Advanced Instruments Inc.

ATEX Certified for Hazardous Areas

GPR-1000 ATEX

Portable PPM O_2 Analyzer

Rechargeable Battery Powered

Technical Specifications *

Accuracy:	< 2% of FS range under constant conditions
Analysis Ranges:	0-1000 PPM, 0-1%, 0-25% (CAL) FS Auto-ranging or manual lock on a single range
Application:	Oxygen analysis in inert, helium, hydrogen, mixed and acid (CO_2) gas streams
Approvals:	Certified for use hazardous areas - see lower right
Area Classification:	Class I, Division 1, Groups C, D
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:	Temperature
Connections:	1/8" quick disconnect
Controls:	Water resistant keypad; menu driven range selection, calibration and system functions
Display:	Graphical LCD 2.75 x 1.375"; resolution 1 PPM
Enclosure:	Painted aluminum NEMA 4X, 4 x 9 x 3", 8 lbs.
Flow:	Not flow sensitive; recommended flow rate 2 SCFH
LED Indicators:	LOW BATT (72 hr. warning); CHARGE mode
Linearity:	> .995 over all ranges
Pressure:	Inlet - regulate to 5-30 psig to deliver 2 SCFH flow; vent - atmospheric
Power:	Rechargeable battery, 60 day cycle, 8 hrs with pump
Recovery Time:	60 sec in air to < 100 PPM in < 15 min on N_2 purge
Response Time:	90% of final FS reading in 10 seconds
Sample System:	None; Brass quick disconnect fittings
Sensitivity:	< 0.5% of FS range
Sensor Model:	GPR-12-100-M for non-acid (CO2) gas streams XLT-12-100-M for gas mixture with > 0.5% CO_2
Sensor Life:	24 months in < 1000 PPM O2 at 25°C and 1 atm
Signal Output:	0-1V FS
Temp. Range:	5°C to 45°C (GPR sensor), -10° to 45°C (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Brass connections; stainless steel optional

Optional Equipment

Carrying case with custom foam insert

Sample conditioning - pump, filter, scrubbers - contact factory

* Subject to change without notice.

Advanced Sensor Technology

- Fast Recovery to < 20 PPM from Exposure to Air
- Sensor Life, Warranty and Performance is Unmatched
- Excellent Compatibility in 0-100% CO_2
- Extended Operating Temperature –10ºC

Sensitivity 0.5% Full Scale

ATEX Certified - Directive 94/9/EC

Examination Cert: INERIS 10ATEX0020

II 2 G
Ex ib IIB T4
T_{amb} -20ºC to +45ºC

CE 0080

ISO 9001:2008 Certified

INTERTEK Certificate No. 485

GPR-1000

Portable PPM Oxygen Analyzer

Owner's Manual

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Table of Contents

1. Introduction

Your new oxygen analyzer incorporates an advanced electrochemical sensor specific to oxygen along with state-of-the-art digital electronics designed to give you years of reliable precise oxygen measurements in a variety of industrial oxygen applications. More importantly, it has been constructed as intrinsically safe in accordance with ATEX Directives 94/9/CE for use in hazardous areas in zone 1 Group C and D when used in conjunction with the recommended operating instructions in this manual. The analyzer meets the following area classification.

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

GPR-1200MS/1200/1200P/1100/1000/2000/2000P
CE 0080
Serial No.:
Year of Manufacture:
INERIS 08ATEX0036

Ex II 2 G
Ex ib IIB T4
T_{amb} -20ºC to +50ºC

WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD – SEE INSTRUCTIONS

The design also meets NEC intrinsic safety standards for use in Class 1, Division 1, Group C, D hazardous areas. Please refer to Appendix A for information on making electrical connections that maintain the desired level of protection.

To obtain maximum performance from your new oxygen analyzer, 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 analyzer for superior performance and minimal cost of ownership. This analyzer was tested thoroughly by the manufacturer prior to shipment for best performance. However, all electronic devices do require service from time to time. The warranty included herein plus a staff of trained professional technicians to quickly service your analyzer is your assurance that we stand behind every analyzer sold.

The serial number of this analyzer may be found on the inside as well as on the outside wall of the analyzer enclosure. 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

	Customer:	Order No.:	Pass
Model	GPR-1000 ATEX Portable PPM Oxygen Analyzer	S/N ______________________	
Sensor	( ) GPR-12-100 PPM Oxygen Sensor ( ) XLT-12-100 PPM Oxygen Sensor	S/N ______________________	
Accessories	Owner's Manual		
	( ) PWRS-1002 9VDC Battery Charger/Adapter 110VAC ( ) PWRS-1003 9VDC Battery Charger/Adapter 220VAC ( ) PWRS-1008 9VDC Battery Charger/Adapter 12VDC Auto Cigarette Lighter		
	CONN-1034 Plug Mini Phone .141 dia. Black Handle		
	FITN-1153 (3x) Plug Male Quick Disconnect Fittings		
Configuration	A-1161-B Rev C3 PCB Software Version B-3562 Battery Assembly Range: 0-1000 PPM, 0-1%, 0-5%, 0-25%		
	Wetted parts: stainless steel/Brass		
Electronics Test	LED indicators: Low battery, charge		
	Electronic offset		
	Analog signal output 0-1V		
Gas Phase Test	Recovery from air to < 100 PPM in < 5 minutes		
	Baseline drift on zero gas < ± 2% FS over 24 hour period on 0-1000 PPM range		
	Noise level < ± 0.5% FS		
	Span adjustment within 10-50% FS		
Final	Overall inspection for physical defects		
Options	B-3653 Pump Assembly		
Notes			

3. General Safety & Installation

Safety

This section summarizes the basic precautions applicable to all analyzers. Additional precautions specific to individual analyzer are contained in the following sections of this manual. To operate the analyzer 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 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.

Electrostatic Discharge Hazard: This symbol is used to caution the user to take all necessary steps to avoid generating electrostatic discharge.

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

Heed Warnings Follow Instructions: Follow all warnings on the analyzer, accessories (if any) and in this Owner's Manual. Observe all precautions and operating instructions. Failure to do so may result in personal injury or damage to the analyzer.
Heat: Situate and store the analyzer away from sources of heat.

Liquid and Object Entry: The analyzer 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 analyzer.

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

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.
Non-use Periods: Turn the power OFF when the analyzer is left unused for a long period of time.

Installation

This analyzer has been constructed in compliance with the following EN directives

EN 60079-0 : 2006
EN 60079-1 : 2007

The analyzers must be used in accordance with the guidelines delineated in this instruction manual.

Gas Sample Stream: Ensure the gas stream composition of the application is consistent with the specifications and if in doubt, review the application and consult the factory before initiating the installation.

Note: In natural gas applications such as extraction and transmission, a low voltage current is applied to the pipeline itself to inhibit corrosion of the pipeline. As a result, electronic devices connected to the pipeline can be affected unless they are adequately grounded.

Contaminant Gases: A gas scrubber and flow indicator with integral metering valve are required upstream of the analyzer to remove any interfering gases such as oxides of sulfur and/or hydrogen sulfide that can interfere with measurement and cause reduction in the expected life of the sensor. Consult factory for recommendations concerning the proper selection and installation of components.

Expected Sensor Life: With reference to the published specification, the expected life of all oxygen sensors is predicated on the basis of average oxygen concentration (<10,000 PPM for a PPM sensor or air for a % sensor), sample temperature of 77°F/25°C and sample pressure of 1 atmosphere in “normal” applications. Deviations from standard conditions will affect the life of the sensor. As a rule of thumb sensor life is inversely proportional to changes in oxygen concentration, sample pressure and temperature.

Accuracy & Calibration: Refer to section 5 Operation.

Materials: Assemble the necessary zero, sample 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 very low % or PPM O_2 level analysis.

Operating Temperature: The sample must be sufficiently cooled before it enters the analyzer and any optional components. A coiled 10 foot length of ¼” stainless steel tubing is sufficient to cool sample gases as high as 1,800 ºF to ambient temperature. The recommended operating temperature is below 35 ºC. However, the analyzer may be operated at temperature up to 45 ºC on an intermittent basis but the user is expected to accept a reduction in expected sensor life –as a rule of thumb, for every degree ºC increase in temperature (above 25 ºC), the sensor life is reduced by approximately 2.5%.

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

Liquid and Object Entry: The analyzer 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 analyzer.

Handling: Do not use force when using the switches, knobs or any other mechanical components. Before moving your analyzer be sure to disconnect the wiring/power cord and any cables connected to the output terminals of the analyzer.

Sample Pressure and Flow

All electrochemical oxygen sensors respond to partial pressure changes in oxygen. The sensors are equally capable of analyzing the oxygen content of a flowing sample gas stream or monitoring the oxygen concentration in ambient air (such as a confined space in a control room or an open area around a landfill or bio-pond). The following is applicable to analyzers equipped with fuel cell type oxygen sensors.

