Advanced Instruments Inc.

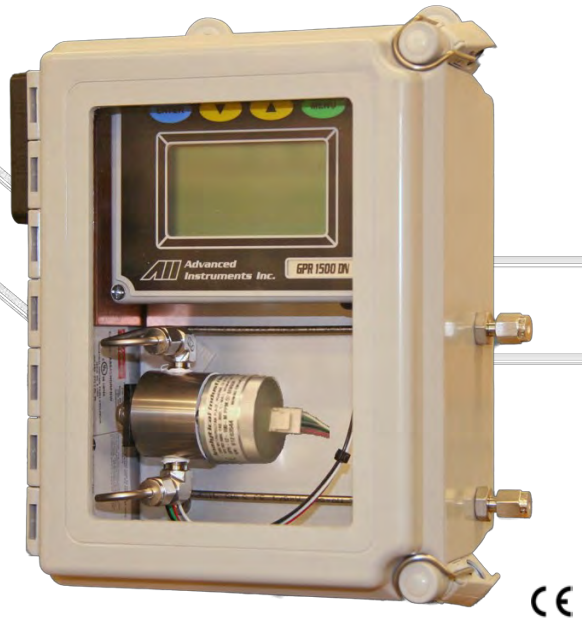
Technical Specifications *

Accuracy:	< 2% of FS range under constant conditions
Analysis:	0-100, 0-1000 PPM, 0-1%, 0-25% (CAL) FS Auto-ranging or manual lock on a single range
Application:	Oxygen analysis in inert, hydrocarbon, helium, hydrogen, mixed and acid (CO_2) gas streams
Area Classification:	General purpose
Alarms:	Two user configurable alarms: magnetic coil relays rated 3A at 100 VAC, field programmable alarm time delays, alarm bypass for calibration and system fail alarm
Calibration:	Max interval—3 months. Use certified span gas with O2 content (balance N2) approximating 80% of full scale for fast 20-30 minute recovery to online use. Alternatively, air calibrate with clean source of compressed or ambient (20.9% O2) air on 0-25% range and allow 60 minutes on zero gas to recover to 10 ppm. For optimum accuracy, calibrate one range higher than the range of interest.
Compensation:	Barometric pressure and temperature
Connections:	1/8" compression tube fittings
Controls:	Water resistant keypad; menu driven range selection, calibration and system functions
Display:	Graphical LCD 2.75″ x 1.375″; resolution 0.01 PPM; displays real time ambient temperature and pressure
Enclosure:	Fiberglass NEMA 4X, 6.75 x 8.375 x 4.25", 8 lbs.
Flow Sensitivity:	Not flow sensitive, 1-2 SCFH recommended
Linearity:	±1% of full scale
Pressure:	Inlet - regulate to 5-30 psig to deliver 1-2 SCFH flow; vent - atmospheric
Power:	12-28 VDC non-loop or 110-220 VAC
Recovery Time:	30 seconds in air to < 100 PPM in < 15 mins on N_2 purge
Response Time:	90% of final reading in 10 seconds
Sample System:	None
Sensitivity:	< 0.5% of FS range
Sensor Model:	GPR-12-100-M for non-acid (CO2) gas streams; XLT-12-100-M for gases containing > 0.5% CO2
Sensor Life:	24 months in < 1000 PPM O2 at 25ºC and 1 atm
Signal Output:	4-20mA non-isolated or 1-5V; optional Modbus Communication
Operating Range:	5ºC to 45ºC (GPR sensor), -10º to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

Optional Equipment

Sample conditioning system - Contact factory.

* Subject to change without notice



GPR-1500 DA
PPM Oxygen Analyzer

12-28 VDC Non-Loop or 110-220 VAC Powered Oxygen Analyzer

Advanced Galvanic Sensor Technology with Optional Sample Systems

2 Field Selectable Alarm Setpoints
12-28 VDC or 110-220 VAC Power
4-20 mA or 1-5V Signal Output
Sensitivity 0.5% Full Scale
4 Ranges Standard
Auto Ranging or Single Fixed
Stainless Steel Wetted Parts

ISO 9001:2008 Certified
INTERTEK Certificate No. 485

2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, www.aii1.com, e-mail: info@aii1.com Rev 10/15

Advanced Instruments Inc.

Gas analysis solutions through advanced analyzer and sensor technology

GPR-1500 DA
ppm Oxygen Transmitter

Owner's Manual

2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, e-mail: info@aii2.com, www.aii2.com

Table of Contents

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 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, 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 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 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.:**	**Pass**
Model:	GPR-1500 DA ppm Oxygen Transmitter		
Sensor:	( ) GPR-12-100-M ppm Oxygen Sensor		
	( ) XLT-12-100-M ppm Oxygen Sensor		
Serial Nos.:	Transmitter _____ Sensor _____		
Accessories:	Owner's Manual		
Configuration:	A-1151-E-A4 PCB Assembly Main Processing		
	A-1153-A-A4 PCB Assembly Alarms/Power Connection		
	Software rev:		
	Ranges: 0-100, 0-1000 ppm, 0-1%, 0-25%		
	Power: 12-36V DC two wire loop power		
	Barometric pressure and temperature compensation		
	NEMA 4X rated wall mount enclosures		

Test:	**Pass**		**Pass**
Set default zero			
Set default span @ 600uA or 300uA		Alarm delay	
Zero calibration		Alarm bypass	
Span Calibration		Alarm configurations; ALARM 1, ALARM 2	
Analog signal output 4-20mA full scale		Alarm function; ALARM 1, ALARM 2	
Calibrates with adequate span adjustment within 10-50% FS		Alarm relays; ALARM 1, ALARM 2	
Baseline drift on zero gas < ± 2% FS over 24 hour period		Alarm system fail, dry contact	
Noise level < ± 1.0% FS		Overall inspection for physical defects	

Options: _____

Notes: _____

3 Safety

General

This section summarizes the essential precautions applicable to the GPR-1500DA ppm 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-1500DA ppm 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 pressure regulated to 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 vent pressure should be atmospheric.

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: The transmitter is approved for indoor or outdoor use. Mount as recommended by the manufacturer.

Power: 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 45° 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 and knobs. 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 & Specifications

See last page, this page left blank intentionally.

5 Operation

Principle of Operation

The GPR-1500DA oxygen transmitter incorporates a variety of ppm range advanced galvanic fuel cell type sensors. The transmitter is configured in two sections. 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.

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.

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 12-36VDC power source and separate wiring for the outputs. A loop power source is not sufficient to power to the circuit. The 4-20mA output is also represented on full scale oxygen readings to an external device.

Sample System:

The GPR-1500DA 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 & Flow

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 metal tubing inside the transmitter. The GPR-1500DA internal sample system includes 1/8" compression tube inlet and vent fittings, a stainless steel 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 recommended 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. To reduce the possibility of leakage for low ppm measurements, position a metering needle valve upstream of the sensor to control the flow rate and position a flow indicator downstream of the sensor.

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.

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 ppm range oxygen measurements, an optional external sampling pump should be positioned downstream of the sensor to draw the sample from the process, by 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 transmitter 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.

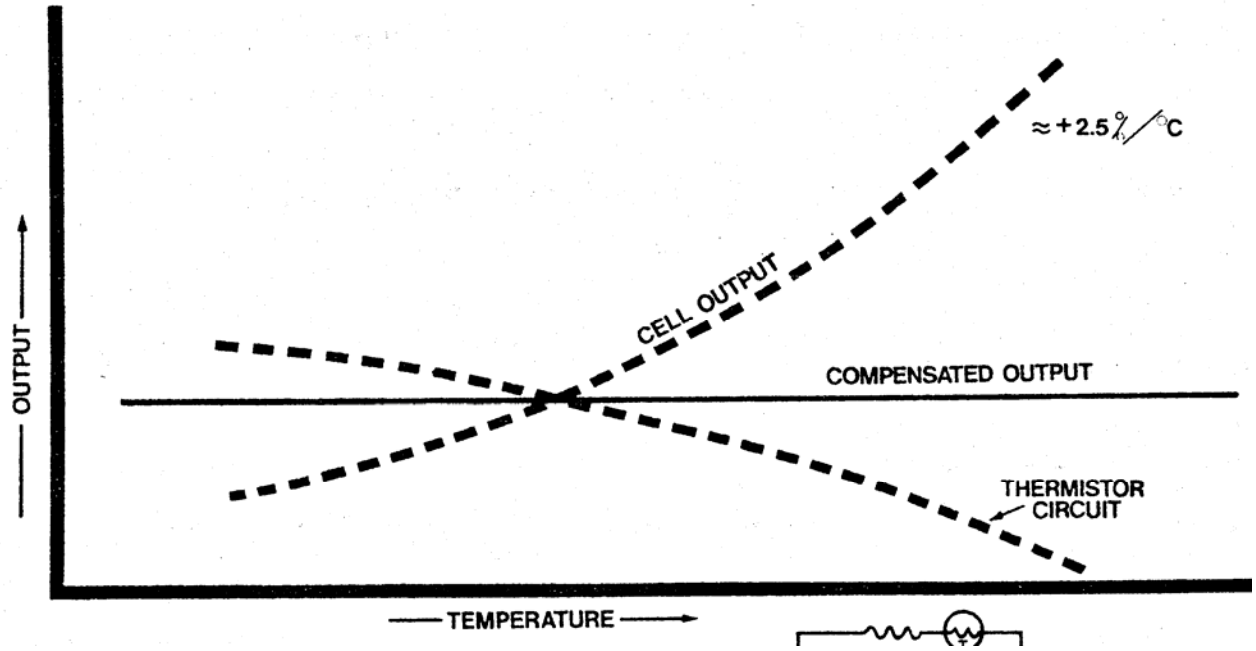
To avoid erroneous oxygen readings and damaging the sensor:

- 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 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.

