Advanced Instruments Inc.

Technical Specifications *

Accuracy:	< 2% of FS range under constant conditions
Analysis:	0-10, 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) atmospheres in glove boxes
Area Classification:	General purpose
Calibration:	Max interval—3 months; For fastest recovery to online use, use certified span gas with O2 content approximating 80% of full scale. For optimum accuracy, calibrate one range higher than range of interest. Air calibrate as last resort on 25% range.
Compensation:	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:	Painted aluminum, 3″x4″x2", 2 lbs.
Flow:	Not flow sensitive; 1-2 SCFH flow rate recommended
Linearity:	±1% of full scale
Pressure:	Atmospheric; Flowing system: inlet - regulate to 5-30 psig, vent - atmospheric or return controlled atmosphere
Power:	18-24 VDC two wire loop
Recovery Time:	60 seconds in air to < 10 PPM in < 1 hour on N_2 purge
Response Time:	90% of final reading in 10 seconds
Sample System:	Glove box Sample Calibration Module (pictured right)
Sensitivity:	< 0.5% of FS range
Sensor Model:	GPR-12-333-M for non-acid (CO2) gas streams XLT-12-333-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
Operating Range:	5ºC to 45ºC (GPR sensor), -10ºC to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

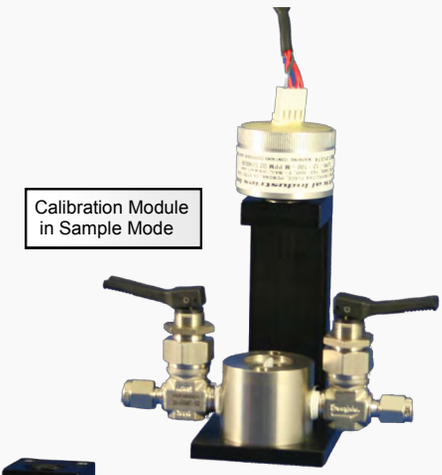
Optional Equipment

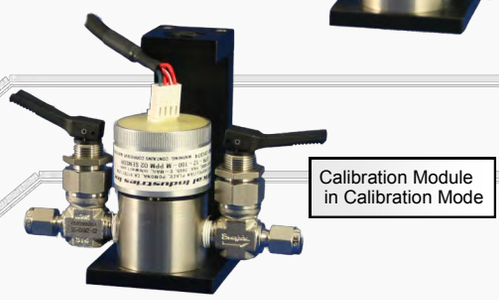
None

* Subject to change without notice

GPR-1500 GB Glove Box PPM Oxygen Transmitter

Advanced Galvanic Sensor Technology





ISO 9001:2008 Certified
INTERTEK Certificate No. 485

GPR-1535 GB
PPM Oxygen Transmitter

Owner's Manual

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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-1535 GB PPM Oxygen Transmitter	S/N _____	
Sensor	( ) GPR-12-100-M ppm Oxygen Sensor ( ) XLT-12-100-M ppm Oxygen Sensor	S/N_____	
Accessories	Owner's Manual		
Configuration	( ) A-1161-L1 PCB Assembly, Main / Display A-1182 PCB Assembly, Interconnection ( ) BARR-1001 Barrier, Intrinsic Safety (ATEX Intrinsic Safety Certified)	Software Ver. _____	
	Range(s): 0-10 PPM, 0-100 PPM, 0-1000 PPM, 0-1%, 0-25% (air calibration only)		
	Power: 12-24V DC two wire loop power		
	Barometric pressure compensation		
	B-3170 Glove Box Housing Assembly		
Test - Electronics	Default zero (without sensor)		
	Default span @ 600uA or 300uA		
	Analog signal output 4-20mA full scale		
Test - Gas Phase	Calibrates with adequate span adjustment within 10-50% FS		
	Baseline drift on zero gas < ± 2% FS over 24 hour period		
	Noise level < ± 1.0% FS		
	Span adjustment within 10-50% FS		
Final	Overall inspection for physical defects		
Options			
Notes			

When operated in conjunction with the manufacturer's recommended optional intrinsic safety barriers the GPR-1535 GB meets the intrinsic safety standards required for use in Class 1, Division 1, Groups C, D hazardous areas.

The GPR-1535 GB is also available in a version, requiring optional intrinsic safety barriers, that has been certified to ATEX Directive 94/9/EC, Ex II 1 G Ex ia IIB T4 Tamb -20ºC to + 50ºC

3 Safety

General

This section summarizes the essential precautions applicable to the GPR-1500AIS 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-1535 GB PPM Oxygen Transmitter is designed for measuring the controlled atmosphere inside a glove box. Calibration requires a flowing sample using the Glove Box Housing Assembly (refer to photo section 4 Specification) which is equipped with 1/8" tube fitting connections and are intended to operate at positive pressure regulated to between 5-30 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 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 a terminal connection. Power consumption is 30 watts, 40 watts with the optional DC powered heater.

Operating Temperature: The maximum operating temperature is 45º C on an intermittent basis unless the user is willing to accept a dramatic reduction in expected sensor life – refer to analyzer specification where expected sensor life is specified at less than 1000 ppm oxygen at 25°C and 1 atmosphere of pressure.

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.

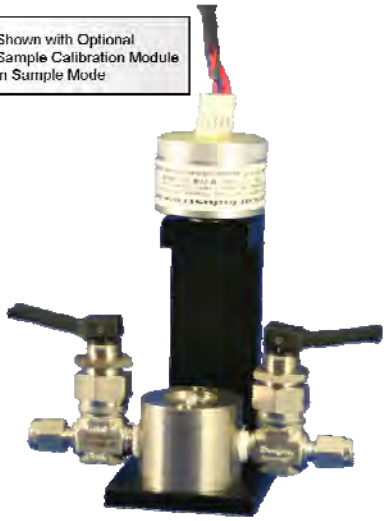
4 Features & Specifications

Specifications and pricing are subject to change without notice. See last page for current specifications.

