PI2-MS-500/1000
PPB OXYGEN ANALYZER

OWNERS MANUAL

Revised Sep 20, 2016 Rev 2
Revised July 10, 2017 Rev 3
Revised Mar 05, 2018 Rev 4
Revised Sep 17, 2018 Rev 5
Revised Sep 26, 2019 Rev 6

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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 Certificate

Quality Control & Calibration Certification

Customer:			**Date:**	
Order No.:				
Model No.:		PI2-MS-500 PPB Oxygen Analyzer	**S/N:**	
Configuration:		A-1146-24 PCB Assembly, Main/Display	**Batch:**	
	()	A-1147 PCB Assy, Interconnect, 4-20mA, 0-1V, 1-5 V	**Batch:**	
	()	A-1174 PCB Assy, Interconnect, ( ) 1-5 V + Contacts **OR** ( ) 4-20mA + Contacts		
		Ranges: 0-500 PPB, 0-1000 PPB, 0-10 PPM, 0-100 PPM, 0-1000 PPM	**Software Ver:**	
		Enclosure: Panel mount 10.75"W x 7.5"H x 12"D		
		SS sensor housing, flow control & bypass valves, 1/8" tube connections		
		Temperature Controlled Sample System: ( ) 110 VAC **OR** ( ) 220 VAC		
	()	"Oxygen Service" see P-1507 Rev 1, label analyzer, provide certificate		
	()	Automated Sample/Span/Zero Inlet Valves		
	()	A-2829 Bezel, 19" Rack		
Sensor:	(x)	GPR-12-2000 MS2E PPB Oxygen Sensor	**S/N:**	
Accessories:		Owner's Manual		
		A-3491 Power Cord, Filtered (CABL-1008, FLTR-1014)		

		Expected Value	**Observed Value**	**Pass**
Test & Verify:	Default zero	0.0 ±3 low range		
	Default span @ 25 µA	110 PPM ±2 PPM		
	After sensor installation, reading on continued zero gas purge is < 1 PPM after	< 1 hour	min	
	Reading after calibration with _____ PPM oxygen span gas	±2% of _____ PPM		
	Baseline drift on zero gas over 24 hour period (±5% FS)	±10 PPB of reading		
	Noise level (+1% FS)	±5 PPB of reading		
	Reading after 24 hours in static (no flow to sensor) condition	< 40 PPM		
	Analog signal output 4-20 mA full scale			
	Analog Range ID output 4-20 mA full scale or relay contacts (above)			

	Alarm 1	**Alarm 2**	
SETPOINT - Set alarm thresholds			
MODE - Verify activation mode HIGH / LOW relative to setpoint			
ENABLED - Verify alarms do not activate and OFF replaces SETPOINT			
DELAY - Verify setpoint must be exceeded before activation			
SILENCE/BYPASS - Verify main menu option de-activates alarm			
Overall inspection for physical defects			

Options:	
Other:	NA

3. Safety

This section summarizes the essential generic precautions applicable to all analyzers. Additional precautions specific to individual analyzers 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 all warnings on the analyzer, accessories (if any) and in this Owner's Manual.
Follow Instructions: Observe all precautions and operating instructions. Failure to do so may result in personal injury or damage to the analyzer.
Inlet Pressure: Recommended 5-30 PSIG, 100 PSIG maximum.
Outlet Pressure: The sample gas vent pressure should be atmospheric.
Oxygen Sensor: DO NOT open the sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual appendix. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.
Mounting: The analyzer is approved for indoor use only. It may be used outdoors with optional enclosures. Mount as recommended by the manufacturer.
Power: Supply power to the analyzer only as rated by the specification in Section 4 and/or markings on the analyzer enclosure. The wiring/cords that connect the analyzer to the power source should be installed in accordance with recognized electrical standards and so they are not pinched, particularly near the power source and the point where they attach to the analyzer. Never yank a power cord to remove it from an outlet or from the analyzer.

ENSURE THAT POWER LINE INCULDES "SURGE PROTECTER" AND RFI/EMI FILTER TO PREVENT INTERFERENCE FROM EXCESSIVE LINE VOLTAGE VARIATIONS
Operating Temperature: The maximum recommended operating temperature is 45 ºC. However, an operating temperature of less than 35 oC is ideal to obtain maximum life of the oxygen sensor**.**
Heat: Situate and store the analyzer away from a direct source of heat.

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 of the analyzer.

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

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 per Section 9 and may result in electrical shock, injury or damage. All other servicing should be referred to qualified service personnel.
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.

Oxygen Sensor: DO NOT open the sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual appendix. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.
Nonuse Periods: Isolate the oxygen sensor from exposure to high oxygen as described in this manual. Disconnect the power when the analyzer is left unused.
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.
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 of the analyzer.
Serviceability: Except for replacing the oxygen sensor, there are no parts inside the analyzer for the operator to service. Only trained personnel with authorization of their supervisor should conduct maintenance.
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 per Section 9 and may result in electrical shock, injury or damage. All other servicing should be referred to qualified service personnel.

Installation considerations

Gas Sample Stream: Ensure the gas stream composition of the application is consistent with the specifications and review the application conditions before initiating the installation. If necessary, consult factory to ensure the sample is suitable for analysis with the analyzer purchased.