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.

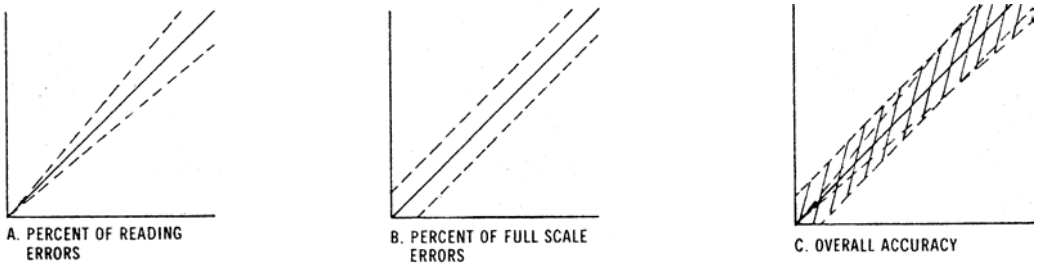
Pressure: Because sensors are sensitive to the partial pressure of oxygen in the sample gas their output is a function of the number of molecules of oxygen 'per unit volume'. Readouts in percent are permissible only when the total pressure of the sample gas being analyzed remains constant. The pressure 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% or better and generates an output function that is independent of temperature. 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.



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.

Start-up

The GPR-1500DA ppm Oxygen Transmitter has been calibrated at the factory prior to shipment and is fully operational from the shipping container. The ppm oxygen sensor has been removed and packaged in a nitrogen atmosphere to assure optimum performance. Once installed, we recommend the user allow the transmitters to stabilize for 30 minutes and then recalibrate the device as instructed below.

Installation Considerations:

The GPR-1500DA consists of an electronic module that includes the terminals for incoming power and outgoing signal outputs, and, the power supply, sensor housing; and, 1/8” sample inlet and vent connections housed in a NEMA 4X rated enclosure.

For optimum accuracy zero and calibrate a ppm 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 for measurements below 1 ppm. 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

1. 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.
2. Review the application conditions 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.

3. 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.
4. Pressure & Flow: As described above.
5. 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.
6. Contaminants: 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.
7. Gas connections: Inlet and outlet vent gas lines require 1/8" diameter tubing preferably metal.
8. Power connection: Locate a source of AC power to meet area classification and to plug in the charging adapter.
9. Zero calibration (required only for very low percentage range measurements).
10. Span calibration – Users are responsible for certified span gas cylinder, regulator and flow control valve.

Mounting the Transmitter:

The GPR-1500DA is housed in a 9Hx4Wx3.5"D NEMA4X rated enclosure. This configuration is designed to be mounted directly to any flat vertical surface, wall or bulkhead plate with eight (8) of the appropriate screws. To facilitate servicing the interior of the transmitters, position it approximately 5 feet off ground level.

1. Remove the four (4) screws securing the top section of the enclosure, set them aside for reinstallation and raise the hinged top section 180º until it locks in place.
2. Locate the mounting holes cast into the enclosure.
3. 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.
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.

Gas Connections:

The GPR-1500DA with its standard flow through configuration is designed for positive pressure samples and requires connections for incoming sample and outgoing vent lines. Zero and span inlet ports are offered as part of the optional sample systems. The user is responsible for calibration gases and the required components, see below.

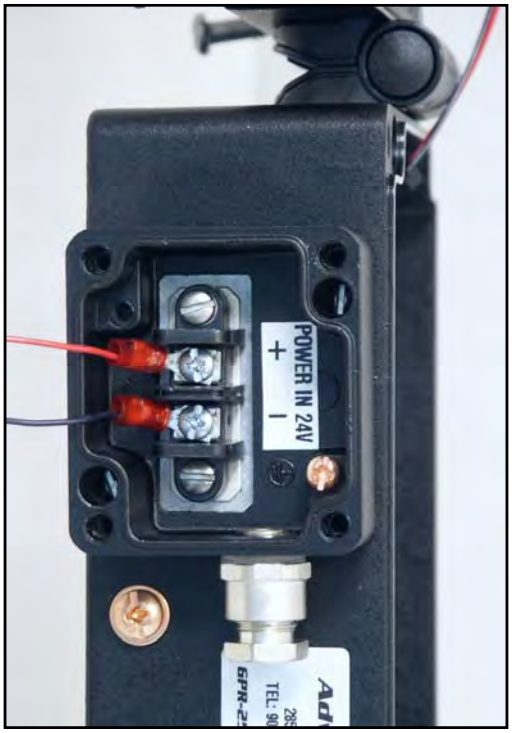
Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate backpressure and erroneous oxygen readings because the diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate. A flow indicator with an integral metering valve upstream of the sensor is recommended as a means of controlling the flow rate of the sample gas. A flow rate of 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).

Procedure:

1. **Caution:** Do not change the factory setting until instructed to do in this manual.
2. Designate one of the bulkhead tube fittings as the VENT and the other SAMPLE.
3. Regulate the pressure as described in Pressure and Flow above.
4. Connect a 1/8" vent line to the compression fitting to be used for venting the sample.
5. Connect a 1/8" ZERO, SPAN or SAMPLE line to the fitting designated SAMPLE.
6. If equipped with optional fittings and/or sample system, connect the ZERO and SPAN gas lines.
7. Allow gas to flow through the transmitters and set the flow rate to 2 SCFH.
8. **Note:** If equipped with the optional H2S sample conditioning system, see drawing A-3237:
9. Regulate the pressure so that it does not exceed 30 psig
10. Use ¼" tubing to make the appropriate connections as labeled on the sample panel.

Electrical Connections:



Electrical connections to the GPR-1500DA are made at two different locations within the transmitters.

Power requirements consist of a two wire shielded cable and a 12-36V DC with negative ground power supply. Incoming power is connected via a terminal strip found in the junction box on the left side of the GPR-1500DA enclosure.

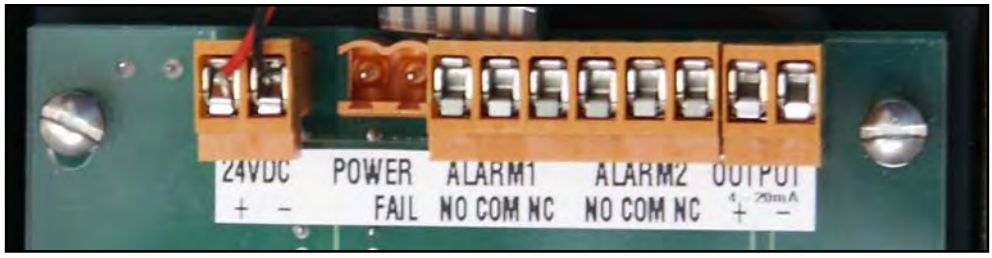
Caution: The integral 4-20mA converter is internally powered and does not require external power. **DO NOT** supply any voltage to either of the two terminals of the 4-20mA output or the 4-20mA converter will be damaged.

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

Procedure:

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

The incoming power from the external junction box is interconnected internally to the 24VDC terminal of the PCB with the alarm and 4-20mA output terminals as illustrations below.



