressure must not exceed 30 psig.

Application Pressure - Atmospheric or Slightly Negative:

For accurate oxygen measurements, an optional external sampling pump should be positioned upstream of the sensor to draw the sample from the process and push it through the sensor housing and out to atmosphere. A flow meter is not necessary if the discharge of the sampling pump approximates the recommended 1-2 SCFH flow rate.

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.

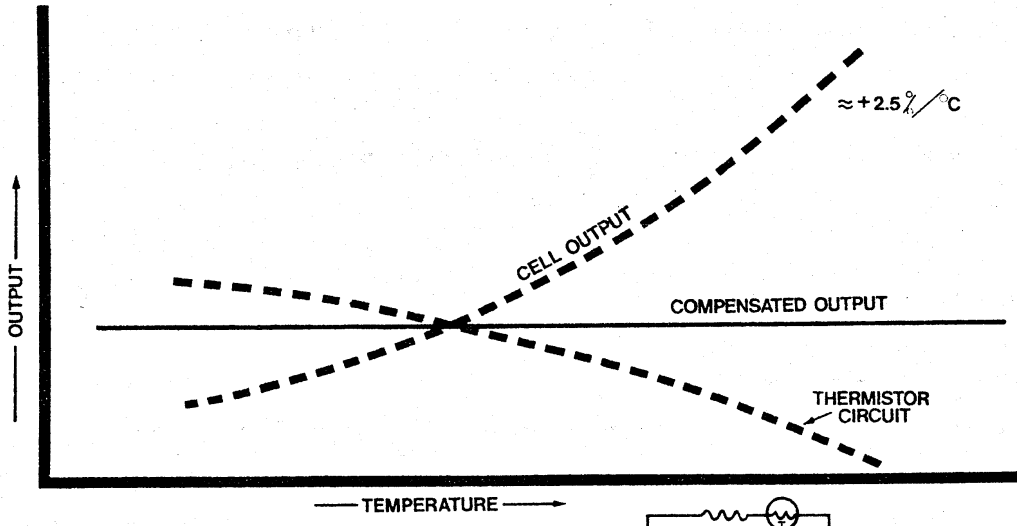
To avoid erroneous oxygen readings and damage to the sensor:

- 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 transmitter 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.

Choices of Calibration & Accuracy

Single Point Calibration: As previously described the galvanic oxygen sensor generates an electrical current sensor exhibiting an absolute zero, e.g. the sensor does not generate a current output in the absence of oxygen. Given these linearity and absolute zero properties, single point calibration is possible.

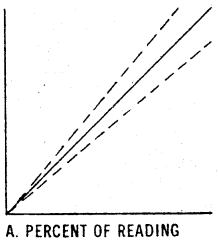


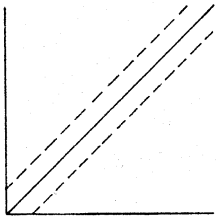
Pressure: Because sensors are sensitive to the partial pressure of oxygen in the sample gas their output is a function of the number of molecules of oxygen 'per unit volume'. Readouts in percent are permissible only when the total pressure of the sample gas being analyzed remains constant. The pressure of the sample gas and that of the calibration gas(es) must be the same (reality < 1-2 psi).

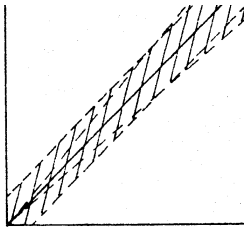
Temperature: The rate oxygen molecules diffuse into the sensor is controlled by a Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier' and all diffusion processes are temperature sensitive, the fact the sensor's electrical output will vary with temperature is normal. This variation is relatively constant 2.5% per ºC. A temperature compensation circuit employing a thermistor offsets this effect with an accuracy of +5% (over the recommended operating temperature range) or better and generates an output signal that is relatively independent of temperature. **Note:** There is no error if the calibration and sampling are performed at the same temperature or if the measurement is made immediately after calibration. Lastly, small temperature variations of 10-15º produce < +1% error.

Accuracy: In light of the above parameters, the overall accuracy of an transmitter is affected by two types of errors: 1) those producing 'percent of reading errors', illustrated by Graph A below, such as ±5% temperature compensation circuit, tolerances of range resistors and the 'play' in the potentiometer used to make span adjustments and 2) those producing 'percent of full scale errors', illustrated by Graph B, such as +1-2% linearity errors in readout devices, which are really minimal due to today's technology and the fact that other errors are 'spanned out' during calibration.

Graph C illustrates these 'worse case' specifications that are typically used to develop an transmitter's overall accuracy statement of +2% of full scale at constant temperature or +5% over the operating temperature range. QC testing is typically <+0.5% prior to shipment.


A. PERCENT OF READING ERRORS


B. PERCENT OF FULL SCALE ERRORS


C. OVERALL ACCURACY

Example: As illustrated by Graph A any error, play in the multi-turn span pot or the temperature compensation circuit, during a span adjustment at 20.9% (air) of full scale range would be multiplied by a factor of 4.78 (100/20.9) if used for measurements of 95-100% oxygen concentrations. Conversely, an error during a span adjustment at 100% of full scale range is reduced proportionately for measurements of lower oxygen concentrations.

Recommendation: Calibrating with a span gas approximating 80% of the full scale range one or two ranges higher than the full scale range of interest is recommended for 'optimum calibration accuracy'. Always calibrate at the same temperature and pressure of the sample gas stream.

Starting-up the Analyzer

The GPR-2500A Oxygen Transmitter has been tested, calibrated at the factory prior to shipment with the sensor installed and is fully operational from the shipping container. Allow the transmitters to stabilize for 30 minutes and then recalibrate the device as instructed below.

Installation Considerations

The GPR-2500A consists of two circuit boards, sensor housing and sample 1/8" sample inlet and vent connections housed in a NEMA 4X rated enclosure and is suitable for mounting on any vertical flat surface.

For optimum accuracy zero and calibrate a transmitter after it has been allowed to stabilize, typically 24-36 hours after installation. Assuming the initial zero is performed according to the procedure described herein, the analyzer should not require zeroing again until the either the sensor is replaced or a change is made to the sample system or gas lines. Following the initial zero and calibration, the analyzer should not require span calibration again for up to 3 months under "normal" application conditions as described in the published specifications.

Note: As described below, zeroing the transmitter is recommended only for measurements below 1% and not practical for measurement ranges above 1%. The low end sensitivity (zero capability) has been verified at the factory; however, no ZERO OFFSET adjustment has been made. A factory adjustment would be meaningless because of the difference in sample systems and leakage factors between the factory set-up and the actual application conditions.

Assemble the necessary hardware for mounting the transmitter and optional components - such as coalescing or particulate filters and pumps, 1/8" metal or plastic tubing for interconnecting the transmitter and optional components.

Temperature: The sample must be sufficiently cooled before it enters the transmitter and any optional components. A coiled 10 foot length of ¼" stainless steel tubing is sufficient for cooling sample gases as high as 1,800ºF to ambient.

Pressure & Flow as described above

Moisture & Particulates: Prevent water and/or particulates from entering the sample system. They can clog the tubing and damage the optional components such as pumps, scrubbers or sensors. 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. Consult the factory for recommendations concerning the proper selection and installation of components.

Contaminant Gases: A gas scrubber and flow indicator with integral metering valve are required upstream of the transmitter to remove interfering gases such as oxides of sulfur and nitrogen or hydrogen sulfide that can produce false readings and reduce the expected life of the sensor. 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.

Gas Connections: Inlet and outlet vent gas lines require 1/8" diameter tubing preferably metal.

Power Connection: Locate a source of AC power to meet area classification and to plug in the charging adapter.

