# Advanced Instruments Inc.

## Technical Specifications *

| | |
|---|---|
| Accuracy: | < 2% of FS range under constant conditions |
| Analysis: | 0-10, 0-100, 0-1000 PPM, 0-1%, 0-25% (CAL) FS Auto-ranging or manual lock on a single range |
| Application: | Oxygen analysis in inert, helium, hydrogen, mixed and acid ($CO_2$) gas streams |
| Approvals: | CE |
| Area Classification: | General purpose |
| Alarms: | Two adjustable form C relay contacts non-latching; "weak sensor" indicator; power failure; system failure |
| Calibration: | Max interval—3 months. Use certified span gas with O2 content (balance N2) approximating 80% of full scale for fast 20-30 minute recovery to online use. Alternatively, air calibrate with clean source of compressed or ambient (20.9% O2) air on 0-25% range and allow 60 minutes on zero gas to recover to 10 ppm. For optimum accuracy, calibrate one range higher than the range of interest. |
| Compensation: | Barometric pressure and temperature |
| Connections: | 1/4" compression tube fittings |
| Controls: | Water resistant keypad; menu driven range selection, calibration, alarm and system functions |
| Data Acquisition: | Selectable data point intervals |
| Display: | Graphical LCD 5" x 2.75"; resolution .01 PPM; displays real time ambient temperature and pressure |
| Enclosure: | Painted aluminum 7.5" x 10.8" x 12.25" panel mount |
| Flow: | Not flow sensitive; recommended flow rate 2 SCFH |
| Linearity: | > .995 over all ranges |
| Pressure: | Inlet - regulate to 5-30 psig to deliver 2 SCFH flow; vent - atmospheric |
| Power: | Universal 100-240 VAC; option heater system (specify 110 or 220 VAC) |
| Range ID: | 1-5V; Optional (1) 4-20mA non-isolated OR (2) relay contacts w/ 4-20mA or 1-5V |
| Recovery Time: | 60 sec in air to < 10 PPM in < 1 hour on $N_2$ purge |
| Response Time: | 90% of final FS reading < 10 seconds |
| Sample System: | Stainless steel wetted parts consisting of flow control and sample/bypass valves, flow indicator |
| Sensitivity: | < 0.5% of FS range |
| Sensor Model: | GPR-12-333 for non-acid (CO2) gas streams<br>XLT-12-333 for gas mixture with > 0.5% $CO_2$ |
| Sensor Life: | 24 months in < 1000 PPM O2 at 25°C and 1 atm |
| Signal Output: | 4-20mA isolated, 0-1V, and 0-5V |
| Temp. Range: | 5°C to 45°C (GPR sensor), -10°C to 45°C (XLT) |
| Warranty: | 12 months analyzer; 12 months sensor |

## Optional Equipment

19" rack, wall mounting, auto zero/cal, remote communication-contact factory

* Specification subject to change without notice.


# GPR-1600
# PPM Oxygen Analyzer

**Advanced Full Featured Process PPM O2 Analyzer**

## Advanced Sensor Technology

- Unmatched Performance in PPM O2 Analysis
- Unmatched Expected Life & Warranty
- Unmatched Recovery to 10 PPM
- Sensitivity < 0.5% FS Range
- Excellent Compatibility with 0-100% CO2

## Bypass Sample System

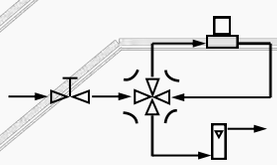
## 2 Field Selectable Alarm Setpoints

## Auto Ranging or Single Fixed

## Options: Temperature Control

## Auto-Zero and Auto-Cal

## Remote Communication via USB, RS232, RS485



Integral stainless steel bypass sample system significantly increases user productivity. The bypass valve isolates the sensor from high oxygen levels when changing sample lines.

**ISO 9001:2008 Certified**
**INTERTEK Certificate No. 485**

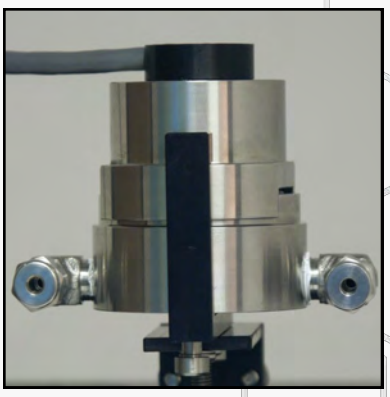
2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, www.aii1.com, e-mail: info@aii1.com Rev 10/15

# Advanced Instruments Inc.

**GPR-1600 W**

**GPR-1600 W306**

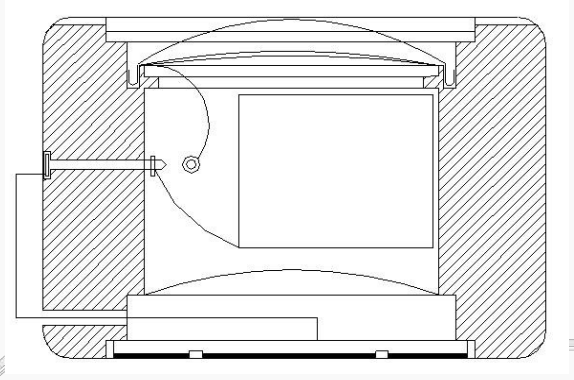
## The sensor is the heart of any analyzer . . . which means sensor technology is the critical factor in analyzer performance . . . don't settle, get the best !



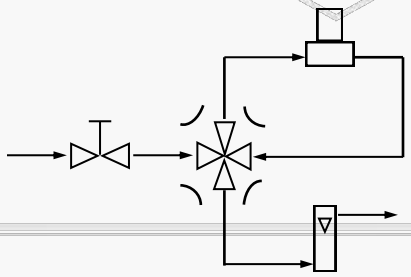
### Sensor Housing

Constructed from stainless steel as are all wetted parts, this unique design features a compression type o-ring seal that virtually eliminate air leaks.

An APIMS mass spectrometer verified that the Bypass Sample System including this housing is capable of accurately and repeatedly distinguishing hourly changes of 1 ppb oxygen concentration.



**Galvanic PPM Oxygen Sensor**



### Bypass Sample System

Integral stainless steel bypass sample system significantly increases user productivity. The bypass isolates the sensor from high oxygen levels when changing sample lines.

### Advancements:

Signal output 2x higher
Innovative design, materials
Proprietary mfg process
Insensitive to vibration
Retain compact design
Low cost of ownership

### Performance:

Accuracy < ± 1% FS
Sensitivity 0.5% FS (50 ppb)
Service life 24 mos < 100 ppm
Recovery air to 10 ppm < 1 hr.
Op temp -20ºC in 0-100% $CO_2$
No sensor maintenance

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

# *GPR-1600*
# *PPM Oxygen Analyzer*


# Owner's Manual

Revised October 2013

2855 Metropolitan Place, Pomona, California 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, e-mail: info@aii1.com

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# 1. Introduction

Your new oxygen analyzer is a precision piece of equipment designed to give you years of use in a variety of industrial oxygen applications.

This analyzer is designed to measure oxygen concentration in inert gases, gaseous hydrocarbons, hydrogen, and a variety of gas mixtures. In order to derive maximum performance from your new oxygen analyzer, please read and follow the guidelines provided in this Owner's Manual.

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

Serial Number: _____

Every effort has been made to select the most reliable state of the art materials and components designed for superior performance and minimal cost of ownership. This analyzer was tested thoroughly by the manufacturer for best performance. However, modern electronic devices do require service from time to time. The warranty included herein plus a staff of trained professional technicians to quickly service your analyzer is your assurance that we stand behind every analyzer sold.

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

# 2. Quality Control Certification

| | | | Pass |
|---|---|---|---|
| **Date:** | **Customer:** | **Order No.:** | |
| **Model:** | GPR-1600 PPM Oxygen Analyzer | **S/N** _____ | |
| **Sensor:** | ( ) GPR-12-333 PPM Oxygen Sensor<br>( ) XLT-12-333 PPM Oxygen Sensor | **S/N** _____ | |
| **Accessories:** | Owner's Manual<br>CABL-1008 Power Cord<br>TOOL-1001 5/16" Combination Wrench | | |
| **Configuration:** | Ranges: 0-10 PPM, 0-100 PPM, 0-1000 PPM, 0-1%, 0-25% | | |
| | A-1146-10 PCB Assembly Main / Display | **Software V.** _____ | |
| | ( X ) A-1146-10 PCB Power Supply / Interconnect, 1-5V Range ID | | |
| | ( ) A-1174-10 PCB Power Supply / Interconnect, 5x Relay Contacts Range ID | | |
| | ( ) Stainless steel sensor housing, manual flow control and bypass valves, ¼" compression type fittings for sample inlet and vent | | |
| | ( ) Delete sample/bypass valve from above (T and TO options) | | |
| | ( ) Sample, span, zero inlet solenoid valves | | |
| | ( X ) Temperature controlled heater system 85°F specify: ( ) 110VAC (X ) 220VAC | | |
| | Power: 100/120/220/250 VAC (universal without temperature controlled heater systems) | | |
| | Enclosure: ( X ) Std. panel mount ("T") 7.5x10.8x12"; ( ) "TO" option 7.75x 7.75x12" | | |
| | ( ) Bezel for 19" rack mount 19x12x12" option | | |
| | ( ) GPR-1600-W option general purpose wall mount 12x12x8" | | |
| | ( ) GPR-1600-W306 option general purpose panel mount 18.2x16x10" | | |
| **Test** | System start-up diagnostics satisfactory | | |
| | Auto/manual range | | |
| | Alarm relays activate/deactivate with changes in $O_2$ concentration | | |
| | Alarm bypass | | |
| | Analog outputs: Signal output 4-20mA | | |
| | Range ID: ( X ) 1-5 VDC or ( ) 5x relay contacts plus 1x common | | |
| | Recovery from air to < 10 PPM in < 60 minutes | | |
| | Baseline drift on zero gas < ± 2% FS over 24 hour period | | |
| | Noise level < ± 1.0% FS | | |
| | Span calibration gas value | | |
| | Span adjustment within 10-50% FS | | |
| | Peak to peak over/under shoot < 0.5% FS | | |
| | Overall inspection for physical defects | | |
| **Options** | | | |
| **Notes** | | | |

The certificate applies to the analyzer specifically ordered to use components for oxygen service. Check the QC of the analyzer to ensure whether such an option was ordered.

# Certificate of Cleaning

# Oxygen Service

| | |
|---|---|
| Standard: | Manufacturing Procedure No. P-1057 Rev-1,<br>Compressed Gas Association,<br>Publication: G-4.1 Edition 4,<br>Title: Cleaning Equipment for Oxygen Service,<br>Published 1/1/1996 and related publications |
| Mfg. Item No.: | GPR-1600 Series |
| Description: | ppm Oxygen Analyzer |
| Serial No.: | _____ |
| Customer: | _____ |
| Purchase Order: | _____ |
| Quantity: | 1 of |
| Warranty Date: | 12 months from _____ |

The undersigned warrants on behalf of Manufacturer that the product identified above conforms to the manufacturing, testing and packaging criteria set forth by the 'Standard' specified above.

| | |
|---|---|
| Date: | _____ |
| Place: | Pomona, CA |
| By print name: | _____ |
| Signature: | _____ |
| Title: | _____ |

# Declaration of Conformity

| | |
|---|---|
| Directives: | 2006/95/EC Low Voltage<br>2004/108/EC Electromagnetic Compatibility |
| Standards: | EN 61010-1 Safety<br>EN 61326-1 Minimum Immunity Test<br>ISO 9001:2008 |
| Compliance: | All applicable standards |
| Products: | General purpose online oxygen analyzers:<br>GPR-1600UHP series<br>GPR-1600MS series GPR-16MS series<br>GPR-1600 series GPR-16 series<br>GPR-1900 series GPR-19 series<br>GPR-2600 series GPR-26 series<br>GPR-2900 series GPR-29 series<br>GPR-3100 series GPR-31 series<br>GPR-1500 series GPR-15 series<br>GPR-2500 series GPR-25 series<br>GPR-1500AIS GPR-15A series<br>GPR-1800AIS GPR-18MS/18/28<br>GPR-2500AIS GPR-980 series<br>GPR-2800AIS GPR-35<br><br>General purpose portable oxygen analyzers:<br>GPR-1200MS series GPR-12MS series<br>GPR-1200 series GPR-12 series<br>GPR-1100 series GPR-11 series<br>GPR-1000<br>GPR-2000 series GPR-20 series<br>GPR-3000 series GPR-30 series<br>GPR-3500MO GPR-35MO |
| Intended Use: | Analyze oxygen concentration in a gas mixture in a non-explosive atmosphere. |
| Manufacturer: | Analytical Industries, Inc. dba Advanced Instruments, Inc.,.<br>2855 Metropolitan Place<br>Pomona, California 91767 USA<br>Tel: 909-392-6900, Fax: 909-392-3665<br>e-mail: info@aii1.com |
| Date: | September 15, 2013 |
| Place: | Pomona, California 91767 USA |

We hereby declare the above product meets the provisions of the directives and standards specified. All supporting documents are retained on the premises of the manufacturer and the notified body above.

Patrick Prindible
Vice President & QA Manager

# 3. Safety Guidelines

## 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 to **CAUTION** and alert the user to recommended safety and/or operating guidelines.

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

**Read Instructions:** Before operating the analyzer read the instructions.

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

**Heed Warnings Follow 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 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 analyzer 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 this Owner's Manual. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.

**Troubleshooting:** Consult the guidelines in section 8 for advice on the common operating errors before concluding that your analyzer is faulty. Do not attempt to service the analyzer beyond those means described in this Owner's Manual.

Do not attempt to make repairs by yourself as this will void the warranty, as detailed by section 9, and may result in electrical shock, injury or damage. All other servicing should be referred to qualified service personnel.

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

**Nonuse Periods:** Disconnect the power when the analyzer is left unused for a long period of time.

# Installation

**Gas Sample Stream:** Ensure the gas stream composition of the application is consistent with the specifications of the analyzer/sensor and review the application conditions before initiating the installation. Consult factory to ensure the sample is suitable for analysis.

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

**Expected Sensor Life**
With reference to the publish specification located as the last page of this manual, the expected life of all oxygen sensors is predicated on the basis of oxygen concentration (< 10,000 PPM), temperature (77°F/25°C) and pressure (1 atmosphere) in "normal" applications. As a rule of thumb sensor life is inversely proportional to changes in the parameters. Deviations of the gas concentration and or temperature outside of the specifications will affect the life of the sensor. Avoid exposure to oxygen levels above 1% (10,000 PPM) for hours at a time.

Failure to do so may result in damage to the sensor(s) as follows:

- GPR Series PPM sensors – reduced sensor life and loss of low end sensitivity when exposed continuously to 20.9% oxygen; sensor will last approximately 6-8 months and may develop a low end offset > 1-2 PPM
- XLT Series PPM sensors - reduced sensor life and loss of low end sensitivity (XLT sensor exposed continuously to the 20.9% O2 content of air will last approximately 7 days).