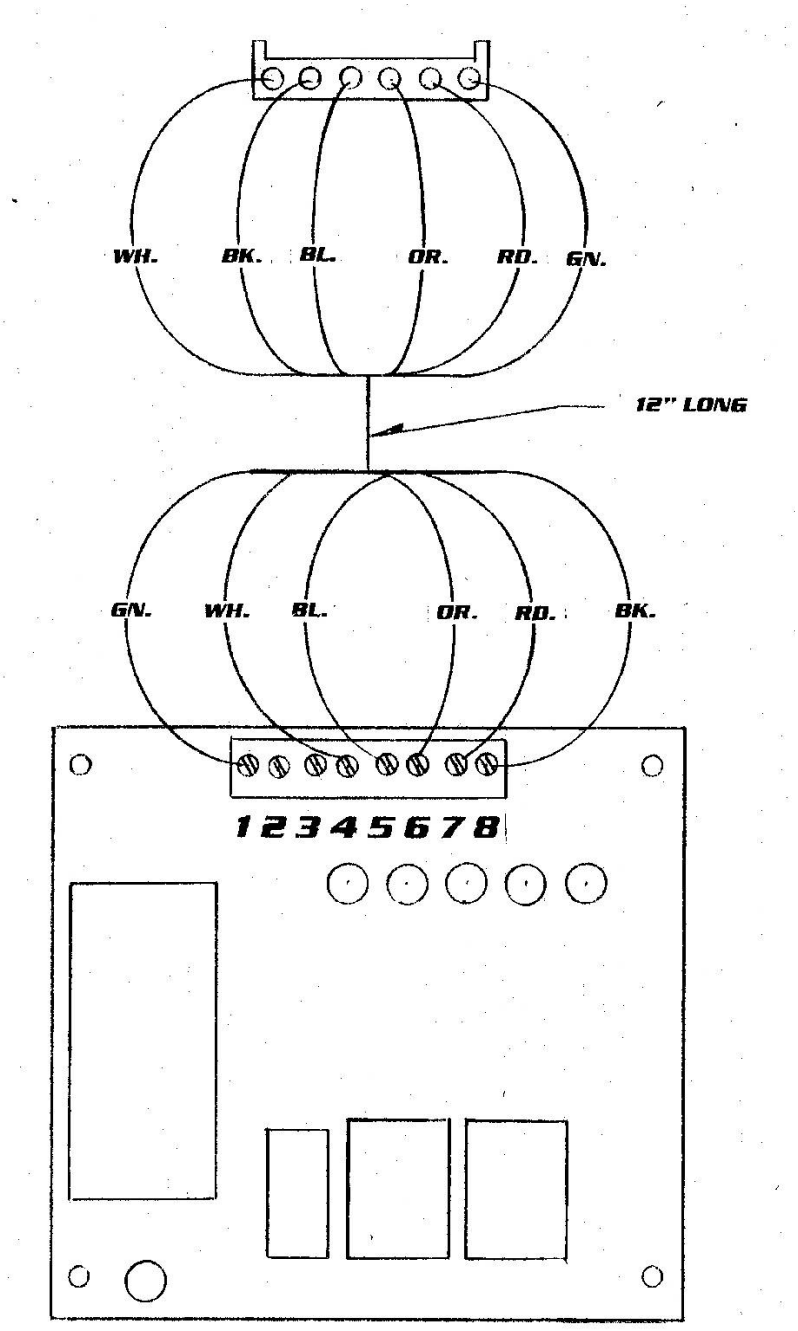
The 4-20mA signal output, power fail, alarm relay contacts, and, output connections are made to a terminal block mounted on a PCB located in the bottom half of the front cover of the enclosure and appear upside when the hinged enclosure is open and front cover swings up as illustrated below. The PCB also includes a transformer to power the alarm relays. The main processing display PCB is located in the upper half of the front cover of the enclosure.

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

Procedure:

1. Remove the four (4) screws securing the protection Plexiglas guard.
2. Separate the shielding from the wires of the cable.
3. Ensure the positive and negative terminals of the incoming 24VDC power supply are connected to the appropriate terminals of the barrier strip as marked.
4. The output connections enter the GPR-1500DA from the hole provided in the right side of the enclosure. **Note:** The user is responsible for providing the appropriate conduit and fittings.
5. Connect the shielding of the cable to the ground screw. **Note:** The terminals snap together, making it possible to detach the section with the ground, install the shielded cable and reinstall.
6. The 4-20mA current output is obtained by connecting the current measuring device between the positive and negative terminals of the OUTPUT 4-20mA.
7. To check the signal output of the 4-20mA E/I integrated circuit connect an ammeter as the measuring device and confirm the output is within $\pm$0.1mA of 4mA.
8. Replace the protective Plexiglas guard and secure.

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-1500DA ppm Oxygen Transmitter is equipped with an integral oxygen sensor. They have been tested and calibrated by the manufacturer prior to shipment and are fully operational from the shipping container.

Caution: 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 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.

Procedure:

The sensor has not been installed at the factory (in standard configuration there are no valves to isolate the sensor) and it will be necessary to install the sensor in the field.

1. **Caution:** Do not change the factory settings until instructed to do in this manual.
2. Connect the gas lines as previously described.
3. Flow zero gas or sample gas with a low ppm oxygen concentration to the transmitter at 2 SCFH for 3-5 minutes to purge the oxygen (air 209,00 ppm) trapped in the lines.
4. Select the AUTO RANGING option from the SAMPLE menu with gas flowing to the analyzer.
5. Note: The graphical LCD displays 000.0 until the sensor is connected.
6. Remove the oxygen sensor from the bag. DO NOT remove the shorting device (wire loop) at this time.
7. Screw the oxygen sensor into the sensor flow housing, equipped with elbows and tubing, finger tighten plus one half (1/2) turn to ensure a good seal from the o-ring affixed to the sensor.
8. The sensor must be connected to the PCB A-1151. One end of the sensor cable harness is connected to the PCB, the opposite end is not attached.

9. The female connector at the unattached end of the sensor cable harness must be mated to the male (pins) connector at the rear of the sensor. The connectors snap together when properly oriented. BUT FIRST . . .
10. Remove the shorting device (wire loop) from the connector located at the rear of the sensor.
11. Minimize the time the sensor is exposed to ambient air.
12. Push the female connector from the sensor cable harness onto the male connector until they lock.
13. Once the sensor is connected, the LCD displays an oxygen value. A temporary OVER RANGE indication is normal.
14. Maintain the flow of zero gas until the transmitter "purges down" to less than 10 ppm, 1-2 hours is normal.
15. Proceed to the calibration section.

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. metal tubing measuring 4-6 ft. in length.
- Suitable fittings and 1/8" dia. metal tubing to connect the regulator to the flow meter inlet
- Suitable fitting and 1/8" dia. metal tubing to connect from the flow meter vent to tube fitting designated SAMPLE IN on the GPR-1200.

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.

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.

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 transmitter performs several diagnostic system status checks termed "START-UP TEST" as illustrated below:

START-UP TEST

ELECTRONICS – PASS
TEMP SENSOR – PASS
BAROMETRIC SENSOR – PASS

REV. 1.61

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

33.3 PPM

AUTO SAMPLING
100 PPM RANGE
24.5 C **100 KPA**
LO1 2PPM **10PPM HI2**

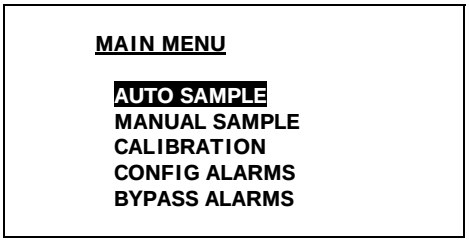
Menu Navigation:

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

1. green ENTER (select)
2. yellow UP ARROW
3. yellow DOWN ARROW
4. blue MENU (escape)

Main Menu:

Access the MAIN MENU by pressing the MENU key:



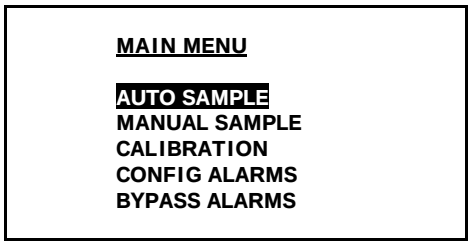
Range Selection:

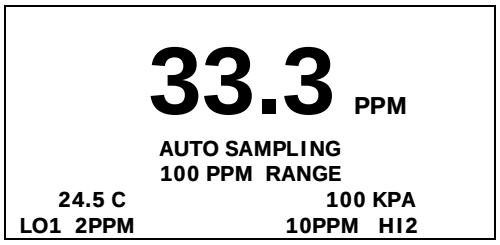
The GPR-1500DA transmitter is equipped with four (4) standard measuring ranges (see specification) and provides users with a choice of sampling modes. By accessing the MAIN MENU, users may select either the AUTO SAMPLING (ranging) or MANUAL SAMPLING (to lock on a single range) mode.

Note: For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can select the full scale MANUAL SAMPLE RANGE for calibration as dictated by the accuracy of the analysis required – for example, a span gas with an 800 ppm oxygen concentration with the balance nitrogen would dictate the use of the 0-1000 ppm full scale range for calibration and a 0-100 ppm measuring range.

Auto Sampling:

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight AUTO SAMPLE.
3. Press the ENTER key to select the highlighted menu option.
4. The display returns to the sampling mode:



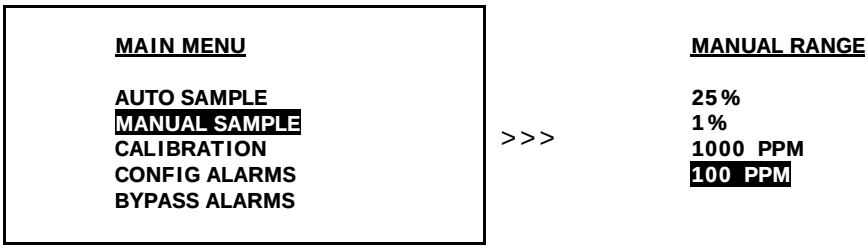


The display will shift to the next higher range when the oxygen reading (actually the sensor's signal output) exceeds 99.9% of the upper limit of the current range. The display will shift to the next lower range when the oxygen reading drops to 85% of the upper limit of the next lower range.