Inlet Pressure: For the analyzers designed to measure oxygen in a flowing gas stream, the inlet sample pressure must be regulated between 5-30 psig. Although the rating of the SS tubing and tube fittings/valves itself is considerably higher (more than 100 psig), a sample pressure of 5-30 psig is recommended for ease of control of sample flow.
The analyzer is equipped with two gas ports. Either port can be connected to SAMPLE gas inlet. If the analyzer is equipped with optional sample pump, pay attention to the SAMPLE IN and SAMPLE OUT ports.

Caution: If the analyzer is equipped with an optional H2S scrubber, sample inlet pressure must not exceed 30 psig.

Outlet Pressure: In applications where sample pressure is positive, the sample must be vented to an exhaust pipe at a pressure less than the inlet pressure so that the sample gas can flow through the sensor housing. Ideally, the sample must be vented to the atmosphere or into a pipe at atmospheric pressure.

Note: The sensor may be used at a slightly positive pressure (e.g., when sample is vented to a common exhaust where the pressure might be higher than 1 atmosphere). However, the pressure at the sensor must remain constant at all times including during the span calibration. This may be accomplished by using a back-pressure regulator at the vent line of the analyzer. **Caution:** A sudden change in pressure at the sensor may result in the sensor electrolyte leakage.

Use only the male "quick disconnect" fittings provided with the analyzer for bringing the sample gas in and venting it out.

Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH may generate a slight backpressure on the sensor resulting in erroneous oxygen readings.

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

Application Pressure - Positive: A flow indicator with integral metering valve positioned upstream of the sensor is recommended for controlling the sample flow rate between 1-5 SCFH. If a separate flow control valve and a flow indicator is used, position flow control valve upstream of the sensor and position a flow indicator downstream of the sensor. If necessary, a pressure regulator upstream of the flow control valve should be used to regulate the inlet pressure between 5-30 psig.

Caution: If the analyzer is 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: The GPR-1000 may be purchased with an intrinsically safe integral sample pump, however, if the analyzer is not equipped with integral sample pump, an external sample pump capable of pulling sample from atmosphere to a pressure down to ~ 40 inches of water column is recommended. However, the user must ensure that by using external pump, the intrinsic safety of the analyzer is not compromised.

Positioning of a Sampling Pump: For low % oxygen measurements, an optional external sample pump may be used upstream of the sensor to push the sample across the sensor and out to atmosphere. For low PPM 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. However, if the sample pump can pull/push more than 5 SCFH, a flow control valve must be used to control the sample flow. The flow control valve must be positioned in such a way that it does not generate any vacuum on the sensor.

Caution: If the analyzer is equipped with a flow indicator with integral metering valve or a metering flow control valve upstream of the sensor and the pump is installed downstream of sensor- open the metering valve completely before turning the pump ON 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.

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 other optional components. Moisture and/or particulates do not necessarily damage the sensor. However, collection of moisture/particulate 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. Consult the factory for recommendations concerning the proper selection and installation of optional components.

Moisture and/or particulates generally can be removed from the sensor by opening the sensor housing and either blowing on the sensing surface or gently wiping or brushing the sensing surface with damp cloth. **Caution:** Minimize the exposure of PPM sensors to air during this cleaning process. Air calibration followed by purging with zero or a gas with a low PPM oxygen concentration is recommended after the cleaning process is completed.

Mounting: The analyzer is approved for indoor as well as outdoor use. However, avoid using the analyzer in an area where direct sun might heat up the analyzer beyond the recommended operating temperature range.

Gas Connections: The Inlet and outlet vent gas lines require quick disconnect stainless steel fittings. The sample inlet tubing must be metallic, preferably SS. The sample vent line may be of SS or hard plastic tubing with low gas permeability.

Power: The analyzer is powered by an integral lead-acid rechargeable battery. The analyzer will continue to run for a minimum of 30-60 days after the battery is fully charged.
WARRNING: THE ANALYZER BATTERY MUST BE CHARGED IN A SAFE AREA ONLY BY USING FACTORY PROVIDED WALL PLUG-IN CHARGER.

4. Features & Specifications

Advanced Instruments Inc.

Technical Specifications

Accuracy:	< 2% of FS range under constant conditions
Analysis Ranges:	0-1000 PPM, 0-1%,,5% 0-25% FS Auto-ranging or Manually lock on a single range
Application:	Oxygen analysis down to 1 PPM in inert, helium, hydrogen, mixed and acid (CO_2) gas streams
Approvals:	EC TYPE EXAMINATION CERTIFICATE: INERIS 08ATEX0036 II 2 G Ex ib IIB T4 T_{amb} -20°C to +50°C
Area Classification:	Meets standards for Class 1, Division 1, Group C, D hazardous areas
Calibration:	Certified gas of O_2 balance N_2 approximating 80% of range of analysis or one range above range of interest
Compensation:	Temperature Compensated
Connections:	Quick Disconnect fittings
Controls:	Water resistant keypad; menu driven range selection, calibration and system functions
Display:	Graphical LCD 2.75 x 1.375"; resolution 1 PPM on 0-1000 PPM range
Enclosure:	Painted aluminum NEMA 4X, 8.6 x 9 x 3", 12 lbs.
Flow Sensitivity:	None between 0.5-5 SCFH, 2 SCFH recommended
LED Indicators:	LOW BATT (72 hr. warning); CHARGE mode
Linearity:	> .995 over all ranges
Pressure:	Inlet - regulate to 5-30 psig and use a Flow Control Valve to set flow; vent - atmospheric
Power:	Rechargeable battery, 60 day duty cycle
Recovery Time:	60 seconds in air to < 10 PPM in < 1 hr on N_2 purge
Response Time:	90% of final FS reading in 10 seconds
Sample System:	Quick disconnect Sample in and vent
Sensitivity:	< 1% of FS range
Sensor Model:	GPR-12-100
Sensor Life:	Expected 24 months at 25ºC, 1 atm with average O_2 < 1,000 PPM
Signal Output:	0-1V FS
Temp. Range:	5º to 45ºC (GPR sensor), -20º to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

Optional Equipment

XLT-12-100 sensor for analysis of a gas mixture with > 0.5% CO_2

Carrying case with custom foam insert

Sample conditioning accessories - contact factory

GPR-1000

Portable PPM O_2 Analyzer

Intrinsically Safe

ATEX Directive 94/9/EC

INERIS 08ATEX0036

II 2 G
Ex ib IIB T4
T_{amb} -20°C to +50°C

CE

ISO 9001:2000 QA System
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 10/08

5. Operation

Principle of Operation

The GPR-1000 portable oxygen analyzer incorporates a variety of PPM range advanced galvanic fuel cell type sensors. The analyzer is configured in a general purpose NEMA 4 rated enclosure and meets the intrinsic safety ATEX Directive 94/9/EC for use in Zone 1 Groups C and D hazardous areas.

Advanced Galvanic Sensor Technology

All galvanic type sensors function on the same principle and are very specific to oxygen. They measure the partial pressure of oxygen from low PPM to % 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 and 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 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 the design and chemistry add significant advantages to an extremely versatile oxygen sensing technology. Sensors for low PPM analysis recover from air to low PPM levels in minutes, exhibit longer life, extended operating temperature range of -20°C to 50°C, excellent compatibility with CO_2 and other acid gases (XLT series sensors only) and reliable quality giving them a significant advantage over the competition.

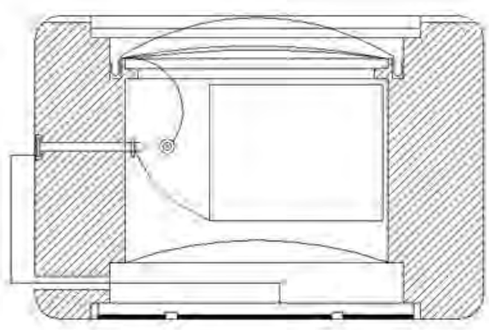
The expected life of our new generation of percentage range sensors now range to five and ten years with faster response times and greater stability. Other significant developments involve the first galvanic oxygen sensor capability of continuous oxygen purity measurements and expanding the operating temperature range from -40°C to 50°C.