Contaminant Gases: Use a scrubber upstream of the of the analyzer to remove interfering gases such as oxides of sulfur and or hydrogen sulfide that can interfere with measurements and, reduce the expected life of the sensor thus voiding sensor warranty.

Expected Sensor Life: With reference to the publish specification, the expected life of the sensor is predicated on oxygen concentration (< 1000 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 outside of the specifications will affect the life of the sensor. Avoid exposure of MS series sensors to oxygen levels above 1000 PPM. Failure to do so will result in permanent damage to the sensor.

Accuracy & Calibration: Refer to section 5 Operation. Analyzers equipped with Pico-Ion oxygen sensors have a maximum range of 0-1000 PPM.

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 1,800 ºF to ambient temp. The maximum operating temperature is 45ºC, on an intermittent basis the analyzer may be operated at 50ºC. At temperatures above 25ºC, user is expected to accept a reduction in expected sensor life.

Pressure & Flow: Sample system and flowing gas sample is required for measuring sub- PPM oxygen in a sample stream. Use of stainless steel tubing and fittings is critical to maintaining the integrity of the gas stream to be sampled.

Inlet Pressure: Analyzer is designed for analyzing a flowing sample stream under positive pressure. Set the sample pressure 5-30 psig; although the rating of the fittings/valves is considerably higher, a pressure between 5-30 psig is recommended for ease of control of sample flow using the integral flow control valve.

Outlet Pressure: Sample must always be vented to atmospheric pressure.

Flow Rate: For optimum performance, a flow rate of 1-2 SCFH is recommended.

Moisture & Particulates: Installation of a suitable coalescing and/or particulate filter is required to remove condensable liquid and/or particulates from the sample gas. Moisture and/or particulates do not necessarily damage the sensor, however, collection on the sensing surface can block or inhibit the diffusion of sample gas into the sensor resulting in a reduction of sensor signal output – and the appearance of a sensor failure as indicated by lower oxygen reading of a known standard.

4. Specifications

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Technical Specifications *

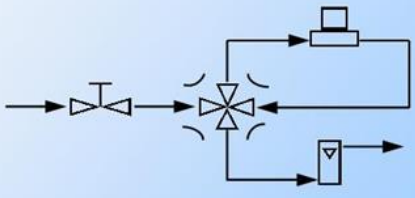
	PI2-MS 500	PI2-MS 1000
Accuracy:	< 3% of reading or ± 3 PPB at constant temp, pressure, flow	< 3% of reading or ± 5 PPB at constant temp, pressure, flow
Analysis:	0-0.5, 0-1, 0-10, 0-100, 0-1000 PPM Full Scale ranges	0-1, 0-10, 0-100, 0-1000 PPM Full Scale ranges
Application:	Analyze PPB O_2 in high purity N_2, He, Ar, H_2	Analyze PPB O_2 in high purity N_2, He, Ar, H_2
LDL:	< 2.5 PPB	< 5 PPB
Sensor:	GPR-12-2000 MS-2E	GPR-12-2000 MS-2

Area Classification:	General purpose, CE certified
Alarms:	2 adjustable form C relay contacts non-latching; "weak sensor" indicator; power failure
Calibration:	Certified span gas with O2 content (balance N2) approx 50-80% of FS range of interest or next higher range
Compensation:	Barometric pressure and temperature; heated sample system and sensor housing
Connections:	Sample and span inlets - 1/4" compression tube fittings; option: 1/8" or NPT fittings
Controls:	Water resistant keypad; menu driven range selection, calibration, alarm and system functions
Data Acquisition:	Selectable data point intervals; USB or RS232 or RS485
Display:	Graphical LCD 5 x 2.75; resolution 0.01 ppb; displays real time ambient temperature and pressure
Enclosure:	Bench top, painted aluminum 13.9" x 9.9" x 13.4"; options: panel or 19" rack mount, wall mount
Flow:	Recommended flow rate 1-2 SCFH
Linearity:	> .995
Pressure:	Inlet - 20-50 psig, max 150 psig; vent - atmospheric
Power:	Specify 100-240 VAC
Range ID:	1-5VDC and 4-20mA, optional Dry Relay Contacts
Recovery Time:	O_2 Level: 9 ppm, Air; Duration: 2 minute, 30 seconds; O_2 Target: 10 PPB, 1 PPM; Recovery on N_2: 10 minutes, 45 minutes
Response Time:	<15 seconds
Sample System:	Stainless steel wetted parts consisting of flow control and sample bypass valves, flow indicator; option: automated inlet valves
Sensor Life:	12-24 months
Signal Output:	4-20mA isolated, 0-1V and 0-5V Full Scale
Temp. Range:	0º to 45ºC
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless Steel

* Specifications subject to change without notice

PI2-MS 500 / 1000
PPB Oxygen Analyzers

2nd Generation Pico-Ion™ Sensor
LDL < 2.5 parts-per-billion
Fast Recovery from Upset Excursions
Expanded User Interface
Bypass Sample System Standard
Choice of Communication Link
No Maintenance or Electrolyte Additions
Low Cost Ownership - High Performance
Options: Panel, 19" Rack, Wall Mounting
Automated Inlet Valves



An integral stainless steel bypass sample system isolates the sensor from high oxygen levels (or air) and enables the analyzer to come back online in minutes reducing downtime related to changing sample lines.