GPR-1535 GB PPM Oxygen Glove Box Transmitter

Technical Specifications	
Accuracy:	< 1% of FS range under constant conditions
Analysis:	0-10 PPM, 0-100 PPM, 0-1000 PPM, 0-1%, 0-25% FS ranges; auto-ranging or manually lock on single range
Application:	Oxygen analysis in inert, hydrocarbon, helium, hydrogen, mixed and acid (CO_2) atmospheres in glove boxes
Area Classification:	General purpose (ATEX Certified version available)
Calibration:	Air or certified span gas of O_2 balance N_2 approximating 80% of analysis range or next higher range
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:	Painted aluminum, 3"x4"x2", 2 lbs.
Flow Sensitivity:	None; Flowing system 1-2 SCFH recommended
Linearity:	±1% of full scale
Pressure:	Atmospheric; Flowing system: Inlet - regulate to 5-30 psig, vent - atmospheric or return controlled atmosphere
Power:	12-24 VDC (2 wire loop power)
Recovery Time:	60 seconds in air to < 10 PPM in < 1 hour 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 general use XLT-12-100-M for gases containing > 0.5% CO2
Sensor Life:	24 months at 25ºC and 1 atm.
Signal Output:	4-20mA
Operating Range:	Recommended -10 ºC to 45ºC (GPR sensor), -20º to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

Optional Equipment
Sample Calibration Module (shown above right)
ATEX Certified version for hazardous areas (requires certified safety barrier)



Shown with Optional Sample Calibration Module in Sample Mode

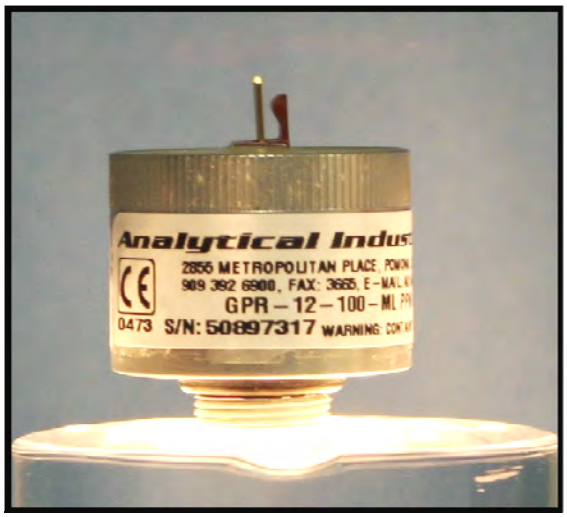
Shown with Optional Sample Calibration Module in Calibration Mode

5 Operation

Principle of Operation

The GPR-1535 GB incorporates a variety of ppm range advanced galvanic fuel cell type sensors. The transmitter is configured in a general purpose NEMA 4 rated enclosure and meets the intrinsic safety standards required for use in Class 1, Division 1, Groups C, D hazardous areas when operated in conjunction with the manufacturer's recommended intrinsic safety barriers.

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



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

Electronics:
The signal generated by the sensor is processed by state of the art low power micro-processor based digital circuitry. The first stage amplifies the signal. The second stage eliminates the low frequency noise. The third stage employs a high frequency filter and compensates for signal output variations caused by ambient temperature changes. The result is a very stable signal. Sample oxygen is analyzed very accurately. Response time of 90% of full scale is less than 10 seconds (actual experience may vary due to the integrity of sample line connections, dead volume and flow rate selected) on all ranges under ambient monitoring conditions. Sensitivity is typically 0.5% of full scale low range. Oxygen readings may be recorded by an external device via the 0-1V signal output jack.

A 4-20mA signal output is provided from a two-wire 12-28VDC loop power source such as a PLC and is represented on full scale oxygen readings to an external device. When operated in conjunction with the manufacturer's recommended optional intrinsic safety barriers the GPR-1535 GB meets the intrinsic safety standards required for use in Class 1, Division 1, Groups C, D hazardous areas.

The GPR-1535 GB is also available in a version, requiring optional intrinsic safety barriers, that has been certified to ATEX Directive 94/9/EC, Ex II 1 G Ex ia IIB T4 Tamb -20ºC to + 50ºC

Sample System:
The GPR-1535 GB is supplied with a unique Glove Box Housing Assembly that also includes a mounting bracket for sampling (see photo section 4 Specifications) and flow housing with valves for calibration.

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 info@aii1.com

Installation Considerations

Gas Sample Stream: Ensure the gas stream or composition of the controlled atmosphere of the application is consistent with the specifications and review the application conditions before initiating the installation. Consult the factory if necessary to ensure the sample is suitable for analysis.

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

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

Temperature: The sample or atmosphere must be controlled within the operating temperature parameters in section 4 Specifications. Note: Operating the sensor above the nominal specification of 25ºC or 77º F has an exponential affect on sensor life, 2.5% per ºC.

Pressure & Flow
All electrochemical oxygen sensors respond to partial pressure changes in oxygen. The sensors are equally capable of analyzing the oxygen content of a flowing sample gas stream or monitoring the oxygen concentration in a controlled atmosphere.

Sample systems and/or flowing gas samples are generally required for applications involving oxygen measurements or calibration below ambient air to maintain the integrity of the sample. In these situations, the use of stainless steel tubing and fittings is critical to maintaining the integrity of the gas stream to be sampled and the inlet pressure must always be higher than the pressure at the outlet vent which is normally at atmospheric pressure.