Design Objectives

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

ppm Oxygen Sensors

- Shorten manufacturing cycle from 4-6 weeks to 3-4 days
- Recovery to 10 ppm from oxygen shock or air . . .
  in less than 1 hour on nitrogen purge
- Higher signal output to achieve . . .
  50 ppb sensitivity
  Enhanced stability, less temperature dependent
- Superior compatibility with 0.5 to 100% CO_2 gas streams
  ppm O_2 contamination in natural gas
  ppm O_2 contamination in beverage grade pure CO_2
- Operating life of 24 months in ppm O_2 concentrations
- Extended operating range -20^{o}F to 50^{o} F
- Develop special sensor for high ppm/low % applications



GPR/XLT 12 Series ppm Oxygen Sensor

Electronics

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

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

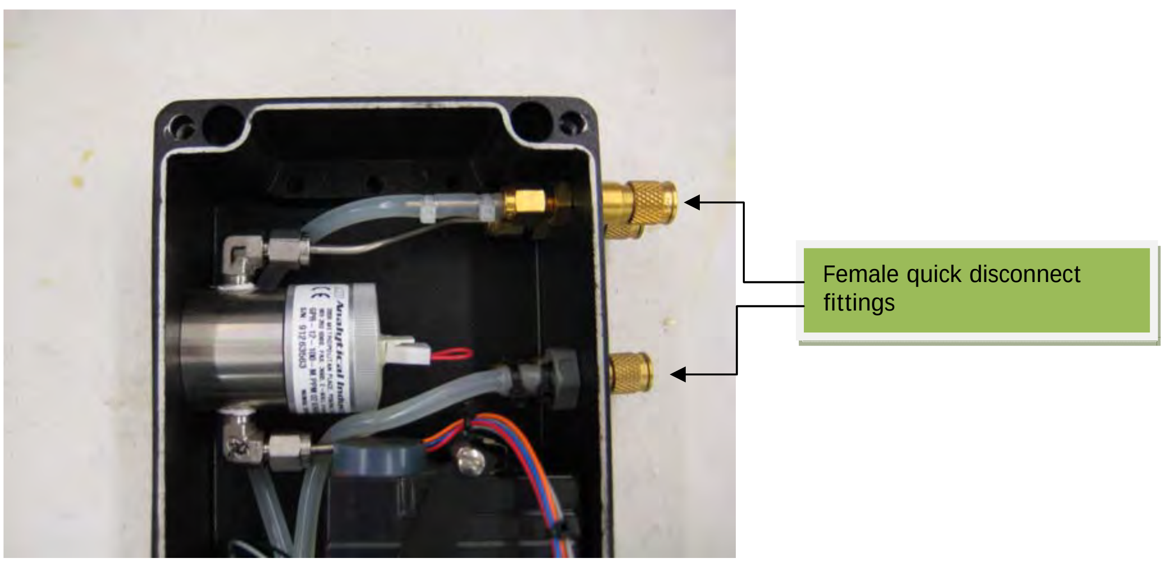
Power is supplied by an integral rechargeable lead acid battery which provides enough power to operate the analyzer continuously for approximately 60 days. An LED located on the front panel provides a blinking 72 hour warning to recharge the battery. A 9 VAC adapter (positive pole located on the inside of the female connector) can be used to recharge the battery from a 110V or 220V convenience outlet. The analyzer is designed to be fully operational during the 8-10 hour charging cycle which is indicated by a second continuously lit CHARGE LED (only when the analyzer power is turned ON).

Sample System

The GPR-1000 is supplied with two female quick connect fittings. Without the mating male quick disconnect fittings inserted, the female fittings lock themselves thus preventing the ambient air from seeping into the sensor housing. The analyzer is shipped with the sensor pre-tested and installed but is isolated from the ambient air by the self-locking female fittings and is ready for immediate operation.

Caution: Do not insert the male quick connect fittings into the female fittings unless the provision for the sample gas to flow through the sensor housing is established. Further, before connecting the sample gas inlet fitting, ensure that the vent line is open. Failure to do so will generate a pressure on the sensor. Sudden release of pressure (by inserting the male fittings in the vent line) may cause the sensor electrolyte leakage thus voiding sensor warranty.

For PPM oxygen measurements, the sensor is exposed to the sample gas that must flow or be drawn through the analyzer's internal sample system. The sample flow must be controlled by using an external flow control device. Sample flow rate of 1-5 SCFH has no significant effect on the accuracy of the analyzer, however, for optimum performance, a flow rate of 1-2 SCFH is recommended.

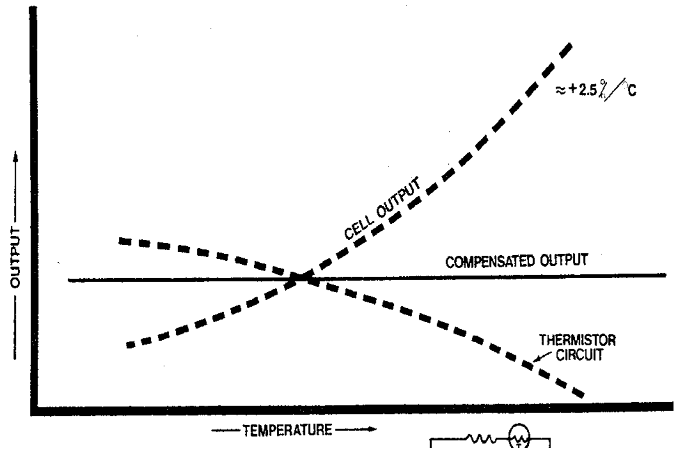


As illustrated above, the GPR-1000's internal sample system includes:

1. Female quick connect/disconnect fittings for the inlet and outlet and
2. Stainless steel sensor housing with a thread-in type sensor installation mechanism.
3. Optional intrinsically safe pump

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 info@aii1.com

Accuracy & Calibration



Single Point Calibration: As previously described the galvanic oxygen sensor generates an electrical current proportional to the oxygen concentration in the sample gas.

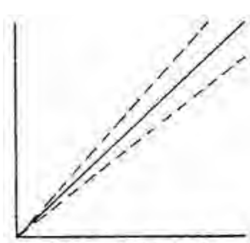
Absolute Zero: In the absence of oxygen the sensor exhibits an absolute zero, e.g. the sensor does not generate a current output in the absence of oxygen. Given these linearity and absolute zero properties, single point calibration is possible.

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 or PPM are permissible only when the total pressure of the sample gas being analyzed remains constant. For optimum accuracy, the pressure of the sample gas and that of the calibration gas must be the same (in reality, within 1-2 psig).

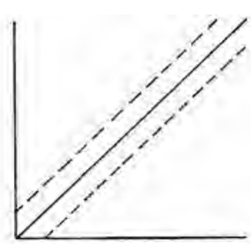
Temperature: The rate of diffusion of oxygen molecules into the sensor is controlled by a thin Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier'. All diffusion processes are temperature sensitive, therefore, the fact that the sensor's electrical output varies with temperature is normal. This variation, however, is relatively constant (2.5% increase per ºC increase in temperature).

A temperature compensation circuit employing a thermistor offsets this effect with an accuracy of better than ±5% (over the entire Operating Temperature Range of the analyzer) and generates an output function that is virtually independent of temperature. There is essentially no error in measurements if the analyzer calibration and sampling are performed at the same temperature or if the measurement is made immediately after analyzer calibration. Lastly, a small sample/ambient temperature variations (within 10-15º) produce < 2% error in measurements.

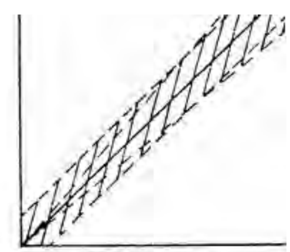
Accuracy: In light of the above parameters, the overall accuracy of an analyzer is affected by two types of errors: 1) those producing 'percent of reading errors', as illustrated by Graph A below, such as ±5% error in temperature compensation circuit due to tolerances in electronic components and 2) those producing 'percent of full scale errors', illustrated by Graph B, such as ±1-2% linearity errors in readout devices, which are generally very minimal due to today's advancements in technology and the fact that these errors are 'spanned out' during calibration. Graph C illustrates these 'worse case' specifications that are typically used to develop the analyzer's overall accuracy statement of < 1% of full scale at constant temperature and pressure or < 5% over the operating temperature range. The error in QC testing is typically < 0.5% prior to shipment of analyzers.



A. PERCENT OF READING ERRORS



B. PERCENT OF FULL SCALE ERRORS



C. OVERALL ACCURACY

Example: As illustrated by Graph A, any error due to the tolerances in the circuit, will increase with increasing oxygen concentration if the analyzer calibration is done at lower end of the range, e.g., calibration with 20.9%, any error would be multiplied by a factor of 4.78 (100/20.9) when used for measurements near 100% oxygen. 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 galvanic fuel cell type oxygen sensor exhibits an absolute zero, meaning it produces no signal output when exposed to an oxygen free sample gas. In reality, however, the analyzer may generate an oxygen reading when sampling supposedly a zero gas due to:

1. Contamination or quality of the zero gas
2. Minor leakage in the sample line connections
3. Residual oxygen dissolved in the sensor's electrolyte
4. Tolerances of the electronic components

The Zero Offset feature of the analyzer allows the user to eliminate this offset. The extent of the zero offset, however, is limited to 50% of the most sensitive range available with the analyzer.
As part of our Quality Control Certification process, the zero capability of every PPM analyzer is qualified prior to shipment. Since the factory sample system conditions may differ from that of the user, no ZERO OFFSET adjustment is made to analyzer at the factory.