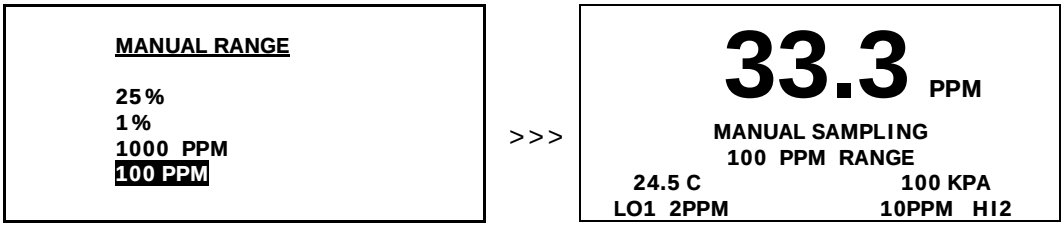
For example, if the transmitter is reading 1% on the 0-10% range and an upset occurs, the display will shift to the 0-25% range when the oxygen reading exceeds 9.9%. Conversely, once the upset condition is corrected, the display will shift back to the 0-10% range when the oxygen reading drops to 8.5%.

Manual Sampling:

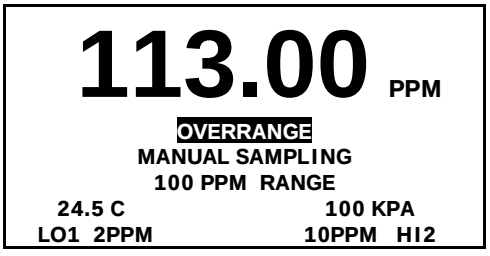
1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.
3. Press the ENTER key to select the highlighted menu option.
4. The following display appears:



5. Advance the reverse shade cursor using the ARROW keys to highlight the desired MANUAL RANGE.
6. Press the ENTER key to select the highlighted menu option.
7. The following displays appears with the range selected and oxygen concentration of the sample gas:



8. 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.
9. **Note:** 3.3 PPM displayed on ranges of 1000 PPM and below, 0.0% displayed on ranges of 1% and above.



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.

Alarms

The CONFIG ALARMS features a system that can be configured in the field. Two field adjustable alarm relays with dry contacts operate independently of one another which means the alarms can be set-up as:

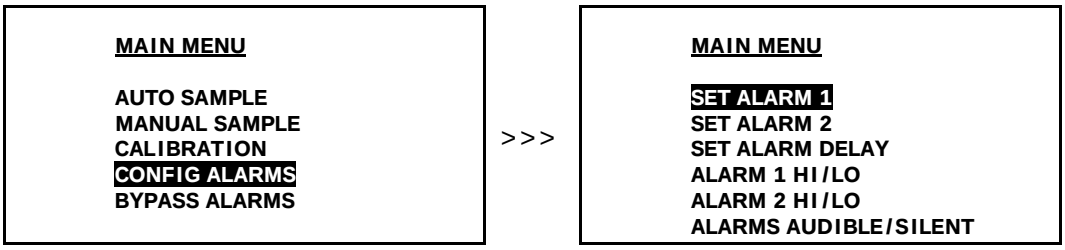
- HI and LO
- LO and LO, LO,
- HI and HI,HI

Additional feature includes delaying the activation of the local audible alarm and relay contacts for up 99 minutes to enable users to distinguish between transient occurrences and true upset conditions which is particularly useful on remote applications without affecting the 4-20mA signal output. The local audible alarm can be silenced or disabled as well without affecting the 4-20mA signal output.

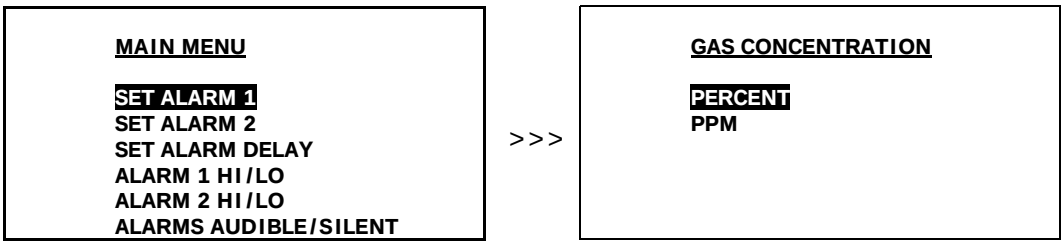
Note: A separate feature, BYPASS ALARMS described below, enables the user to disable the local audible alarm and relay contacts during calibration or servicing. The alarms are enabled when the alarm condition is corrected.

Set Alarm Values:

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CONFIG ALARMS.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appears:

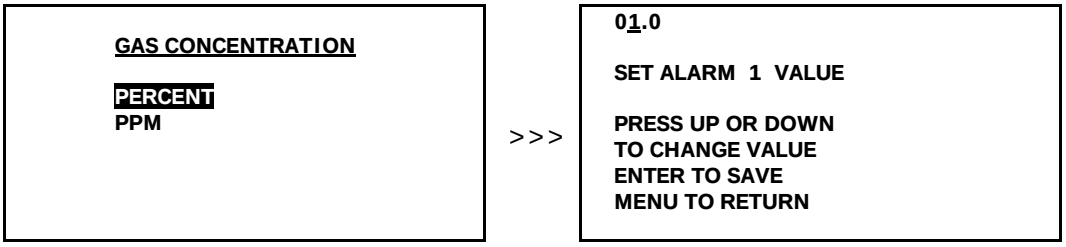


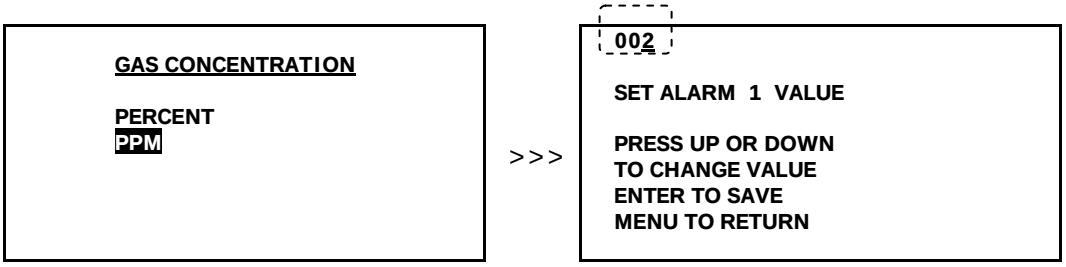
5. Advance the reverse shade cursor using the ARROW keys to highlight the SET ALARM 1 option.
6. Press the ENTER key to select the highlighted menu option.
7. The following displays appears with PERCENT as the default alarm value :



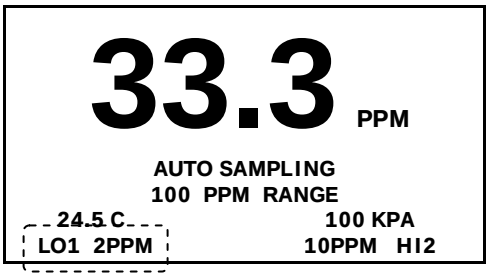
8. Advance the reverse shade cursor using the ARROW keys to highlight the desired option.
9. Press the ENTER key to select the highlighted menu option.

10. **Note:** The PERCENT alarm value is entered with one decimal, the PPM alarm value is entered as an integer.

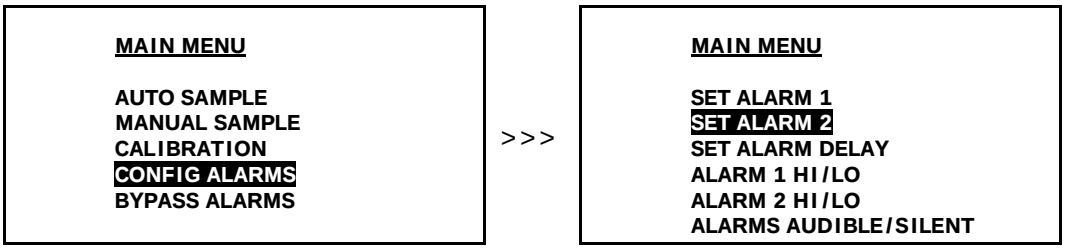




11. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
12. Press the ARROW keys to enter the alarm value.
13. Repeat steps 11 and 12 until the complete span value has been entered.
14. **Note:** If an alarm is set as a PERCENT value and subsequently changed to a PPM value, the PERCENT value is not retained and is reset to 00.0. This holds if the alarm was first set as PPM value and then changed to a PERCENT value.
15. **Save the alarm value by pressing the ENTER key or abort by pressing the MENU key.**
16. The system returns to the SAMPLING mode and displays:



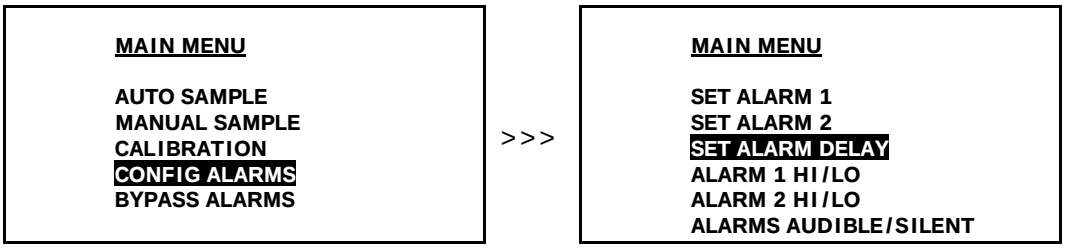
Repeat the steps above to set the ALARM 2 value:



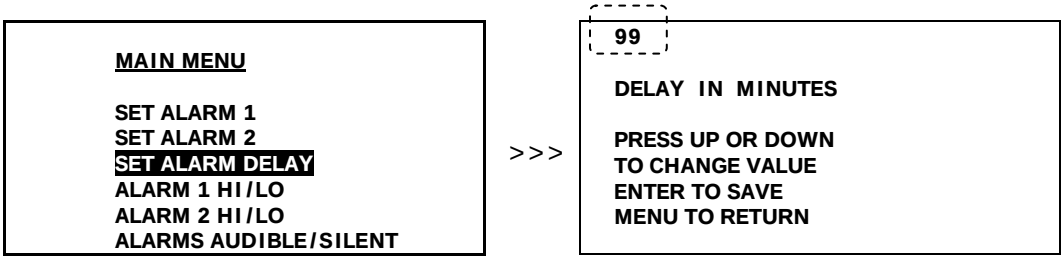
Set Alarm Delay:

Once the values for ALARM 1 and ALARM 2 have been entered, the user may elect to delay the activation of the local alarms and relay contacts for up to 99 minutes. This feature allows users to distinguish between transient occurrences and true upset conditions. This feature can be particularly useful on remote applications without affecting the 4-20mA signal output.

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CONFIG ALARMS.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appear:

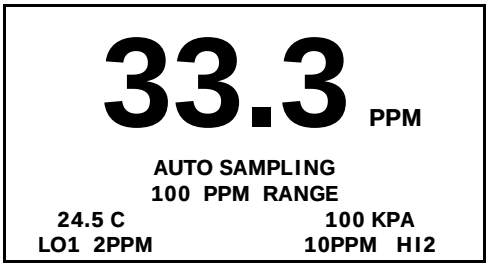


5. Advance the reverse shade cursor using the ARROW keys to highlight the SET ALARM DELAY.
6. Press the ENTER key to select the highlighted menu option.
7. The following displays appear with last alarm delay value :



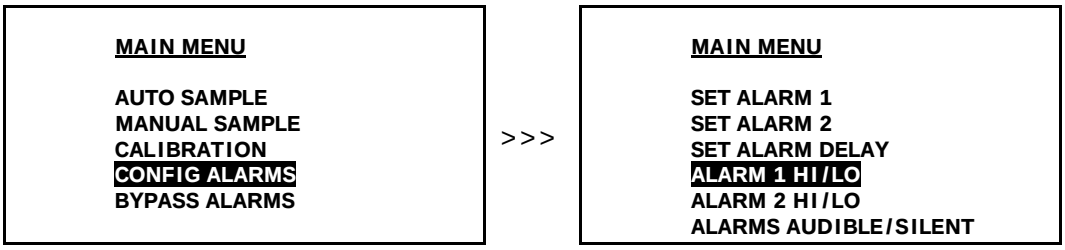
8. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
9. Press the ARROW keys to enter the alarm value.

10. Repeat steps 17 and 18 until the complete span value has been entered.
11. **Save the alarm value by pressing the ENTER key or abort by pressing the MENU key.**
12. The system returns the SAMPLING mode and displays:

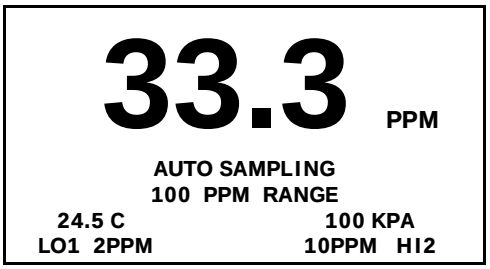


Set HI/LO Alarms:

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CONFIG ALARMS.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appears:



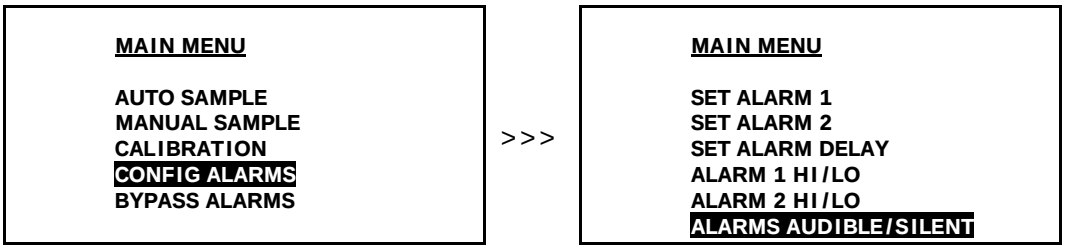
5. Advance the reverse shade cursor using the ARROW keys to highlight the ALARM 1 option, which appears as either ALARM 1 HI or ALARM 1 LO.
6. Press the ENTER key to toggle and change the displayed setting. After 3 seconds, the system returns to SAMPLING mode.



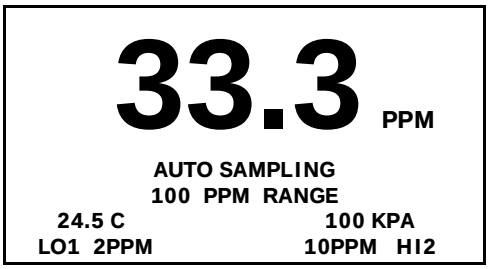
7. Repeat steps 1 through 6 for the ALARM 2 HI/LO setting.

Set Local Alarms:

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CONFIG ALARMS.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appears:



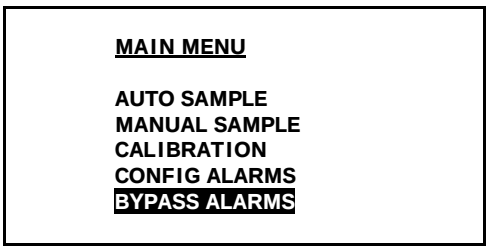
5. Advance the reverse shade cursor using the ARROW keys to highlight the ALARMS AUDIBLE/SILENT option, which appear as either ALARMS AUDIBLE or ALARMS SILENT.
6. Press the ENTER key to toggle and change the displayed setting. After 3 seconds, the system returns to SAMPLING mode.



Bypass Alarms:

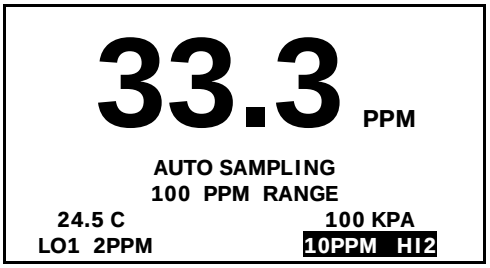
This feature, separate from CONFIG ALARMS above, enables the user to disable the local audible alarm and relay contacts during calibration or servicing. The alarms are enabled when the alarm condition is corrected.

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight BYPASS ALARMS.
3. The following displays appears:



4. Press the ENTER key to bypass and disable both the local audible alarm and relay contacts. After 3 seconds, the system returns to SAMPLING mode.

Note: The appropriate alarm setting will alternately reverse shades indicating the alarm condition exists but the BYPASS ALARMS feature has disabled the local audible alarm and relay contact. The alarms are enabled when the alarm condition is corrected.



Start-Up is complete . . . proceed to Calibration

Zero Calibration

In theory, the oxygen sensor produces no signal output when exposed to an oxygen free sample gas. However, the transmitter 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 ppm on the 10 ppm range only, as it is not practical on higher ranges as described below.

Procedure:

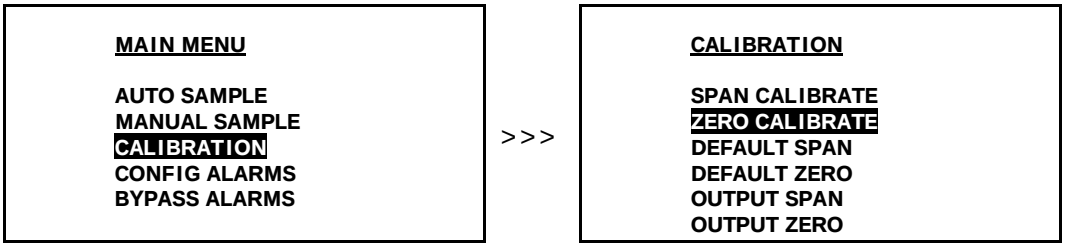
Zero calibration should precede the span calibration and once performed should not have to be repeated with subsequent span calibrations. Normally, zero calibrations are performed when a new sensor is installed or changes are made in the sample system connections.

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 transmitter 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 this reasons above, it is not practical to zero a portable transmitter every time it is moved from one sample point to another. 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 transmitter can cause a negative reading in both the ZERO and SAMPLE modes.