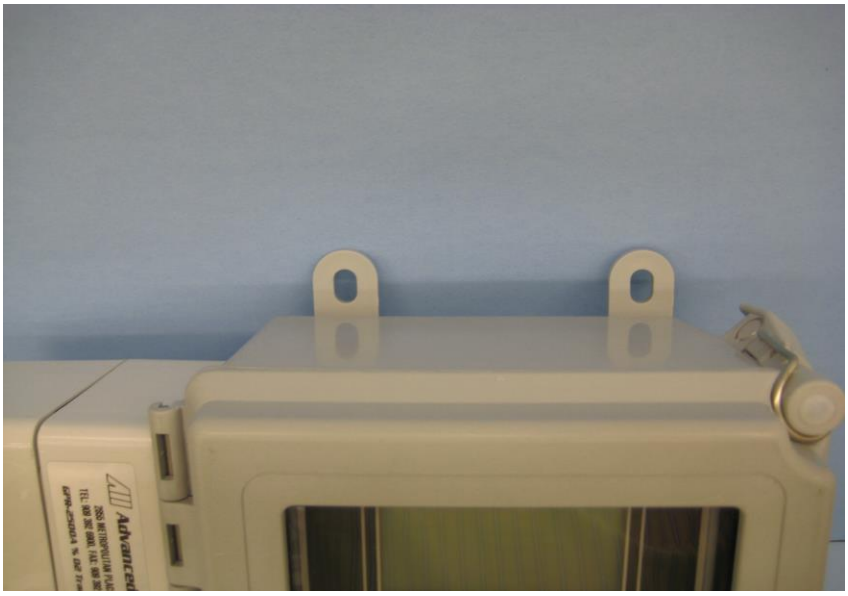
Zero Calibration: Required only for very low percentage range measurements, less than 5% of full scale at the most sensitive range of the analyzer.

Span Calibration: Users are responsible for certified span gas cylinder, regulator and flow control valve. The analyzer must be calibrated with a certified span gas and regular intervals, typically every 30 days of operation.

Mounting the Analyzer

The GPR-2500A is housed in a Fiber Glass NEMA4X rated enclosure. Th Mounting Pads esigned to be mounted directly to any flat vertical surface, wall or bulkhead plate with four (4) of the appropriate size screws. To facilitate servicing the interior of the transmitters, position it approximately 5 feet off ground level.

- Loosen the four mounting pads at the rear of the enclosure.
- Select four appropriate mounting screws (customer supplied).
- Secure 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.

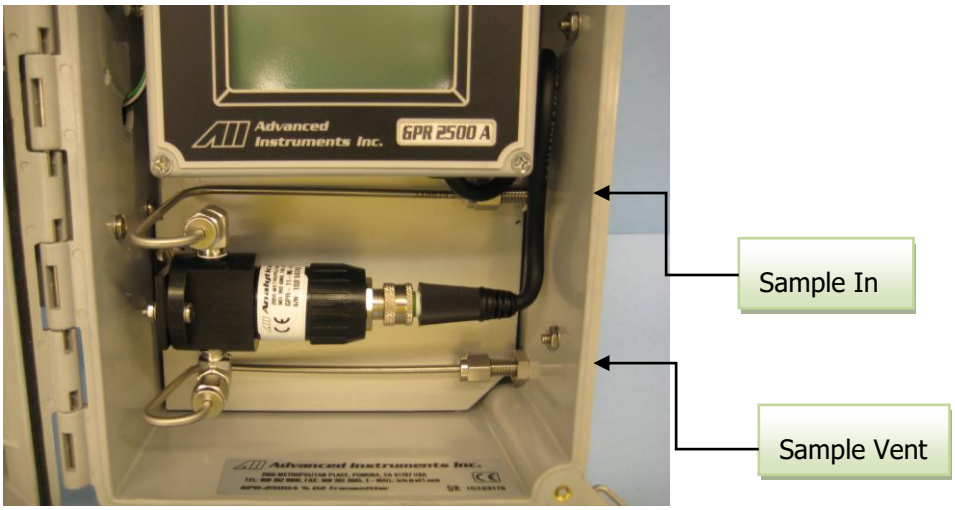


Caution: Do not remove or discard the gaskets from either the enclosure or junction box.

The transmitters design provides protection from RFI that is maintained by leaving specific mating areas of the enclosure unpainted to maintain conductivity of the gasket, top and bottom sections of the smaller enclosure housing the electronics. These unpainted areas are protected by gaskets and contribute to maintaining the NEMA 4 rating as well as protection from RFI/EMI. Do not paint these areas.

Gas Connections

The GPR-2500A with its standard flow through configuration is designed for positive pressure samples and requires connections for incoming sample and outgoing vent lines. The user is responsible for calibration gases and other required components, see below.



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. A flow indicator with an integral metering valve upstream of the sensor is recommended as a means of controlling the flow rate of the sample gas. A flow rate of 1-2 SCFH or 0.4-1 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).

Procedure of Connecting Sample Gas:

- Designate one of the bulkhead tube fittings as the VENT and the other as SAMPLE.
- Regulate the sample/span gas pressure to 5-30 PSIG.
- Connect a 1/8” vent line to the compression fitting to be used for venting the sample.
- Connect a 1/8” ZERO, SPAN or SAMPLE line to the fitting designated SAMPLE.
- If equipped with optional fittings and/or sample system, connect the ZERO and or SPAN gas lines.
- Allow gas to flow through the transmitters and set the flow rate to 1-2 SCFH.

Installing the Oxygen Sensor

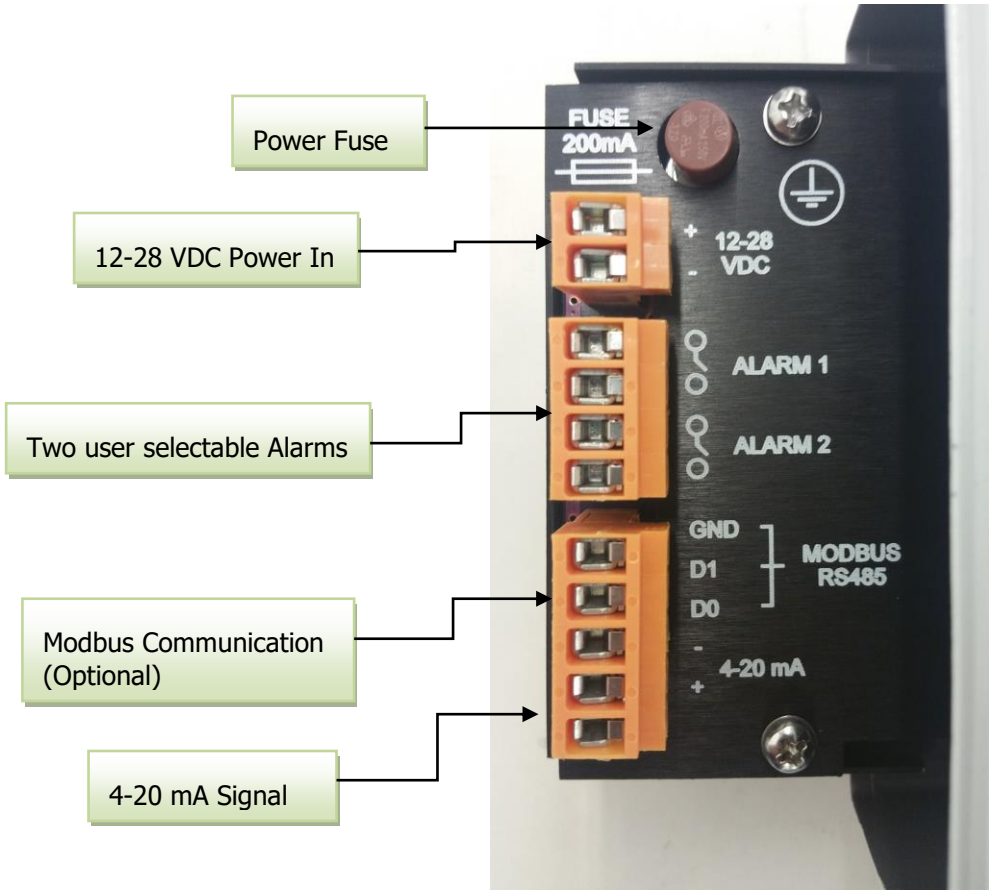
- Loosen the two (2) anchors securing the top lid of the enclosure.
- Remove the oxygen sensor from the bag.
- Screw the oxygen sensor into the sensor flow-through housing, finger tighten plus one half (1/4) turn to ensure a good seal from the o-ring affixed to the sensor.
- Remove the shorting device (looped wire) from the receptacle located at the rear of the sensor.
- Assure the keyway registration of the female plug on the cable and male receptacle on the sensor match up.
- Push the female plug on to the sensor mating connector
- Screw the knurled lock nut (attached to the cable) onto to the male connector (attached to the sensor), tighten finger tight.
- Close the front cover of the transmitter and ensure that the gasket remains in place to maintain CE approval and NEMA 4 rating.
- Secure the lid by the two (2) anchors