**Accuracy & Calibration**
Refer to section 5 Operation. The 0-25% Range is provided only for the purpose of air calibration which is recommended only if span gas is not available. Bringing the analyzer back online after calibration with the 20.9% oxygen content of air, takes longer than calibrating the analyzer with a span gas, for example, 80 PPM oxygen.

**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 PPM measurements.

**Operating Temperature**
The sample must be sufficiently cooled before it enters the analyzer and any optional components. A coiled 10 foot length of ¼" stainless steel tubing is sufficient for cooling sample gases as high as 1,800ºF to ambient. The maximum recommended operating temperature is 45º C. On an intermittent basis, unless the user is willing to accept a reduction in expected sensor life – refer to analyzer specification, the analyzer may be operated at 50 degree $^{o}$C. At temperatures above 25$^{o}$C, the user can expect a reduction in sensor life of ~ 2.5% per degree increase in temperature. As an example, if the analyzer is continuously operated at 35$^{o}$C, the expected sensor life will be reduced by ~25%.

**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 in a confined space in a control room or an open area such as a landfill or bio-pond).

Sample systems and flowing gas samples are generally required for applications involving oxygen measurements in a gas mixture. For sub PPM measurements, the use of stainless steel tubing and fittings is critical to maintaining the integrity of the gas stream to be sampled. Further, the inlet sample pressure must always be higher than the pressure at the outlet vent, which is normally at atmospheric pressure.

To analyze a gas stream, the gas must flow or be drawn through the sensor housing. The internal sample system of the analyzer may include sample/bypass valves, shut off valve, a flow control (please check the QC sheet to ensure

the included sample system), a flow indicator and a stainless steel sensor housing with an o-ring seal to prevent the leakage of air into the sensor housing.

**Inlet Pressure**
Analyzers designed for flowing samples under positive pressure or for samples at atmospheric or slightly negative atmospheres, are equipped with bulkhead tube fitting connections at the rear of the analyzer. The recommended operating sample pressure is between 5-30 PSIG.

A pressure greater than 30 PSIG may prevent the solenoid valves from operating properly (GPR-1600-AV only). Further, the pressure of Sample, Span and Zero gas must be within 10 PSIG for ease of control of gas flow rate.

**Outlet Pressure**
In positive sample pressure applications, the sample must be vented to ambient air or in a vent with pressure less than the sample inlet pressure. If the sample is vented to a line at pressure above ambient, a back pressure regulated set at no greater 1-2 PSIG must be installed on the downstream of the sensor to ensure a constant pressure on the sensor.

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

The analyzer is equipped with a flow control valve with a flow indicator upstream of the sensor housing. A flow rate of 2 SCFH or 1 liter per minute is recommended for optimum performance.

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

**Recommendations to avoid erroneous oxygen readings and damaging the sensor:**
- Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor.
- Assure there are no restrictions in the sample or vent lines.
- Avoid excessive flow rate, flow rate above 5 SCFH may generate backpressure on the sensor.
- Avoid sudden releases of backpressure that can severely damage the sensor.
- Avoid the collection of liquids or particulates on the sensor, they block the diffusion of oxygen into the sensor - wipe away any liquid and particulate with a damped cloth only.

**Moisture & Particulates**
Installation of a suitable coalescing and or particulate filter is required to remove liquid condensates, and/or particulates from the sample gas to prevent clogging of the sampling system. Moisture and/or particulates do not necessarily damage the sensor itself but collection of moisture/particulate on the sensing surface can block or inhibit the diffusion of sample gas into the sensor thus resulting in a reduction of sensor signal output – and the appearance of a sensor failure. Consult factory for recommendations concerning the proper selection of coalescing/particulate filters.

Moisture and/or particulates collected at the sensor may be removed by either blowing on the sensing surface or gently wiping the sensing surface with damp cloth.

**Caution:** Minimize the exposure of sensor to air during this cleaning process. Air calibration followed by purging with zero or a gas with a low PPM oxygen concentration is recommended following the cleaning process.

**Mounting**
The standard analyzer is approved for indoor use only. Outdoor use requires optional enclosures, consult factory. Mount analyzer as recommended in this manual.

The analyzer is configured for panel mounting and requires a 7.5x10.8" (T configuration) cutout with 4 holes for the analyzer's front panel. Optional configurations include a panel mount (TO configuration) with 7.75x7.75" cutout; 19" bezel for rack mounting either the T or TO; 12x12x8" wall mount enclosure (GPR-1600W) and 18.2x16x10" panel mount configuration (GPR-1600W-306).

**Gas Connections**

Sample Inlet and Sample Vent gas lines for PPM analysis require 1/8" or ¼" stainless steel compression fittings; hard plastic tubing with a low gas permeability factor may be used for measurements of oxygen above 1000 PPM.

**Power**

Supply power to the analyzer only as rated by the specification or markings on the analyzer enclosure. The wiring that connects the analyzer to the power source should be installed in accordance with recognized electrical standards. Ensure that the analyzer enclosure is properly grounded and meets the requirements of recommended local electrical standards.

Never yank wiring to remove it from a terminal connection.

**AC powered analyzers consume a maximum of 30 watts, without the optional heaters. With optional 110 VAC or 220 VAC heaters installed, the maximum power consumption is 230 watts**.

# 4. Features & Specifications

Advanced Instruments Inc.

## Technical Specifications *

| | |
|---|---|
| Accuracy: | < 2% of FS range under constant conditions |
| Analysis: | 0-10, 0-100, 0-1000 PPM, 0-1%, 0-25% (CAL) FS Auto-ranging or manual lock on a single range |
| Application: | Oxygen analysis in inert, helium, hydrogen, mixed and acid ($CO_2$) gas streams |
| Approvals: | CE |
| Area Classification: | General purpose |
| Alarms: | Two adjustable form C relay contacts non-latching; "weak sensor" indicator; power failure; system failure |
| Calibration: | 3 month interval using certified span gas (preferred for fastest online time) or air with O2 value approximating 80% of full scale range balance N2 |
| Compensation: | Barometric pressure and temperature |
| Connections: | 1/8" compression tube fittings |
| Controls: | Water resistant keypad; menu driven range selection, calibration, alarm and system functions |
| Data Acquisition: | Selectable data point intervals |
| Display: | Graphical LCD 5" x 2.75"; resolution .01 PPM; displays real time ambient temperature and pressure |
| Enclosure: | Painted aluminum 7.5" x 10.8" x 12.25" panel mount |
| Flow: | Not flow sensitive; recommended flow rate 2 SCFH |
| Linearity: | > .995 over all ranges |
| Pressure: | Inlet - regulate to 5-30 psig to deliver 2 SCFH flow; vent - atmospheric |
| Power: | Universal; specify 100 or 200 VAC for heater system |
| Range ID: | Voltage, 4-20 mA or relay contacts |
| Recovery Time: | 60 sec in air to < 10 PPM in < 1 hour on $N_2$ purge |
| Response Time: | 90% of final FS reading < 10 seconds |
| Sample System: | Stainless steel wetted parts consisting of flow control and sample/bypass valves, flow indicator |
| Sensitivity: | < 0.5% of FS range |
| Sensor Model: | GPR-12-333 for non-acid (CO2) gas streams<br>XLT-12-333 for gas mixture with > 0.5% $CO_2$ |
| Sensor Life: | 24 months in < 1000 PPM O2 at 25ºC and 1 atm |
| Signal Output: | 4-20mA isolated or 0-1V |
| Temp. Range: | 5ºC to 45ºC (GPR sensor), -20ºC to 45ºC (XLT) |
| Warranty: | 12 months analyzer; 12 months sensor |

## Optional Equipment

19" rack, wall mounting, auto zero/cal, remote communication-contact factory

* Specification subject to change without notice.

### *GPR-1600*
### *PPM Oxygen Analyzer*

**Advanced Full Featured Process PPM O2 Analyzer**

**Advanced Sensor Technology**

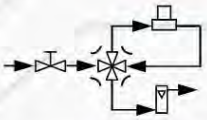
- Unmatched Performance in PPM O2 Analysis
- Unmatched Expected Life & Warranty
- Unmatched Recovery to 10 PPM
- Sensitivity < 0.5% FS Range
- Excellent Compatibility with 0-100 CO2

**Bypass Sample System**

**2 Field Selectable Alarm Setpoints**

**Auto Ranging or Single Fixed**

**Options: Temperature Control**
**Auto-Zero and Auto-Cal**
**Remote Communication**



Integral stainless steel bypass sample system significantly increases user productivity. The bypass valve isolates the sensor from high oxygen levels when changing sample lines.

**ISO 9001:2008 Certified**
**INTERTEK Certificate No. 485**

2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, www.aii1.com, e-mail: info@aii1.com Rev 3/12

# 5. Operation

## 5.1 Principle of Operation

The GPR-1600 Oxygen Analyzers incorporates a variety of PPM range advanced galvanic fuel cell type sensors. The analyzer is configured for panel mounting and requires a 7.5x10.8" (T configuration) cutout with 4 holes for the analyzer's front panel. Optional configurations include a panel mount (TO configuration) 7.75x7.75" with cutout; 19" bezel for rack mounting either the T or TO; 12x12x8" wall mount enclosure (GPR-1600W); 18.2x16x10" panel mount configuration (GPR-1600W-306) using the wall mount enclosure. Contact the factory for additional information on options. All configurations are tested and calibrated by the manufacturer prior to shipment.

The GPR-1600 series analyzers and sensors conform to CE standards and are manufactured under a Quality Assurance System, certified by an independent agency, in accordance with ISO 9001:2004 standards.

## Advance Galvanic Sensor Technology

All galvanic sensors function on the same principle and are specific to oxygen. They measure the partial pressure of oxygen ranging from low PPM to 100% levels in inert gases, gaseous hydrocarbons, helium, hydrogen, mixed gases and acid gas streams. **Oxygen, the fuel for this electrochemical transducer, diffuses 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 over all measuring ranges and remains virtually constant over its useful life. The sensor requires no maintenance and is easily and safely replaced at the end of its useful life.

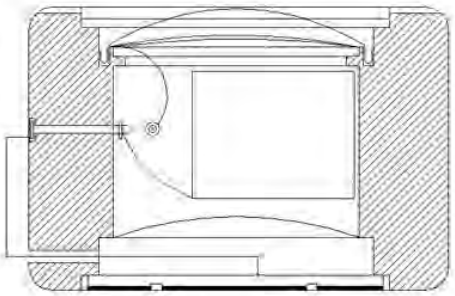
Proprietary advancements in the design and chemistry add significant advantages to an extremely versatile oxygen sensing technology. Sensors for low PPM analysis recover from air to PPM levels in minutes, exhibit longer life, offer extended operating range of -20°C to 50°C, have excellent compatibility with $CO_2$ and acid gases (XLT series sensors) and reliable quality thus giving the user a significant advantage over other competitors. Other advancements include extending the expected life of our new generation of percentage range sensors to five to ten years with faster response times and greater stability. Another significant development involves the first galvanic oxygen sensor capable of measuring oxygen purity continuously and expanded operating temperature range from -40°C to 50°C. Consult factory for selection of sensors for your specific applications.

**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 –20ºF to 50º F
- Develop special sensor for high ppm/low % applications



GPR/XLT 12 Series ppm Oxygen Sensor

# 5.2 Electronics

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

Sensor's response time of 90% of a "step change" is less than 10-30 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 of the lowest range of analysis.

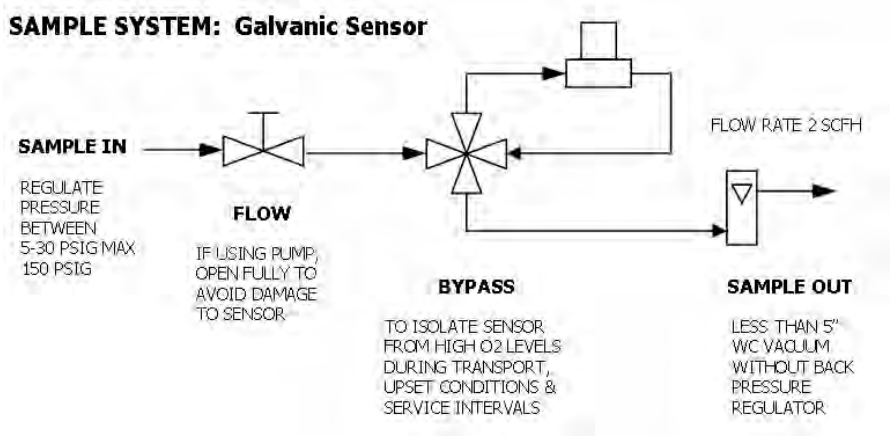
Additional features of the micro-processor based electronics include manual or auto ranging, auto-zero and auto-cal, isolated 4-20mA signal for signal output, optional 4-20 mA as range ID, separate relay contacts rated 30 VDC max @ 1A or 110/220 VAC @ 5A are provided for the alarm feature. Optional range ID contacts are rated at 30 VDC @1A.

Whenever the analyzer is span calibrated, a unique algorithm predicts and displays a message indicating a 'weak sensor' (if the sensor output has fallen below a certain level), suggesting the sensor be replaced in the near future.

# 5.3 Sample System

For accurate measurements, the sample gas must be properly presented to the sensor. In standard form, the GPR-1600 is equipped with a sample system that complements the performance capabilities of the advanced oxygen sensor.

The integral sample system of the analyzer is shown schematically below (please check the QC sheet in this manual to ensure the analyzer is equipped with the sample system ordered).

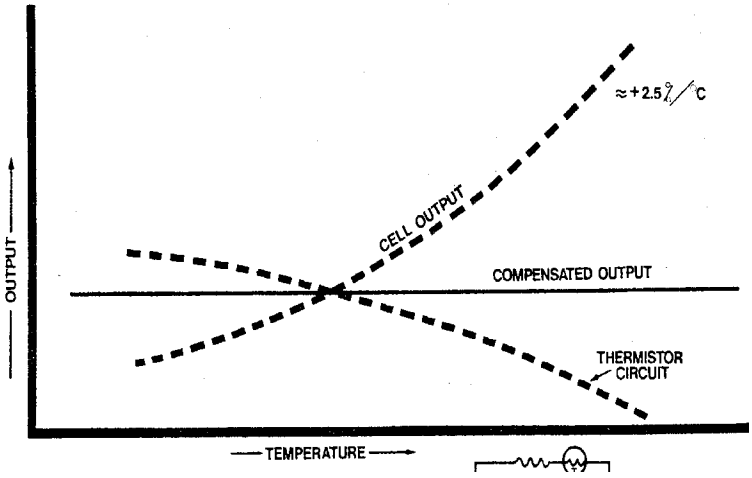



Advanced Instruments Inc. offers a full line of sample handling, conditioning and expertise to meet your application requirements. Contact us at 909-392-6900 or e-mail us at info@aii1.com for your specific requirements.