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.

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.

Recommendations to avoid erroneous oxygen readings and damaging the sensor:

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

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

Gas Connections: Inlet and outlet vent gas lines for ppm analysis require 1/8" stainless steel compression fittings; hard plastic tubing with a low permeability factor can be used percentage range measurements.

Power Connection: Locate the appropriate power source to meet the analyzer or transmitter requirements, ensure that

Mounting the Transmitter:
The GPR-1535 GB enclosure and Glove Box Housing Assembly are designed for any flat surface.

Gas Connections:
The GPR-1535 GB is designed for measuring a controlled atmosphere and requires only that the sensor be screwed into the upper section of the Glove Box Housing Assembly.

Calibration: The user is responsible for calibration gases and regulating the pressure to 5-30 psig, controlling the flow rate to 1-2 SCFH or .5-1 liter per minute and the plumbing to and from the Glove Box Housing Assembly.

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).

Power Connection:
To assure proper grounding, connect the 4-20mA signal output to the external device (PLC, DCS, etc.) before attempting any zero or span adjustments. Power requirements consist of a two wire shielded cable and a 12-28V DC with negative ground power supply.

Connections – Optional Intrinsic Safety Barrier:
See attached addendum

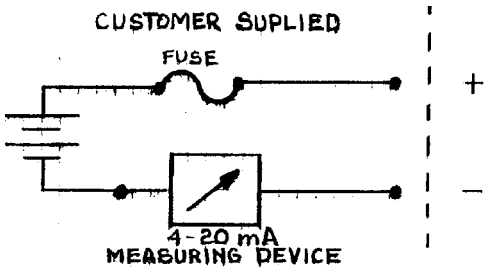
Hazardous Area Operation:
When used in conjunction with the optional intrinsic safety barriers, the design of the GPR-1535 GB meets recognized standards as intrinsically safe for operation in Class I, II, III; Division I, II; Groups C-G hazardous areas. **Note:** Locate the optional intrinsic safety barrier as close to the power source in the non-hazardous area as possible.

The GPR-1535 GB is also available in a version, requiring optional intrinsic safety barriers, that has been certified to ATEX Directive 94/9/EC, Ex II 1 G Ex ia IIB T4 Tamb -20ºC to + 50ºC

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

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

Power 12-28V DC To Transmitters



Terminal Strip

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-1535 GB ppm Oxygen Transmitters are tested and calibrated by the manufacturer prior to shipment and accompanied by the qualified PPM oxygen sensor package in a separate 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.

Procedure:
1. **Caution:** Do not change the factory settings until instructed to do in this manual.
2. Open the barrier bag containing the new sensor.
3. If the sensor is equipped with a shorting loop, remove the shorting wire from the pins of the female socket attached to the new sensor.
4. Align the holes and tabs of the female connector with the 4 pins and vertical support of the male connector.
5. Push the female connector with the wire cable to the cable onto the male section until they snap together.
6. Initial installation, air calibration is recommended, however, span gas calibration is at the user's discretion.
7. Once the reading stabilizes, calibrate the transmitter as described in section 5 Operation Span Calibration.
8. Once calibrated, temporarily separate the connectors and disconnect the sensor.
9. Immediately screw the sensor, finger tight plus 1/2 turn, into the flow housing and reconnect the sensor.
10. The analyzer will OVER RANGE for a short period of time as indicated by the graphical LCD display.
11. Following calibration immediately introduce or expose low PPM gas, either sample or zero gas, to the sensor.

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 you designate for SAMPLE IN.

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.

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
LOOP POWER – 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.

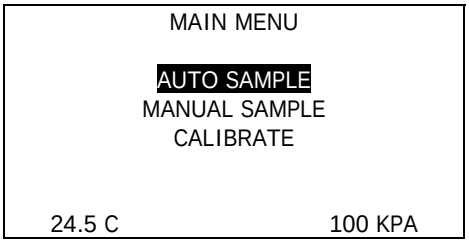
3.3 PPM

AUTO SAMPLING
10 PPM RANGE

24.5 C 100 KPA

Menu Navigation:
The four (4) pushbuttons located on the front of the transmitter operate the micro-processor:
- green ENTER (select)
- yellow UP ARROW
- yellow DOWN ARROW
- blue MENU (escape)

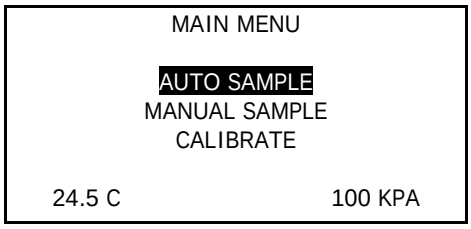
Main Menu:
Access the MAIN MENU by pressing the MENU key:

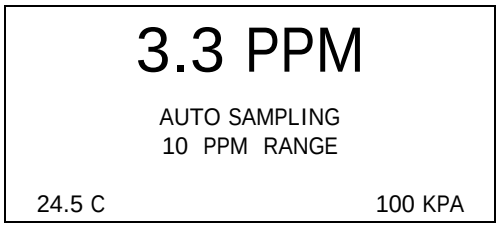


Range Selection:
The GPR-1500/1500D transmitter is equipped with five (5) standard measuring ranges (see specification) and provides users with a choice of sampling modes. By accessing the MAIN MENU, users may select either the AUTO SAMPLING (ranging) or MANUAL SAMPLING (to lock on a single range) mode.

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 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.