Proceed to calibration (see below for details).

Electrical Connections

All electrical connections are located in a small junction box located on the side of the larger enclosure. Power at the specified rating must be supplied via a two wire shielded cable. A safety fuse is also mounted in the junction box.

Do not supply power beyond the rating. Failure to do so may permanently damage the analyzer.



The integral 4-20mA converter is internally powered and does not require external power. **DO NOT** supply any voltage to either of the two terminals of the 4-20mA output connector. Failure to do so will permanently damage the 4-20mA converter.

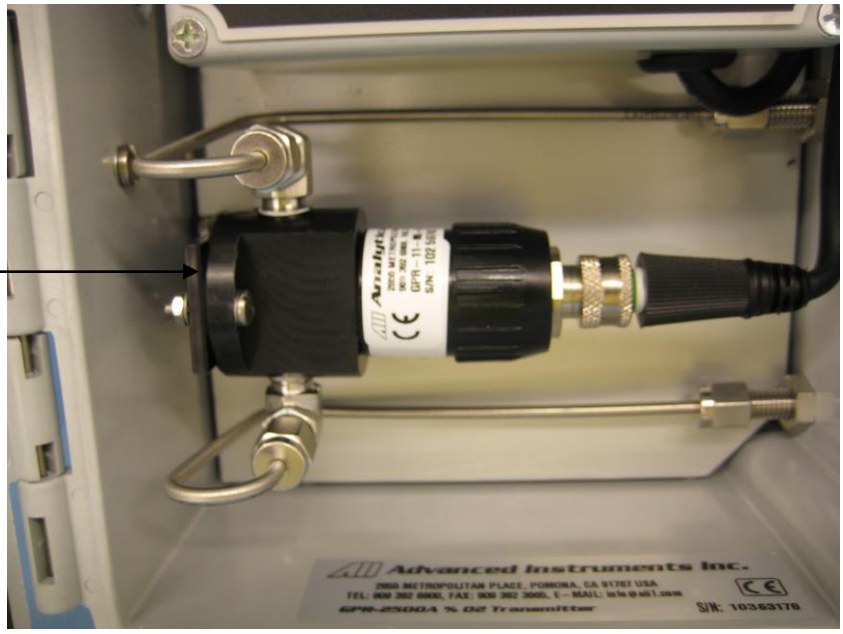
Procedure

- Remove the front cover of the junction box located on left side of the transmitters by removing the four (4) screws securing the cover and set them aside for reinstallation.
- Loosen the nut of the cable gland (customer provide and mounted at the bottom of the smaller enclosure).
- Insert power and alarm and signal output wires through the cable gland. Strip ~ ¼ inch of the wires. Insert the stripped end of wires to the appropriate terminals and secure them by tightening the screws of the terminal block. **Note:** Use wires that comply with local regulatory requirements.
- Thread the wires through the cable gland into the inside of the junction box.
- Ensure the positive and negative terminals of the power supply are connected to the appropriate terminals.

- If using shielded cables, connect the shielding of the cable to the copper ground screw inside the junction box.
- Replace the junction box cover ensuring the gaskets are in place and tighten the four (4) screws.
- Tighten the cable gland to maintain NEMA 4 rating.

Installation of Oxygen Sensor

The GPR-2500A Oxygen Transmitter 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 transmitter. If the sensor has not been installed at the factory, it will be necessary to install the sensor in the field.



Delrin Housing with Oxygen Sensor installed

Note: All transmitters must be calibrated once the installation has been completed and periodically thereafter as described below. Following the initial installation and calibration, allow the transmitters to stabilize for 24 hours and perform a calibration again with a 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.

Span Calibration

Span Gas Preparation

One of the most accurate, reliable and inexpensive means of calibrating the GPR-2500A is to expose the sensor to the 20.9% oxygen content found in ambient air. However, exposing the sensor to ambient air with the GPR-2500A flow through configuration requires opening the enclosure and unscrewing the sensor from its flow housing. However, many users opt to calibrate with a certified span gas which requires additional components and time.

Caution: When using a certified span gas from a span gas cylinder, do not contaminate the span gas cylinder when connecting the pressure regulator. When installing the pressure regulator, bleed the air filled regulator to flush air from the regulator before securing it on the cylinder. When using a span gas, always bleed the pressure regulator before opening the span gas to the analyzer (this requires a bypass valve at the exit of the pressure regulator valve).

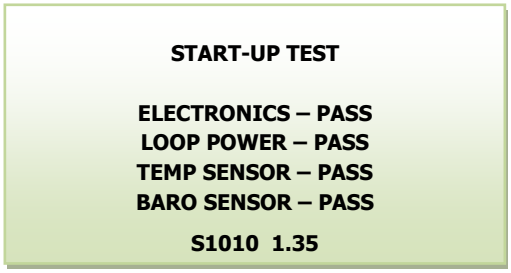
Note: Always use a certified span gas with an oxygen concentration, balance nitrogen, approximating 50-80% of the full scale range of interest or one range above the intended measuring range. You will require the following components to deliver a span gas to the analyzer/transmitter.

Set the span gas pressure as close as possible to the sample gas pressure. This will assure a smooth shift from sample to span or vise versa without the need to readjust the gas flow rate.

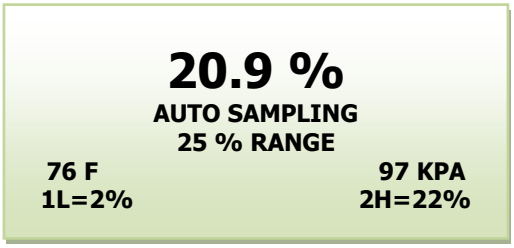
Establishing Power to Electronics

Once the two power input wires of the shielded cable are properly connected to the terminals as described above, connect the other end of the two wires to a suitable 12-28 VDC power source such as a battery, PLC, DCS, etc.

The digital display responds instantaneously. The analyzer performs several self-diagnostic system status checks termed as "START-UP TEST" as illustrated below:



After self diagnostic tests, the transmitter turns itself into the sampling mode and displays the O2 contents the sensor is exposed to, the analysis range, the ambient temperature and pressure, and high/low alarm set points.