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. The following displays appear:



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

7. The following displays appear:

```
0.000  PPM

ZERO
CALIBRTION
ENTER TO CALIBRATE
MENU TO ABORT
```

8. Press the ENTER key to calibrate or MENU key to abort and return to SAMPLING mode.
9. 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.
10. Both the Zero Calibrate and Span Calibrate functions result in the following displays:

```
PASSED
CALIBRATION
```

OR

```
FAILED
CALIBRATION
```

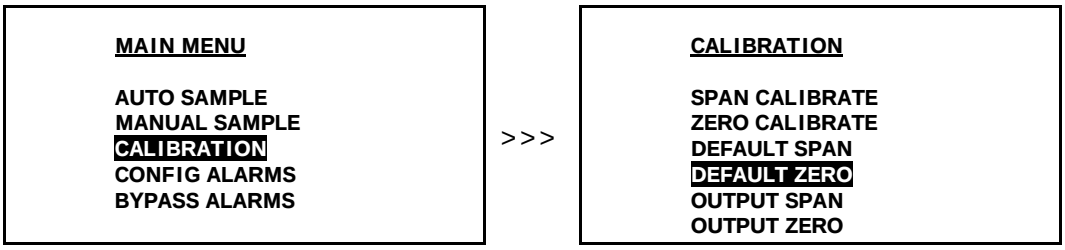
Satisfying users that the zero offset is reasonably acceptable for their application can be accomplished much quicker. Unless the zero gas is contaminated or there is a significant leak in the sample connections, the transmitter should read less than 100 ppm oxygen within 15 minutes after being placed on zero gas.

The maximum zero calibration adjustment permitted is 60% of the lowest full scale range available, which normally is 100 ppm. Thus the maximum zero calibration adjustment or zero offset is 60 ppm oxygen. Accordingly, the transmitter's ZERO has not been adjusted prior to shipment because the factory conditions are different from the application condition at the user's installation.

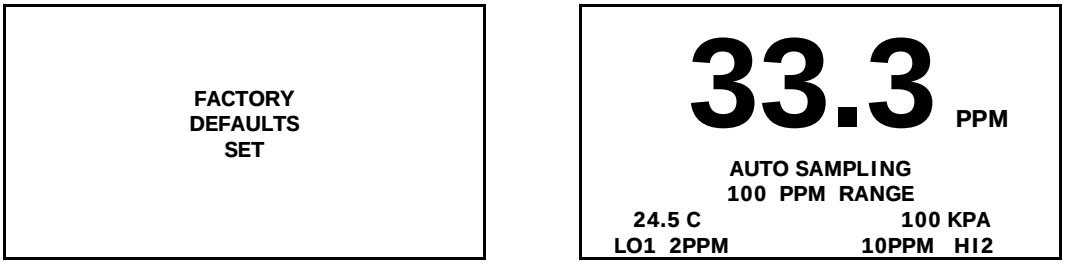
Default Zero:

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.

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. The following displays appear:



5. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT ZERO.
6. Press the ENTER key to select the highlighted menu option.
7. The following display appears and after 3 seconds the system returns to the SAMPLING mode:

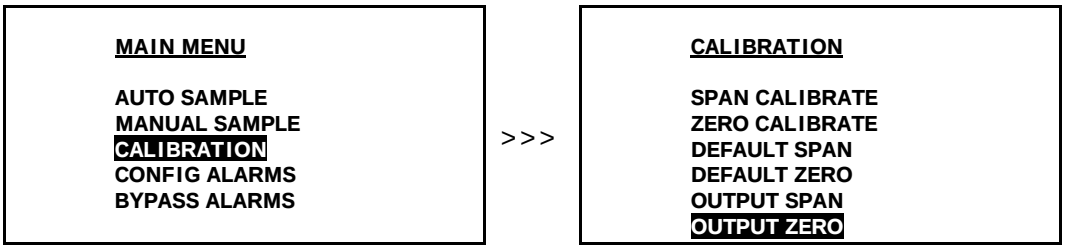


Output Zero:

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 4mA signal output when the LCD displays 00.00.

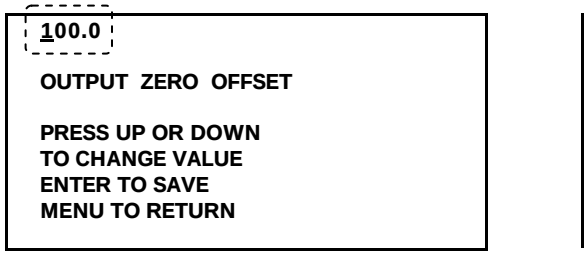
Note: Adjust the 20mA signal output with the OUTPUT SPAN option described below.

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. The following displays appear:



5. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT ZERO.
6. Press the ENTER key to select the highlighted menu option.

7. The following display appears



8. Compute the adjustment value as follows:

   a.) The adjustment value defaults to 100.0% to start.

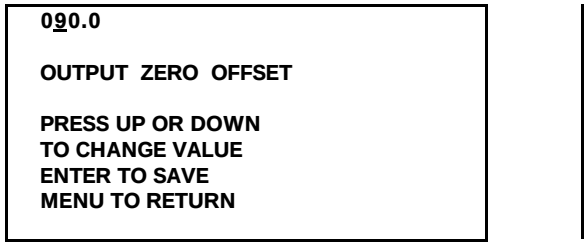
   b.) If the 4mA output at the PLC is 4.4mA when the LCD displays 00.00 or near zero, the adjustment value will be < 100.0%; conversely, if the 4mA output is 3.6mA the adjustment value will be > 100.0%.

   c.) Calculate the difference between 4mA output at the PLC and 4mA.

   d.) Divide the difference from c.) above by 4mA (0.4/4mA) to calculate the percent error, 10% in this case.

   e.) Add or subtract the percent error from d.) above to the 100.0% default value to calculate the adjustment value of 90%.

   f.) **Note:** The true adjustment value must be determined empirically by trial and error. Once the initial adjustment is made and checked at the PLC it may be necessary to fine tune the initial adjustment by repeating step 8. Any additional percent error must be added or subtracted from the initial adjustment value of 90%.



9. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
10. Press the ARROW keys to enter the alarm value.
11. Repeat steps 9 and 10 until the complete span value has been entered.
12. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
13. The system returns to the SAMPLING mode.

Span Calibration

Maximum drift from calibration temperature is approximately 0.11% of reading per °C. The transmitter has been calibrated at the factory. However, in order to obtain reliable data, the transmitter 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 transmitter 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.

Preparation:

1. Required components: Refer to Installing Span Gas section above.
2. Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range above the intended measuring range.
3. Regulator to reduce pressure to between 5 and 30 psig.
4. Flow meter to set the flow between 1-5 SCFH,
5. 2 lengths of 1/8" dia. metal tubing measuring 4-6 ft. in length.
6. Suitable fittings and 1/8" dia. metal tubing to connect the regulator to the flow meter inlet
7. Suitable fitting and 1/8" dia. metal tubing to connect to the flow meter vent
8. 1/8" male NPT to tube adapter fitting to connect the 1/8" dia. metal tubing from the flow meter vent to the mating male quick disconnect fitting supplied with the GPR-1500DA.

Procedure:

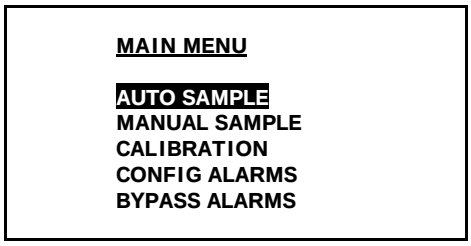
The user must ascertain that the oxygen reading (actually the sensor's signal output) has reached a stable value within the limits entered below before entering the span adjustment. Failure to do so will result in an error.

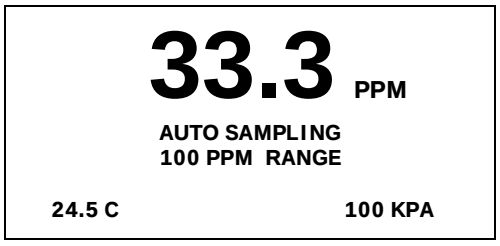
This procedure assumes a span gas under positive pressure and is recommended for a transmitter without an optional sampling pump, which if installed downstream of the sensor should be placed in the OFF position and disconnected so the vent is not restricted during calibration.

To assure an accurate calibration, the temperature and pressure of the span gas must closely approximate the sample conditions.

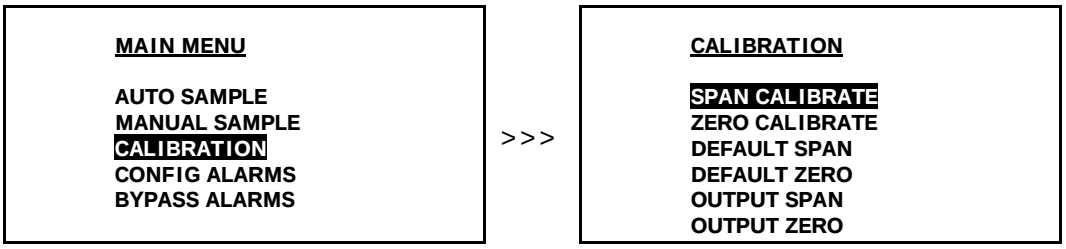
For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can select the full scale MANUAL SAMPLE RANGE for calibration as dictated by the accuracy of the analysis required – for example, a span gas with an 80 ppm oxygen concentration with the balance nitrogen would dictate the use of the 0-100 ppm full scale range for calibration and a 0-10 ppm measuring range. Select as described above.