2855 Metropolitan Place, Pomona, CA 91767 USA ♦ Tel: 909-392-6900, Fax: 909-392-3665, www.aii1.com, e-mail: info@aii1.com Rev 8/23

5. Operation

Principle of Operation

The PI2-MS-500/1000 series oxygen analyzers incorporate a proprietary second generation Pico-Ion oxygen sensor. It is configured for panel mounting and requires a 7.5 x 10.8" cutout with 4 holes for the analyzer's front panel. Optional configurations include 19" bezel for rack mounting or wall mount enclosure. Contact factory for additional information on options.

Breakthrough Sensor Technology

A breakthrough sensor technology of the second generation Pico-Ion oxygen sensor measures the partial pressure of oxygen from less than 3 PPB to 1000 PPM level in inert gases, gaseous hydrocarbons, helium, hydrogen and mixed gas streams.

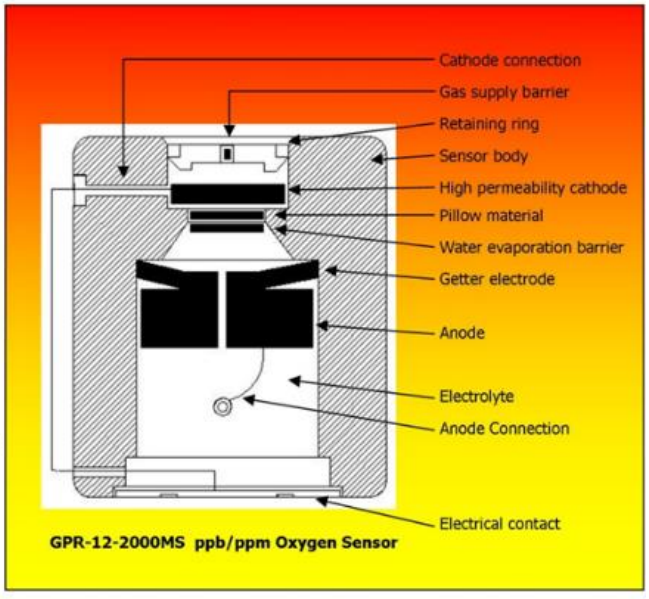
Pico-Ion 'MS' Oxygen Sensor

Design Criteria

The evolution of electronics influences virtually every aspect of our personal and business lives. The world of industrial gas analyzers is no exception. However, often overlooked is the fact that the heart of any analyzer is the sensor. Thus advancing the sensor technology is a critical element in the development of analyzers.

- Proprietary metal catalyzed cathode . . .
  - High signal output 10x greater than galvanic sensors
  - High signal to noise ratio
  - Fast response time
- Maximize the rate oxygen is reacted . . . Minimize oxygen dissolving into electrolyte
- Fast recovery from exposure to oxygen

O_2 Exposure	Duration	O_2 Target	Recovery
Air	30 sec	10 ppm	15 min
Air	30 sec	1 ppm	45 min
9 ppm	2 min	100 ppb	3 min
9 ppm	2 min	10 ppb	10 min
1 ppm	5 min	10 ppb	15 min



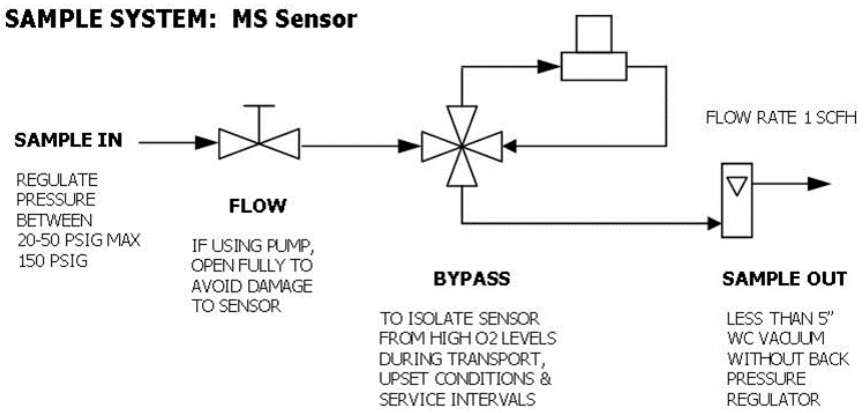
- Lower detectable limit < 10 ppb
- High accuracy and repeatability < ±1%
- Employ a water evaporation limiting barrier
- Employ a barrier to limit the amount of oxygen dissolving into electrolyte
- Operating life minimum 36 month target
- No sensor maintenance
- Compact disposable design
- Long term stability less than 5% drift from span over 6 months
- Extended intervals between calibration minimum 3 months to 6 month target
- Readily transportable and insensitive to minor mechanical shock
- Low cost of ownership

Oxygen, the fuel for this electrochemical transducer, 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 four ranges and remains virtually constant over its useful life. The sensor requires no maintenance or electrolyte addition and is easily and safely replaced at the end of its useful life.

Analyzer Sample System

The sample must be properly presented to the sensor to ensure an accurate measurement. In standard form the PI2-MS-500/1000 is designed with a sample system that complements the performance capabilities of the Pico-Ion oxygen sensor and enables the user to isolate the sensor from exposure to high oxygen concentration which results is a substantial increase is user productivity. This 4-way Sample/Bypass valve has two important features: 1) the sensor can be isolated from exposure to high oxygen levels when changing sample lines, during transport and during standby intervals making it ideal for mobile cart applications, 2) it enables the user to purge newly connected gas lines thus eliminating oxygen trapped gas lines.