Manu Navigation

The four (4) pushbuttons located on the front of the transmitter control the micro-processor functions:

Blue ENTER (select)

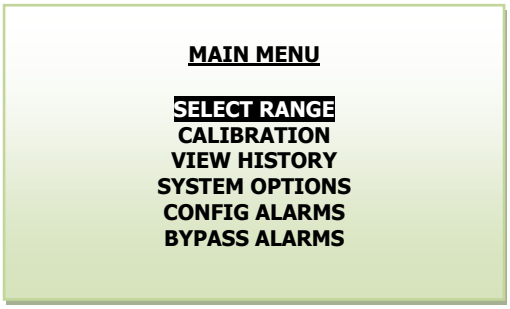
Yellow UP ARROW

Yellow DOWN ARROW

Green MENU (escape)

Main Menu

To access the MAIN MENU, press the MENU (ESC) key and the following screen will appear



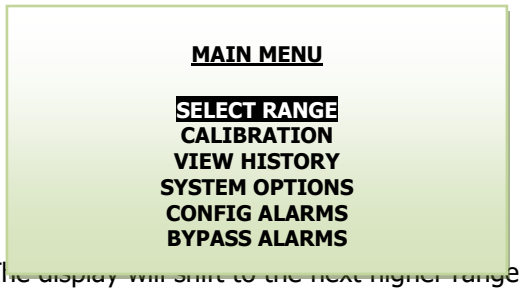
Range Selection

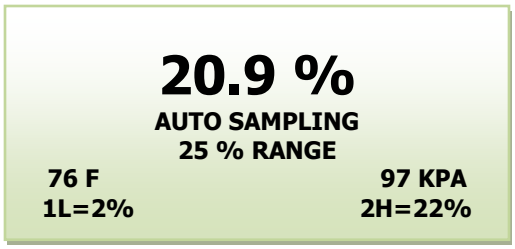
The GPR-2500A transmitter is equipped with four (4) standard measuring ranges (see specification) and provides users with a choice of sampling modes. By accessing the MAIN MENU, users may select either the AUTO SAMPLING (ranging) or MANUAL SAMPLING (to lock on a single range) mode.

Note: For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can also select the MANUAL SAMPLE mode for calibration but the span gas must not exceed the full scale of the manual range selected.

Auto Sampling

- Access the MAIN MENU by pressing the MENU key.
- Advance the reverse shade cursor using the ARROW keys to highlight SELECT RANGE.
- Press the ENTER key to select the highlighted menu option.
- Advance the reverse shade cursor using the ARROW keys to highlight AUTO.
- Press the ENTER key to select the highlighted menu option
- The display returns to the sampling mode:





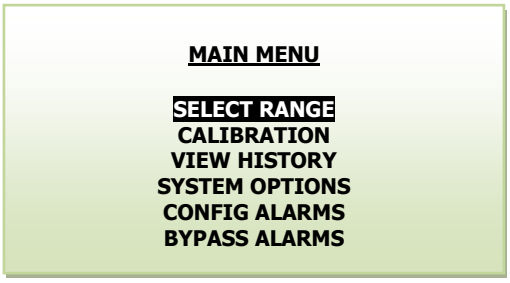
The display will shift to the next higher range when the oxygen reading (actually the sensor's signal output) exceeds 99.9% of the upper limit of the current range. The display will shift to the next lower range when the oxygen reading drops to 85% of the upper limit of the next lower range.

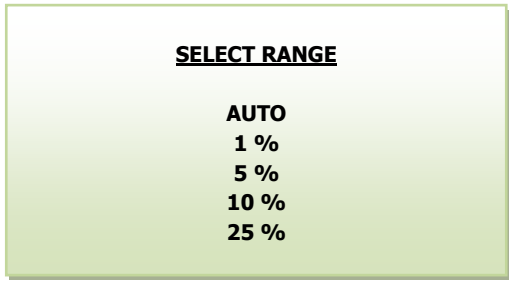
For example, if the transmitter is reading 1% on the 0-10% range and an upset occurs, the display will shift to the 0-25% range when the oxygen reading exceeds 9.9%. Conversely, once the upset condition is corrected, the display will shift back to the 0-10% range when the oxygen reading drops to 8.5%.

Manual Sampling

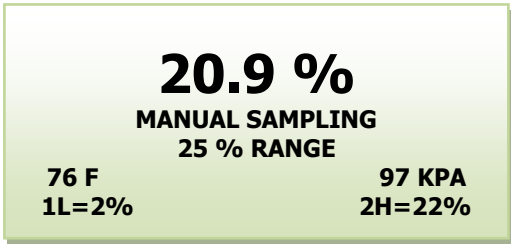
- Access the MAIN MENU by pressing the MENU key.
- Advance the reverse shade cursor using the ARROW keys to highlight SELECT RANGE.
- Press the ENTER key to select the highlighted menu option.
- Advance the reverse shade cursor using the ARROW keys to highlight the desired MANUAL RANGE.
- Press the ENTER key to select the highlighted menu option.

The following displays appears:

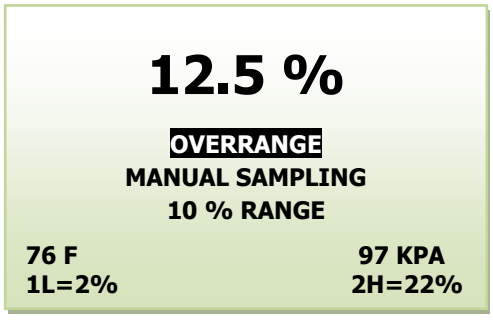




The following display appears with the range selected and oxygen concentration of the sample gas:



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 advance the transmitter 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.

Analyzer Calibration

The electrochemical oxygen sensors generate an electrical current that is linear or proportional to the analyzer concentration in a sample gas. In the absence of oxygen, the sensor exhibits an absolute zero, i.e. the sensor does not generate a current output in the absence of oxygen. Given the properties of linearity and an absolute zero, a single point calibration is possible.

The analyzer is equipped with a "Zero Calibration" feature. However, as described below, zero calibration is recommended only when the application (or user) demands optimum accuracy of below 5% of the most sensitive or lowest range available on the analyzer. For example, if the user requires analysis of a sample gas below 0.05% zero calibration may be required.

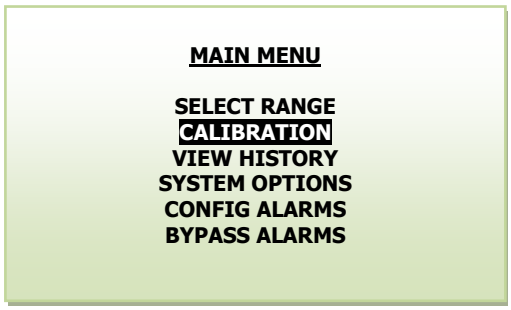
Span calibration is necessary to adjust the analyzer sensitivity for accurate measurements of oxygen by using a standardized (certified) oxygen or by using ambient air (20.9%).

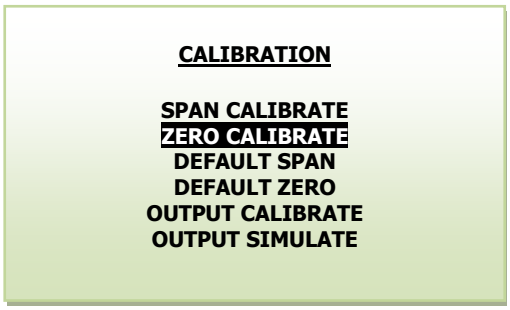
Zero Calibration

The maximum zero offset correction is limited to a maximum of 50% of the lowest (most sensitive) range for positive zero offset and 10% of the lowest range for negative zero offset.

Normally, zero calibration is performed when a new sensor is installed or changes are made in the sample system connections. Allow the ZERO gas to flow through the analyzer and wait until the signal has dropped to a low value and is stable.