Recommendations

Zero calibration is recommended only for analyzers performing continuous analysis below 5% of the most sensitive range available with the analyzer, e.g. analysis below 0-50 PPM on the 1000 PPM range, or 0.05% on the 1% range (with a percent analyzer).

Determining the true Zero Offset requires approximately 12-24 hours wait to ensure that the sensor has consumed all the dissolved oxygen in the electrolyte (during exposure of sensor to air, a part of oxygen is reduced at the electrode while a portion of oxygen dissolves in the electrolyte which is then consumed only slowly after the sensor is exposed to oxygen free gas). Allow the analyzer to stabilize with a flowing zero gas as evidenced by a stable reading or a horizontal trend on an external recording device.
Generally, Zero calibration should be performed after a span calibration has been performed.

Initiate the DEFAULT ZERO and DEFAULT SPAN procedures before performing either a ZERO or SPAN CALIBRATION.

Caution: Prematurely initiating the ZERO CALIBRATION function can result in negative readings near zero.
Once the zero offset adjustment has been made, further zero calibration is normally not required unless substantial changes in the sample system connections are made or a new sensor is installed.

Span Calibration

Span Calibration involves adjusting the analyzer electronics gain to match with the sensor's signal output at a given oxygen standard. After span calibration, the analyzer output will reflect accurately the oxygen content in a sample gas. The signal output may drift with changes in the ambient temperature. Maximum drift from calibration temperature is approximately 0.11% of reading per °C. The frequency of calibration varies with the application conditions, the degree of accuracy required by the application and the Quality Assurance Protocol requirements of the user. However, **the interval between span calibrations should not exceed beyond three (3) months.**

Note: Regardless of the oxygen concentration of the standard used, the span calibration process takes approximately 10-15 minutes. However, the time required to bring the analyzer back on-line (within 10% of the original reading) can vary. As a rule of thumb, the span gas concentration must not be greater than 100 times the range of analysis selected. For example, when using the analyzer on a 10 PPM range, the span gas concentration must be below 100 PPM. Further, the recovery after span calibration will also depend on the duration of calibration; the longer the duration, the longer it would take for the analyzer to recover. The data below gives an estimated recovery time after span calibration (the data assumes that after span calibration, the sensor is exposed to a zero/purge/sample gas** with an oxygen content in the low PPM level).

Galvanic Sensor *	Oxygen Standard	Time Required to Come On-line**
O_2 levels above 1000 ppm / 0.1%	Air (209,000 ppm / 20.9%)	< 5 minutes
O_2 levels above 100 ppm	Air (209,000 ppm / 20.9%)	< 10 minutes
O_2 levels below 10 ppm	Air (209,000 ppm / 20.9%)	< 60 minutes for install or replacement
		< 30 minutes if in ppm service for > 1 week
O_2 levels below 10 ppm	800 ppm Certified Span Gas	< 5 minutes
O_2 levels below 10 ppm	80 ppm Certified Span Gas	< 1 minute

Recommendation, General

The interval between span calibrations should not exceed three (3) months.
Initiate the DEFAULT ZERO and DEFAULT SPAN procedures before performing either a ZERO or SPAN CALIBRATION. This procedure clears up previous calibration data from the analyzer internal memory.

Caution: Prematurely initiating the SPAN CALIBRATION function before the analyzer reading has stabilized can result in erroneous readings. This is especially true when installing a new sensor that must adjust to the difference in oxygen concentrations. It should take about 2 minutes for the sensor to equilibrate in ambient air from storage packaging.

Always calibrate analyzer close to the normal operating temperature and pressure of the sample gas.
For optimum calibration accuracy, calibrate with a span gas approximating 80% of the full scale range of analysis or one range above the range of interest. This will “narrowing the error” when moving downscale (close to zero) as illustrated by Graph A in the Accuracy & Calibration section.

Calibrating with a span gas approximating 5-10% 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 above.

Calibrating at the same 5-10% of the full scale range for measurements at the higher end of the range (example: calibrating an Oxygen Purity Analyzer in air at 20.9% oxygen with the intention of measuring oxygen levels of 50-100%) results in the effect of “expanding the error” by moving upscale as illustrated by Graph A and Example 1 in the Accuracy & Calibration section above and is not recommended. Of course the user can always elect at his discretion to accept an accuracy error of $\pm$2-3% of full scale range if no other span gas is available.

Recommendation, Air Calibration

The inherent linearity of the 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. Further, after air calibration, it is not necessary to recalibrate the analyzer with a span gas containing a lower oxygen concentration.

When installing or replacing a new sensor (PPM or percent), a quick air calibration is recommended to verify that the new sensor has the proper output.

Air calibration can verify the oxygen content of a certified span gas (within +/- 2% of the reading).
When a certified low PPM span gas is not available, after air calibration, immediately return to sample gas.

In order to perform air calibration, remove the sensor from its bag. Remove the Molex connector (shorting the negative and positive terminals of the sensor)

Remove the Molex connector

Connect the sensor with the sensor cable and hold the sensor in your hand for a couple of minutes to allow the sensor to stabilize with ambient air.
Check the oxygen reading; with factory default span setting, it should reach close to 20.9% (+7% -4%) indicating that the sensor has proper signal output. At this time perform air calibration

Hold the sensor in your hand in air and perform air calibration

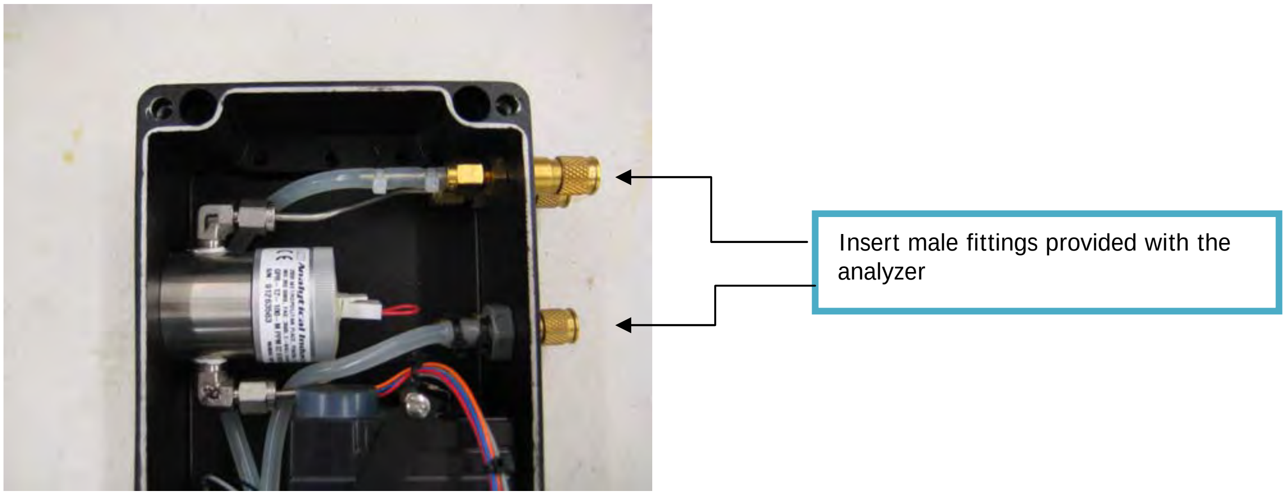
After air calibration, screw the sensor in the sensor housing and immediately allow the sample or zero gas to flow through the sensor housing.

Mounting the Analyzer

Normally mounting a portable analyzer is not a consideration. However, the GPR-1000 analyzer can operate continuously when connected to AC power using the factory provided battery charging adapter. The analyzer enclosure is cast with four (4) holes in the bottom section specifically intended for wall mounting option.

Gas Connections

The GPR-1000 flow through configuration is designed for positive pressure samples and requires connections to incoming sample and vent quick connect/disconnect fittings. Use only the male quick connect fittings provided with the analyzer for making gas connections. Improper male fittings may cause irreparable damage to the female fittings.
Note: The user is responsible for making provision for calibration gases, see Calibration section of the Analyzer Specification and Installing Span Gas below.



Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate a backpressure on sensor and cause erroneous oxygen readings (because the 1/8" diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate quickly).