CAUTION: The sample gas must flow through the analyzer's internal sample system at a recommended flow rate of 1-2 SCFH. The Sample/Bypass valve must be in Bypass position to purge gas line for 2-3 minutes before switching Sample/Bypass valve to sample.



The advantages of the 4-way Sample/Bypass sample system include:

- Supplying the analyzer with the sensor it was qualified with.
- Isolating the sensor during transport, calibration and maintenance intervals when changing gas line connections.
- Isolating the sensor from exposure to high oxygen levels during upset conditions.
- Purging air (or high oxygen levels) trapped in the gas lines following a process upset.

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

Temperature Controlled Heater System with Runaway Protection Circuit

The standard PI2-MS-500/1000 Series analyzer is equipped with the heater system set at 85°F at the factory. The heater maintains the temperature around the sensor that enhances the measurement accuracy where ambient temperature may change.

The temperature 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/closed when the temperature controller is ON.

When power is applied to the analyzer, the temperature controller tunes itself to the temperature set point. It is recommended that at initial start-up, when replacing the oxygen sensor or when trouble shooting, set the temperature set point at 60°F (to turn the heater off) to prevent overheating the analyzer.

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 interior of the analysis unit.

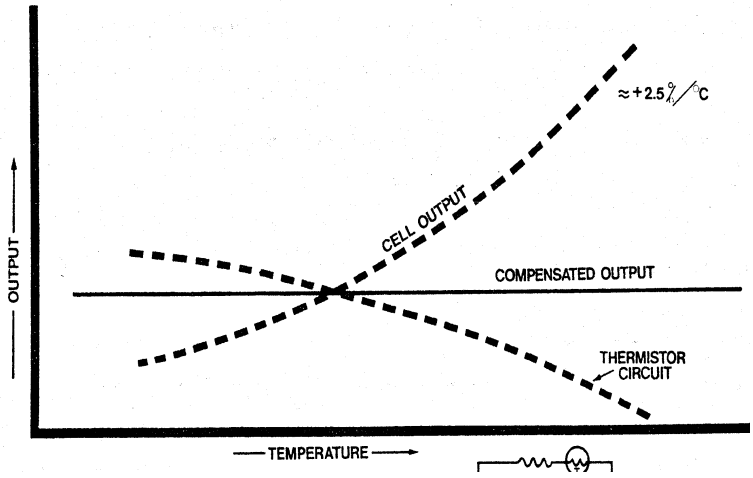
The runaway protection is provided by a J2 type device positioned between the temperature controller and the heater. This device cuts of power to the heater if the temperature inside the analysis unit exceeds 70°C. Should the J2 device cut power to the heater, correct the problem and reset the runaway protector device by exposing it to 0°C for a few minutes (a refrigerator freezer will do) or replace J2.

6. 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 these linearity and absolute zero properties, single point calibration is possible.

Electrochemical sensors are sensitive to the partial pressure of oxygen in a sample gas and their output is always a function of the number of molecules of oxygen 'per unit volume reaching to the sensor's sensing surface. It is essential that during measurements, the sample pressure remains constant.

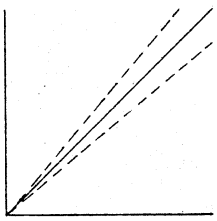
NOTE: The pressure of the sample gas and that of the calibration gas must be within 5 psig so that when sample/span gases are switched, the flow rate will relatively remain constant and hence avoid any error in measurements. A significant difference in the sample/span pressure may affect the flow rate that could affect the oxygen reading. If setting the sample and span gas pressure with 5 psig is not possible, assure that the sample and span gas flow rates are adjusted to one selected value after switching the sample/span gas.

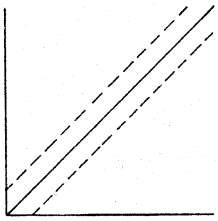


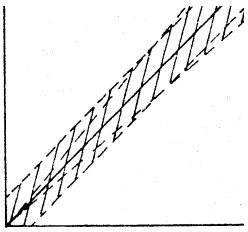
Temperature effect: The rate at which oxygen molecules diffuse through the sensing; a Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier' is temperature sensitive. Therefore, the fact the sensor's electrical output will vary with temperature, is normal. This variation is relatively constant 2.5% per ºC. A temperature compensation circuit employing a thermistor offsets this effect with an accuracy of ±2% or better and generates an output function that is independent of temperature. If the calibration and sampling is performed at the same temperature or if the measurement is made immediately after calibration, there measurement will be very accurate. A significant variation in the temperature during analysis could cause an error of up to +/-5% of full scale.

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

Graph C illustrates these 'worse case' specifications that are typically used to develop an analyzer's overall accuracy statement of < 1% of full scale at constant temperature or < 5% over the operating temperature range. QC testing confirms the typical error is < 0.5% at constant conditions prior to shipment.


A. PERCENT OF READING ERRORS


B. PERCENT OF FULL SCALE ERRORS


C. OVERALL ACCURACY

Example 1: As illustrated by Graph A any error, play in the multi-turn span pot or the temperature compensation circuit, during a span adjustment at 20.9% (air) of full scale range would be multiplied by a factor of 4.78 (100/20.9) if used for measurements of 95-100% oxygen concentrations. Conversely, an error during a span adjustment at 100% of full scale range is reduced proportionately for measurements of lower oxygen concentrations.