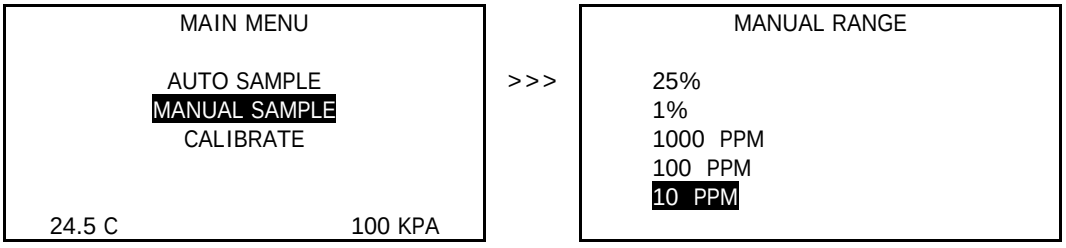
Procedure - Auto Sampling:
1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight AUTO SAMPLE.
3. Press the ENTER key to select the highlighted menu option.
4. The display returns to the sampling mode:



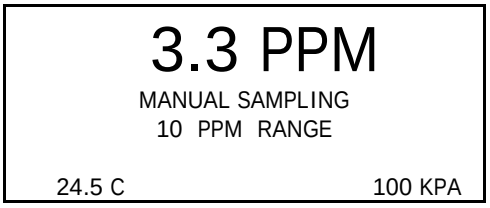


5. The display will shift to the next higher range when the oxygen reading (actually the sensor's signal output) exceeds 99.9% of the upper limit of the current range. The display will shift to the next lower range when the oxygen reading drops to 85% of the upper limit of the next lower range.
6. For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

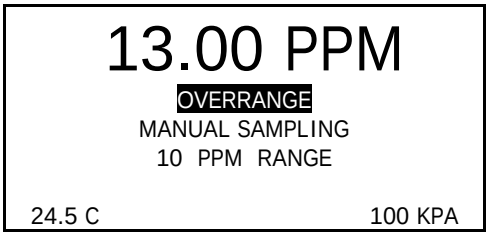
Procedure - Manual Sampling:
Access the MAIN MENU by pressing the MENU key.
Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.
Press the ENTER key to select the highlighted menu option.
The following displays appear:



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



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

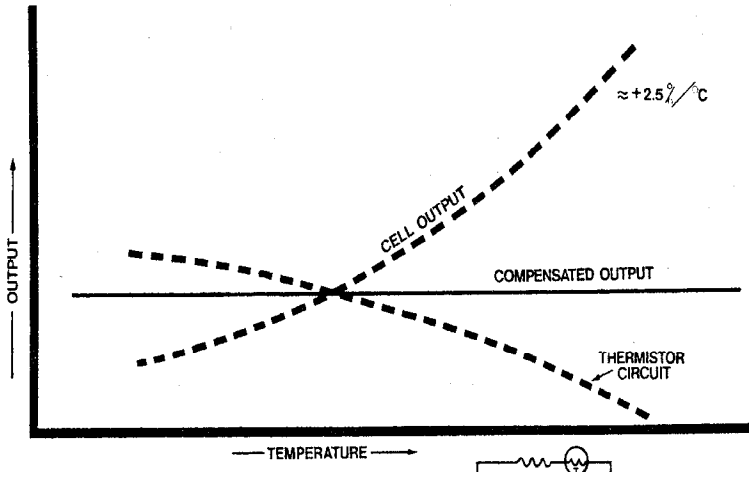


Once the OVER RANGE warning appears the user must advance the transmitter to the next higher range via the menu and keypad Press MENU, select MANUAL SAMPLING, press ENTER, select the appropriate MANUAL RANGE and press ENTER again.

Note: To enhance viewing the LCD display, all analyzers and transmitters are equipped with a backlit LCD display. Due to the limited power availability of the GPR-1500/1500D series of two wire loop powered transmitters, the backlit LCD feature does not operate when the signal output is less than 10mA.

Start-Up is complete . . . proceed to Calibration

Calibration



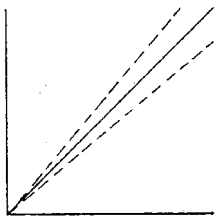
Single Point Calibration: As previously described the galvanic oxygen sensor generates an electrical current proportional to the oxygen concentration in the sample gas. In the absence of oxygen the sensor exhibits an absolute zero, e.g. the sensor does not generate a current output in the absence of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

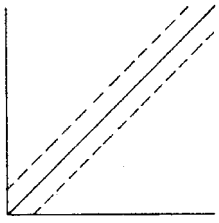
Pressure: Because sensors are sensitive to the partial pressure of oxygen in the sample gas their output is a function of the number of molecules of oxygen 'per unit volume'. Readouts in percent are permissible only when the total pressure of the sample gas being analyzed remains constant. The pressure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

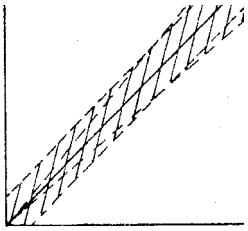
Temperature: The rate oxygen molecules diffuse into the sensor is controlled by a Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier' and all diffusion processes are temperature sensitive, the fact the sensor's electrical output will vary with temperature is normal. This variation 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 analyzer 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 < 1% of full scale at constant temperature or < 5% over the operating temperature range. QC testing is typically < 0.5% prior to shipment.


A. PERCENT OF READING ERRORS


B. PERCENT OF FULL SCALE ERRORS


C. OVERALL ACCURACY

Example 1: 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.