# 5.4 Accuracy Overview

**Single Point Calibration:** As previously described the galvanic oxygen sensor generates an electrical current proportional to the oxygen concentration in the sample gas. In the absence of oxygen the sensor exhibits an absolute zero, e.g. the sensor does not generate a current output in the absence of oxygen. Given the 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'. For best accuracy, the pressure of the sample gas and that of the calibration gas must be the same (in reality within 2-5 psi) so that when the SAMPLE/SPAN gases are switched, the gas flow rate would not drastically change.




**Temperature:** The rate at which oxygen molecules diffuse into the sensor is controlled by a Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier. The fact that all diffusion processes are temperature sensitive, the sensor's electrical output also varies with temperature. This variation is relatively constant (2.5% per ºC change in temperature). A temperature compensation circuit employing a thermistor offsets this effect with an accuracy of ±5% or better (over the operating temperature range of the analyzer) and generates an output signal that is virtually independent of small ambient temperature variation. To minimize error in oxygen measurement, the calibration of the analyzer should be carried out as close as possible to the temperature during sampling. A small temperature variation of ~10º F will produce < 2% error.

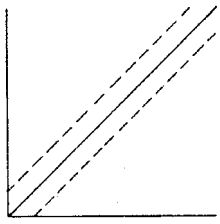
**Accuracy:** In light of the above parameters, the overall accuracy of an analyzer is affected by two factors:

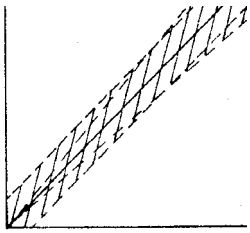
1) 'Percent of reading errors', illustrated by Graph A below, such as ±5% inherited error in the temperature compensation circuit due to the tolerances of the resistors and thermistor.

2) 'Percent of full scale errors', illustrated by Graph B, such as ±1-2% linearity errors generally associated with tolerances in the electronic components, which are really minimal due to today's technology and the fact that other errors are 'spanned out' during calibration.

Graph C illustrates these 'worse case' specifications that are typically used to develop an analyzer's overall accuracy statement of < 1% of full scale at constant temperature or < 5% over the operating temperature range. QC testing is typically < 1% prior to shipment.


A. PERCENT OF READING ERRORS


B. PERCENT OF FULL SCALE ERRORS


C. OVERALL ACCURACY

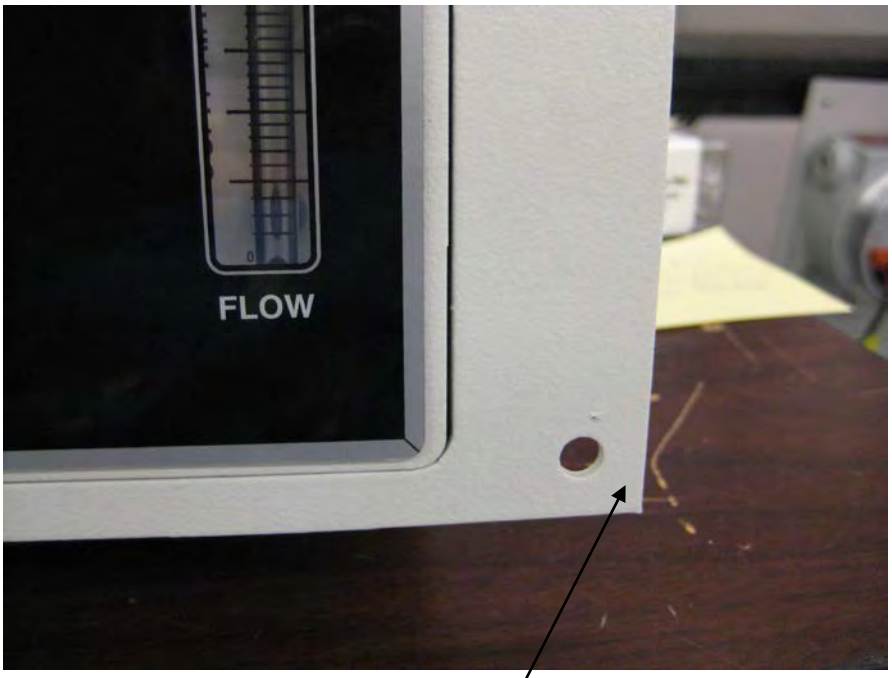
**Example 1:** As illustrated by Graph A any error during a span adjustment, e.g., at 20.9% (air) of full scale range would be multiplied by a factor of 4.78 (100/20.9) when used for measurements of 95-100% oxygen concentrations. Conversely, an error during span adjustment at 100% of full scale range will be reduced proportionately for measurements of lower oxygen concentrations. Refer to the Calibration section for additional details.

# 5.5 Mounting the Analyzer

The standard GPR-1600 is designed to be panel mounted and requires a cutout that accommodates the enclosure and 4 mounting bolts. The design also lends itself to 19" rack mounting with an optional bezel or wall mount enclosures as illustrated below.

# 5.5.1 Procedure

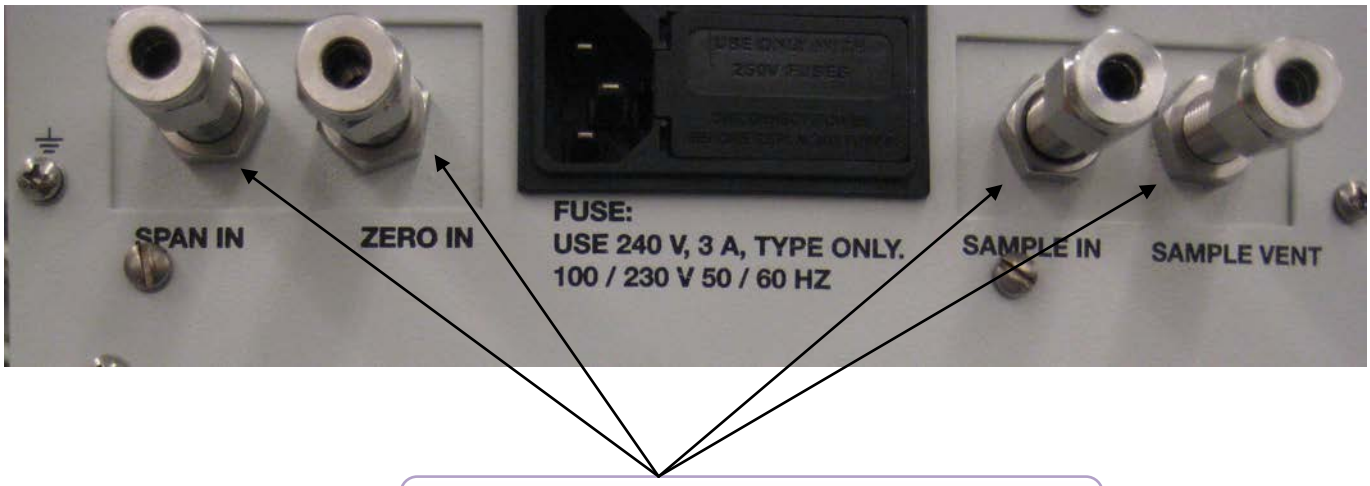
1. The standard GPR-1600 is designed for panel mounting directly to any flat vertical surface, wall or bulkhead plate with the appropriate cut out and four ¼" diameter holes for insertion of the mounting studs through the front mounting bazel.
2. When mounting the analyzer, position it approximately 5 feet above the floor for better viewing purposes and easy access to various functions of the analyzer. Leave sufficient room for access to the terminal connections at the rear of the enclosure.
3. **Note:** The proximity of the analyzer to the sample point and use of optional sample conditioning components, such as a sample cooling coil, a coalescing filter and or a particulate filter may have an impact on sample lag time and hence the analyzer response time.




Four mounting holes on four corners to secure analyzer on a flat vertical surface

# 5.5.2 Gas Connections

The GPR-1600 with its standard flow through configuration is designed for positive sample pressure and requires ¼" compression type connections for incoming sample, span and zero gas and outgoing vent lines.



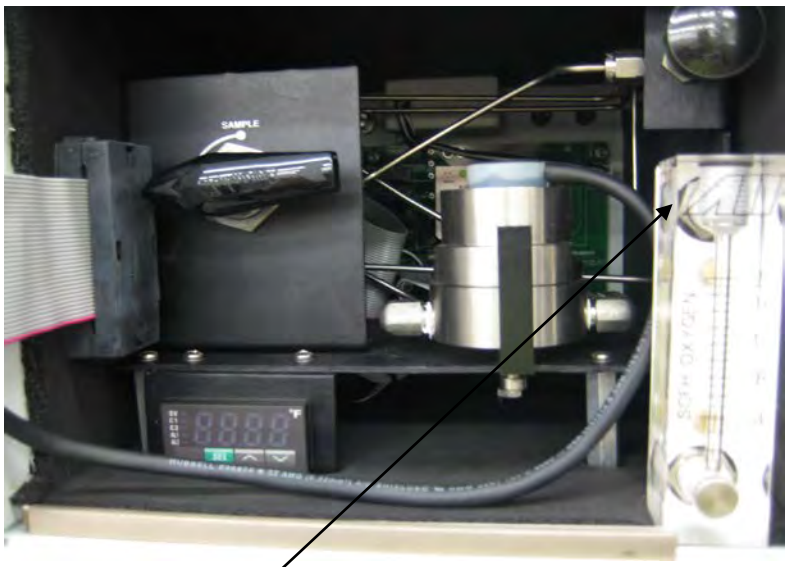

Rear of analyzer showing the SAMPLE, SPAN, ZERO AND VENT ports (Span and Zero ports are optional)

The user is responsible for providing calibration gases and other optional components (if not purchased with the analyzer).

**Caution:** The sample, span and zero gas pressure must be set between 5-30 PSIG and must be within 5 PSIG of each gas. Failure to do so will cause a sudden spike in the gas flow when switching from sample to span/zero gas and back which may cause an upward/downward spike on the analyzer signal output.

**Flow Control Valve:** A flow control valve is mounted upstream of the sensor and provides means of controlling the flow rate of the sample, span and zero gases. Sample flow rate of 1-5 SCFH cause no appreciable change in the oxygen reading. However, for optimum performance, a flow rate of 1-2 SCFH is recommended.

**Caution:** Do not place your finger over the fitting designated as the vent (it pressurizes the sensor) to test the gas flow. Blocking of the gas vent will pressurize the sensor and by suddenly removing finger, a slight vacuum will be pulled on the sensor which may damage the sensor.



Flow Control Valve

# 5.5.3 Procedure

1. **Caution:** Do not change any of the factory's setting until instructed.
2. Regulate the sample gas pressure and sample flow as described in the section "Pressure & Flow" above.
3. Install the "Sample Vent" line connection to the fitting labeled SAMPLE VENT.
4. Install the incoming sample, span and zero gas line to the fitting labeled SAMPLE, SPAN and ZERO (Span and Zero ports are optional, check the QC certificate for the options included with your analyzer).
5. Set the flow rate to 1-2 SCFH.
6. Keep the Sample/Bypass Valve at Bypass position.
7. Allow gas to flow through the analyzer for 3-5 minutes before proceeding for installation of sensor (the analyzer is generally shipped with the sensor installed but if the sensor is included in a separate sealed bag, follow instructions to install the sensor Section 5.7).

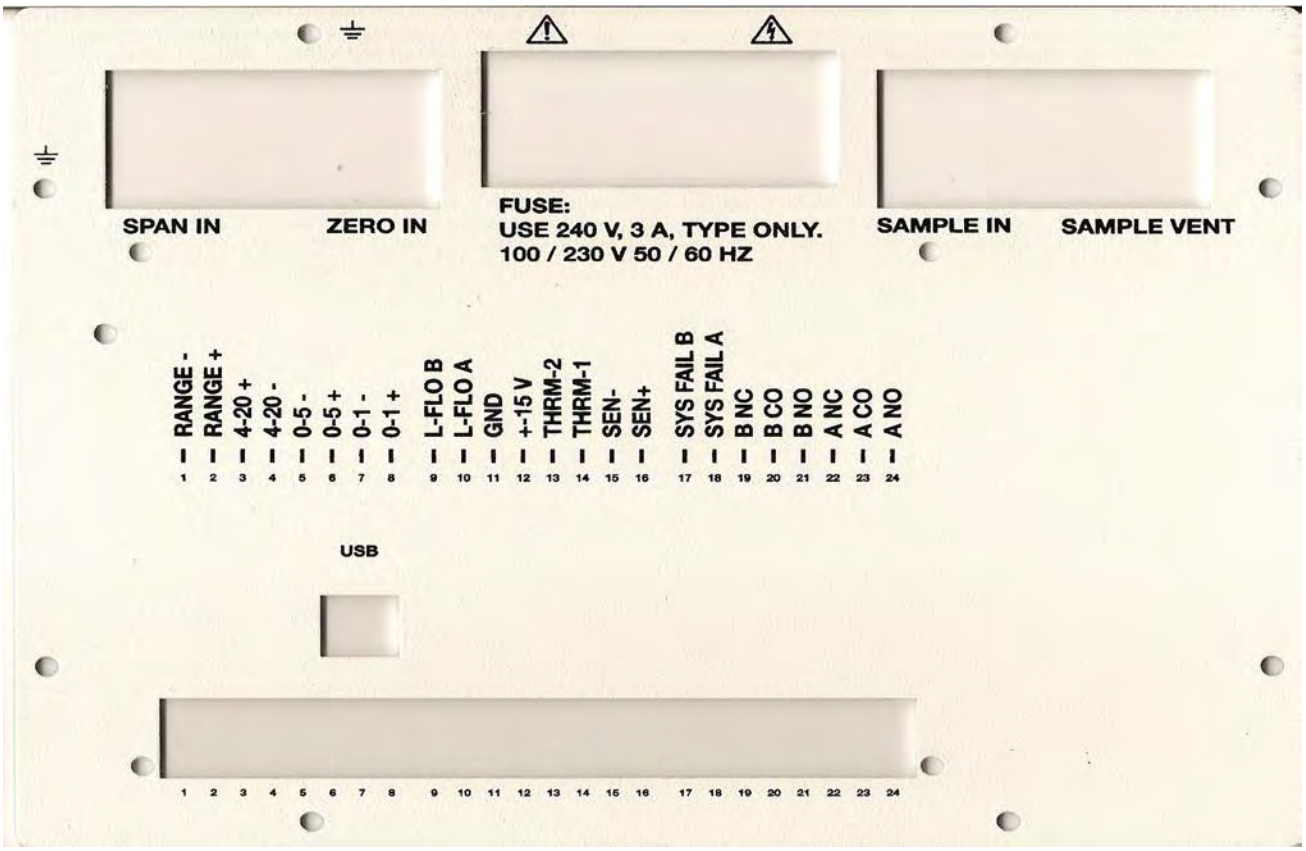
# 5.6 Electrical Connections

Incoming power for the 100-250V AC powered analyzers is supplied through a universal power entry module. A standard computer type power cord (Part# A-1008) is required for the universal power entry module. A well grounded insulated power cable is recommended to avoid noise resulting from unwanted interference.