Refer to the Calibration section for additional details.

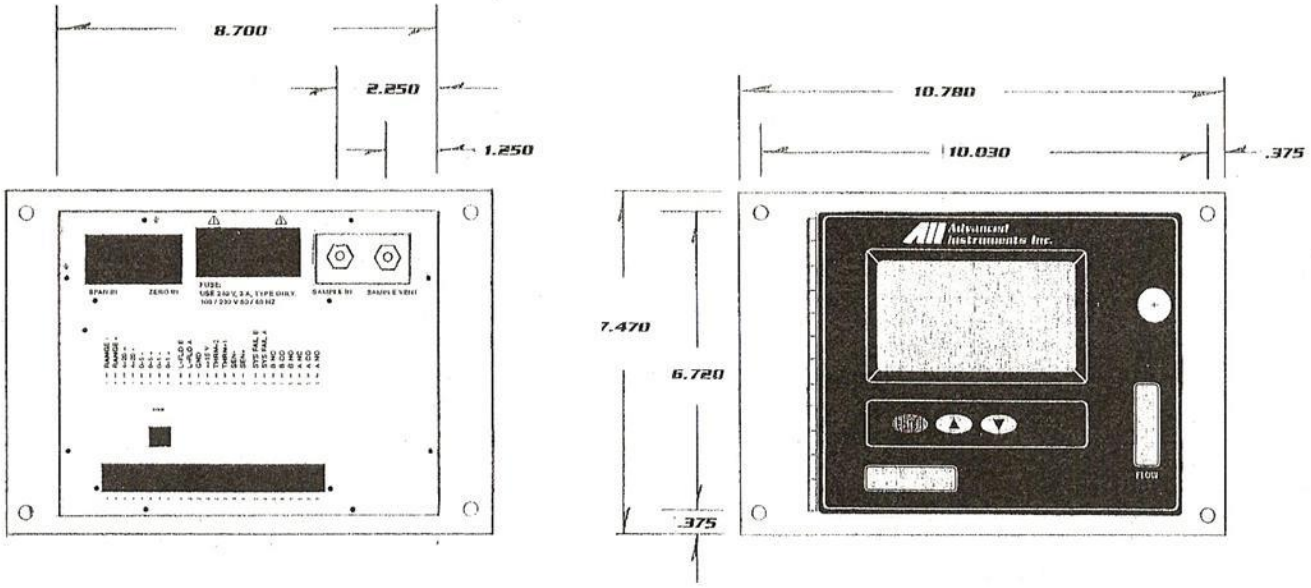
Mounting the Analyzer

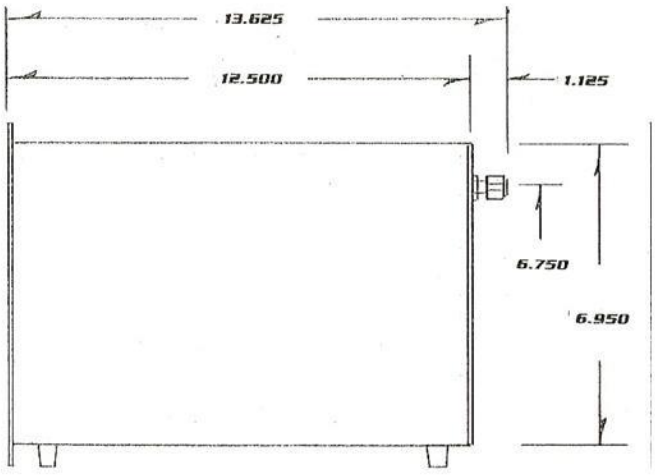
The standard PI2-MS-500/1000 is designed to be panel mounted and requires a cutout that accommodates the enclosure and 4 mounting bolts. The design also lends itself to 19" rack mounting with an optional bezel or wall mount enclosures as illustrated below.

The PI2-MS-500/1000 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 located on the back side of the front panel. When mounting the analyzer position it approximately 5 feet off the floor for viewing purposes and allow sufficient room for access to the terminal connections at the rear of the enclosure.