Zero Calibration: In theory, the electrochemical galvanic fuel cell type oxygen has an absolute zero meaning it produces no signal output when exposed to an oxygen free sample gas. In reality, expect the analyzer to 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; and, tolerances of the electronic components. The Zero Offset capability of the analyzer is limited to 50% of lowest most sensitive range available with the analyzer.

Recommendation: Zero calibration, see Determining True Zero Offset below, is recommended only for online analyzers performing continuous analysis below 5% of the lowest most sensitive range available with a ppm analyzer, e.g. analysis below 0.5 ppm on the 10 ppm range, or below 0.1% (1000 ppm) with a percent analyzer.

Determining True Zero Offset: Allow the transmitter approximately 24 hours to stabilize with flowing zero gas as evidenced by a stable reading or horizontal trend on an external recording device.

Once the zero offset adjustment is made, zero calibration is not required again until the sample system connections are modified, or, when installing a new oxygen sensor. As a result, zero calibration is not practical and therefore not recommended for higher ranges or portable analyzers.

Span Calibration: Involves adjusting the transmitter electronics to the sensor's signal output at a given oxygen standard. Regardless of the oxygen concentration of the oxygen standard used, a typical span calibration takes approximately 10 minutes.

The amount time required to get the analyzer back on line for normal use is influenced by a.) the level of oxygen analysis anticipated during normal operation (also determines the initial analyzer selection), and, b.) whether the sensor is new or has been in service at ppm levels.

General guidelines for analyzers to come online following span calibration and exposure to a zero/purge/sample gas with an oxygen content below the stated thresholds:

- measurements above 1000 ppm or 0.1% require less than 3 minutes
- measurements above 100 ppm (parts-per-million analyzer) require less than 10 minutes
- measurements below 10 ppm (part-per-million analyzer) require 20 minutes if the sensor has been in service at ppm levels
- measurements below 10 ppm require 60 minutes if the sensor is new or has been air calibrated assuming the zero/purge/sample gas has an oxygen concentration below 1 ppm

Recommendation: For 'optimum calibration accuracy' calibrate with a span gas approximating 80% of the full scale range one or two ranges higher than the full scale range of interest (normal use) to achieve the effect illustrated on Graph A and Example 1. Always calibrate at the same temperature and pressure of the sample gas stream.

Note: Calibrating with a span gas approximating 10% of the full scale range near the expected oxygen concentration of the sample gas is acceptable but less accurate than 'optimum calibration accuracy' method recommended – the method usually depends on the gas available. Calibrating at the same 10% of the full scale range for measurements at the higher end of the range results in magnification of errors as discussed in Graph A and Example 1 and is not recommended. Of course the user can always elect at his discretion to accept an accuracy error of ±2-3% of full scale range if no other span gas is available.

Air Calibration: Because the sensor takes longer to recover from exposure to air than span gas, see General Guidelines above, air calibration is recommended only 1) when a certified span gas is not available, 2) when installing and replacing a ppm oxygen sensor or 3) to verify the oxygen content of a certified span gas.

Based on the inherent linearity of the electrochemical galvanic fuel cell type oxygen sensor enables the user to calibrate the analyzer with ambient air (20.9% oxygen) and operate the analyzer within the stated accuracy spec on the lowest most sensitive range available with the analyzer – there is no need to recalibrate the analyzer with span gas containing a lower oxygen concentration.

Calibrating either a ppm analyzer with ambient air on the CAL or 0-25% range meets the 80% criteria discussed in the Recommendation above.

Calibration Procedures:

Certified Gas Cylinder for Zero or Span Calibration:
Calibration: The user is responsible for calibration gases and regulating the pressure to 5-30 psig, controlling the flow rate to 1-2 SCFH or .5-1 liter per minute and the plumbing to and from the Glove Box Housing Assembly.

1. Install the sensor in the Calibration Mode of the Glove Box Housing Assembly (right).
2. Use metal tubing to transport the span gas to the sensor.
3. The main consideration is to eliminate air leaks and 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 gas line.
5. Regulate pressure and control flow as described above.
6. Assure the sample is adequately vented for optimum response and recovery – and safety.

Air Calibration:
1. Install the sensor in the Sample Mode of the Glove Box Housing Assembly (right).
2. Expose or introduce a know source of ambient or instrument air (20.9%).

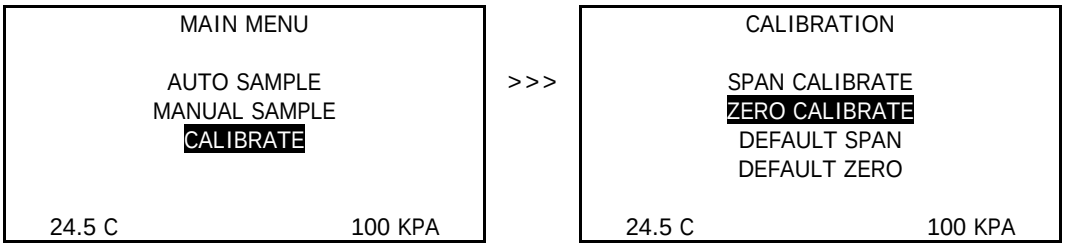
Calibration Routine:
Zero calibration should precede the span calibration and once performed should not have to be repeated with subsequent span calibrations. Normally, zero calibrations are performed when a new sensor is installed or changes are made in the sample system connections.

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).