The appropriate AC power supply (110V or 220V) must specified be specified at order placement if the analyzer is to be equipped with a temperature controlled heater system.

Power consumption is approximately 30 watts without optional heater and 150-200 watts with the heater system.

**Caution:** Integral 4-20mA converters are internally powered and do not require external power. DO NOT supply any voltage to any of the terminals of the 4-20 mA signal output or the 4-20 mA range ID. If a power is supplied, the 4-20 mA chip can be permanently damaged.

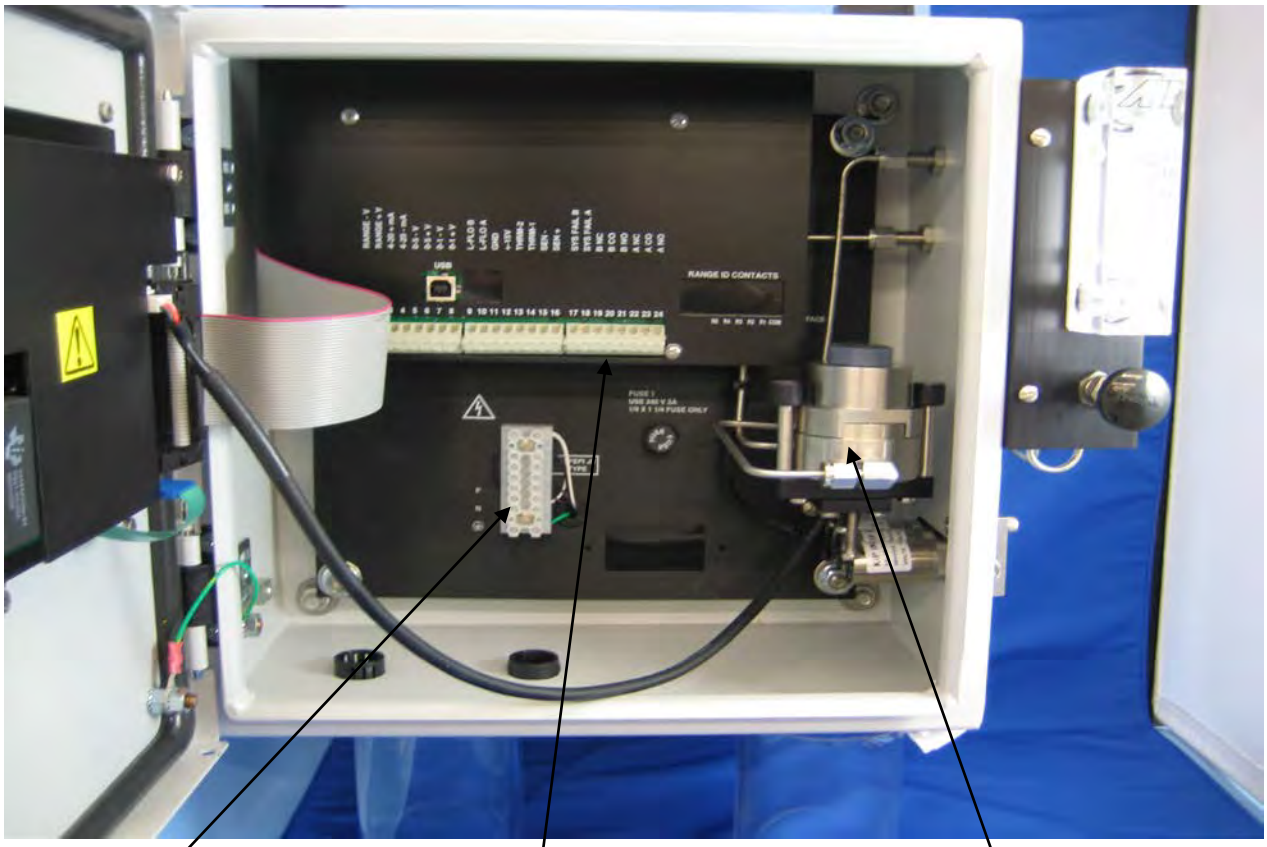


**Optional Range ID**

The standard 1-5 VDC output is provided for range identification, as described below. An optional 4-20 mA signal or 5 independent relay contact representing 5 ranges amy be provided as well. Check the QC certificate to verify the option(s). The appropriate relay contact will close when a specific range is selected. The dry contacts are rated at 30VDC @ 1A.

The voltage or 4-20 mA Range ID; Range 1= 5V or 20 mA
Range 2 = 4V or 16 mA
Range 3 = 3V or 12 mA
Range 4 = 2V or 8 mA
Range 5 = 1V 0r 4 mA

**Interior of the GPR-1600 with optional Wall Mount Enclosure**



# 5.6.1 Procedure

1. As illustrated above the alarm relays and signal output connections are hard wired to push-open type terminal blocks located at the rear of the analyzer.
2. Use a small bladed screwdriver to push the lever down and insert the stripped end of the wire into the slot. **NOTE:** Strip insulation of the wires no more than 3/16 inch in length.
3. Insert the stripped end of the cables into the appropriate terminal slots assuring no bare wire remains exposed that could come in contact with the back panel of the analyzer enclosure.
4. Release the lever to secure the wires in the receptacle.
5. To connect to an active relay or "fail safe", connect the live cable to the common terminal C and the secondary cable to the normally open NO terminal.
6. To break the connection upon relay activation, connect the secondary cable to the normally closed NC terminal.

**Danger:** While connecting the cables to the relay terminals, ensure there is no voltage on the cables to prevent electric shock and possible damage to the analyzer.

**Caution:** Assure the stripped wire ends of the cable are fully inserted into the terminal slots and do not touch each other or the back panel of the analyzer enclosure.

# 5.6.2 Oxygen Level Alarms

The analyzer is configured with two user adjustable threshold type alarm relays that can be configured in the field from the ALARM option on the MAIN MENU as follows:

- Establish independent alarm set points
- Either Hi or Lo oxygen condition
- Either On or Off (enabled or disabled)
- Both alarms may be temporarily defeated using a user entered 'timeout' period (normally in minutes)

The alarm set point represents an oxygen value. When the oxygen reading exceeds (high alarm) or falls below (low alarm) the alarm set point, the relay is activated and the LCD displays the alarm condition.

When activated, the alarm function triggers the corresponding SPDT Form C non-latching relay rated @ 5A, 30VDC or 240VAC resistive. To prevent chattering of the relays, a 2% hysteresis is added to the alarm set point. This means that the alarm will remain active until the oxygen reading has fallen 2% below the alarm set point (high alarm) or risen 2% above the alarm set point (low alarm) after the alarm was activated. The timeout feature is useful while replacing the oxygen sensor or during calibration when the oxygen reading might well rise above the alarm set point and trigger a false alarm.

**Note:** When making connections the user must decide whether to configure/connect Alarm 1 and Alarm 2 in failsafe mode (Normally Open – NO – where the alarm relay de-energizes and closes in an alarm condition) or non-failsafe mode (Normally Closed – NC – where alarm relay energizes and opens in an alarm condition).

# 5.6.3 Power/System Failure Alarm

A dry contact rated at 30VDC @ 1A is provided as a power/system failure alarm that activates when power supplied to the analyzer's circuits is interrupted. The contact is normally closed but opens when the power to the analyzer is switched off or interrupted. The power fail alarm cannot be disabled.

# 5.6.4 4-20 mA Signal Output

The analyzer provides a 4-20mA full scale signal with a fully isolated ground for external recording devices. The integral IC on the main PCB provides 4-20mA fully isolated signals for output and optional range ID. This IC does not require any external power. To check the signal output of the 4-20mA E/I integrated circuit connect an ammeter as the measuring device and confirm the output is within ±0.1mA of 4mA (without sensor installed or with the sensor Bypass switch to OFF position). A finer adjustment of the zero offset of the 4-20mA converter can be achieved by using AII Configuration Software via a PC. Consult factory for instructions.

# 5.6.5 Range ID

The standard range ID is designated with a voltage output corresponding to a specific range. For example, 5V corresponds to the least sensitive range (25% on the GPR-1600 analyzer) and drops 1V for each additional range. Optional 4-20 mA signal as range ID is also available. With 4-20 mA range ID option, 20mA represents the least sensitive range and it drops by 4mA (16mA, 12mA, 8mA, 4mA) for each additional range. Please check the QC sheet to confirm the range ID option ordered.

Relay contacts associated with each range may also be provided as range ID. With relay contacts as range ID, the common pin of all relays is connected to the terminal marked COMM and five (5) normally open relay contacts that close when the related range is active. The dry contacts are rated at 30VDC @ 1A.

**Caution:** The integral 4-20mA converters are internally powered and do not require external power. Applying any external voltage will permanently damage the 4-20mA converter.

# 5.6.6 Loss of Flow Alarm

The analyzer may be equipped with an optional integral loss of flow/low flow alarm. The alarm is set at 1.5 SCFH. The contact will close when the gas flow exceeds 1.5 SCFH but will open when the gas flow falls below 1.5 SCFH. The set point is relatively rough, therefore, to prevent false alarm, set the gas flow rate above 2 SCFH. Check the QC certificate to verify whether this option is available with your analyzer.

The contact is rated at 1A@30 VDC. Do not exceed the recommended rating.

# 5.6.7 Temperature Controlled Heater System with Thermal Runaway Protection

The standard GPR-1600 Series analyzer is generally not equipped with the heater system. However, in anticipation of very low PPM (less than 0.2 PPM) oxygen analysis, the user may elect to add the heater system. If the analyzer is equipped with an optional temperature controlled heater system, open the front door of the analyzer to access it. This unit is a PID controller which operates between 0-99°F. At the factory the controller is programmed to maintain the temperature at 85°F.


**Caution:** Do not change this setting. A higher temperature setting may drastically reduce sensor life and possibly cause damage to the electronic circuitry of both the controller and the analyzer.

**Warning:** Keep the front door securely fastened and closed when the temperature controller is ON.

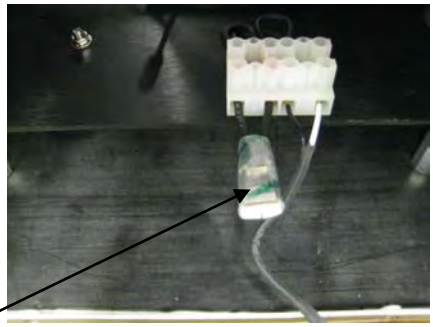
When power is applied to the temperature controller, the controller tunes itself to eliminate and/or minimize the over/under shoot of temperature from the set point. It is recommended that at initial start-up, when replacing the oxygen sensor or when trouble shooting, turn off the power to the heater (by setting the temperature set point at 60°F to prevent overheating the analyzer). When operating the analyzer under normal conditions, set the temperature controller at 85ºF.

Changing the display value from °F to °C:
1. Push the UP ARROW and ENTER buttons down for 5 seconds to access the SECURE MENU
2. Press INDEX to advance to the F-C MENU
3. Select °C or °F by pressing the UP ARROW key
4. Press the ENTER key when F-C starts flashing on the display
5. Press INDEX to exit the SECURE MENU

**Heater Runaway Protection**
Part of the optional temperature controlled heater system is a heater runaway protection circuit that protects the electronics in the event the temperature controller should fail and thereby allowing the heater to runaway damaging the components inside the analyzer.

The runaway protection is provided by a J2 type device positioned between the temperature controller and the heater. This device cuts-off power to the heater if the temperature inside the analyzer exceeds 70°C. Should the J2 device cut power to the heater, correct the problem and reset the runaway protector device (J2 will conduct under normal conditions) by exposing it to 0°C for a few minutes (a refrigerator freezer will do). NOTE, should the J2 fail to reset itself, replace it.

To access the J2, remove the back cover of the analyzer. The j2 is mounted on a white terminal block as shown in the figure above.

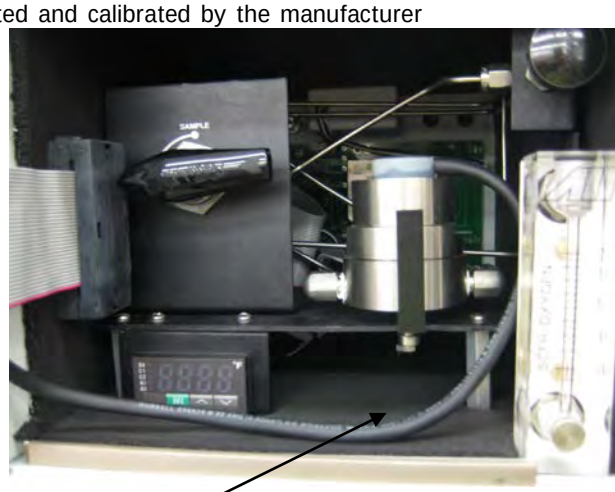


J2 device

# 5.7 Installing a new Oxygen Sensor

The analyzer is equipped with an internal oxygen sensor that has been tested and calibrated by the manufacturer prior to shipment and is fully operational from the shipping containers. The sensor has been installed at the factory. However, it may be necessary to install the sensor in the field. **Caution:** Complete "ESTABLISHING POWER TO ANALYZER" section before proceeding.

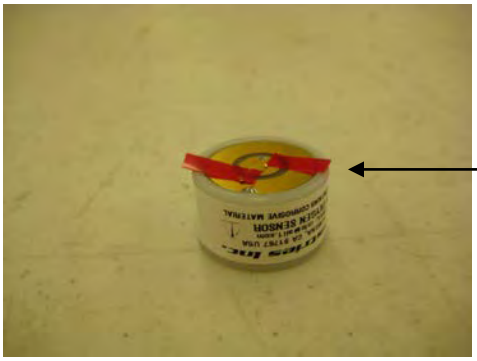
**Caution:** DO NOT open/dissect the sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual appendix. Avoid contact with any liquid or crystal type powder in or around the sensor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



Nut holding two sections of the sensor housing

# 5.7.1 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. Loosen the nut at the bottom of the sensor housing with 5/16" ranch provided.
5. Twist the upper section of the sensor housing 90 degree and then pull it away.
6. Remove old sensor (if previously installed).
7. Remove the new sensor from the package (use a pair of scissors to cut the bag, do not use hands to tear the bag)
8. Remove the two red ribbons from the two ring gold contact plate at the back of the sensor.