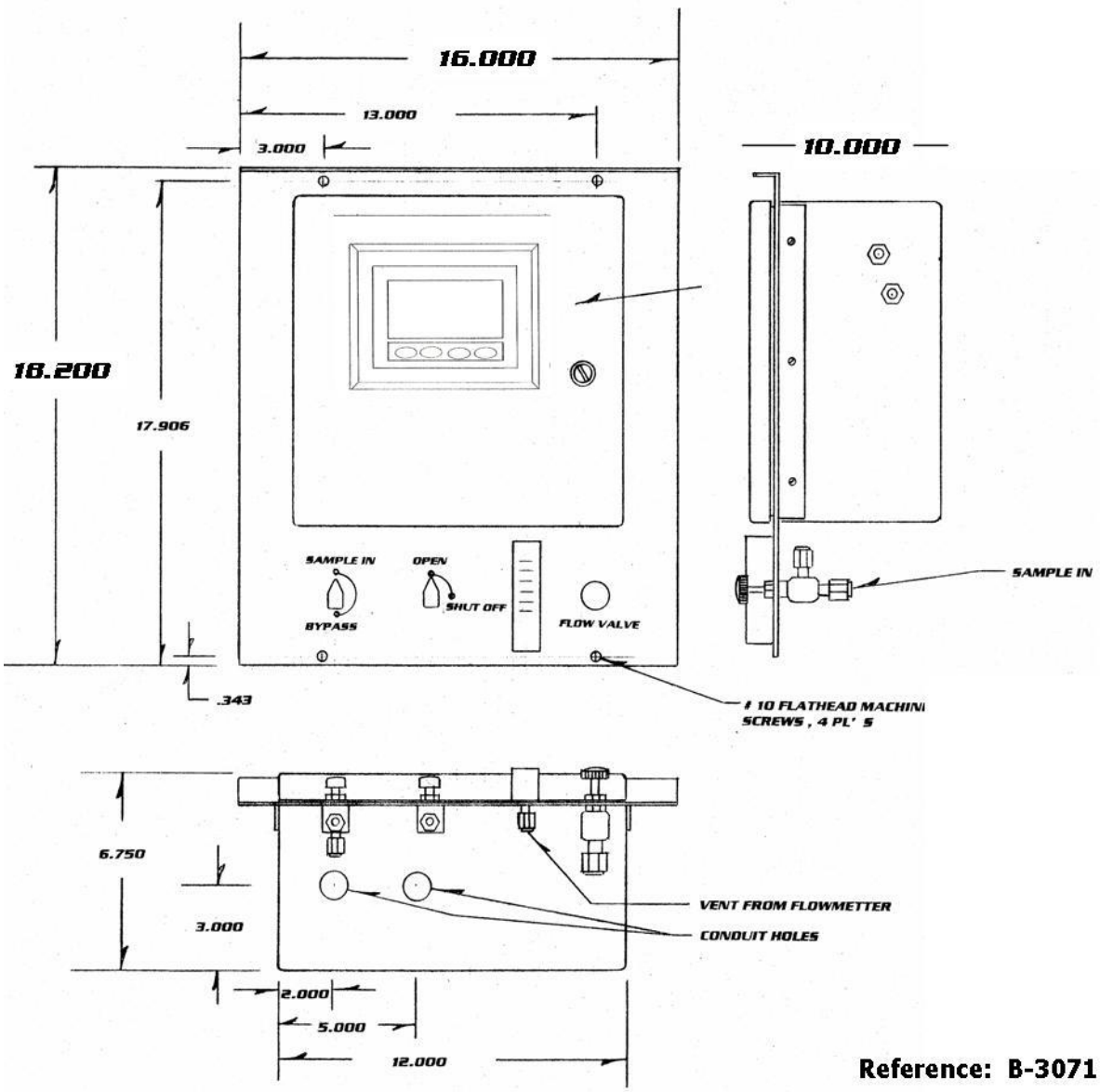
Note: The proximity of the analyzer to the sample point and use of optional sample conditioning components have an impact on sample lag time.

PI2-MS-500/1000 dimensional drawing:





PI2-MS-500/1000-W-306 Option:



Reference: B-3071

Gas Connections

The PI2-MS-500/1000 with its standard flow through configuration is designed for positive pressure samples and requires connections for incoming sample and outgoing vent lines, see illustrations above. The user is responsible for calibration gases and the required components. Follow the procedure below to set up gas connections.

- Regulate the pressure and flow as described in Pressure & Flow above.
- Install the sample out or vent line connection to the fitting labeled SAMPLE VENT.
- Install the incoming sample or span gas line to the fitting labeled SAMPLE IN.
- Set sample and span gas pressure between 5-30 psig
- Set the 4-way Sample/Bypass valve to BYPASS position
- Set the sample flow rate to 1-2 SCFH
- Purge the gas line for 2-3 minutes and proceed to installation of sensor

Analyzer Electronics

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

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 and range ID, separate relay contacts rated 30VDC max @ 1A are provided for the oxygen alarm feature and an optional range ID feature (auto-zero/auto-cal with relay contacts for Range ID is special order). Whenever the analyzer is calibrated, a unique algorithm predicts and displays a message indicating a 'weak sensor' suggesting the sensor be replaced in the near future.

Electrical Connections

The analyzer operates with a universal 100-240 VAC input. Supply power to analyzer as rated and marked on the analyzer panel. Incoming power is supplied through a universal power entry module. A standard computer type power cord is required t0 supply power.

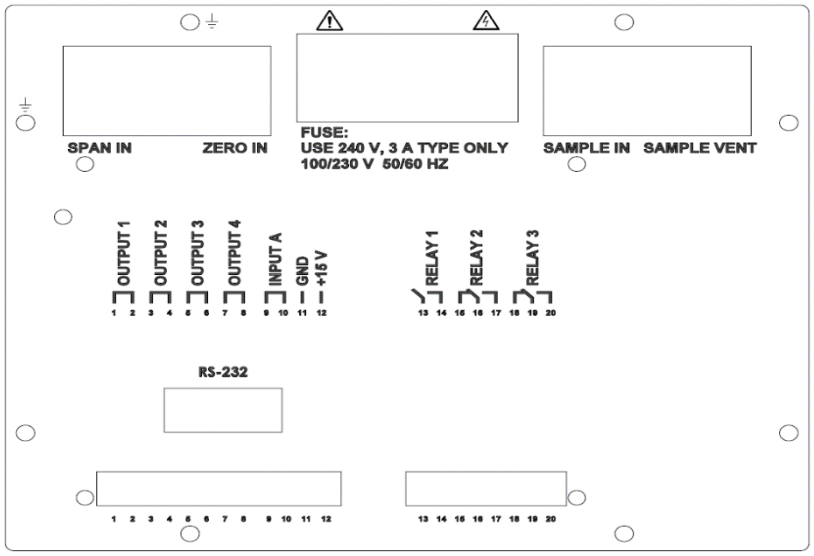
To make electrical connections with terminal block marked,