A flow control valve upstream of the sensor is highly recommended. For optimum performance, a flow rate of 1- 2 SCFH or 0.5 – 1 liter per minute is recommended.

For applications where the sample flow is ambient or at a slightly negative pressure (up to 40" of water column pressure), the analyzer may be purchased with an optional internally mounted sample pump, otherwise, an external sample pump connected to the vent of the analyzer should be used to draw the sample through the sensor housing. **In order t prevent any vacuum drawn on the sensor, use sample tubing of a minimum of ¼" size.**

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).

Caution: When using an external pump to draw the sample through, open the flow control valve (if used as recommended above) completely. Failure to do so will draw vacuum on the sensor and may cause permanent damage to the sensor.

Electrical Connections

Power is supplied by an integral rechargeable lead acid battery which provides enough power to operate the analyzer continuously for approximately 60 days. A LOW BATTERY LED located on the front panel provides a blinking 72 hour warning to recharge the battery when the battery voltage drops below a pre-determined value. A 9 V AC/DC adapter (with positive pole located on the inside of the female connector) can be used to recharge the battery from 110V or 220V convenience outlet. The battery will be fully charged within 8-10 hours. The analyzer is designed to be fully operational during the 8-10 hour charging cycle. When the adopter is connected to the analyzer, the battery charging process is indicated by a second continuously lit CHARGE LED (only when the analyzer power is turned ON).

CAUTION: The battery must be charged in a safe are only. Do not leave the charger connected to the analyzer for more than 24 hours.

Charging Battery

Locate a source of AC power to meet the area classification, plug in the appropriate charging adapter to the outlet. Connect the female jack to the mating male receptacle identified as CHARGE on the analyzer.

Analog Signal Output

A separate receptacle is provided for signal output. The analyzer signal output is 0-1 V full scale selected. The signal output must be connected to an external recording device in accordance with local safety directives.

Connect the lead wires from the external recording device to the male phone plug supplied with the analyzer. (Note: Connect the positive lead to the center terminal of the male phone plug.)
Insert the male phone plug into the integral female OUTPUT jack located on the side of the enclosure.

Caution: Do not connect a recording device capable of generating a voltage greater than 12 VDC. A voltage greater than 18 V may blow the safety fuse on A-1161-B Rev C3 main signal processing PCB. A blown fuse must be replaced with the recommended fuse only.

Installing the Oxygen Sensor

GPR-1000 Oxygen Analyzer is equipped with an integral oxygen sensor that has been tested and calibrated by the manufacturer prior to shipment and is fully operational from the shipping container. Should it be necessary to install a new oxygen sensor, refer to section “6 Maintenance” for further instructions.

The analyzer must be calibrated once the installation has been completed and periodically thereafter as described below.

Unscrew the old sensor and screw in the new sensor finger tight

Caution: DO NOT open/dissect 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 in section 10. 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. Do not remove sensor from its original package until the analyzer is ready to accept sensor installation.
2. Make sure that a low PPM gas is flowing through the analyzer.
3. Set the sample flow rate between 1-2 SCFH
4. Remove old sensor (if previously installed).
5. Remove the new sensor from the package (use a pair of scissors to cut the bag, do not use hands to tear the bag)
6. Remove the Molex connector at the back of the sensor. Connect the sensor to the sensor cable. While holding the sensor in your hand, perform a quick air calibration (see above).
7. Screw the sensor into the sensor housing (to finger tight pressure)
8. Check the oxygen reading; it should reach close to 20.0% (+7% -4%) indicating that the sensor has proper signal output. At this time perform air calibration.

9. After air calibration, insert the sensor into the bottom section of the sensor housing, replace the upper section of the sensor housing and twist it 90 degree until it fits on the lower section of the sensor housing. Tighten the nut (3/4 turn after figure tight).

Span Gas Preparation

Avoid contamination of the span gas cylinder when connecting the pressure regulator. Bleed the air filled regulator for a couple of minutes before closing the vent valve of the pressure regulator (faster and more reliable method of purging the regulator than simply allowing the span gas to flow through the regulator and the span gas line). Following components/tools are required for setting a span gas cylinder.

1. Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range above the intended measuring range.
2. Use a pressure Regulator to reduce span gas pressure to between 5 and 30 psig.
3. Use flow meter (only if the analyzer is not equipped with a flow meter) and set the flow between 1-2 SCFH.
4. Use suitable fittings and 1/8” dia. metal tubing to connect the regulator to the inlet of the analyzer.

Procedure of Setting up a Span Gas Cylinder

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 pressure. Excessive pressure would make flow adjustment more difficult.

Establishing Power to Analyzer

The analyzer power is provided by an integral lead-acid rechargeable battery mounted inside of the analyzer. The analyzer is fully operational from the shipping container with the oxygen sensor installed and calibrated at the factory prior to shipment. Once installed, we recommend the user allow the analyzer to stabilize for 10-15 minutes before analyzing a sample gas (this will remove any residual oxygen that might have trapped in the sample system during installation).

Establish power to the analyzer electronics by pushing the red ON/OFF key. The digital display responds instantaneously. When power is applied, the analyzer performs several diagnostic system status checks termed “START-UP TEST” as illustrated below.

Note: In the unlikely event, the LOW BATTERY warning LED comes on when the analyzer is turned on – proceed immediately to section 6 Maintenance Battery.

The analyzer is supplied with a 9 V AC/DC adapter for recharging the batteries or operating the analyzer continuously. The analyzer’s charging circuit accepts only 9 VDC from any standard AC 110V or 220V adapter (with positive supply in the center of the female charging jack). The electronic design enables the analyzer to remain fully operable during the 8-10 hour charging cycle. However, the analyzer must be charged in safe area only.

Once the power to the electronics is established, the digital display responds instantaneously. When power is applied, the analyzer 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. 2.37

After self diagnostic tests, the analyzer turns itself into the sampling mode. And displays oxygen contents the sensor is exposed to, the analysis range, the ambient temperature and pressure.

0.30%

AUTO SAMPLING
1% RANGE

76 F **100 KPA**

Menu Navigation

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

Blue ENTER (select)
Yellow UP ARROW
Yellow DOWN ARROW
Green MENU (escape)

Main Menu

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

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

This screen show various option available. You can use the UP and DOWN arrow key to move the cursor and highlight the desired function. After moving the cursor to the desired function, you can press ENTER to get to that function.

Range Selection

The GPR-1100 analyzer 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 and ambient air (20.9% oxygen on the 0-25% range which meets the 80% of FS recommendation described below) 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 8% oxygen concentration in nitrogen would dictate the use of the 0-10% full scale range for calibration and a 0-10% 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.

The display returns to the sampling mode:

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

0.3%

AUTO SAMPLING
1% RANGE

76 F **100 KPA**

The display will shift to the next higher range when the oxygen reading 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.

The following display appears:

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

>>>

MANUAL RANGE

25%
1%
5%
1000 PPM

4. Advance the reverse shade cursor using the ARROW keys to highlight the desired MANUAL RANGE.
5. 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:

MANUAL RANGE

25%
1%
5%
1000 PPM

>>>

0.3%

MANUAL SAMPLING
1% RANGE

76 F **100 KPA**

If the oxygen value goes above the 1%, display will not shift to the next higher range. Instead, when the oxygen reading exceeds 110% of the upper limit of the current range, an OVER RANGE warning will be displayed.

1.25%

OVERRANGE
MANUAL SAMPLING
1% RANGE

76 F **100 KPA**

Once the OVER RANGE warning appears the user must advance the transmitter to the next higher range.
NOTE: With oxygen reading above 110% of the selected range, the analog signal output will increase but will freeze at a maximum value of 1.2 V. After the oxygen reading falls below the full scale range, the voltage signal will become normal.

Calibration of Analyzer

The electrochemical oxygen sensors generate an electrical current that is **linear** or proportional to the oxygen concentration in a sample gas. In the absence of oxygen the sensor exhibits an **absolute zero**, i.e., the sensor does not generate a current output in the absence of oxygen. Given the properties of linearity and an absolute zero, a single point calibration is possible. As described below, zero calibration is recommended only when the application (or user) demands optimum accuracy of below 5% of the most sensitive or lowest range available on the analyzer. Span calibration, in one of the forms described below, is necessary to adjust the analyzer sensitivity for accurate measurements of oxygen. As a rule of thumb, zero calibration should be carried out after span calibration.