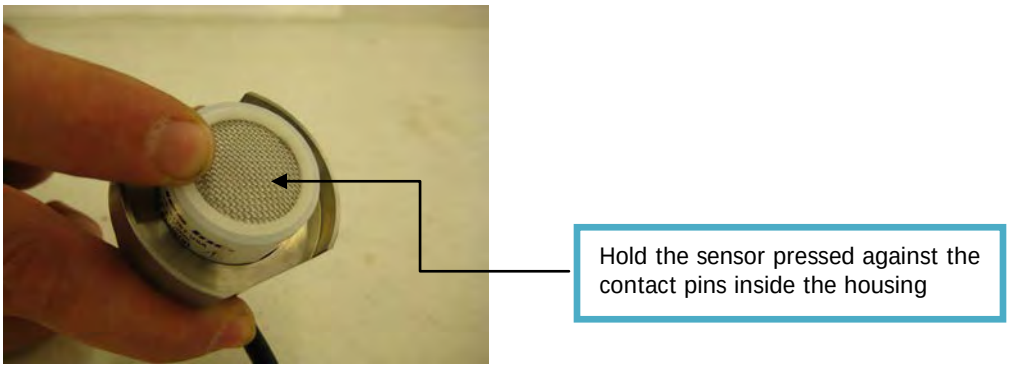


Remove two red taps from sensor PCB before installing


You may check the Sensor output in air, it must be within ~500 uA to 950 uA

## Quick Air Calibration when installing a new sensor

1. Insert the sensor into the upper section of the sensor housing with the contact plate facing toward the two gold pins of the sensor housing. Hold the sensor and the sensor housing in your hand while keeping the sensor pushed against the two gold pins.




2. Advance the cursor on the MAIN MENU to SAMPLE and press ENTER to accept the selection. 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 a quick air calibration (detailed instruction for span calibration follows).
3. After air calibration, insert the sensor into the bottom section of the sensor housing with metal screen of the sensor facing down. Place the upper section of the sensor housing, push it gently downward 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) holding the two section of the sensor housing.

# 5.7.2 Span Gas Preparation

**The analyzer must be calibrated periodically; see the Calibration Section below for recommendations.**

# Required Components

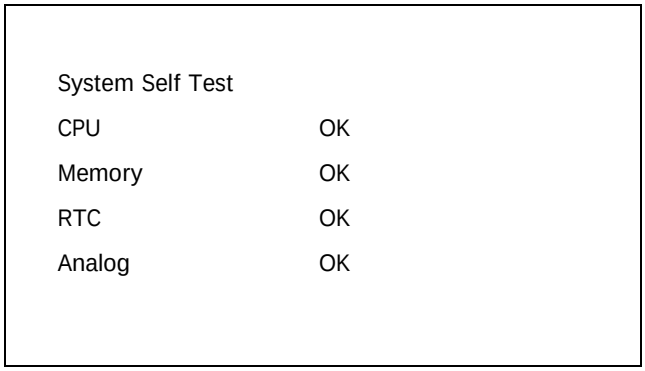
**1.** Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range of analysis or one range above the intended measuring range.
2. Regulator to set gas pressure to 5-30 psig (for the solenoid valves to operate properly, the difference between the Span and Sample gas pressure must not exceed 5 PSIG).
3. Flow meter to set the flow between 1-2 SCFH (only if analyzer is not equipped with integral flow control device).
4. Suitable fittings and 1/8" or ¼" dia. metal tubing to connect the regulator to the flow meter inlet.
5. Suitable fitting and 1/8" or ¼" dia. 4-6 ft. in length of metal tubing to connect from the flow meter vent to tube fitting connection designated SAMPLE IN or SPAN IN (for analyzer with a separate span port) at the rear of the analyzer.

# Procedure

1. With the span gas cylinder valve closed, install the regulator on the cylinder.
2. Open the regulator's exit valve and partially open the pressure regulator's control knob.
3. Open slightly the cylinder valve.
4. Loosen the nut connecting the regulator to the cylinder and bleed the pressure regulator.
5. Retighten the nut connecting the regulator to the cylinder
6. Adjust the regulator exit valve and slowly bleed the pressure regulator.
7. Open the cylinder valve completely.
8. Set the outlet pressure between 5-30 psig using the pressure regulator's control knob.
9. **Caution:** Do not exceed the recommended pressure range. Excessive pressure could cause malfunctioning of the solenoid valves result in erroneous readings.

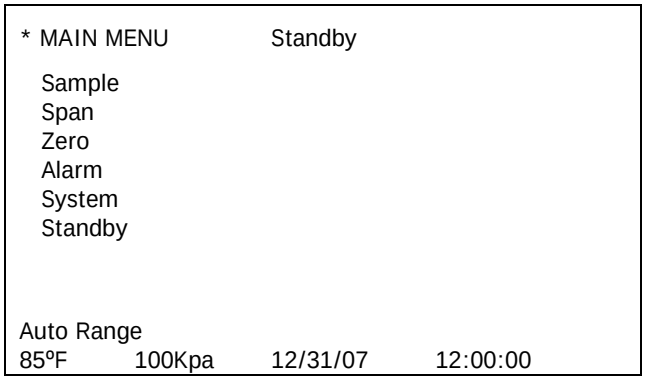
# 5.8 Establishing Power to the Electronics:

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 “SYSTEM SELF TEST” as illustrated below:





After 3 seconds the system defaults to the STANDBY mode and the LCD displays the following:



# 5.8.1 Menu Format

Menu selected – displayed on the top line in the upper left corner of the display.
Menu options available – all menus displayed on the left side of the LCD.
Menu option selected - indicated by the cursor (*) positioned to the left of the menu option selected.
System mode - indicated at the top center of the display.
Range mode and current auto or fixed manual range - displayed on the first line at the bottom of the display.
Temperature inside of the analyzer and ambient pressure - displayed on the second line at the bottom of the screen.


Note: In the event power to the analyzer is interrupted, the system defaults to the “Standby” mode when power is restored. To resume sampling, advance the cursor (*) to “Sample” mode, press ENTER to select and select the range mode as described below.

# 5.8.2 Menu Navigation

The four (4) pushbuttons located on the front of the analyzer control the system’s micro-processor:

1. Green - ENTER (select)
2. Yellow UP ARROW – advance cursor up
3. Yellow DOWN ARROW – advance cursor down
4. Red – ESC (menu)

Select the menu option by advancing cursor (*) by repeatedly pressing the yellow UP/DOWN ARROW keys.

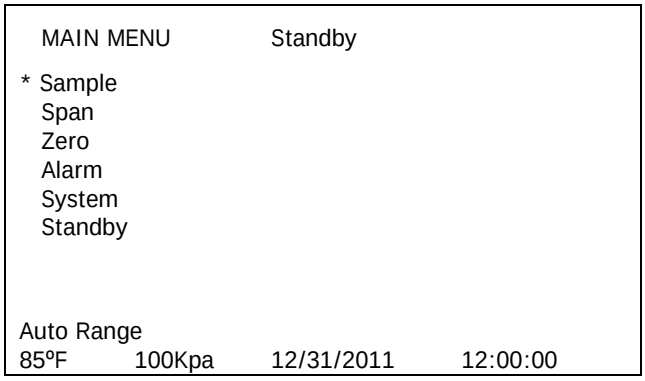
Accept the menu option selected with cursor (*) by pressing the green ENTER key.

Abort the menu option selected with cursor (*) and return to the previous menu by pressing the red ESC key.

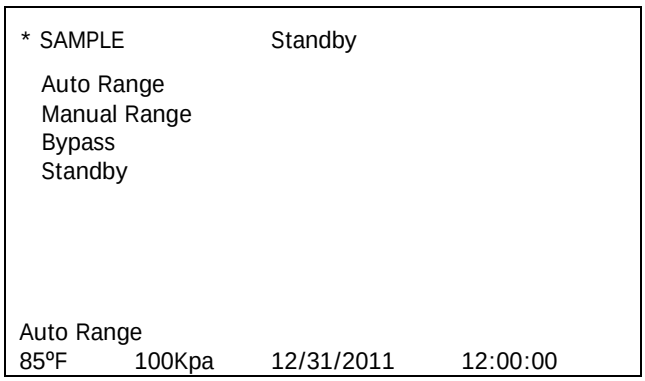
Note: If a selection is not made within 30 seconds, the system returns to the MAIN MENU.

# 5.8.3 Range Mode Selection

Advance the cursor (*) to the “Sample” option as illustrated and press the green ENTER key to accept the selection.




The following menu appears:




The 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 Range or a fixed Manual Range mode.

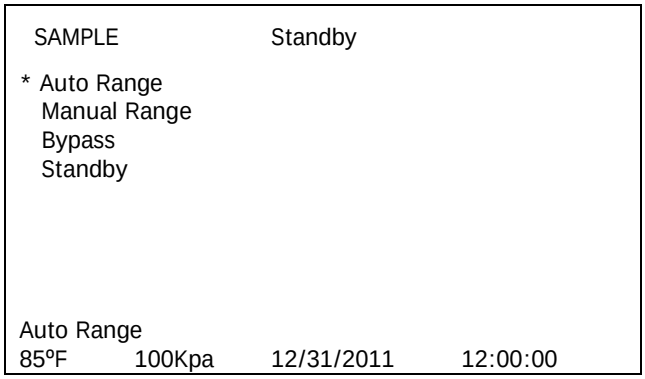
Note: During span calibration, the analyzer will automatically switch to Auto Range mode.

# 5.8.4 Auto Range Sampling

In the Auto Range mode, the analyzer will automatically select the appropriate full scale range depending on the concentration of oxygen in a sample gas. The display will shift to the next higher range when the oxygen reading exceeds 99.9% of the current range. The display will shift to the next lower range when the oxygen reading drops to 85% of the next lower range.

For example, if the analyzer is reading 1 PPM on the 0-10 PPM range and an upset occurs, the display will shift to the 0-100 PPM range when the oxygen reading exceeds 9.99 PPM. Conversely, once the upset condition is corrected, the display will shift back to the 0-10 PPM range when the oxygen reading drops to 8.5 PPM.

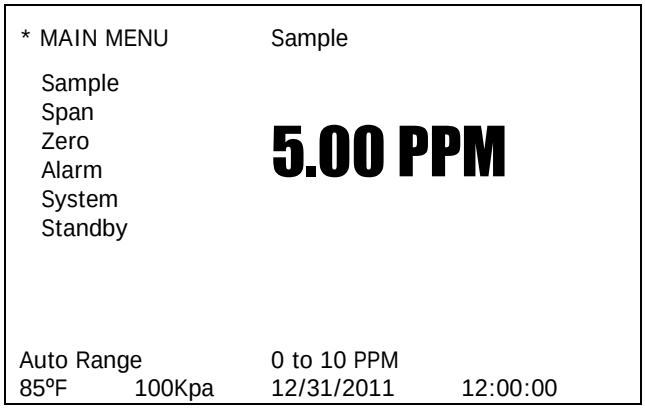
Procedure: From the SAMPLE menu, advance the cursor (*) to the “Auto Range” option and press ENTER:




Note: For an optional automated Sample System, the system displays a message "Opening Sample Valve". This message does not apply to analyzers equipped with standard manually operated Sample System.

Similarly, the Bypass and Standby modes do not apply to analyzers equipped with manual Sample System

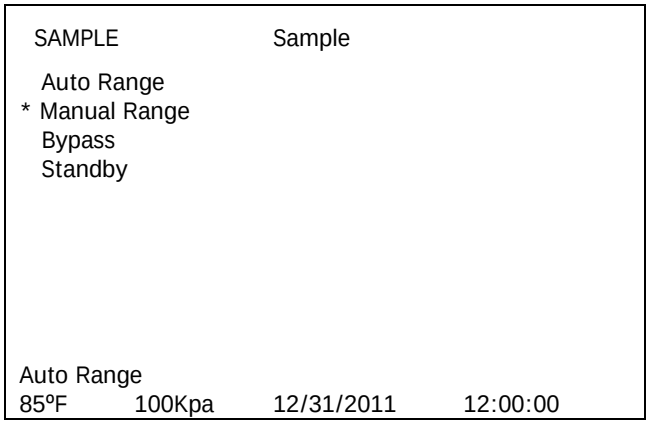
Within seconds the system assesses the oxygen concentration, selects the appropriate range (as described above) and returns to the MAIN MENU in the “Sample” mode. On the second line from the bottom of the menu screen, the Auto Range mode is indicated along with the current full scale range.



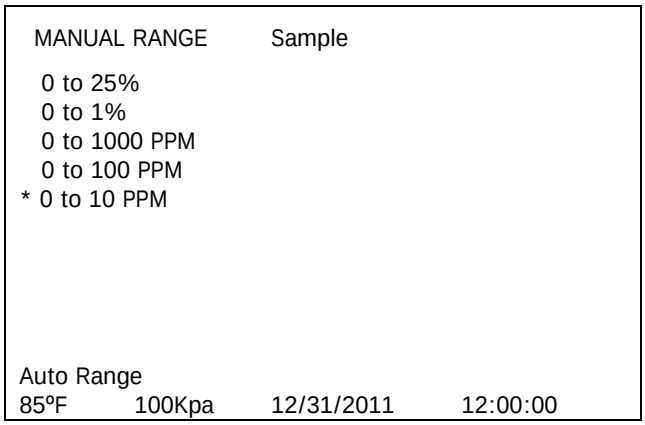
# 5.8.5 Manual Range Sampling

In the manual range mode, the display will not shift automatically. Instead, when the oxygen reading exceeds 125% of the upper limit of the current range, an" OVER RANGE" warning will be displayed. Once the OVER RANGE warning appears the user must advance the analyzer to the next higher range.

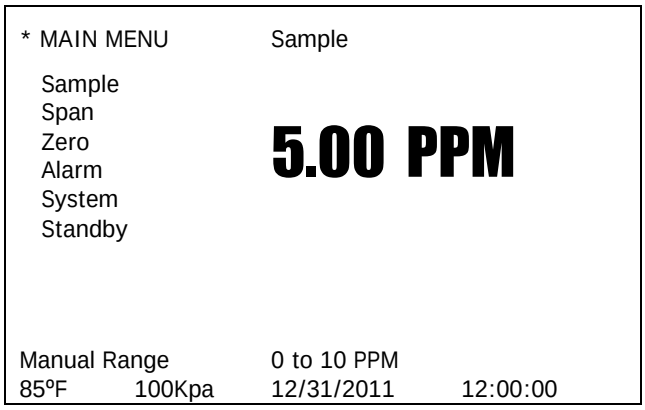
Procedure: From the SAMPLE menu, advance the cursor (*) to the "Manual Range" option and press ENTER:



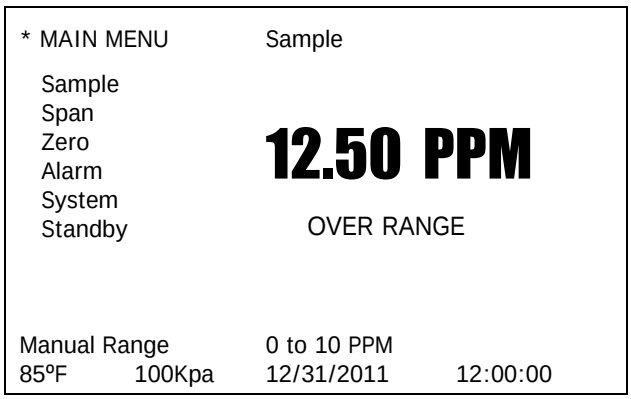

The following display appears:




Advance the cursor (*) to the desired fixed manual range, e.g. 0 to 10 PPM and press ENTER.
Within seconds the system assesses the oxygen concentration and returns to the MAIN MENU in the "Sample" mode. On the second line at the bottom of the menu, the Manual Range mode is indicated along with the fixed full scale range selected.