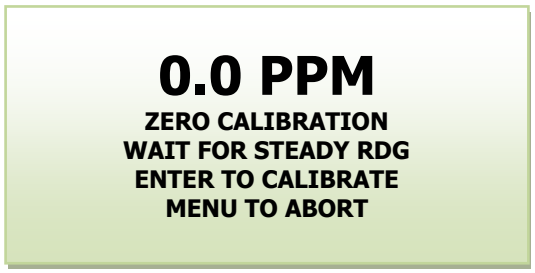
- Access the MAIN MENU by pressing the MENU key.
- Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
- Press the ENTER key to select the highlighted menu option.
- Select ZERO CALIBRATE. The following display appears



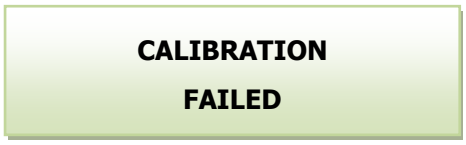


Allow the zero gas to flow through the transmitter until a stable oxygen reading is obtained. This may take from several minutes to a few hours. It is highly recommended to monitor oxygen trend on a chart recorder to ensure that the oxygen reading has stabilized; evidenced by a horizontal trend.

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



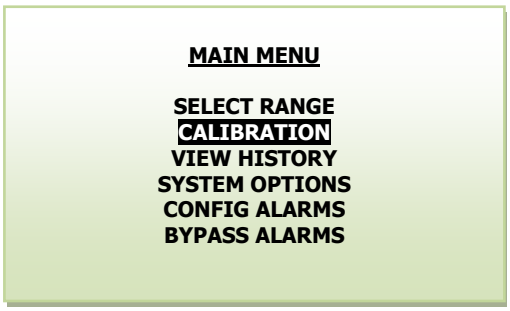
Pressing ENTER, the analyzer will complete ZERO calibration and return to Sample mode. If you press ENTER when the oxygen reading is outside of the acceptable zero offset limit, the analyzer will fail ZERO calibration and return to the Sample mode.

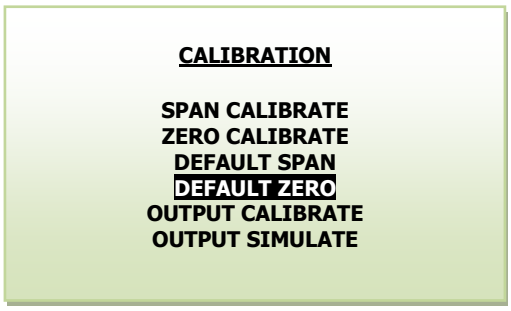


Note: The maximum zero calibration adjustment permitted is approximately 60% of the lowest full scale range available. Thus the maximum zero calibration adjustment or zero offset for this analyzer is 0.6% oxygen.

Factory Default Zero

The software will eliminate any previous zero calibration adjustment and display the actual 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 zero oxygen contents. However, a small oxygen reading contributed by the sensor and electronics may be seen (typically less than 2% of the full scale of the most sensitive range of the transmitter. This feature allows the user to test the integrity of the sample system, sensor and electronics without removing the sensor from the sensor housing.





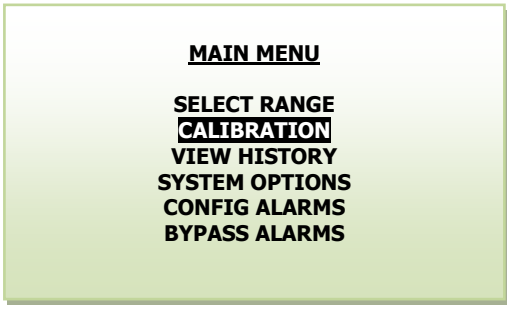
Factory Default Span

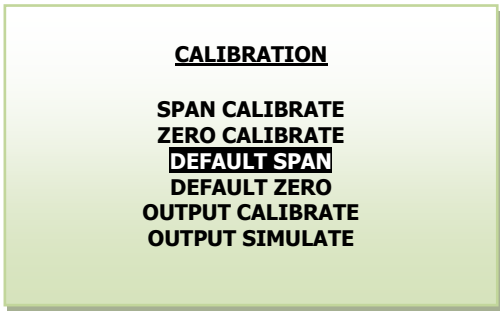
The embedded software will remove previous span calibration data and reset the SPAN adjustment to the factory default value based on the average oxygen sensor's signal output. For example, after factory default span, when a span gas is introduced, the micro-processor will display oxygen reading within ±50% of the span gas value when the sensor signal output is within its specification. If the sensor's signal output is outside of its specification, the oxygen reading will be beyond +/-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 CALIBRATION.

Press the ENTER key to select the highlighted menu option. The following display appears:





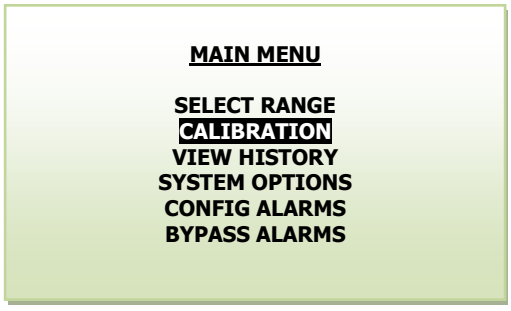
Span Calibration

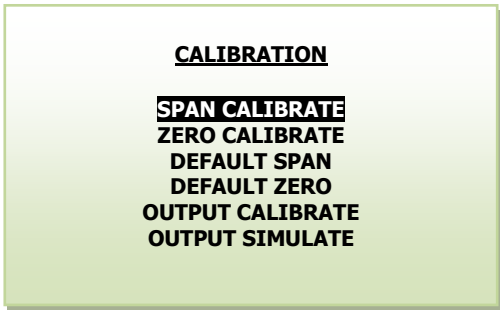
The analyzer is generally delivered calibrated and ready to use. However, in order to obtain reliable data, the analyzer must be calibrated at the initial start-up and periodically thereafter. The maximum calibration interval recommended is approximately 1-3 months, or as determined by the user's application.

Calibration involves adjusting the transmitter electronics gain (sensitivity) 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 range of analysis or one range above the intended measuring range is recommended for optimum accuracy, see Calibration and Accuracy. Calibration with ambient or instrument air (20.9%) is recommended when installing a new sensor or when a certified gas is not available.

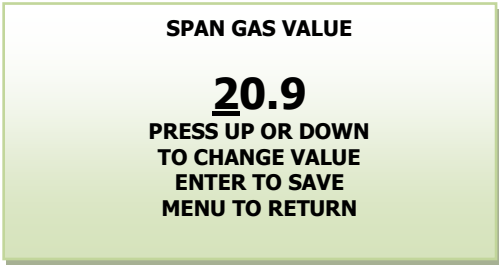
The user must ascertain that the oxygen reading (actually the sensor's signal output) has reached a stable value within the acceptable limits before completing the span adjustment. Failure to do so will result in an error.

- For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can select the full scale MANUAL SAMPLE RANGE – for example, a span gas with an 8% oxygen concentration with the balance nitrogen would dictate the use of the 0-10% full scale range for calibration.
- Regulate the span gas pressure between 5-30 psig and set flow rate between 1-2 SCFH.
- Allow the span gas to flow for 1-2 minutes to purge the air trapped in the span gas line.
- Disconnect the sample gas line and connect the span gas line to the sample IN.
- The transmitter will immediately respond to the span gas. Typically, within 5-10 minutes, oxygen reading will stabilize. To perform span calibration
- Access the MAIN MENU by pressing the MENU key.
- Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
- Press the ENTER key to select the highlighted menu option.
- Advance the reverse shade cursor using the ARROW keys to highlight SPAN CALIBRATE and press ENTER.
- The following displays appear:





Use the ARROW keys to enter the first digit of the span value.