Zero Offset

Despite the absolute zero inherent in the electrochemical oxygen sensors, the reality is that analyzers may display an oxygen reading even when sampling a zero gas (oxygen free gas) due to:

1. Contamination or questionable quality of the zero gas
2. Minor leakage in the sample line connections
3. Residual oxygen dissolved in the sensor's electrolyte
4. Tolerances of the electronic components

The maximum zero offset of every analyzer is checked prior to shipment. However, due to the fact that the factory sample system conditions differ from that of the user, no ZERO OFFSET adjustment is made at the factory

Span Calibration

Involves periodically, see Intervals section below, checking and/or adjusting the electronics to the sensor's signal output at a given oxygen standard. The frequency of calibration varies with the application, e.g., the degree of accuracy required by the application and the quality assurance protocol of the user. However, the interval between span calibrations should not exceed three (3) months.

Note: Regardless of the oxygen concentration of the standard used, the span calibration process takes approximately 10-15 minutes. However, the time required to bring analyzer back on-line (within 0.01% of original value) after span calibration can vary, see Online Recovery Time below.

Considerations

When it comes to the calibration of oxygen analyzers utilizing an electrochemical oxygen sensor, circumstances vary widely from the ideal conditions that exist at the factory to a variety of differing circumstances users encounter in the field. The following describes the most common factors and reasons that influence the calibration procedures.

All electrochemical sensor based analyzers require periodic calibration, e.g. weekly intervals to a 3 month maximum, to ensure accuracy and ascertain the integrity of the sensor. Although, the sensor signal remains relatively constant throughout the useful life of the sensor, some components in a gas stream, e.g., sulfides, can adversely affect the sensor causing the sensor to loose its sensitivity with time. Hence it is highly recommended to verify/adjust the sensitivity of the sensor by performing span calibration.

For optimum accuracy, calibrate the analyzer at or close to the temperature and pressure of the sample gas
The priority users place on getting or keeping an analyzer online is "the" most significant factor involved in calibration and troubleshooting issues. The time it takes an analyzer to come down to a specific level after exposure to high O_2 concentrations or air is significantly different if a sensor is being installed than if the sensor had been in-service at low oxygen levels for more than 1 week.

Sensor	Recovery from Calibration	In-service Calibration Recovery
PPM Fuel Cell	Air to 0.1% < 30 seconds Air to 0.01% <2 min 2 minute exposure to Air to 10 PPM < 60 min	Similar Less than 30 min

The above times assume the introduction of a zero gas (low level of oxygen in nitrogen) after span calibration.

When purging the analyzer to lower ranges and calibrating with a span gas, observe the following guideline.

If the oxygen reading reaches less than 2% of the intended calibration range, enter the value of the span gas. However, if the oxygen reading is greater than 2% of the calibration range, add the O2 reading to the value of the span gas (the impact of the offset on accuracy is minor but the addition allows the oxygen sensor to continue to purge down and avoid negative readings after calibration).

Zero Calibration

Typical offset from a PPM analyzer is less than 0.5 PPM. Therefore, for most applications, a Zero calibration is not required. However, ZERO calibration option has been provided to allow the user to measure oxygen concentration at the very low levels (less than 0.5 PPM) with great precision. As described below, accomplishing either objective places a degree of responsibility on the user.

Determining the true offset requires the user to wait (see Online Recovery Time section) until the analyzer reading is no longer trending downward (best evidenced by a constant horizontal trend on an external recording device.

The zero offset adjustments is limited to 50% of the most sensitive range of the analyzer. At factory, analyzer is QC tested to confirm that the maximum offset is less than 50% of the most sensitive range available. Should you observe a zero offset more than 50% of the lowest range, check sample system for any possible leaks, integrity of the zero gas and assure that the analyzer has been given enough time to stabilize on zero gas before initiating the “ZERO CALIBRATION”.

Caution: If adequate time is not allowed for the analyzer to establish the true baseline and a ZERO calibration is performed, the analyzer will in all probability display a negative reading in the sample mode after a certain period of time. If a negative reading is seen, perform ZERO calibration again.

Zero Calibration Procedure

Zero calibration should carried out after 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.

The maximum zero calibration adjustment permitted is 50% of the lowest full scale analysis range available. At the factory, each analyzer is QC tested to confirm that the maximum offset is less than 50% of the most sensitive range available. Should you observe a zero offset more than 50% of the lowest range, check the sample system for any possible leaks, integrity of the zero gas and, assure that the analyzer has been given enough time to stabilize on zero gas before initiating the “ZERO CALIBRATION”.

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

The following displays appear

MAIN MENU		CALIBRATION
AUTO SAMPLE	>>>	SPAN CALIBRATE
MANUAL SAMPLE		ZERO CALIBRATE
CALIBRATION		DEFAULT SPAN
		DEFAULT ZERO
		OUTPUT SPAN
		OUTPUT ZERO

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

The following displays appear:

1 PPM

ZERO
CALIBRTION
ENTER TO CALIBRATE
MENU TO ABORT

6. Wait until the analyzer reading stabilizes (depending on the history of the sensor, it may take a few minutes to several hours) and then press the ENTER key to calibrate (or MENU key to abort).
7. If the offset is less than 50% of the lowest range, by pressing ENTER will pass the calibration and the analyzer will return to the Sample mode. On the other hand, if the offset is above 50%, pressing ENTER will fail calibration and the analyzer will return to Sample mode without completing the Zero calibration.

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

PASSED
CALIBRATION

OR

FAILED
CALIBRATION

Default Zero

This feature will eliminate any previous zero calibration adjustment and display the actual signal output of the sensor at a specified oxygen concentration. For example, assuming a zero gas is introduced, the display above 0.00 PPM will reflect an actual zero offset. This feature allows the user to ensure that the accumulative zero offset never exceeds 50% of the lowest range limit. To perform Default Zero,

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

The following displays appear

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

>>>

CALIBRATION

SPAN CALIBRATE
ZERO CALIBRATE
DEFAULT SPAN
DEFAULT ZERO
OUTPUT SPAN
OUTPUT ZERO

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

The following display appears and after 3 seconds the system returns to the SAMPLING mode:

FACTORY
DEFAULTS
SET

0 PPM
AUTO SAMPLING
1000 PPM RANGE
76 F 100 KPA

Analog Output with Zero O_2

In rare instances the 0-1 V signal output may not agree with the reading displayed on the LCD. This feature enables the user to adjust the 0V signal output when the LCD displays 00.00. **Note:** Adjust the 1V 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 and the following displays appear:

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

>>>

CALIBRATION

SPAN CALIBRATE
ZERO CALIBRATE
DEFAULT SPAN
DEFAULT ZERO
OUTPUT SPAN
OUTPUT ZERO

4. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT ZERO.
5. Press the ENTER key to select the highlighted menu option and the following display appears:

100.0
OUTPUT ZERO OFFSET
PRESS UP OR DOWN
TO CHANGE VALUE
ENTER TO SAVE
MENU TO RETURN

6. The default setting of 100 illustrates no adjustment to the analog output signal. Compute the adjustment value as described in Appendix B or consult the factory. The true adjustment value must be determined empirically by trial and error. Adjust the initial value to above 100 to increase the analog signal value or decrease it below 100 to decrease the analog signal.

095.0
OUTPUT ZERO OFFSET
PRESS UP OR DOWN
TO CHANGE VALUE
ENTER TO SAVE
MENU TO RETURN

7. 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 OUTPUT ZERO OFFSET value.
8. Press the ARROW keys to enter the OUTPUT ZERO OFFSET value.
9. Repeat the OUTPUT ZERO OFFSET routine until the output is 0.00V.
10. Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key. After adjustment, the system returns to the SAMPLING mode.

Span Calibration Procedure

Air Calibration

This procedure requires only a source of clean ambient air and removal of the sensor from its flow housing.

1. Access the interior of the analyzer by removing the 4 clamps securing the door of the analyzer.

Caution: Do not remove the gaskets from the enclosure. Failure to reinstall the gasket will void the NEMA rating.

2. Remove the sensor from the sensor housing. Hold the sensor pushed inside of the upper sensor housing with your hand while exposing the sensor to ambient air.

Hold the sensor pressed against the contact pins inside the housing

3. Advance the cursor on the MAIN MENU to SAMPLE and press ENTER to accept the selection.
4. From the above SAMPLE menu advance the cursor to AUTO RANGING and press ENTER.
5. Analyzer will return to the MAIN MENU and display the oxygen concentration which should approximate 20.9% oxygen.
6. Wait approximately 2 minutes to ensure the reading is stable.
7. Using the menus below, advance the cursor on the MAIN MENU to SPAN and press ENTER to accept the selection.
8. From the SPAN menu advance the cursor to Calibrate and press ENTER to select.

Follow the menus below to enter and accept the 20.9% span value.

The analyzer returns to the SAMPLE mode after accepting calibration.
Replace the sensor in the housing – tighten the clamp by turning the bolt (finger tight plus 3/4) turn.
Close the door of the enclosure, ensure that the gasket is in place to maintain NEMA 4 rating and lock the door by using (4) screws. Proceed to sampling.