If the oxygen reading exceeds 125% of the full scale fixed range manually selected, the system displays the following message, e.g., on 0-10 PPM range:




# 5.8.6 Setting Alarms

The analyzer is configured with two user adjustable threshold type alarm relays that can be configured in the field from the ALARM option on the MAIN MENU as follows:

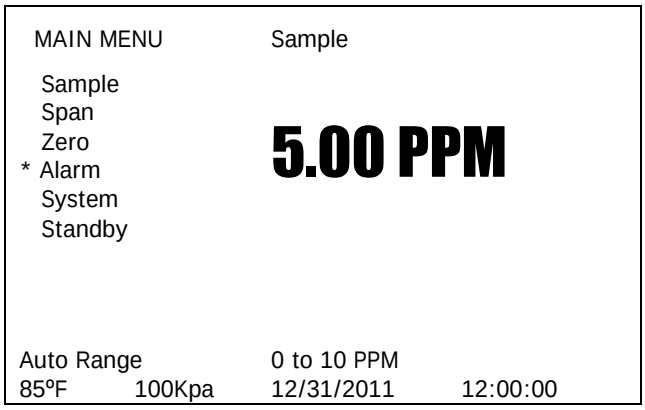
- Establish independent set points
- Either Hi or Lo
- Either On or Off (enabled or disabled)
- Both temporarily defeated using a user entered 'timeout' period (normally a few minutes)

The alarm set point represents a value. When the oxygen reading exceeds (high alarm) or falls below (low alarm) the alarm set point, the relay is activated and the LCD displays the alarm condition.

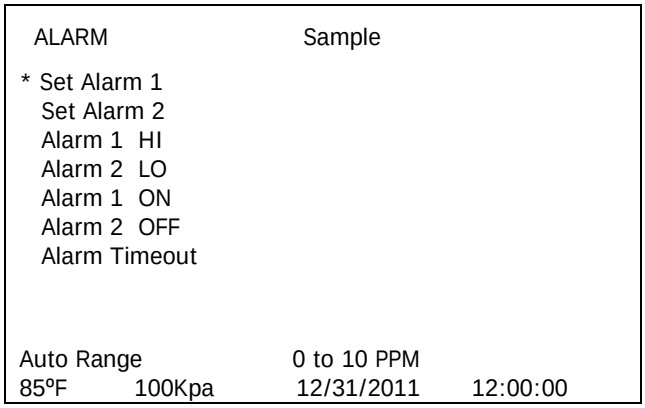
When activated the alarms trigger SPDT Form C non-latching relays @ 5A, 30VDC or 240VAC resistive. To prevent chattering of the relays, a 2% hysteresis is added to the alarm set point. This means that the alarm will remain active until the oxygen reading has fallen 2% below the alarm set point (high alarm) or risen 2% above the alarm set point (low alarm) after the alarm was activated. The timeout feature is useful while replacing the oxygen sensor or during calibration when the oxygen reading might well rise above the alarm set point and trigger a false alarm.

**Note:** When making connections the user must decide whether to configure/connect Alarm 1 and Alarm 2 in failsafe mode (Normally Open – NO – where the alarm relay de-energizes and closes in an alarm condition) or non-failsafe mode (Normally Closed – NC – where alarm relay energizes and opens in an alarm condition).

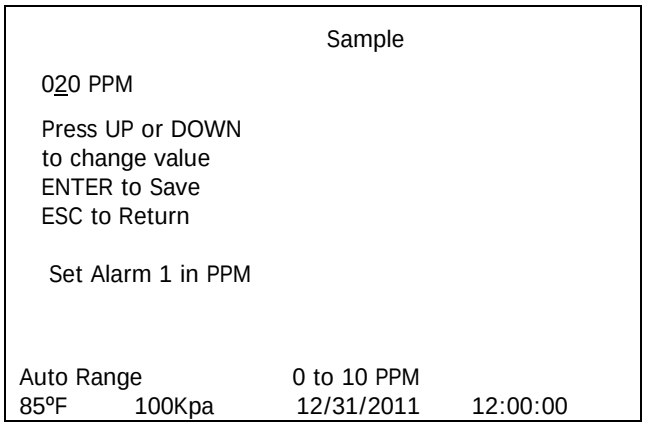
**Procedure:** Advance the cursor (*) to the "Alarm" option and press the green ENTER key to accept the selection.




The following menu appears:



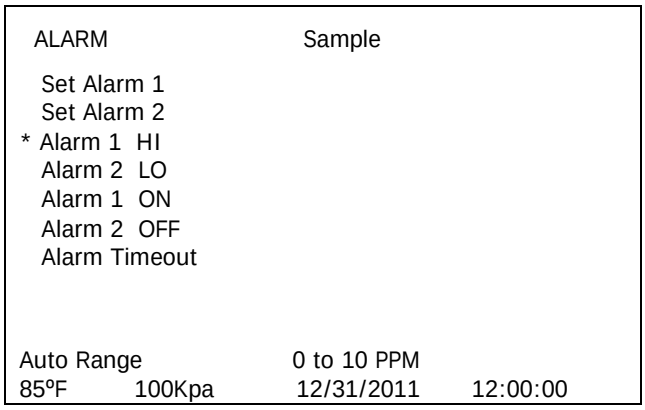

Advance the cursor (*) to the “Set Alarm 1” option and press the green ENTER key to accept the selection. The Menu will then prompt to select the units of alarm set points, for example, % or PPM or PPB (PPB option is for GPR-1600-UHP analyzer only).
After selecting the gas units, the following menu appears (assuming the user selected PPM units):




Follow selection of set point, press the ENTER key to save the alarm value or ESC to return to the MAIN MENU.
Within a few seconds after pressing the ENTER key, the system returns to the MAIN MENU.

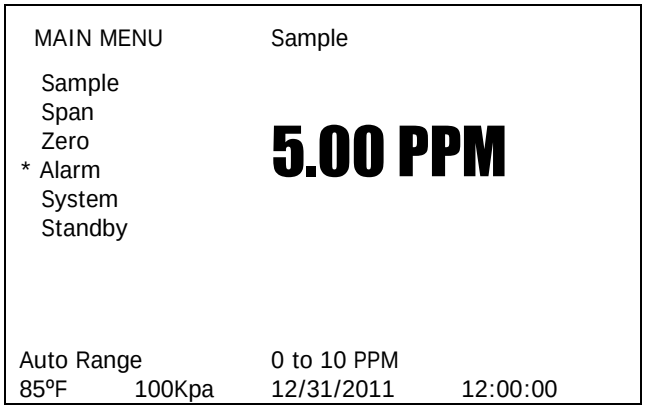
Repeat the above steps for “Set Alarm 2”.

Configure Alarm 1 and Alarm 2 as High or Low by advancing the cursor (*) to the desired feature as illustrated below.

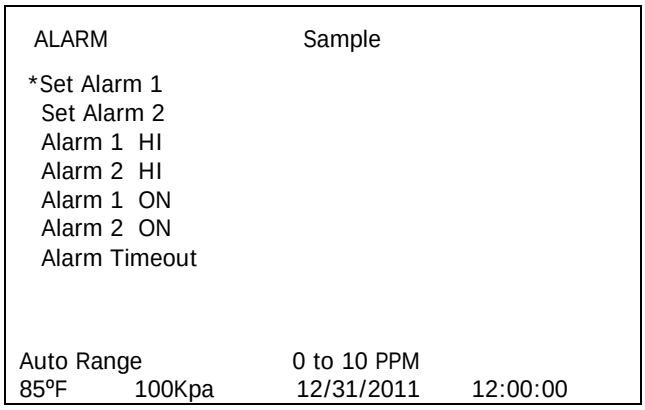



Press the ENTER key to toggle between the settings: HI and LO and/or ON and OFF.
Pressing the ENTER key will toggle the selection and the system will return to the MAIN MENU.

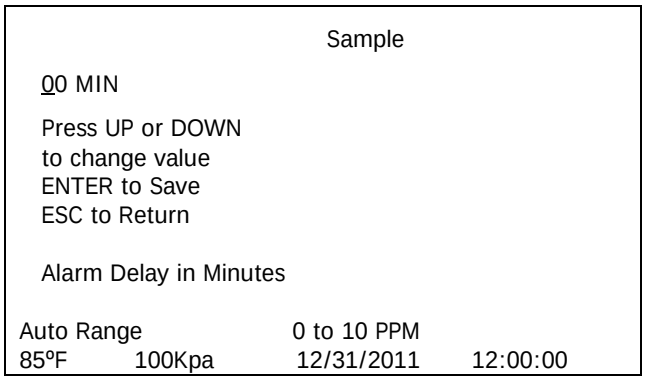
**ALARM TIMEOUT:** The Alarm Timeout feature allows the user to select a "time delay" to prevent the alarm from triggering relay immediately after the alarm condition occurs. The time delay feature allows the user from triggering a false alarm during maintenance or self induces signal spike. In order to enter the time delay, advance the cursor (*) to the "Alarm" option and press the green ENTER key to accept the selection.




The following menu appears:




Advance the cursor (*) to the "Alarm Timeout" option and press the green ENTER key to accept the selection.
The following menu appears:

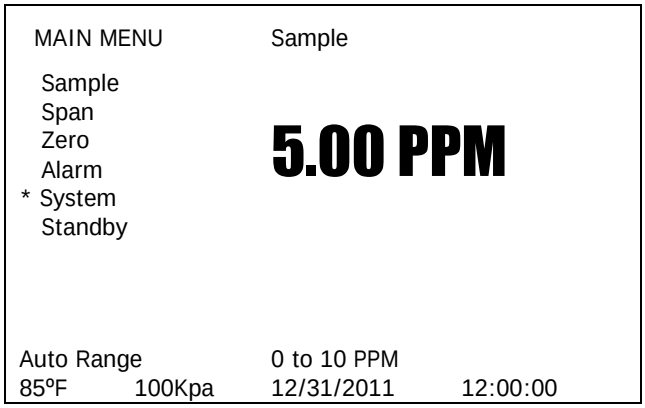



Follow the prompt above and press the ENTER key to save the alarm timeout value or ESC to return to the MAIN MENU.
Within a few seconds after pressing the ENTER key, the system returns to the MAIN MENU.

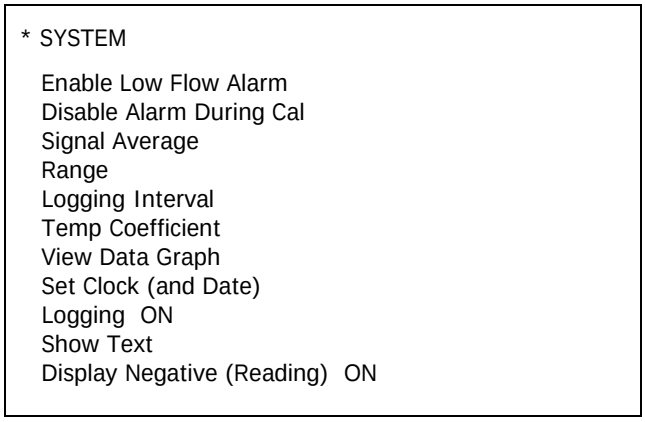
# 5.8.7 System Menu

The analyzer is equipped with a wide range of features that enables users to enhance performance and tailor their interface with the analyzer. The SYSTEM menu shown below lists the features available and is followed by a description of each function. Most of the functions are initiated by toggling between options by pressing the ENTER key as previously described.

Advance the cursor (*) to the “Alarm” option and press the green ENTER key to accept the selection.




The following menu appears:



Advance the cursor (*) to the desired option, press ENTER key and follow the instructions below.

| | |
|---|---|
| Enable Low Flow Alarm | If the analyzer is equipped with a low flow alarm, press ENTER key to toggle between ENABLE and DISABLE (this feature is currently not controlled by the microprocessor). |
| Disable Alarm During Cal | Press ENTER key to toggle between ENABLE and DISABLE. |
| Signal Average | Press ENTER key to select and choose Low, Medium (default) or High – functions allows users to select their preference regarding the trade-off of response time vs. noise filtering. The signal averaging is roughly 5, 8 and 10 seconds when selecting LOW, MEDIUM OR HIGH option |
| Range | Same as Auto/Manual Range option found on SAMPLE menu. |
| Logging Interval | Press ENTER key and a display appears similar to Alarm Timeout above for the user to enter the interval in minutes for capturing data points for logging purposes. |
| Temp Coefficient | Enables the user to fine tune the temperature compensation (this feature is an option, consult factory for more details). |
| View Data Graph | Provided that the "Logging" feature is toggled ON, selecting this feature provides a full-screen display or graph of the data points in the analyzer memory. |
| Set Clock (and Date) | Selecting this option generates a display for selecting Time or Date with each followed by a detailed display for setting hour, minute, second or year, month, day. |
| Logging | Press ENTER key to toggle between ON and OFF. With Logging ON, the analyzer will store the data in its internal memory. The internal memory is limited to 32K. The total number data points that can be stored are 5500. Depending on the time interval between the points selected, the data can be stored from a few days to several weeks. |
| Show Text | Press ENTER key to toggle between "Text and Graph" display options:<br>1.) With Show Text option, large numbers of gas concentration (as illustrated herein)<br>2.) Show Graph option, small numbers and a small graphical trend of O2 reading. The Graph only shows a limited number of data points. After the graph has filled the limited space on the LCD, the graph will refresh itself by "First in First out" methodology. This feature allows the user to look at trending of the data when installing a new sensor, after calibration or after a process upset condition. |
| Display Negative (Reading) | Press the ENTER key to toggle between ON and OFF. With "Display Negative" ON, the analyzer will show negative numbers on the screen in the event sensor shows a negative reading or after premature Zero Offset calibration. |

# 5.9 Installation & Start-up is now complete . . . Proceed to calibrate the Analyzer

The electrochemical oxygen sensors manufactured by Analytical Industries Inc. (dba Advanced Instruments) generate an electrical current that is **linear** or proportional to the oxygen concentration in the sample gas. In the absence of oxygen the sensor exhibits an **absolute zero**, e.g. the sensor does not generate a current output in the absence of oxygen. Given the properties of linearity and an absolute zero, single point calibration is possible.

As described below, zero calibration is recommended only when the application (or user) demands optimum accuracy for analysis below 5% of the most sensitive or lowest range available on the analyzer. Span calibration in one of the forms described below is sufficient for all other measurements. **When employed, Zero calibration should be carried out after Span calibration.**

# 5.9.1 Zero Calibration

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

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

The zero capability (low end sensitivity) of every analyzer is qualified prior to shipment. However, because the factory sample system conditions differ from that of the user, no ZERO OFFSET adjustment is made to the analyzer by the factory

# 5.9.2 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 or a span gas. After span calibration, maximum drift from calibration point with varying temperature is approximately 0.11% of reading per °C change in ambient temperature. Therefore, calibration of the analyzer is recommended as close as possible to the sampling temperature conditions. The frequency of calibration varies with the application conditions; the degree of accuracy of the measurement required. 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 a PPM analyzer back on-line can vary, see Online Recovery Time below.