- Strip the ends of wires to no more than 3/16 inch.
- Use a small bladed screwdriver to loosen the appropriate terminal levers as illustrated above and insert the stripped end of the wire in the slot and release the lever. The wire will firmly be held by the lever of the terminal block
- Repeat above step for making all required connections. NOTE: In the standard analyzer configuration, the sensor is internally connected to the PCB, therefore, no external SEN+ and SEN- connection are required
- Provide power by inserting the power cable provide in to the Power Entry Module.
- 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.
- 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.

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.



Oxygen Threshold Alarms

Analyzer is provided with two user configurable oxygen alarms. The alarms Alarm 1 (Relay 2) and Alarm 2 (Relay 3) represent two oxygen threshold type alarms that can be configured in the field as either HI-HI or HI-LOW alarms from the analyzer's menu driven LCD display as follows:

- Establish independent set points for oxygen concentration
- Select each alarm either Hi or LOW
- Select either On or Off (enabled or disabled); this feature is useful during maintenance or an upset condition when Alarms may trigger un-necessary alarm.
- Both alarms can be temporarily defeated using a user entered 'timeout' period (normally minutes)

The alarm set point represents an oxygen value. When 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 resistive relays rated @ 5A, 30VDC or 240VAC.

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.

Alarm Bypass and Alarm Timeout

Aside from being totally defeated in the Alarm Bypass mode, the Alarm 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 as "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).

Note: Selection of the optional Range ID contacts configuration utilizes the alarms relays contacts thereby eliminating the alarms feature.

Power Failure Alarm (Relay 1)

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

Range ID (Output 1)

1-5 VDC is provided as range ID. The voltage output changes 1 V with each range, for example, 4V, 3V, 2V and 1 V; 1V representing the most sensitive analysis range.

4-20 mA is also provided as range ID, with each range change, the range ID will change 4 mA.

4-20mA Signal Output (Output 2)

The analyzer provides a 4-20mA full scale fully isolated ground.

The 4-20mA current output is obtained by connecting the current measuring device between the positive and negative terminals labeled OUTPUT 4-20mA.

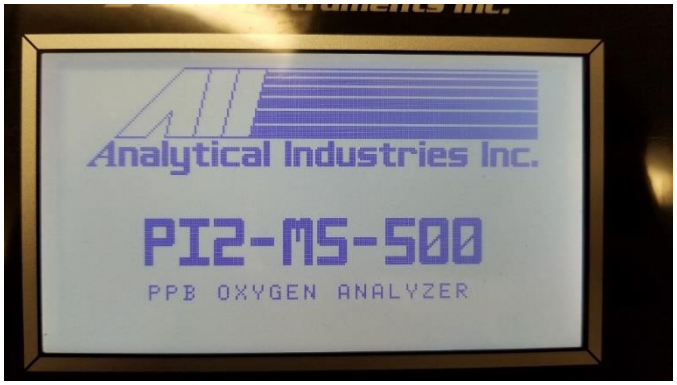
Caution: Integral 4-20mA converters are internally powered and do not require external power. DO NOT supply any voltage to any of the terminals for 4-20mA signal output and range ID.

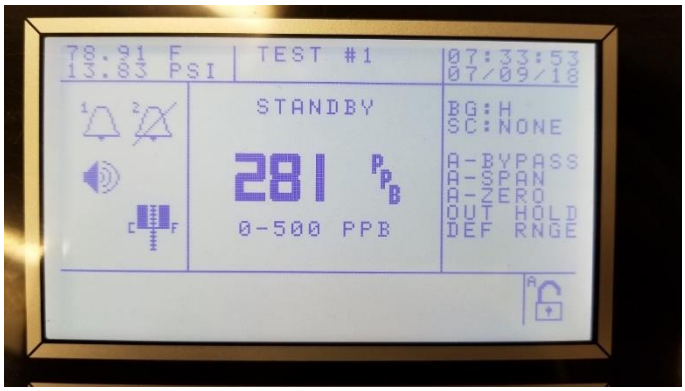
0-5 (Output 3) and 0-1 (Output 4) VDC Output

In addition to 4-20 mA full scale signal, 0-1 V and 0-5 VDC full scale signal output is also provided.