Span Gas Calibration

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, set the analyzer to AUTO SAMPLE.

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.

The following displays appear:

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

30 PPM

AUTO SAMPLING
1000 PPM RANGE

76 F **100 KPA**

4. Return to the MAIN MENU by pressing the MENU key.
5. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
6. Press the ENTER key to select the highlighted menu option.
7. Repeat to select SPAN CALIBRATE

The following displays appear:

MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION

>>>

CALIBRATION

SPAN CALIBRATE
ZERO CALIBRATE
DEFAULT SPAN
DEFAULT ZERO
OUTPUT SPAN
OUTPUT ZERO

8. After selecting the SPAN CALIBRATION, enter appropriate span gas value.
9. Assure there are no restrictions in vent line.
10. Regulate the Span gas pressure, as described above at 5-30 psig, and set gas flow 1-2 SCFH flow rate.
11. If the span gas line is not already connected, connect the span gas to the sample inlet or span inlet (if equipped with a separate span inlet).

After selecting the span menu, the following display appears:

GAS CONCENTRATION

PERCENT
PPM

12. Select PERCENT or PPM option. After gas concentration selection, following menu appears to enter the actual span gas value.

000.00 PPM
PRESS UP OR DOWN
TO CHANGE VALUE
ENTER TO SAVE
MENU TO RETURN

>>>

1000 PPM
SPAN
CALIBRATION
ENTER TO CALIBRATE
MENU TO ABORT

13. By using the UP or DOWN arrow keys, enter the appropriate digit where the cursor is blinking
14. 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.
15. Repeat until the complete span value has been entered. In the example above, a span value of 09.00 PPM has been entered.
16. After the span value has been entered, the analyzer will prompt to press the ENTER key to accept SPAN CALIBRATION.

Caution: Allow the span gas to flow until the analyzer reading has stabilized before accepting calibration. The wait time will vary depending on the amount of oxygen introduced to the sensor when the sample and span gas lines were switched

17. After successful calibration, the analyzer will display a message "Passed Calibration" and return to the Sample mode.

NOTE: The analyzer is allowed to accept calibration when O2 reading is within 50% of the span gas value. If the O2 reading is outside of this limit, by pressing ENTER to accept calibration will result in "Failed Calibration" and return to the Sample mode without completing Span calibration. After pressing ENTER either of the following two messages will be displayed.

PASSED
CALIBRATION

OR

FAILED
CALIBRATION

If the calibration is unsuccessful, return to the SAMPLING mode with span gas flowing through the analyzer and retry the calibration before concluding that the analyzer is defective.

Before disconnecting the span gas line and connecting the sample gas line (if the analyzer is not equipped with a SPAN/SAMPLE vale option), flow the sample gas for 1-2 minutes to purge the air inside the sample line before connecting it to the sample input port. Disconnect the span gas line and replace it with the purged sample gas line.

Default Span

The software will set the SPAN adjustment based on the average output of the oxygen at a specific oxygen concentration. For example, with factory default settings, when a span gas is introduced, the micro-processor will display oxygen reading within ±50% of the span gas value, indicating that the sensor output is within the specified limits. This feature allows the user to check 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.

The following display appears

MAIN MENU	>>>	CALIBRATION
AUTO SAMPLE		SPAN CALIBRATE
MANUAL SAMPLE		ZERO CALIBRATE
CALIBRATION		**DEFAULT SPAN**
		DEFAULT ZERO
		OUTPUT SPAN
		OUTPUT ZERO

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

The following displays appear and after 3 seconds the system returns to the SAMPLING mode

FACTORY DEFAULTS SET	1 PPM AUTO SAMPLING 1000 PPM RANGE 76 F 100 KPA

Analog Output Adjustment at known O_2

In rare instances the 0-1V signal output may not agree to the reading displayed by the LCD. This feature enables the user to adjust the 0-1V signal output should the LCD display not agree. **Note:** Adjust the 0.0V signal output with the OUTPUT ZERO option described above.

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

The following displays appear

MAIN MENU	>>>	CALIBRATION
AUTO SAMPLE		SPAN CALIBRATE
MANUAL SAMPLE		ZERO CALIBRATE
CALIBRATION		DEFAULT SPAN
		DEFAULT ZERO
		OUTPUT SPAN
		OUTPUT ZERO

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

The following display appears

100.0
OUTPUT SPAN OFFSET
PRESS UP OR DOWN
TO CHANGE VALUE
ENTER TO SAVE
MENU TO RETURN

6. Compute the adjustment value as described in Appendix B or consult the factory. The true adjustment value must be determined empirically by trial and error. Adjust the initial adjustment value for additional percent errors.
7. 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 OUTPUT SPAN OFFSET value.
8. Press the ARROW keys to enter the OUTPUT SPAN OFFSET value.
9. Repeat steps 9 and 10 until the complete OUTPUT SPAN OFFSET value has been entered.
10. Save the adjustment by pressing the ENTER key or abort by pressing the MENU key

Note: The number 100 is the default value. With OUTPUT SPAN set at 100, no adjustment is made to the 1V signal. To increase the 1V signal increase the OUTPUT SPAN above 100. To decrease the 1V signal, decrease the OUTPUT SPAN below 100.

Sampling a Gas

GPR-1000 Oxygen Analyzer requires a positive pressure to flow the sample gas across the sensor to measure the oxygen concentration in a sample gas. If a positive sample pressure is not available see the option of using a sample pump as described above.

Procedure

Following calibration, the analyzer will return to the SAMPLE mode.

1. Select the desired sampling mode - auto or manual – as described above.
2. Use metal tubing to transport the sample gas to the analyzer
3. The main consideration is to eliminate any air leaks which can affect oxygen measurements. For sample gases under positive pressure, the user must provide a means of controlling the inlet pressure between 5-30 psig.
4. For sample gases under atmospheric or slightly negative pressure, an optional sampling pump is recommended to push the sample through the sensor housing. Generally, when using a pump, no pressure regulation or flow control device is involved. However, a flow meter upstream of analyzer is recommended to ensure that the sample flow is adequate.
5. Assure the sample is adequately vented for optimum response and recovery – and safety.
6. Allow the oxygen reading to stabilize for approximately 10 minutes at each sample point.
7. Avoid drawing a vacuum that exceeds 14” of water column pressure – up to 40 “if done gradually
8. Avoid flow rates above 5 SCFH which may generate backpressure on the sensor.
9. Avoid sudden releases of backpressure that can severely damage the sensor.
10. Avoid the collection of particulates, liquids or condensation on the sensor that could block the diffusion of oxygen into the sensor.
11. If an external sampling pump (positioned downstream of the sensor) is used, open the flow control metering valve (positioned upstream of the sensor) completely to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

Standby

The analyzer has no special storage requirements.
The sensor should remain connected to the analyzer PCB during storage periods.
Store the analyzer with the power OFF at a safe location and away from a direct heating source.
If storing for an extended period of time, protect the analyzer from dust, heat and moisture.

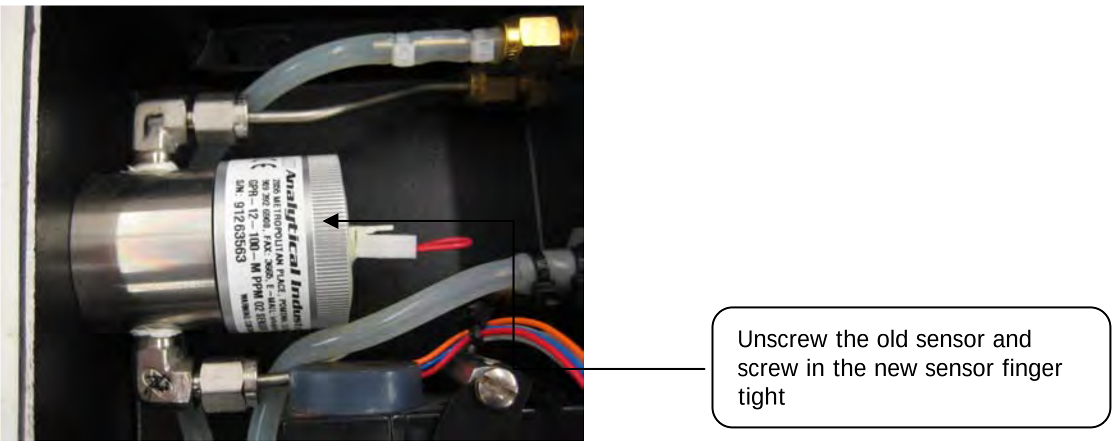
6. Maintenance

With exception of components related to optional equipment and charging the battery of portable analyzers, cleaning the electrical contacts when replacing the sensor is the extent of the maintenance requirements of this analyzer as there are no serviceable parts in the analyzer given the nature of the solid state electronics and sensor.