# 5.9.3 Menu Functions - Zero Calibration

| | |
|---|---|
| **Factory Default Zero:** | The feature eliminates any previous zero calibration offset adjustment stored in the analyzer memory.<br><br>This factory default calibration is recommended before performing a ZERO CALIBRATION or when troubleshooting the analyzer. The factory default zero calibration is not recommended when subsequent periodic SPAN CALIBRATION is done. |
| **Zero Calibration:** | Recommended for optimum accuracy. The user must ascertain that the oxygen reading has reached a stable value and is below 50% of the most sensitive or |

lowest range available on the analyzer before the system will accept and perform a ZERO CALIBRATION.

If the user attempts to initiate the ZERO CALIBRATION function while the oxygen reading is above 50% of the most sensitive or lowest range, the system displays the message "CALIBRATION FAILED" and returns to the "Sample" mode.

## 5.9.4 Menu Functions - Span Calibration

**Factory Default Span:** The system eliminates any previous span calibration adjustment stored in the analyzer memory and displays an oxygen reading within ±50% of the span gas value currently flowing through the analyzer.

If the oxygen reading is outside ±50% of the span gas value, the attempt to perform Span calibration will result in "CALIBRATION FAILED" message and the analyzer will return to the "Sample" mode. This feature allows the user to test the sensor's signal output without removing it from the sensor housing.

This function is recommended before performing a SPAN CALIBRATION or when troubleshooting an analyzer.

**Span Gas Units/Value:** After initiating either Auto or Manual Span from the SPAN CALIBRATION menu, the system produces a display prompting the user to select span gas in PPM or % units, which is followed by a second display prompting the user to enter a numerical span gas value.

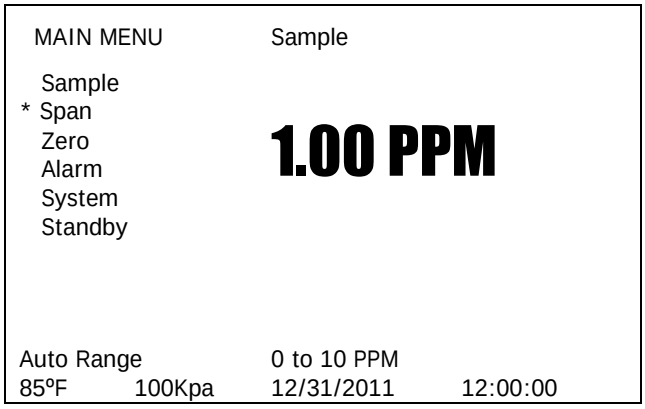
**Span Calibration:** The user must ascertain that the oxygen reading has reached a stable value before completing Span Calibration. A premature Span calibration will result in inaccurate results.

## 5.9.5 Calibration Procedure – Span Calibration

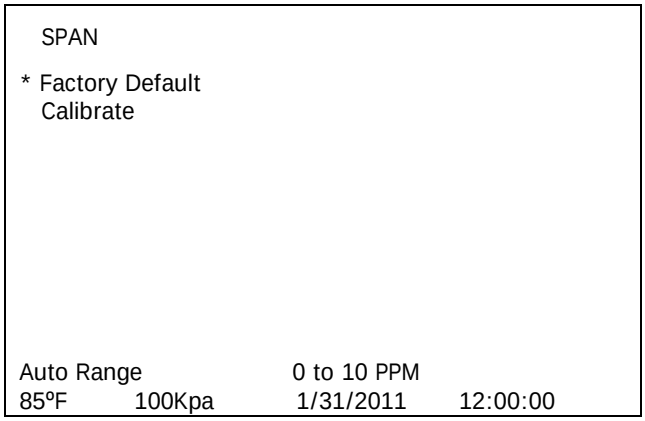
To perform Span calibration

1. Assure that the analyzer is in the Auto Range mode as described above.
2. Span gas is connected to the SPAN IN port at the rear of the analyzer
3. Set the span gas pressure between 5-30 PSIG (for the solenoid valves to operate properly, the difference between the Span and Sample gas pressure must not exceed 5 PSIG) and set the flow at 1-2 SCFH
4. Allow the analyzer reading to stabilize before attempting calibration.

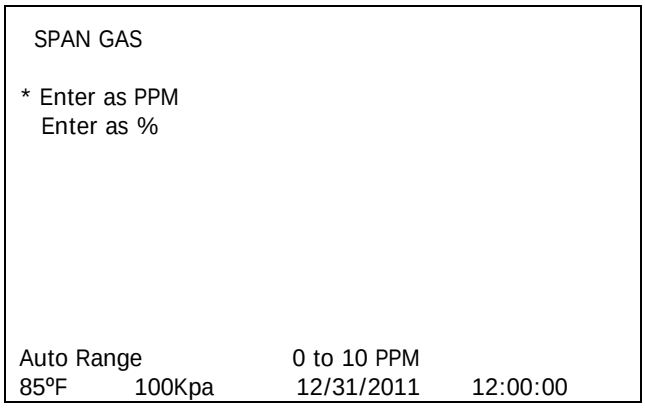
   From Main Menu, Advance the cursor (*) to the "Span" option as illustrated and press the green ENTER key to accept the selection.



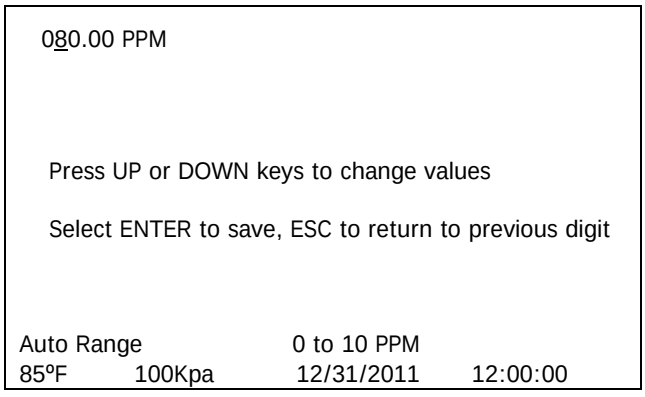
The following menu appears:




Advance the cursor (*) to the Auto or Manual Span option and press ENTER. The following screen will appear prompting the user to select calibration gas unit. Select % or PPM (PPB is available with GPR-1600-UHP analyzer only).

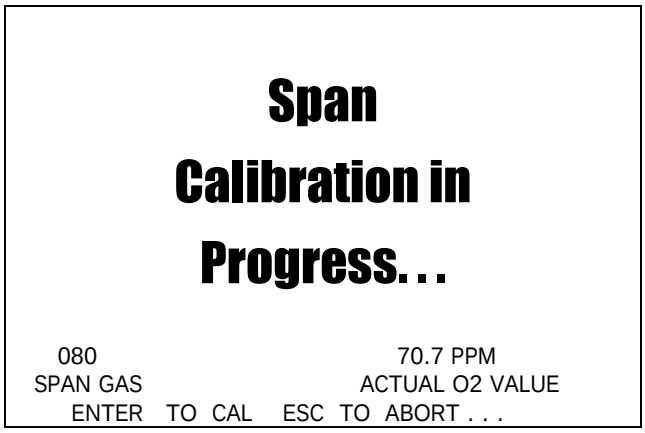



After selecting the calibration gas units, following screen will appear.




After accepting the span gas value, the micro-controller will shut the Sample valve and open the Span valve and the following screen will appear (this is true with analyzers with sample system equipped with auto/pneumatic sample/span/zero valves) .

**Note:** When span valve opens, assure that the gas flow is the same as was set for Sample gas. Further, the analyzer might show positive spike on the signal due to excessive oxygen in the span gas line (due to minor leakage in the gas line, oxygen from air diffuses into the gas line even though the span gas line is under pressure) but within a few minutes the excessive oxygen will purge out of the system and the analyzer will begin to analyze the true oxygen content of the span gas.

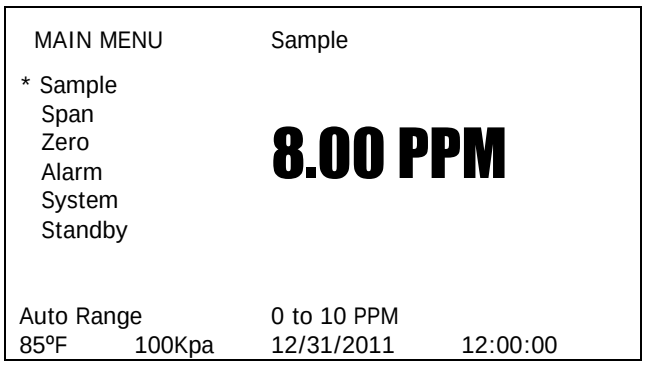



After the oxygen reading has stabilized, press ENTER to complete the Span Calibration (if Manual Span option was selected). If the user attempts to complete the SPAN CALIBRATION function while the oxygen reading is outside the +/-50% of the span gas value entered, the system displays the message "CALIBRATION FAILED" and returns to the "Sample" mode.

# 5.9.6 Auto Span Calibration

In the Auto Span mode, the micro processor will watch the trending of the oxygen reading. When the reading has stabilized and is within +/-50% of the span gas value entered, the micro will adjust the oxygen reading to match with the span gas value and return to the Sample mode and start displaying the true oxygen reading in the sample gas. The Auto Calibration process may take from a few minutes to more than an hour (depending on the level of oxygen contamination of the span gas line).

After completing the Auto Calibration, the system returns to the MAIN MENU in the "Sample" mode and displays the real time oxygen contents in the sample gas. The oxygen value will slowly trend down from the span gas value.



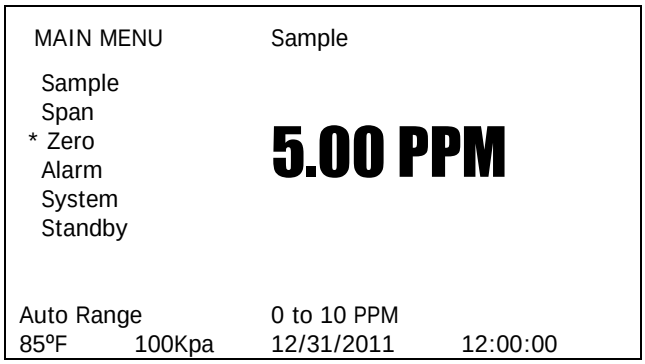

# 5.9.7 Calibration Procedure – Zero Calibration

To perform Zero calibration

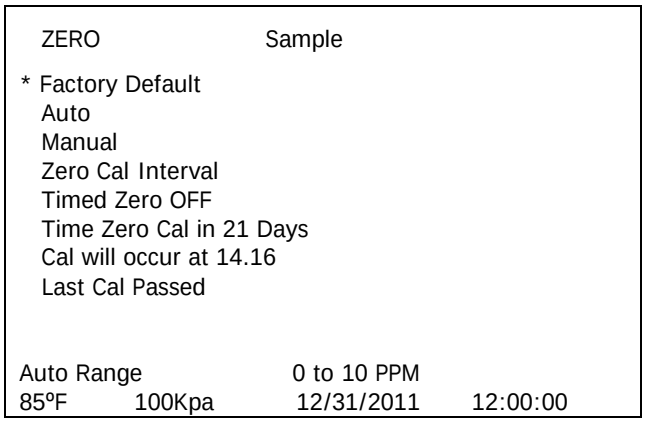
1. Ensure that the analyzer is in the Auto Range mode as described above.

2. A good quality Zero gas is connected to the ZERO IN or SAMPLE IN (with manually operated Sample System) at the rear of the analyzer.
3. Assure there are no restrictions in vent line.
4. Regulate the Zero gas pressure between 5-30 PSIG (for the solenoid valves to operate properly, the difference between the Zero and Sample gas pressure must not exceed 5 PSIG) and set the flow rate to 1-2 SCFH.
5. Allow the analyzer reading to stabilize below 50% of the most sensitive or lowest range available on the analyzer before attempting Zero calibration.

Advance the cursor (*) to the “Zero” option as illustrated and press the green ENTER key to accept the selection.




The following menu appears:

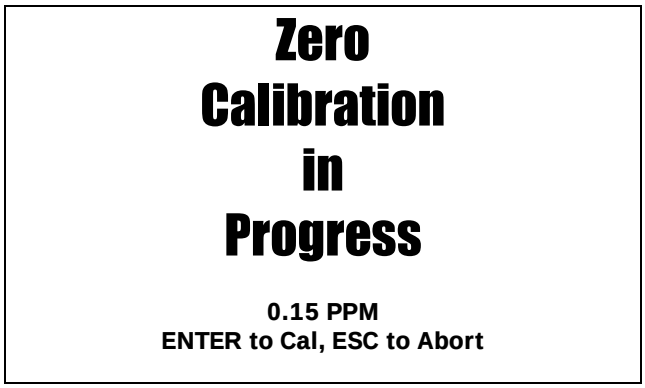



Advance the cursor (*) to the Auto or Manual Zero option and press ENTER. The microprocessor will open/energize the Zero gas solenoid valve and allow the Zero gas to flow through the analyzer (analyzers equipped with pneumatic sample/span/zero valves). For analyzers without pneumatic valves, allow the zero gas to flow through the analyzer.

It is recommended that initially, perform a Manual Zero calibration to ensure that the analyzer and all the gas lines/connections are properly setup and purged. After first Manual Zero, subsequent Zero calibration could be done by selecting Auto or Manual options.

Advance the cursor (*) to the “Manual Zero” option and press the green ENTER key to accept the selection.

The following menu with current oxygen value appears:




After the oxygen reading has stabilized, press ENTER to complete the Zero Calibration (if Manual Zero option was selected). If the user attempts to initiate the ZERO CALIBRATION function while the oxygen reading is above 50% of the most sensitive or lowest range, the system displays the message "CALIBRATION FAILED" and returns to the "Sample" mode. In the Auto Zero mode, the micro processor will watch the trending of the oxygen reading. When the reading has stabilized and is within 50% of the allowed limit, the micro will offset the oxygen reading and return to the Sample mode and display the true oxygen reading.

**Note:** When Zero gas is first introduced, there might appear a spike on the oxygen signal (due to the trapped oxygen in the sample manifold and or in the zero gas line). Allow sufficient time for the oxygen reading to stabilize before attempting Zero calibration.

After Zero calibration, the "CALIBRATION FAILED or CALIBRATION PASSED" message will appear.

**Note:** With Auto calibration routine, the micro processor will watch the downward trend and wait until the change in slope of the downward trend approaches zero (no further drop in the oxygen reading). A zero calibration will pass only if the zero offset had reached less than 50% of the most sensitive range. If the zero offset remains above the 50% of the most sensitive range (but the downward trend had stabilized), the Zero calibration will fail and the analyzer will return to the Sample mode. A message "Failed Cal" will appear on the main display.