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight AUTO SAMPLE.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appear:

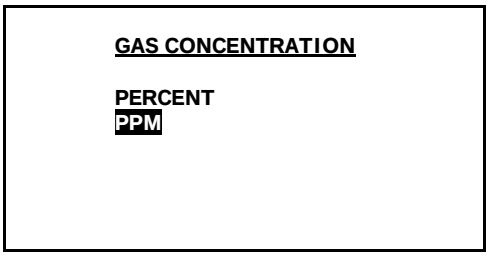




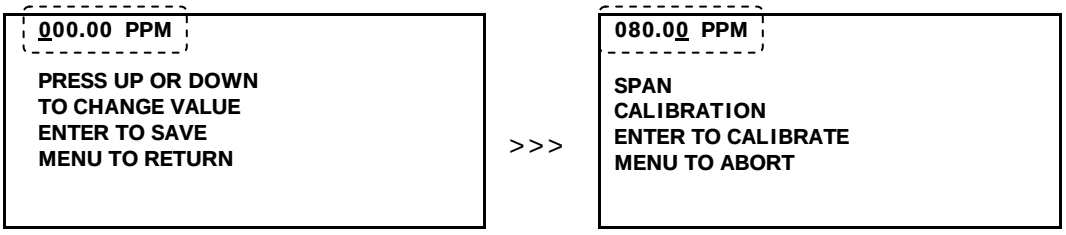
5. Return to the MAIN MENU by pressing the MENU key.
6. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
7. Press the ENTER key to select the highlighted menu option.
8. Repeat to select SPAN CALIBRATE
9. The following displays appear:



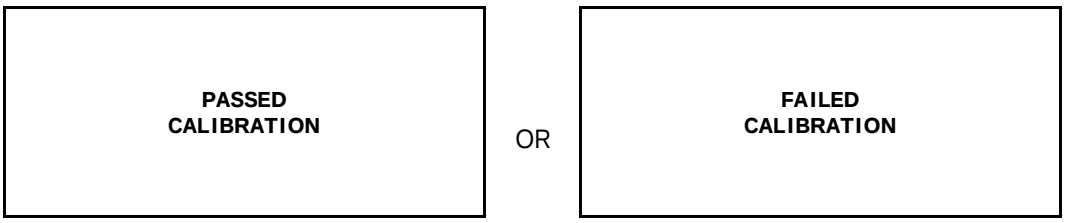
10. Assure there are no restrictions in vent line.
11. Regulate the pressure and control the flow rate as described above at 5-30 psig and a 2 SCFH flow rate.
12. Allow the span gas to flow for 1-2 minutes to purge the air trapped in the span gas line.
13. Disconnect the sample gas line and install the purged span gas line.
14. **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.
15. Press the ENTER key to select the SPAN CALIBRATE option.
16. **Note:** A span gas concentration above 1000 ppm dictates the selection of the PERCENT option.
17. Advance the reverse shade cursor using the ARROW keys to highlight the desired GAS CONCENTRATION.
18. Press the ENTER key to select the highlighted menu option.



19. The following displays appear:



20. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
21. Press the ARROW keys to enter the alarm value.
22. Repeat steps 20 and 21 until the complete span value has been entered.
23. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
24. 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:

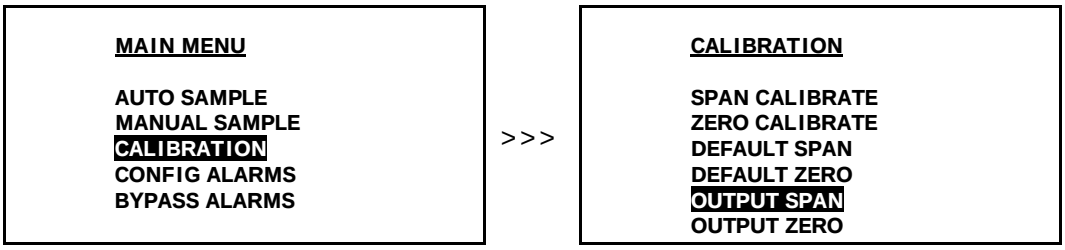


25. If the calibration is successful, the transmitter returns to the SAMPLING mode after 30 seconds.
26. If the calibration is unsuccessful, return to the SAMPLING mode with span gas flowing through the transmitter, make sure the reading stabilizes and repeat the calibration before concluding the equipment is defective.
27. Before disconnecting the span gas line and connecting the sample gas line, restart if necessary the flow of sample gas and allow it to flow for 1-2 minutes to purge the air inside the line.
28. Disconnect the span gas line and replace it with the purged sample gas line.
29. Wait 10-15 minutes to ensure the reading is stable and proceed to sampling.

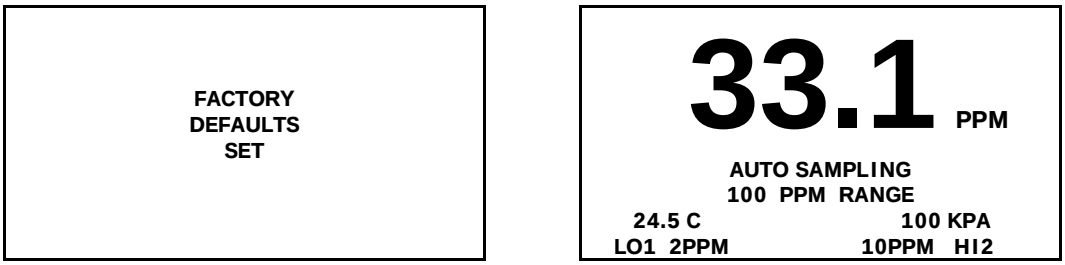
Default Span

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 ±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.

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. The following displays appears:



8. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT SPAN.
9. Press the ENTER key to select the highlighted menu option.
10. The following displays appear and after 3 seconds the system returns to the SAMPLING mode:

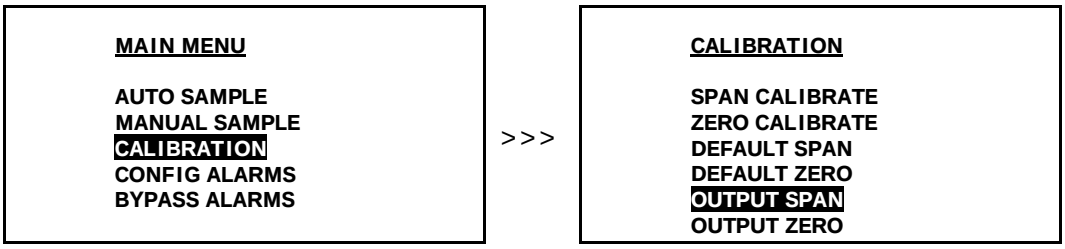


Output Span:

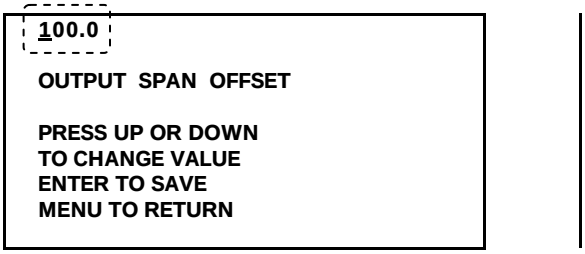
In rare instances the 4-20mA signal output may not agree to the reading displayed by the LCD. This feature enables the user to adjust the 20mA signal output should the LCD display not agree.

Note: Adjust the 4mA signal output with the OUTPUT ZER) 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.
4. The following displays appear:



5. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT SPAN.
6. Press the ENTER key to select the highlighted menu option.
7. The following display appears



8. Compute the adjustment value as follows:

   a.) The adjustment value defaults to 100.0% to start.

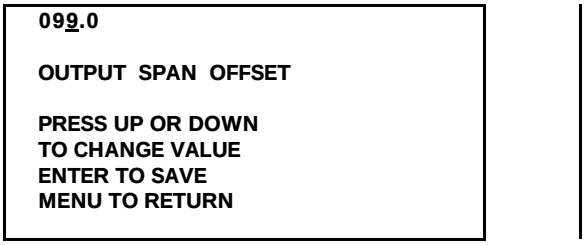
   b.) If the 20mA output at the PLC is 20.2mA when the LCD displays the full scale range value, the adjustment value will be < 100.0%; conversely, if the 20mA output is 19.8mA the adjustment value will be > 100.0%.

   c.) Calculate the difference between 20mA output at the PLC and 20mA.

   d.) Divide the difference from c.) above by 4mA (0.2/20mA) to calculate the percent error, 1% in this case.

   e.) Add or subtract the percent error from d.) above to the 100.0% default value to calculate the adjustment value of 99%.

f.) **Note:** The true adjustment value must be determined empirically by trial and error. Once the initial adjustment is made and checked at the PLC it may be necessary to fine tune the initial adjustment by repeating step 8. Any additional percent error must be added or subtracted from the initial adjustment value of 99%.



9. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
10. Press the ARROW keys to enter the alarm value.
11. Repeat steps 9 and 10 until the complete span value has been entered.
12. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
13. The system returns to the SAMPLING mode.

Sampling

GPR-1500DA ppm Oxygen Transmitter requires positive pressure to flow the sample gas by the sensor to measure the oxygen concentration in a sample gas. If not available see Pressure & Flow section.

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

Procedure:

Following calibration the transmitter returns to the SAMPLE mode after 30 seconds.

1. Select the desired sampling mode - auto or if manual, the range that provides maximum resolution – as described above.
2. Use metal tubing to transport the sample gas to the transmitter.
3. 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 fit tightly into the 1/8" male NPT to tube adapter, and, the NPT end is taped and securely tightened into the mating male quick disconnect fittings which mate with the female fittings on the transmitter
4. Assure there are no restrictions in the sample line.
5. 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 2 SCHF is recommended
6. For sample gases under atmospheric or slightly negative pressure an optional sampling pump is recommended to draw the sample into the transmitter. Generally, no pressure regulation or flow control device is involved.
7. **Caution:** If the transmitter is equipped with an optional sampling pump and is intended for use in both positive and atmospheric/slightly negative pressure applications where a flow meter valve is involved – ensure the valve is completely open when operating the sampling pump. Refer to the Pressure & Flow section above.
8. Assure the sample is adequately vented for optimum response and recovery – and safety.
9. Allow the oxygen reading to stabilize for approximately 10 minutes at each sample point.

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 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.

Standby

- The transmitter has no special storage requirements.
- The sensor should remain connected during storage periods.
- Store the transmitter 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 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-1500DA transmitter. 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 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.

Procedure:

1. Remove the four (4) screws securing the transmitter's front panel.
2. **Caution:** Do not discard the gaskets from the enclosure.
3. The sensor must be disconnected from the PCB A-1151. One end of the sensor cable harness is connected to the PCB, the opposite end is attached to the connector at the rear of the sensor.
4. The female connector at the end of the sensor cable harness snaps to mate to the male (pins) connector at the rear of the sensor.
5. Using your thumbnail, coin or small screwdriver blade, separate the vertical flap of the male connector from the female connecter and carefully pull the female connector up and away.
6. Unscrew the oxygen sensor counterclockwise from the sensor flow housing.
7. Remove the old oxygen sensor and dispose of it as you would a battery.
8. Remove the new oxygen sensor from the bag. DO NOT remove the shorting device (wire loop) at this time.
9. Flow zero gas or sample gas with a low ppm oxygen concentration to the transmitter at 2 SCFH for 3-5 minutes to purge the oxygen (air 209,00 ppm) trapped in the lines.
10. Select the AUTO RANGING option from the SAMPLE menu with gas flowing to the analyzer.
11. Note: The graphical LCD displays 000.0 until the sensor is connected.
12. Remove the oxygen sensor from the bag. DO NOT remove the shorting device (wire loop) at this time.

13. Screw the oxygen sensor into the sensor flow housing, equipped with elbows and tubing, finger tighten plus one half (1/2) turn to ensure a good seal from the o-ring affixed to the sensor.
14. The sensor must be connected to the PCB A-1151. One end of the sensor cable harness is connected to the PCB, the opposite end is not attached.
15. The female connector at the unattached end of the sensor cable harness must be mated to the male (pins) connector at the rear of the sensor. The connectors snap together when properly oriented. BUT FIRST . . .
16. Remove the shorting device (wire loop) from the connector located at the rear of the sensor.
17. Minimize the time the sensor is exposed to ambient air.
18. Push the female connector from the sensor cable harness onto the male connector until they lock.
19. Once the sensor is connected, the LCD displays an oxygen value. A temporary OVER RANGE indication is normal.
20. Maintain the flow of zero gas until the transmitter “purges down” to less than 10 ppm, 1-2 hours is normal.
21. Proceed to the calibration section.

7 Spare Parts

Recommended spare parts for the GPR-1500DA ppm Oxygen Transmitter:

Item No.	Description
GPR-12-100-M	ppm Oxygen Sensor
XLT-12-100-M	ppm Oxygen Sensor

Other spare parts:

Item No.	Description
A-2244	Battery Assembly
FITN-1018	Connector SS 1/8” MNPT to 1/8” Tube
FITN-1039	Elbow SS 1/8”
A-3051	Housing Flow Adaptor
MTR-1011	Meter Digital Panel LCD Backlight
A-1151-E-A4	PCB Assembly Main / Display
A-1153-A-A4	PCB Assembly Alarms/Power Connection

8 Troubleshooting

Symptom	Possible Cause	Recommended Action
Slow recovery	At installation, defective sensor	Replace sensor if recovery unacceptable or O_2 reading fails to reach 10% of lowest range
	Air leak in sample system connection(s)	Leak test the entire sample system: Vary the flow rate, if the O_2 reading changes inversely with the change in flow rate indicates an air leak - correct source of leak
	Abnormality in zero gas	Qualify zero gas (using portable transmitter)
	Damaged in service - prolonged exposure to air, electrolyte leak	Replace sensor
	Sensor nearing end of life	Replace sensor
High O_2 reading after installing or replacing sensor	Transmitter calibrated before sensor stabilized caused by:	Allow O_2 reading to stabilize before making the span/calibration adjustment
	1) Prolonged exposure to ambient air, worse if sensor was **unshorted**	Continue purge with zero gas
	2) Air leak in sample system connection(s)	Leak test the entire sample system (above)
	3) Abnormality in zero gas	Qualify zero gas (using portable transmitter)
High O_2 reading Sampling	Flow rate exceeds limits	Correct pressure and flow rate
	Pressurized sensor	Remove restriction on vent line or open SHUT OFF valve completely
	Improper sensor selection	Replace GPR/PSR sensor with XLT sensor when CO_2 or acid gases are present
	Abnormality in gas	Qualify the gas (use a portable transmitter)
Response time slow	Air leak, dead legs, distance of sample line, low flow rate, volume of optional filters and scrubbers	Leak test (above), reduce dead volume or increase flow rate

Symptom	Possible Cause	Recommended Action
O_2 reading doesn't agree to expected O_2 values	Pressure and temperature of the sample is different than span gas	Calibrate the transmitter (calibrate at pressure and temperature of sample)
	Abnormality in gas	Qualify the gas (use a portable transmitter)
Erratic O_2 reading or No O_2 reading	Test sensor independent from transmitter	Remove sensor from housing. Using a volt-meter set to uA output; apply the (+) lead to the outer ring of the sensor PCB and the (-) lead to the center circle to obtain the sensor's output in air. Contact factory with result. Sensors without PCB use mV setting.
	Change in sample pressure	Calibrate the transmitter (calibrate at pressure and temperature of sample)
	Dirty electrical contacts in upper section of sensor housing	Clean contacts with alcohol (minimize exposure time of MS sensor to ambient air to extent possible)
	Corroded solder joints on sensor PCB from corrosive sample or electrolyte leakage from sensor	Replace sensor and return sensor to the factory for warranty determination
	Corroded spring loaded contact in upper section of sensor housing from liquid in sample or electrolyte leakage from sensor	Upper section of sensor housing: Clean contacts with alcohol, flow sample or zero gas for 2-3 hours to flush sample system and sensor housing. Sensor: Replace if leaking and return it to the factory for warranty determination
	Liquid covering sensing area	Wipe with alcohol and lint free towel or flow sample or zero gas for 2-3 hours to flush
	Improper sensor selection	Replace GPR/PSR sensor with XLT sensor when CO_2 or acid gases are present
	Presence of interference gases	Consult factory
	Presence of sulfur gases	Replace sensor and install scrubber
	Unauthorized maintenance	Replace sensor, obtain authorized service
	Sensor nearing end of life	Replace sensor

Symptom	Possible Cause	Recommended Action
Erratic O_2 reading or Negative O_2 reading or No O_2 reading possibly accompanied by electrolyte leakage	Pressurizing the sensor by flowing gas to the sensor with: the vent restricted or SHUT OFF valve closed and suddenly removing the restriction draws a vacuum on the sensor or partially opening the valves upstream of the transmitter when using a pump downstream of the transmitter to draw sample from a process at atmospheric pressure or a slight vacuum A pressurized sensor may not leak but still produce negative readings. Placing a vacuum on the sensor in excess 4” of water column is strongly discouraged. The front sensing membrane is .000625 thick, heat sealed to the sensor body and subject to tearing when vacuum is suddenly applied.	Zero the transmitter. If not successful replace the sensor Avoid drawing a vacuum on the sensor
	A premature adjustment of the ZERO OFFSET potentiometer is a common problem	From MAIN MENU select DEFAULT ZERO

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 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 the 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 the 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