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

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-1200 Series analyzer. Expected sensor life is inversely proportional to changes in oxygen concentration, pressure and temperature.



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.

Procedure

1. Remove the four (4) screws securing the analyzer's front panel.

Caution: Do not discard the gaskets from the enclosure.

2. Connect zero gas or low oxygen content sample gas line to purge the analyzer sample system. Set the flow between 1- 2 SCFH.
3. Unscrew the old sensor from the sensor housing.
4. Dispose it off as you would a battery.
5. Remove the new oxygen sensor from the shipping bag.
6. Remove the Molex connector (shorting device) from the PCB at the rear of the sensor.

Caution: Minimize the time the sensor is exposed to ambient air.

Once the reading stabilizes – see above.

7. Holding the sensor in your hand, span Calibrate the analyzer in 20.9% ambient air.
8. Screw the new sensor in the sensor housing finger tight (you may need to temporarily remove the sensor cable from the senor for ease of sensor installation).
9. With a zero gas containing less than 1 PPM oxygen concentration flowing (see #7 above), expect the analyzer reading to recover to less than 100 PPM in roughly 5 minutes and less than 10 PPM in roughly 60 minutes.
10. Begin sampling once the analyzer has reached the value close that of the purge gas.

Note: If a sample gas containing even a lower oxygen concentration is subsequently introduced into the analyzer, expect the analyzer reading to continue to decrease gradually for several minute. This is normal considering the fact that the sensor will continue to consume the residual oxygen dissolved in the sensor during air calibration.

Charging Battery

Charging the battery requires a common 9VDC adapter (positive pole located inside the female connector) supplied with the analyzer and a convenience outlet. The analyzer's charging circuit accepts 9VDC from any standard AC 110V or 220V adapter. The electronic design enables the analyzer to remain fully operable during the 8-10 hour charging cycle.

Procedure

1. Unless the analyzer is to be operated while charging, turn the analyzer OFF when charging the battery for the shortest charging cycle.
2. Connect the appropriate 9VDC adapter supplied with the analyzer to an 110V or 220V outlet.
3. Insert the male phone plug from the 9VDC adapter into the integral female CHARGE jack located on the bottom of the enclosure.

The analyzer is designed to operate in the charging mode, however, **operating the analyzer in hazardous or explosive atmospheres while charging the battery IS NOT recommended** despite the intrinsically safe design.

Service

A single charge is sufficient to operate the GPR-1200 analyzer continuously for a period of 60 days, 1 day when operating the optional integral sampling pumps continuously.

Battery Warning LED Indicators

An LED indicator located on the front panel will light continuously during the CHARGE cycle.
A second LED (LOW BATTERY) indicator located on the front panel provides a blinking 72 hour warning when battery voltage drops below a certain level. Operating the analyzer beyond this 72 hour may permanently damage the battery (a drained out battery will never recharge). **If the battery does not charge in 10-24 hour period, replace the battery.**

7. Spare Parts

Recommended spare parts for the GPR-1000 Series Portable Oxygen Analyzer:

Item No.	Description
GPR-12-100	PPM Oxygen Sensor
XLT-12-100	PPM Oxygen Sensor for gases containing CO2

Other spare parts:

Item No.	Description
B-3652	Battery Assembly
A-3377	Housing Flow Adaptor Stainless Steel
MTR-1011	Meter Digital Panel LCD Backlight
A-1161-B Rev C3	PCB Assembly Main / Display
PWRS-1002	Power Source Plug-in 9VDC 110V Battery Charger
PWRS-1003	Power Source Plug-in 9VDC 220V Battery Charger
B-3653	Pump Assembly Intrinsically Safe

8. Troubleshooting

Symptoms	Possible Cause	Recommended Actions
Slow recovery	At installation, defective sensor Air leak in sample system connection(s) Abnormality in zero gas Damaged in service - prolonged exposure to air, electrolyte leak Sensor nearing end of life	Replace sensor if recovery unacceptable or O_2 reading fails to reach 10% of lowest range 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 Qualify zero gas (using portable analyzer) Replace sensor Replace sensor
High O_2 reading in Sampling	Flow rate exceeds limits Pressurized sensor Improper sensor selection Abnormality in sample gas	Correct pressure and flow rate Remove restriction on vent line/ open SHUT OFF valve completely Replace GPR/PSR sensor with XLT sensor when CO_2 or other acid gases are present Qualify sample gas independently by using a second analyzer
Response time slow	Air leak, dead legs, longer distance of sample line, low flow rate, high volume of optional filters and scrubbers	Leak test sample system bringing sample gas to analyzer, reduce dead volume and/or increase sample flow rate
O_2 reading doesn't agree with expected O_2 values	Pressure and temperature of the sample may be different than the span gas used for calibration Abnormality in the sample gas	Calibrate the analyzer (calibrate close to the pressure and temperature of the sample gas) Qualify sample gas independently
Erratic O_2 reading or No O_2 reading	Test sensor signal output independent from analyzer Abrupt changes in sample pressure Damaged sensor	Remove sensor from housing. Using a volt-meter set to uA, apply the (+) lead to the outer pin and the (-) lead to the second pin of the Molex connector on the sensor, measure the output in air (expected value 290-400 uA). If no current signal, replace sensor, otherwise contact factory. Regulate sample gas pressure and flow. Clean contacts with alcohol (minimize exposure time of sensor to ambient air to extent possible) Replace sensor and return damaged sensor to the

	Corroded solder joints on sensor PCB from corrosive sample or electrolyte leakage from sensor Corroded spring loaded contact in upper section of sensor housing from liquid in sample or electrolyte leakage from sensor Liquid covering sensing area Improper sensor selection Presence of other interference gases Presence of sulfur gases Unauthorized maintenance Sensor nearing end of life	factory for warranty determination Clean spring loaded contacts in upper section of sensor housing with a damped cloth. If electrolyte leakage from sensor is evident, replace sensor and return leaking sensor to the factory for warranty determination Wipe sensor and sensor housing and sensor with a damped towel. Replace GPR series sensor with XLT sensor when CO_2 or other acid gases are present, consult factory Replace sensor and install H2S scrubber Replace sensor, obtain authorized service Replace sensor
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 the suddenly removing the restriction draws a vacuum on the sensor or partially opening the valves upstream of the analyzer when using a pump downstream of the analyzer to draw sample from a process at atmospheric pressure or a slight vacuum A pressurized sensor may not leak but still can produce negative readings. Placing a vacuum on the sensor in excess 40” of water column is strongly discouraged. The front sensing membrane is only 5/8 mil thick, heat sealed to the sensor body and is subject to tearing when vacuum is suddenly applied. A premature ZERO OFFSET of analyzer is a common problem Sensor output outside the recommended range Zero offset beyond the limit permitted Low Battery	Re-Zero the analyzer. If not successful replace the sensor Avoid drawing a vacuum on the sensor Remove restriction from vent line/open shut off valve completely Replace a leaking sensor From MAIN MENU select DEFAULT ZERO and perform a zero calibration again Replace sensor Perform DEFAULT ZERO, wait until the analyzer reading falls below 50% of the most sensitive range and perform zero calibration again Charge battery, if unsuccessful, replace battery

Fails span calibration	Integrity of span gas Sensor end of its useful life	Verify span gas Replace sensor
Fails Zero calibration	Integrity of zero gas Attempted premature calibration	Verify integrity of zero gas Wait and allow the analyzer reading to stabilize and re-zero the analyzer
Analyzer does not power up	Weak battery	Replace battery

9. Warranty

The design and manufacture of Advanced Instruments Inc. oxygen analyzers and oxygen sensors are performed under a certified Quality Assurance System that conforms to established standards 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 Owner's Manual, the units will provide many years of reliable service.

Coverage

Under normal operating conditions, the analyzers and sensors 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. Advanced Instruments Inc. reserves the right in its sole discretion to invalidate this warranty if the serial number does not appear on the analyzer.

If your Advanced Instruments Inc. monitor, analyzer and/or oxygen sensor 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 Advanced Instruments 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

Advanced Instruments Inc. will not pay for: loss of time; inconvenience; loss of use of your Advanced Instruments Inc. analyzer or property damage caused by your Advanced Instruments 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, these exclusions may not apply.

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

For service related questions, call Advanced Instruments Inc. at 909-392-6900 between 8:00am and 5:30pm Pacific Time Monday thru Thursday or before 12:00 pm on Friday (or e-mail info@aii1.com). 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:

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 Advanced Instruments 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	Aqueous solutions: KOH = Colorless, odorless or Acetic Acid = Colorless, vinegar-like odor

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).

Disposal	In accordance with federal, state and local regulations.

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

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