# 5.9.8 Timed Zero and Span Calibration

If the analyzer is equipped with pneumatically controlled Sample, Span and Zero valves, the analyzer could be programmed to perform Zero and Span calibration at pre-determined time intervals.

**Note:** In order to benefit from the auto calibration feature, assure that span and zero gases are connected to the respective ports at the rear of the analyzer. If running separate span and zero gas lines to the analyzer is not possible (due to remote location of span and zero gas sources), connect the SAMPLE IN to the SPAN IN and ZERO IN ports by using TEE adopters to assure that gas will flow through the span and zero inlet port when span or zero calibration routine is initiated.

In order to perform "Timed Zero or Timed Span Calibration", the user must enter the number of days between each calibration and the time of day the calibration will commence. For "Timed Span Calibration", Span Gas value must be entered as well.

With the Timed Calibration or Auto Calibration (Zero or Span) routine, after the Timed or Auto Calibration, a message "Last Calibration Passed or Failed" will appear in the Span and Zero calibration Menu. If the Timed or Auto calibration failed, (when analyzer reading with the span gas was outside of the acceptable limit or the zero offset was outside of the acceptable limit) a flag "Failed Cal" will also appear on the main menu. If "Failed Cal" message appears, perform a Manual calibration to determine the cause of calibration failure.

The Timed calibration routine will be operative only when at least one day interval is specified. In order to set the Timed calibration on the same day, set the date of the system a one day earlier than the current date. For example, the actual date displayed is January 02, 2010, if a "Timed calibration" is to start on January 02, 2010, set the system date as January 01, 2010.

# 5.9.9 All Configuration Software

***All Configuration Software*** is available to access all analyzer functions through a PC via a USB connection. This software can be used to perform Zero and Span calibration, select ranges, set alarms and so on. Should you need this software, contact factory.

# 5.9.9 Analog Output Adjustment

Although the analog signal output (0-1 V or 4-20 mA) has been tested and matches the analyzer display, in rare cases, the analog signal output may not match with the analyzer display. However, the analog signal output may be adjusted in the field by using ***All Configuration Software***, available free of charge. The configuration software must be installed on a PC and connected to the USB port of the analyzer to make analog signal output adjustment. A procedure to use the configuration software is provided with the software. Should you need a copy, consult factory.

# 5.10 Sampling

After installation and calibration is complete, select the Sample from the main Menu. Choose the Auto or Manuel range option. The analyzer will immediately begin to analyze the gas sample and display the real time oxygen concentration on the screen.

When switching sample gas streams, a sudden spike in the analyzer signal might appear. Allow sufficient time to the analyzer to stabilize before starting to collect the real time analysis data. The analyzer data may be stored in the internal analyzer memory or recorded on a recording device by using the 0-1V or 4-20 mA analog signal. When connecting the analog output to an external recording device, limit the length of cable to less than 6 feet. If possible, use a shielded cable with the shield connected to the ground of the recording device.

# 5.11 Standby

- The analyzer has no special storage requirements.
- The sensor should remain inside of the sensor housing and connected with the analyzer electronics during storage periods.
- Turn the Sample/Bypass valve to Bypass position
- Store the analyzer with the power OFF.
- If storing for an extended period of time, protect the analyzer, cable and the sensor housing (with external sensor option) from dust, excessive heat (no more than 45 degree C) and moisture (non condensing atmosphere).

# 6. Maintenance

There are no moving parts in the analyzer given the modular nature of the electronics and sensor. Cleaning the electrical contacts when replacing the sensor is the extent of the maintenance required.
**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.

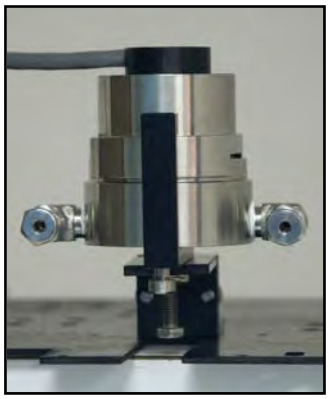
**Sensor Replacement**
Periodically, the oxygen sensor will require replacement. The operating life is determined by a number of factors that are influenced by the user and therefore difficult to predict. The sections dealing with Specification and Installation Considerations define the normal operating conditions and expected life of the standard sensor utilized by the GPR-1600 analyzer. As a general guideline, expected sensor life is inversely proportional to changes in oxygen concentration, pressure and temperature.

The signal output of a PPM sensor (GPR-12-333 OR XLT-12-333) in air ranges from 500 uA to 950 uA. You may check the sensor output of a sensor by using an ammeter (set ammeter in the micro-amp mode and connect the com of the meter to the inner gold contact and the mA/uA of the meter to the outer gold contact at the back of the sensor). If the output of the sensor in air is not within the expected range, do not install the sensor. Install a new sensor and send the defective sensor to factory for warranty evaluation.


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

**Procedure**

1. Determine your calibration requirements by reviewing the ZERO CALIBRATION and SPAN CALIBRATION discussions in section 5 Operation. Consult the analyzer specifications for recovery times and recommended span gas values.
2. Open the door of the analyzer to access the sensor housing.
3. Using the 5/16 wrench supplied loosen but do not remove the clamp bolt located in the center of the bracket attached to bottom section with the elbow fittings.
4. Rotate the upper section of the sensor housing 90º to disengage from the clamp.
5. Remove the upper section by pulling it straight up and place it on a smooth surface.
6. Remove the old oxygen sensor and dispose of it as you would a battery.
7. Remove the o-ring from the bottom section of the sensor housing.
8. Wipe the o-ring with a damp lint free cloth.
9. Lightly lubricate the o-ring with vacuum grease for optimal seal.
10. Reinstall the o-ring into the bottom section of the sensor housing.
11. From the MAIN MENU select AUTO RANGING as described above.
12. If equipped with SAMPLE/BYPASS valve, place it in the SAMPLE position.
13. Set the flow rate to 2 SCFH.
14. Connect zero gas or low oxygen content sample gas line to purge the lines and the sensor of oxygen (once reinstalled).
15. **Caution:** Minimize the time the new sensor is exposed to ambient air.
16. Remove the new oxygen sensor from the shipping bag.
17. Remove the red label and the gold ribbon (shorting device) from the PCB at the rear of the sensor.



18. Place the new sensor in the bottom section of the sensor housing with the PCB facing up. **NOTE:** You may perform a quick “Air Calibration” before installing the sensor in the sensor housing; see Section 5, sub-section 5.7.1 above for details.
19. Place the upper section of the sensor housing over the sensor.
20. Gently push the upper section downward and rotate 90º to engage the clamp.
21. Finger tighten the clamp bolt and one full turn with the 5/16 wrench to compressed the o-ring seal.
22. Expect the analyzer reading to recover to ppb levels as described in the analyzer specification.
23. Perform the desired calibration(s).
24. Begin sampling once the analyzer has reached the value of the purge gas.

# 7. Spare Parts

Recommended spare parts for the GPR-1600 Oxygen Analyzer include:

| Item No. | Description |
|---|---|
| GPR-12-333 | PPM Oxygen Sensor |
| XLT-12-333 | PPM Oxygen Sensor for Sample containing CO2 |

Other spare parts:

| | |
|---|---|
| CTRL-1004 | Controller Temperature PID |
| HTR-1002 | Heater 110VAC |
| HTR-1003 | Heater 220VAC |
| A-1004-1-36 | Housing Sensor Stainless Steel |
| A-1016-A | Housing Sensor Bottom Assembly Stainless Steel |
| B-2762-A-1-36 | Housing Sensor Upper Assembly Stainless Steel |
| MTR-1008 | Meter Digital Panel LCD Backlight |
| ORNG-1007 | O-ring 3/32 x 1-3/8 x 1-9/16 Viton |
| A-1146-10 | PCB Assembly Main / Display |
| A-1147-10 | PCB Assembly Power Supply |
| A-1147-10-AV | PCB Assembly Power Supply with AV option |
| SNSR-1001 | RTD Temperature Sensor |
| SNSR-1002 | Thermal Runaway Protector J-2 Sensor |
| TOOL-1001 | Wrench Combination 5/16” |

# 8. Troubleshooting

| Symptom | Possible Cause | Recommended Action |
|---|---|---|
| Slow recovery | 1. At installation, sensor was exposed to air for too long.<br>2. Defective sensor<br>3. excessive, dead volume in sample line<br>4. contaminated sample gas due to leakage in sample line connections<br>5. Abnormal zero gas<br>6. Sensor damaged in service due to prolonged exposure to air or electrolyte leakage<br>7. Sensor nearing end of life | 1. Replace sensor while minimizing sensor exposure to air<br>2. If recovery unacceptable or $O_2$ reading fails to reach 50% of lowest range after 48-72 hours of installation of sensor, check gas connections and gas integrity before replacing sensor again<br>3. Leak test the entire sample system:<br>4. Vary the flow rate (1-5 SCFH); $O_2$ reading that changes inversely to the changes in flow rate indicates a leakage in the sample system bringing gas to the analyzer<br>5. Correct source of leak<br>6. Qualify zero gas ( by using a second analyzer). If problem persist,<br>7. Replace sensor |
| 90 % Response time slow | 1. Increased dead legs or distance of sample line<br>2. low flow rate | 1. Reduce dead volume by reducing sample tube length<br>2. Increase flow rate |
| O2 reading doesn't agree with expected O2 values | 1. Pressure and temperature of the sample is varying<br>1. Abnormality in sample gas | 2. Calibrate the analyzer at the sample temperature, pressure and flow.<br>3. Main a constant sample flow.<br>1. Qualify sample gas (using a second analyzer) |
| Continued | 1. Corroded solder joints on sensor PCB from corrosive sample or electrolyte leakage from sensor<br>2. Corroded spring loaded contact in upper section of sensor housing from liquid in sample or electrolyte leakage from sensor<br>3. Liquid covering sensing area of sensor<br>4. Presence of interference gases<br>5. Unauthorized maintenance done<br>6. Sensor nearing end of life | 1. Replace sensor and if corroded contact, return sensor to the factory for warranty determination<br>2. Upper section of sensor housing: Clean contacts with water, flow sample or zero gas for 2-3 hours to flush sample system and sensor housing<br>Sensor: Replace if leaking and return it to the factory for warranty determination<br>3. Replace sensor, follow procedure in section 5 Operation<br>4. Consult factory<br>5. Replace sensor, obtain authorized service<br>6. Replace sensor |

| | | |
|---|---|---|
| Erratic, negative or no O2 reading possibly accompanied by electrolyte leakage | 1. Pressurizing the sensor by flowing gas to the sensor with the vent restricted and suddenly removing the restriction draws a vacuum on the sensor, causing electrolyte leakage | 2. Replace sensor re-calibrate the analyzer.<br>3. Remove any restriction on sample vent line.<br>4. Vent sample to atmospheric pressure. |
| O2 signal shows periodic spikes | 1. Senor exposed to high O2 at time of installation or during normal use | 1. Watch O2 signal for 24-48 hours, if the spikes persist, replace sensor |
| Cannot perform Zero calibration | 1. Zero offset beyond acceptable limit | 1. Check source of zero gas, watch O2 on a recording device, if trends down slowly, wait until zero offset is less than 50% of the lowest range, re-attempt zero calibration |
| Cannot perform zero calibration even after replacing sensor | 1. Contaminated sample/zero gas or exhausted O2 scrubber | 1. Check integrity of sample/zero gas, if O2 in sample gas is in the low PPB level but analyzer still shows high zero offset, replace exhausted O2 scrubber (integral to analyzer or external) |
| O2 reading drifts slowly upward | 1. Sensor exposed to high O2 for an extended period of time or Sensor is nearing end of its useful life | 1. Replace sensor |
| span requires large gain adjustment | 1. Low sensor output signal possibly due to moisture condensation on sensor from liquid in sample gas or electrolyte leakage from sensor | 1. Ensure there is no condensable moisture in the sample gas. Flow sample or zero gas for 2-3 hours to flush moisture from sample system and sensor housing |
| | 2. Liquid covering sensing area of sensor | 2. Sensor: Replace if leaking and return it to the factory for warranty determination |
| | 3. Presence of interference gases, e.g., $CO_2$ ,$Cl_2$, HCl | 3. Consult factory |
| O2 reading swings too much with minor variation in ambient temperature | 1. Sensor exposed to high O2 for an extended period of time, sensor is damaged | 2. Replace sensor |
| The O2 reading freezes even though O2 in sample is changing. | 1. Software bug | 1. Press the RESET button on A-1146 PCB to restart analyzer. Watch start-up screen and check self-diagnostic passes all tests. If any of the tests fail, replace A-1146 PCB. |
| O2 reading same in Sample and Zero mode (Model GPR-1600-UHP only) with known O2 in sample gas | 1. Defective O2 scrubber | 2. Replace O2 scrubber |
| No O2 reading with known O2 sample | 1. Lost electrical contact between sensor housing and PCB | 1. Test the continuity of sensor housing contact pins and sensor cable wiring using a voltmeter as follows: |

| | | |
|---|---|---|
| gas. | | Set the voltmeter to the audible continuity Ohm "Ω' setting (common on Fluke devices)<br>Check the continuity between BLACK wire of the 4-conductor sensor cable and the center spring loaded contact pin inside the upper section of the sensor housing<br>Check the continuity between the RED wire and to the outer spring loaded contact pin inside the upper section of the sensor housing<br>Replace the upper section of the sensor housing if either of continuity tests fails.<br>Check resistance between WHITE and GREEN wires<br>Replace the upper section of the sensor housing if the voltmeter reads outside the range of 15-19K resistance<br>Replace the sensor after testing the electronics and upper sensor housing assembly as described below. |
| LED display does not agree with 4-20mA signal output | Minor variations in tolerances of electronic components | Use AII Configuration software to correct disagreement. If problem persist, Contact the factory. |
| No 4-20mA output | 1. Defective component or PCB | 2. Contact the factory. |
| No graphic on LCD but has the analog signal output | 1. Electrostatic discharge could cause graphic to disappear | 1. Reset electronic by pressing RESET button on A-1146 or turn the power the analyzer OFF and then ON again. |
| "SENSOR" message appears after Span calibration | Sensor output below the recommended range | Perform Factory Default Span Calibration, repeat span calibration. If problem persist, perform Factory Default Span again and then replace sensor. |

# 9. Warranty

The design and manufacture of GPR Series oxygen analyzers, monitors 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 monitor, analyzers and sensor are warranted to be free of defects in materials and workmanship for the period specified in accordance with the most recent published specifications, said period begins with the date of shipment by the manufacturer. The manufacturer information and serial number of this analyzer are located on the rear of the analyzer. 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

Call Advanced Instruments Inc. at 909-392-6900 (or e-mail info@aii1.com) between 7:30 AM and 5:00 PM Pacific Time Monday thru Thursday or before 12:00 pm on Friday. Trained technicians will assist you in diagnosing the problem and arrange to supply you with the required parts. You may obtain warranty service by returning you analyzer, postage prepaid to:

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 |

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## 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 Information

| | |
|---|---|
| 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 |