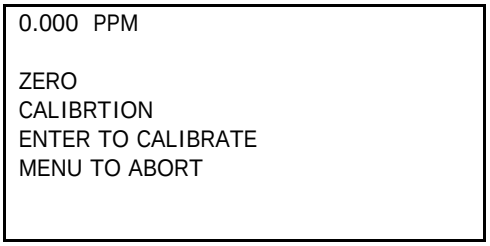
Thus, for the reasons above, it is not practical to zero a transmitter. Finding the true zero offset is not always necessary particularly in the case of applications requiring higher level oxygen measurements because of the low offset value, normally < 0.1 ppm, is not material to the accuracy of higher 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 CALIBRATE.
3. Press the ENTER key to select the highlighted menu option.
4. Repeat to select ZERO CALIBRATE.
5. The following displays appear:

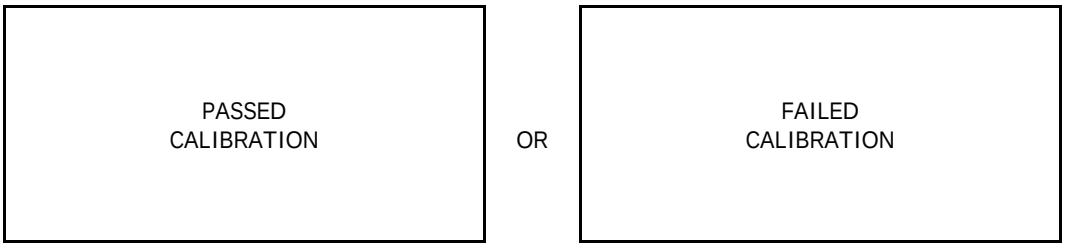


Press the ENTER key to calibrate or MENU key to abort and return to SAMPLING mode.



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.

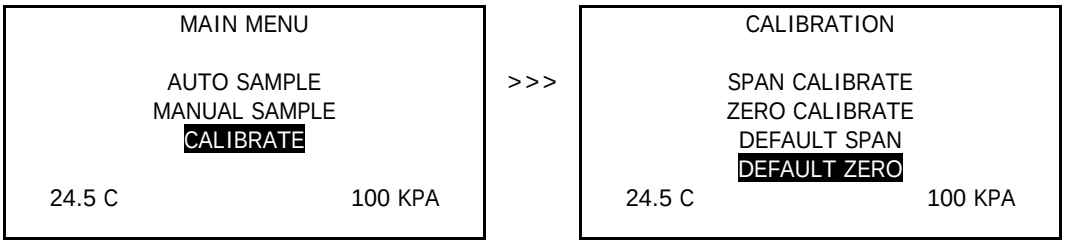
Both the Zero Calibrate and Span Calibrate functions result in the following displays:



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 5 minutes after being placed on zero gas.

The maximum zero calibration adjustment permitted is 60% of the lowest full scale range available, which normally is 1 ppm. Thus the maximum zero calibration adjustment or zero offset is 6 ppm oxygen. Accordingly, the 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.

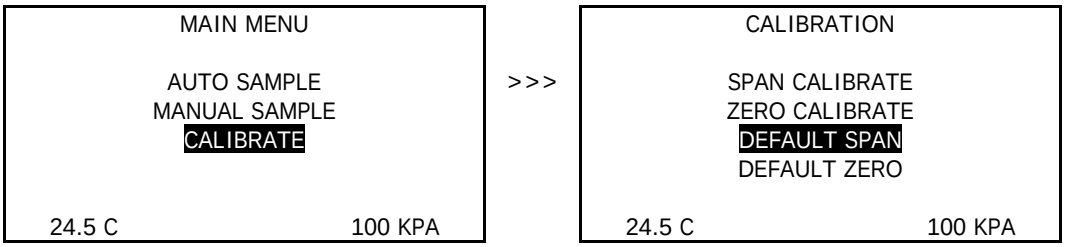
Factory Default Zero:
The software will eliminate any previous zero calibration adjustment and display the actual the signal output of the sensor at a specified oxygen concentration. For example, assuming a zero gas is introduced, the display will reflect an oxygen reading representing basically the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



Span Calibration
Maximum drift from calibration temperature is approximately 0.11% of reading per °C. The 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.

Factory Default Span
The software will set the SPAN adjustment based on the average oxygen reading (actually the sensor's signal output) at a specified oxygen concentration. For example, when a span gas is introduced, the micro-processor will display an oxygen reading within +50% of the span gas value. This feature allows the user to test the sensor's signal output without removing it from the sensor housing.
Access the MAIN MENU by pressing the MENU key.
Advance the reverse shade cursor using the ARROW keys to highlight MANUAL SAMPLE.
Press the ENTER key to select the highlighted menu option.
The following displays appear:



Manual Span

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

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

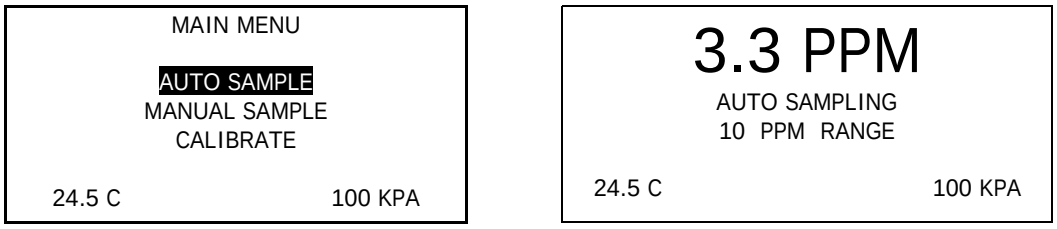
- Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range above the intended measuring range.
- Regulator to reduce pressure to between 5 and 30 psig.
- Flow meter to set the flow between 1-5 SCFH,
- 2 lengths of 1/8" dia. metal tubing measuring 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 to the flow meter vent
- 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-1500/1500D.