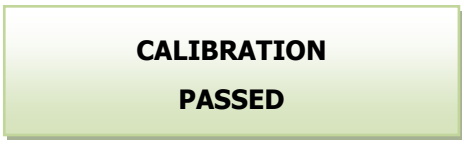


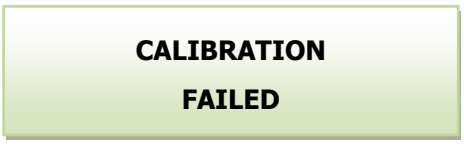
Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left.

Repeat steps until the complete span value has been entered. After entering the span value, the following display appears

Allow approximately 5-10 min for oxygen to stabilize and the press ENTER to complete span gas calibration

Both the Zero Calibrate and Span Calibrate functions result in the following displays showing either 'PASSED CALIBRATION" OR "FAILED CALIBRATION"





In either case, the analyzer returns to the SAMPLING mode and resume sampling.

Disconnect the span gas line and replace it with sample gas line.

Wait 10-15 minutes to ensure the reading is stable and then proceed to sampling.

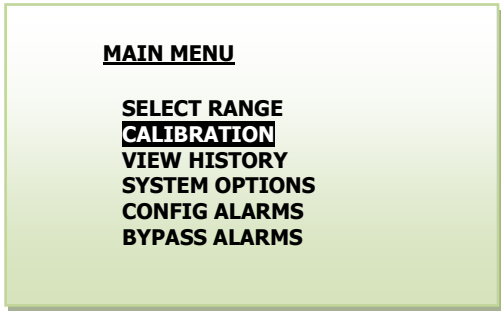
Adjustment of 4-20 mA Analog Output

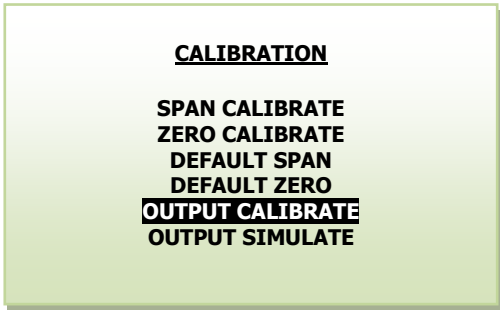
In rare instances the 4-20mA signal output may not agree to the reading displayed by the LCD. This feature enables the user to adjust the 20mA signal output should the LCD display not agree.

Note: Adjust the 4mA signal output with the OUTPUT CALIBRATE option described above.

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
3. Press the ENTER key to select the highlighted menu option.

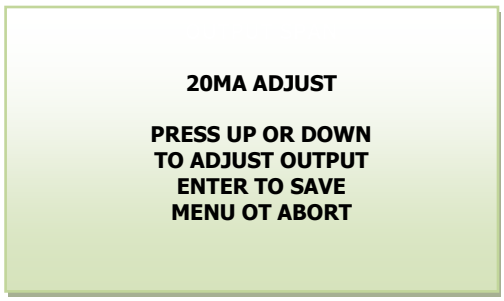
The following displays appear:

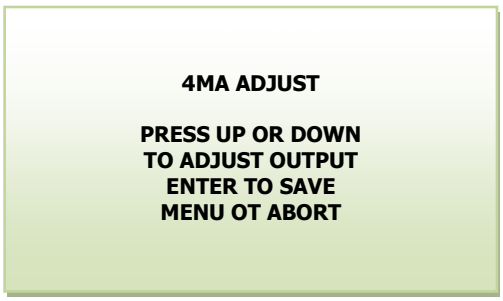




4. Advance the reverse shade cursor using the ARROW keys to highlight OUTPUT CALIBRATE.
5. Press the ENTER key to select the highlighted menu option.

The following display appears





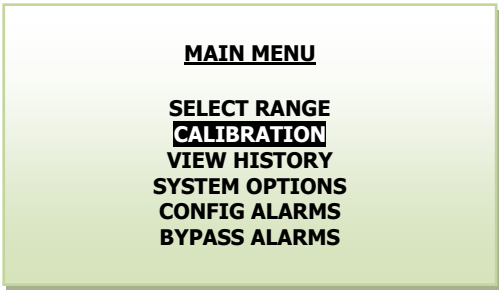
6. While measuring the output value on a meter, use the UP/DOWN keys to adjust the value up or down until the meter reads 20mA.
7. Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.
8. While measuring the output value on a meter, use the UP/DOWN keys to adjust the value up or down until the meter reads 4mA.
9. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**

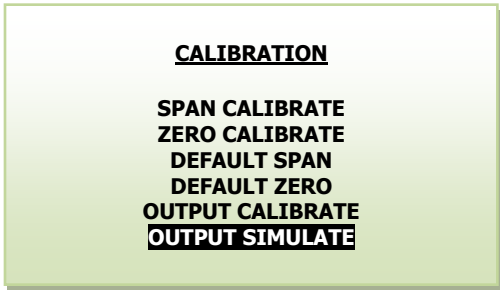
The system returns to the SAMPLING mode.

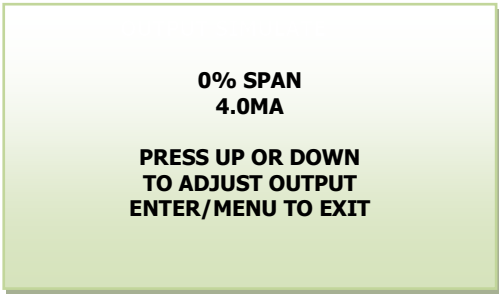
Output Simulate

Forces the 4-20mA output to a specified value. The corresponding value (mA) is shown in steps of 5% of span.

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
3. Press the ENTER key to select the highlighted menu option.
4. Advance the reverse shade cursor using the ARROW keys to highlight OUTPUT SIMULATE.
5. Press the ENTER key to select the highlighted menu option and using the UP or DOWN ARROW keys the output increments or decrements in steps of 5% of span.

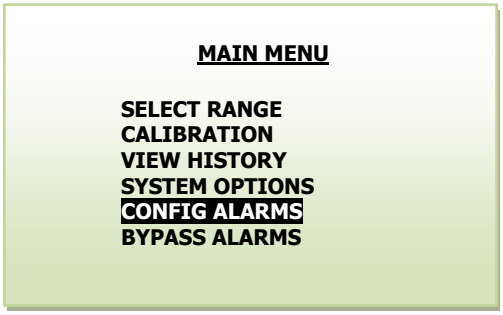


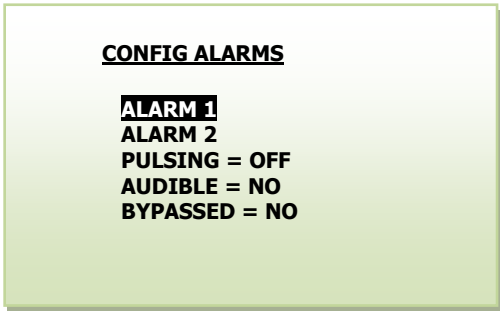


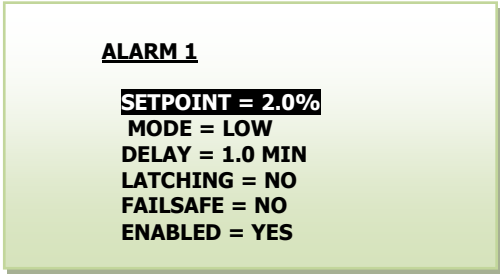


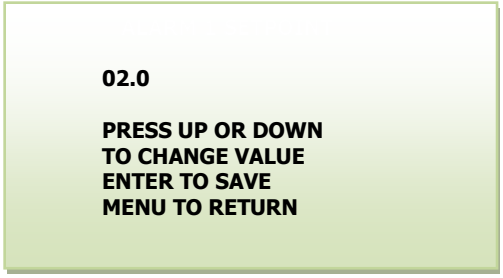
Alarms

The transmitter is equipped with two programmable alarm relays. The two alarms set points are user adjustable and can be set either as LOW/HIGH, LOW/LOW or HIGH/HIGH.