Procedure:

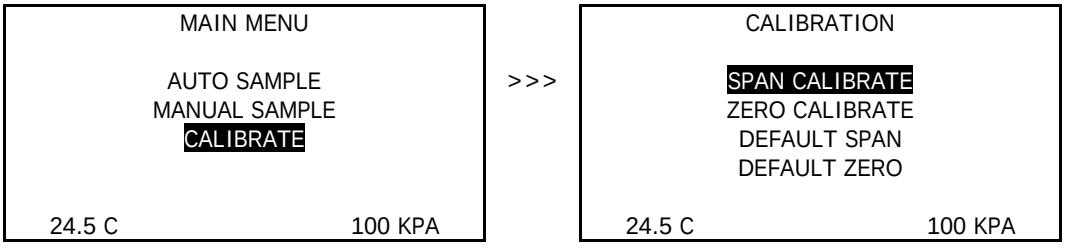
This procedure assumes a span gas under positive pressure and is recommended for an transmitter without an optional sampling pump, which if installed downstream of the sensor should be placed in the OFF position and disconnected so the vent is not restricted during calibration. To assure an accurate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

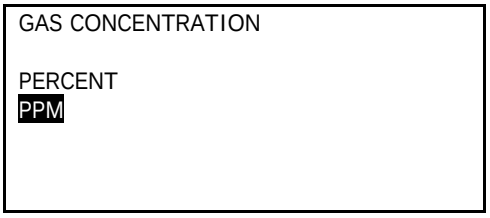
1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight AUTO SAMPLE.
3. Press the ENTER key to select the highlighted menu option.
4. The following displays appear:



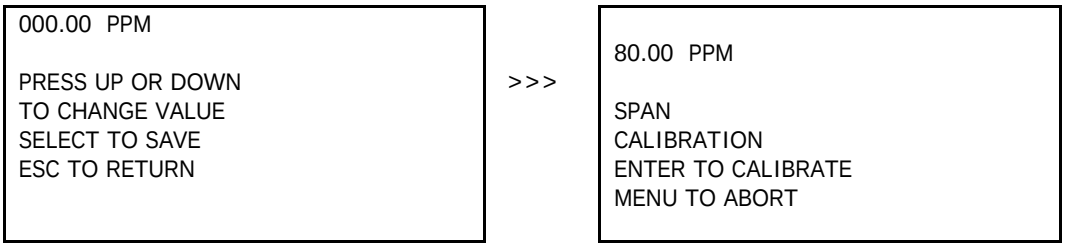
5. Return to the MAIN MENU by pressing the MENU key.
6. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATE.
7. Press the ENTER key to select the highlighted menu option.
8. Repeat to select SPAN CALIBRATE
9. The following displays appear:



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.

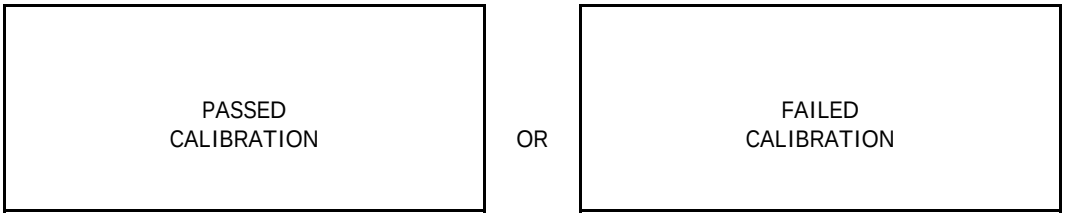


19. The following displays appear:

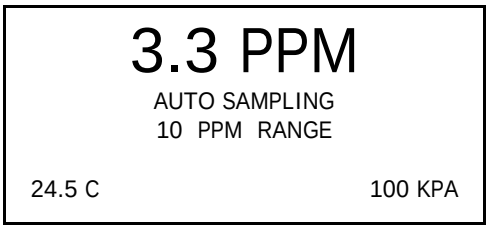


20. Press the UP/ DOWN ARROWS to enter the first digit of the span value.
21. **Press the ENTER key to advance the underline cursor right to the second digit of the span value. Press the MENU key to advance the underline cursor left to the previous digit.**
22. **Press the UP/ DOWN ARROWS to enter the second digit of the span value.**
23. **Repeat steps 21 and 22 until the complete span value has been entered.**
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:



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



25. 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.
26. 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.
27. Disconnect the span gas line and replace it with the purged sample gas line.
28. Wait 10-15 minutes to ensure the reading is stable and proceed to sampling.

Sampling

The GPR-1535 GB is supplied with a unique Glove Box Housing Assembly that also includes a mounting bracket for sampling and is designed for measuring a controlled atmosphere and requires only that the sensor be screwed into the upper section of the Glove Box Housing Assembly.

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 info@aii1.com

Ensure the gas stream or composition of the controlled atmosphere of the application is consistent with the specifications and review the application conditions before initiating the installation. Consult the factory if necessary to ensure the sample is suitable for analysis.

Procedure:

1. Following calibration the transmitter display returns to the SAMPLE mode after 30 seconds.
2. Place the sensor in the Sampling Mode of the Glove Box Housing Assembly (right).
3. Select the desired sampling mode - auto or if manual, the range that provides maximum resolution – as described above.
4. Allow the oxygen reading to stabilize for approximately 10 minutes at each sample point.

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 normal operating conditions and expected life of the standard sensor are defined in section 4 Specifications.

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

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

7 Spare Parts

Recommended spare parts for the GPR-1535 GB Series 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
FITN-1018	Connector SS 1/8" MNPT to 1/8" Tube
B-3170	Glove Box Housing Assembly
A-3051	Housing Flow Adaptor
A-1161-B-IS-1 Rev C3	PCB Assembly Main
A-1182-1 Rev B	PCB Assembly Interconnection
VALV-1026	Valve, Toggle 1/8" NPT 1/8" Tube

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
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)

Symptom	Possible Cause	Recommended Action
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 Consult factory
	Presence of interference gases	Replace sensor and install scrubber
	Presence of sulfur gases	Replace sensor, obtain authorized service
	Unauthorized maintenance	Replace sensor
	Sensor nearing end of life	
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 which places a vacuum on the sensor in excess 4" of water column, something which 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

The design and manufacture of the GPR-1535 GB PPM Oxygen Transmitter is performed under a certified Quality Assurance System that conforms to ISO 9001:2008 and incorporates state of the art materials and components for superior performance and minimal cost of ownership. Prior to shipment every analyzer is thoroughly tested by the manufacturer and documented in the form of a Quality Control Certification that is included in the Owner's Manual accompanying every analyzer. When operated and maintained in accordance with the recommendations in the Owner's Manual, the units will provide many years of reliable service.

Coverage
Under normal operating conditions, the monitor, analyzers and sensor are warranted to be free of defects in materials and workmanship for the period specified in accordance with the most recent published specifications, said period begins with the date of shipment by the manufacturer. The manufacturer information and serial number of this analyzer are located on the rear of the analyzer. Analytical Industries Inc. reserves the right in its sole discretion to invalidate this warranty if the serial number does not appear on the analyzer.

If your transmitter or any component is determined to be defective with respect to material and/or workmanship, we will repair it or, at our option, replace it at no charge to you. If we choose to repair your purchase, we may use new or reconditioned replacement parts. If we choose to replace your Analytical Industries Inc. analyzer, we may replace it with a new or reconditioned one of the same or upgraded design. This warranty applies to all monitors, analyzers and sensors purchased worldwide. It is the only one we will give and it sets forth all our responsibilities. There are no other express warranties. This warranty is limited to the first customer who submits a claim for a given serial number and/or the above warranty period. Under no circumstances will the warranty extend to more than one customer or beyond the warranty period.

Limitations
Analytical Industries Inc. will not pay for: loss of time; inconvenience; loss of use of your Analytical Industries Inc. analyzer or property damage caused by your Analytical Industries Inc. analyzer 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 analyzer; affixing of any attachment not provided with the analyzer 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.

Exclusions
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 analyzer; affixing of any label or attachment not provided with the analyzer; fire, flood, or acts of God; or other failure to follow the Owner's Manual.

Service
Call 909-392-6900 (or e-mail sales-medical@aii1.com) between 8:00am and 5:30pm Pacific Time Monday thru Thursday or before 12:00 pm on Friday. Trained technicians will assist you in diagnosing the problem and arrange to supply you with the required parts. You may obtain warranty service by returning you analyzer, postage prepaid to:

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

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

10 MSDS – Material Safety Data Sheet

Product Identification

Product Name	Oxygen Sensor Series - PSR, GPR, AII, XLT
Synonyms	Electrochemical Sensor, Galvanic Fuel Cell
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 or Acetic Acid, Lead
CAS Number	Potassium Hydroxide = KOH 1310-58-3 or Acetic Acid = 64-19-7, Lead = Pb 7439-92-1
Chemical (Synonym) and Family	Potassium Hydroxide (KOH) – Base or Acetic Acid (CH_3CO_2H) – Acid, Lead (Pb) – Metal

General Requirements

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

Physical Properties

Boiling Point Range	KOH = 100 to 115° C or Acetic Acid = 100 to 117° C
Melting Point Range	KOH -10 to 0° C or Acetic Acid – NA, Lead 327° C
Freezing Point	KOH = -40 to -10° C or Acetic Acid = -40 to -10° C
Molecular Weight	KOH = 56 or Acetic Acid – NA, Lead = 207
Specific Gravity	KOH = 1.09 @ 20° C, Acetic Acid = 1.05 @ 20° C
Vapor Pressure	KOH = NA or Acetic Acid = 11.4 @ 20° C
Vapor Density	KOH – NA or Acetic Acid = 2.07
pH	KOH > 14 or Acetic Acid = 2-3
Solubility in H_2O	Complete
% Volatiles by Volume	None
Evaporation Rate	Similar to water
Appearance and Odor	KOH = Colorless, odorless aqueous solution or Acetic Acid = Colorless, vinegar-like odor aqueous solution

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	KOH = Avoid contact with strong acids or Acetic Acid = Avoid contact with strong bases
Hazardous Decomposition Products	KOH = None or Acetic Acid = Emits toxic fumes when heated
Conditions to Avoid	KOH = None or Acetic Acid = Heat

Spill or Leak

Steps if material is released	Sensor is packaged in a sealed plastic bag, check the sensor inside for electrolyte leakage. If the sensor leaks inside the plastic bag or inside an analyzer 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 (fresh each time).
Waste Disposal Method	In accordance with federal, state and local regulations applicable to the disposal of household batteries.

Health Hazard Information

Primary Route(s) of Entry	Ingestion, eye and skin contact
Exposure Limits	Potassium Hydroxide - ACGIH TLV 2 mg/cubic meter or Acetic Acid - ACGIH TLV / OSHA PEL 10 ppm (TWA), Lead - OSHA PEL .05 mg/cubic meter
Ingestion	Electrolyte could be harmful or fatal if swallowed. KOH = Oral LD50 (RAT) = 2433 mg/kg or Acetic Acid = 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 - soapy slick feeling.
Medical Conditions Aggravated	None
Carcinogenic Reference Data	KOH and Acetic Acid = 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.

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