Alarm Delays

Alarm delay option allows the user to ignore the alarm should a sudden short spike in the oxygen reading occurs.

Alarm Bypass

The alarms bypass feature allows the user to bypass the alarm during trouble shooting/repair or test run. However, once the alarm bypass is selected, alarm will remain disabled even if the oxygen reading is over/under the alarm set point. The alarm will re-arm itself only after the fault condition has been reverted.

The alarms are automatically disabled during SPAN/ZERO calibration.

The relays are rated at 1A @ 230V.

CAUTION; When using these relays, do not exceed the recommended rating.

Standby

The transmitter has no special storage requirements.

The sensor should remain inside of the sensor housing and connected to the electronics during storage periods. Before turning the transmitter OFF, ensure that sample system is purged with clean ambient air. This will keep the sample system clean and would be ready to use again when required with very short down time.

Store the transmitter with power OFF at a safe location and away from a direct heating source.

If storing for an extended period of time, protect the transmitter from dust, heat and moisture.

History

View History displays the highest, lowest and average gas concentration measured during the time period shown in the upper right hand corner of the screen.

MAX TEMP displays the highest temperature recorded since the first calibration of the sensor.

SNSR TIMR displays the number of days since the sensor was first calibrated.

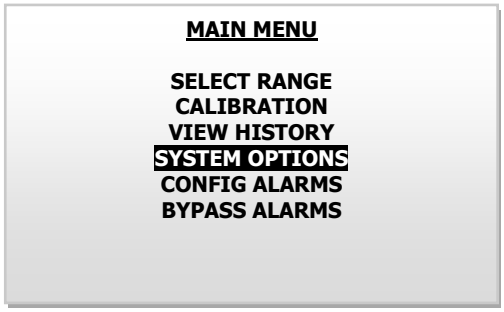
SPAN TIMR displays the number of days since the last span calibration.

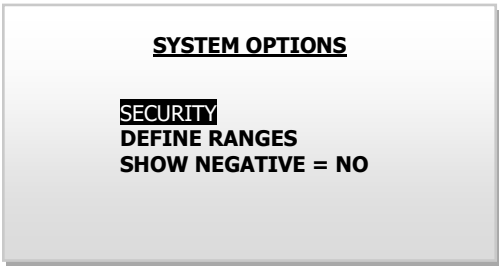
Security

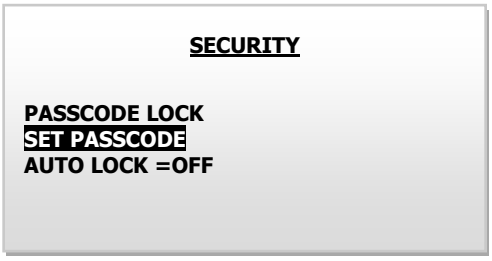
PASSCODE LOCK prevents unauthorized access to the analyzer's menus, functions and settings. Selecting PASSCODE LOCK will put the analyzer in sample mode and accessing the menus will require a valid passcode.

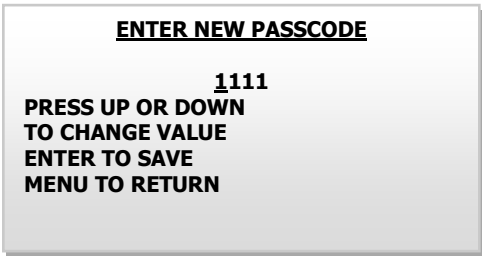
SET PASSCODE changes the security passcode.

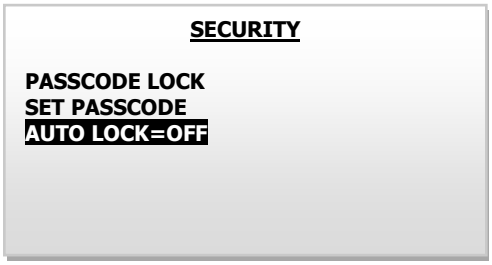
AUTO LOCK enables or disables auto passcode locking. If no keys are pressed for a time period exceeding the auto lock delay, the analyzer will automatically passcode lock. Setting the duration to 0 minutes disables auto locking.

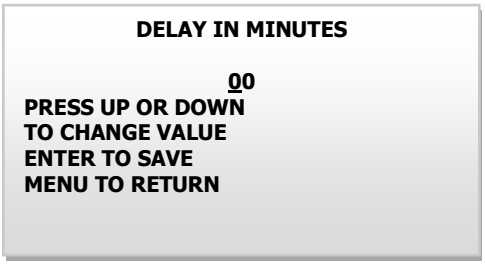


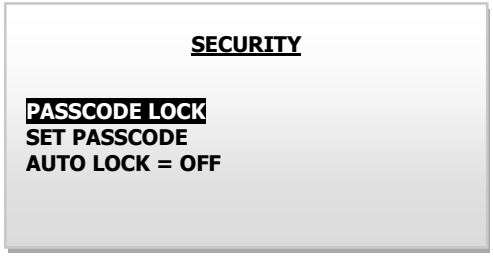












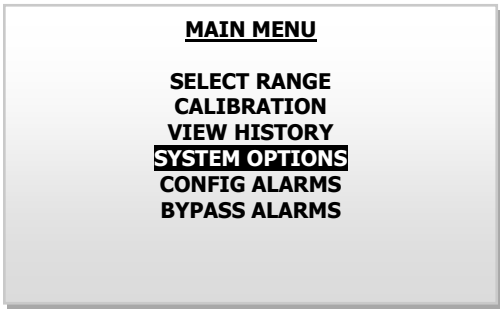
Define Ranges

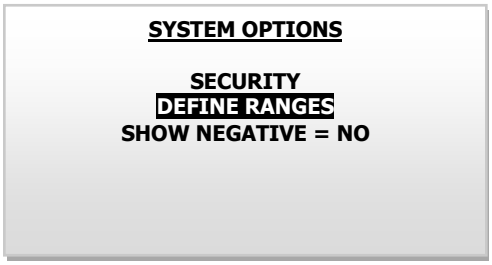
EDIT RANGE sets the full-scale range values. A new range may not exceed the highest or lowest factory-supplied ranges. A new range must be at least 20% greater than the next lower range and at least 20% lower than the next higher range.

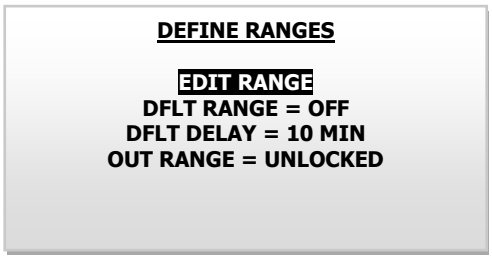
DFLT RANGE sets a default range. If no keys are pressed for a time period exceeding the default range delay (DFLT DELAY), the analyzer will automatically change ranges to the default range. Setting the default range to off disables default ranging.

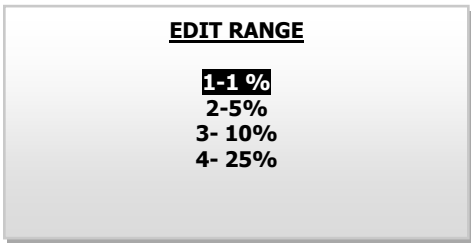
DFT DELAY sets the default delay.

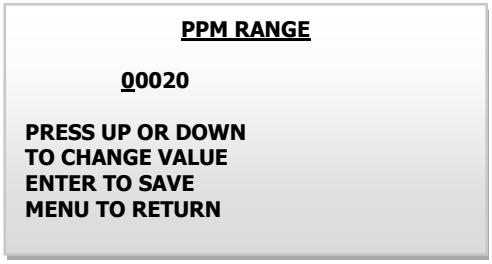
OUT RANGE unlocks or locks the analog output to a specific range. The analog output will only be locked on the set range while the analyzer is in auto ranging mode. Manual ranging will cause the analog output range to follow the display range. Setting the output range to UNLOCKED will cause the analog output range to follow the display range, regardless of auto/manual ranging mode.

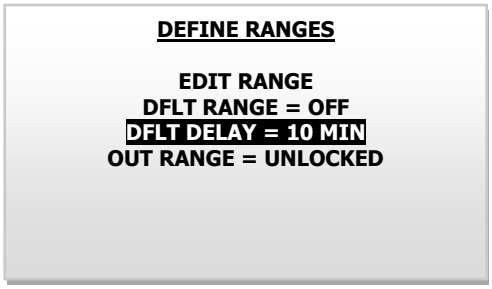












Modbus Communication

SLAVE ID: Sets the network ID (address) of the analyzer. A valid ID is between 1 and 247. Each device on the Modbus network must have a unique ID for the network to operate properly.

BAUD: Sets the network communication baud rate: 9600 or 19200 bites per sec. All devices on the Modbus network must operate at the same baud rate.

PARITY: Sets the communication byte error detection method: NONE, ODD, EVEN. This setting must match with the setting used by the Modbus master.

Sampling Procedure

Following calibration, the transmitter returns automatically to the SAMPLE mode.

Select the desired sampling mode - Auto or if Manual, the range that provides maximum resolution – as described above.

Use metal tubing to transport the sample gas to the transmitter.

The main consideration is to eliminate air leaks which can affect oxygen measurements above or below the 20.9% oxygen concentration in ambient air - ensure the sample gas tubing connections securely connected

For sample gases under positive pressure the user must provide a means of controlling the inlet pressure between 5-30 psig and the flow of the sample gas between 1-5 SCFH, a flow rate of 1-2 SCHF is recommended.

For sample gases under atmospheric or slightly negative pressure an optional sampling pump is recommended to push the sample through the transmitter. Ensure that sample flow is within the recommended range; if necessary, use a flow control valve to set the sample flow.

Assure the sample is adequately vented for optimum response and recovery – and safety.

Allow the oxygen reading to stabilize for approximately 10 minutes at each sample point.

Avoid drawing a vacuum on the sensor that exceeds 14” of water column pressure.

Avoid excessive flow rates above 5 SCFH which generate backpressure on the sensor.

Avoid the collection of particulates, liquids or condensation collect on the sensor that could block the diffusion of oxygen into the sensor.

System Options

- Set security; password protected operation
- Define ranges; choose a range between two ranges, for example, 2% full scale instead of 5% full scale.
- Display signal below 0.000%; negative signal, yes or no.

To enter password, from system option menu, select SECURITY, then enter four-digit PASS CODE, numeral numbers only and press ENTER. Then select AUTO LOCK option and enter the number of minutes after which access to MENU options will be locked (access allowed only after entering the PASS CODE).

In the event PASS CODE is lost, enter the factory default PASS CODE 2855 to access the MENU and then re-enter the new PASS CODE.

Choosing the option to display negative number will allow the user to see the display below 0.00 but the output will be locked at 4 mA.

6. Maintenance

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

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-2500A transmitter. Expected sensor life is inversely proportional to changes in oxygen concentration, pressure and temperature. To replace sensor, follow the procedure outlined in the section "Operation"

Serviceability: Except for replacing the oxygen sensor, there are no parts inside the transmitter 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.

7. Spare Parts

Recommended spare parts for the GPR-2500A Oxygen Transmitter:

Item No.	Description
GPR-11-32-4	Oxygen Sensor (GPR-2500A)
XLT-11-24-4	Oxygen Sensor (GPR-2500A)

Other spare parts:

Item No.	Description
A-2079	Bracket Sensor Mounting
CONN-1014-6	Cable Sensor with Female Socket
FITN-1018	Connector SS 1/8” MNPT to 1/8” Tube
FITN-1039	Elbow SS 1/8”
A-2221	Housing Flow Adaptor
MTR-1016	Meter Digital Panel LCD Backlight
A-2781	Nut Sensor Retaining
A-1161-AIS-2-Rev C4	PCB Assembly Main / Display
A-1166-AIS-2 Rev J2	PCB Assembly Power Supply / Interconnections

8. Trouble Shooting

Symptom	Possible Cause	Recommended Action
No Display	Inadequate power supply Incorrect polarity of power input	Ensure that power to the transmitter is within the recommended range Ensure that the polarity of the input power matches with the designation on the power input terminal
Reading does not reflect expected values	Sensor was not calibrated at similar vent pressure, flow rate and temperature anticipated in the sample gas stream	Recalibrate the analyzer at ambient conditions that resemble with sampling conditions.
Unable to span calibrate the sensor with ambient air or with a certified span gas	Indication sensor signal output is outside the acceptable limit	Replace sensor, see Section 6 - Maintenance.
Slow response time	Longer sample line Low sample flow Liquid covering sensing membrane	Reduce the sample tubing to a minimum, set sample flow between 1-2 SCFH, gently remove any liquid that might have accumulated on the sensor's sensing side. If condensable components are present, use a coalescing filter upstream of sensor
Erratic oxygen reading	Presence of interference gases. Damaged sensor cable and or sensor housing bring signal to the PCB	Consult factory, interfering gas such as H2S might need to removed from the sample gas, replace sensor. Replace sensor cable Replace upper section of sensor housing
No oxygen reading	No signal from sensor possibly due to defective/used up sensor or broken wire connections from sensor cable or sensor housing to PCB	Check for any physical damage to sensor cable and or sensor housing. Use a voltmeter and check continuity from sensor housing to the Molex connector (the connector from sensor housing to the PCB) Check sensor signal output in air (by using a voltmeter (set to measure micro-amp current). Sensor signal in air must be within 40-60 uA (% sensor) or 450-900 uA (PPM sensor).
High oxygen reading	Inadequate control of pressure and sample flow rate Excessive back pressure on sensor caused by high sample flow	Set sample gas pressure within recommended range of 5-30 PSIG Set sample flow between 1-2 SCFH Vent sample to atmosphere

Cannot perform Zero calibration	Obstruction on sample vent line	If venting sample to a vent pipe with pressure above atmosphere, consult factory for recommendations.
	Abnormality in span gas	Qualify span gas with a secondary analyzer
	Leak in sample/zero gas line	Check for any leakage in sample/zero gas line
	Inadequate zero gas flow	Check the integrity of zero gas
	Contaminated zero gas	Set the gas flow rate between 1-2 SCFH
	Attempting to Zero calibrate prematurely	Allow sufficient time for the oxygen reading to stabilize before attempting Zero calibration.

9. Warrant 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 transmitter 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 transmitter.

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. transmitter 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. transmitter, we may use new or reconditioned replacement parts.

If we choose to replace your Advanced Instruments Inc. transmitter, 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. transmitter or property damage caused by your Advanced Instruments Inc. transmitter 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 transmitter; affixing of any attachment not provided with the transmitter 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 transmitter; affixing of any attachment not provided with the transmitter; 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. transmitter, and it sets forth all our responsibilities regarding your Advanced Instruments Inc. transmitter.

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 transmitter, postage prepaid to:

Advanced Instruments Inc.

2855 Metropolitan Place

Pomona, Ca 91767 USA

Be sure to pack the transmitter 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. transmitter, 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_2O	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	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 a transmitter sensor housing do not remove it without rubber or latex gloves and 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	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_3CO_2H) - 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_2O	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 an transmitter 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 (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