Establishing Power to the Electronics

Once the power cord is inserted into to the power entry module at the rear of the enclosure, as illustrated above, connect the plug end of the power cord to an appropriate AC outlet. When power is supplied to the analyzer, the analyzer performs self-diagnostic checks and the 5" x 2.75" graphical back-lit LCD displays the following message





The main screen contains information pertinent to the analyzer. This information consist of

- Temperature and pressure at the upper left corner.
- The current MODE of the analyzer is indicated at the middle center of the LCD. A user customizable name appears across the top center line of the LCD.
- Date and time at the upper right corner.
- Left hand side of the LCD shows if Alarm 1 & 2 are currently active (Example shows Alarm 1 active and Alarm 2 inactive) and the speaker symbol is if the audible alarm is active or not.
- At the center of the LCD displays the current reading of the sensor and below that displays the range the analyzer is currently in (0-500PPB manual range). AUTO will appear underneath the range ID when Auto Ranging is selected.
- Right hand side of the LCD displays:
    - BG: Background Gas selected.
    - SC: Signal Conditioning option selected.
    - A-Bypass: Auto Bypass enabled.
    - A-Span: Auto Span Calibration enabled.
    - A-Zero: Auto Zero Calibration enabled.
    - Out Hold: Holds output until user has finished servicing analyzer.
    - Def Rnge: Default Range enabled.
- Bottom right hand side of LCD displays if the analyzer is locked with a passcode.

Menu Navigation

Sample Screen:

- Press **Menu/Esc** to show Main Menu (if the menu is locked, a passcode prompt will appear)
- Press **Enter** to show graph screen
- Press **Up** to bypass an active alarm or accept a span or zero calibration in progress
- Press **Down** to abort a span or zero calibration in progress
- Hold **Menu/Esc** and **Enter** for ½ second to restart analyzer
- Hold **Menu/Esc** for ½ second to clear non-critical error messages

Main Menu:

- Press **Up/Down** to move selection pointer
- Press **Enter** to select a menu item
- Press **Menu/Esc** to return to previous menu

Graph Screen:

- Press **Enter** to cycle graph (O2, Temperature, Pressure)
- Press **Menu/Esc** to return to sample screen or Data Logging menu
- Press **Up/Down** to go to Next/Previous graph page (page number is displayed in upper-right corner, page 1 is most recent data)
- Hold **Up/Down** for ½ second to zoom graph to next higher/lower range

Numeric/Alpha-numeric entry:

- Press or hold **Up/Down** to increase/decrease digit value
- Press **Enter** to edit next digit to the right or accept entry (right-most digit)
- Press **Menu/Esc** to edit the next digit to the left or abort entry (left-most digit)

There are several sub-menus within each main menu. The details of selecting certain features within a menu or sub-menu are given below

Normal Operation of Analyzer

After sensor installation, analyzer is ready to sample the gas. However, it is recommended that analyzer be calibrated before use.

Auto Ranging Mode

In AUTO RANGING mode, output signal will shift to higher range when oxygen reading exceeds 99.9% of the current range. Output will shift to the next lower range when oxygen reading drops to 85% of the next lower range.

For example, if analyzer is reading 10 PPB on 0-100 PPB range and an upset occurs, output will shift to 0-1 PPM range when oxygen reading exceeds 99.9 PPB. Conversely, once the upset condition is corrected, output will shift back to 0-100 PPB range when oxygen reading drops to 0.085 PPM.

Note: In AUTO RANGING Mode, analog signal output (voltage and mA) will always correspond to the percent of full scale range displayed. For example, at 50.0 PPB on 0-100 PPB range, analog signal will be 0.5 V and 12 mA. Similarly, at 0.50 PPM on 0-1 PPM range, analog signal will be 0.5 V and 12 mA.

Manual Ranging Mode

In MANUAL RANGING, output will not shift automatically. Instead, when oxygen reading exceeds 125% of the upper limit of the current range, output will freeze at 125% value of the selected range but analyzer display will shift to the next higher range and show actual oxygen concentration.

To select MANUAL RANGING, select SAMPLE and press ENTER, then select MANUAL RANGING and then advance cursor to the appropriate range and press ENTER again.

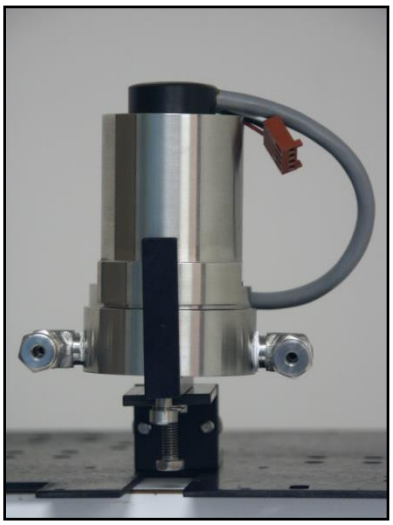
Note: In MANUAL RANGING, signal output will max out at about 125% of the selected range (even though oxygen reading on the LCD will shift to the next higher range).
In MANUAL RANGING, following information will appear on the LCD display.

Installing the Oxygen Sensor

The analyzer is shipped with oxygen sensor separately bagged in a nitrogen filled metalized PE bag. Use the procedure listed below to install the sensor or to replace an expired sensor. Sensor should be installed only after the analyzer installation is complete and Sample and Span gas line have been connected and purged.

GPR-12-2000 MS-2/2E series sensors are for nitrogen, argon, hydrogen and helium application. For any other gas mixture application, consult factory.

WARNING: The **GPR-12-2000 MS-2/2E** sensor can be used for any of the above gas, however, if the sensor has been used with any one gas, allow several sufficient time for the sensor to stabilize with new sample gas before commencing analysis



CAUTION: Before removing the oxygen sensor from the sealed bag, perform the following checks

1. Ensure all gas connections are secure and tight.
2. Select Sample valves from the main menu and ensure that the sample pressure is set at 30-50 PSIG and air pressure is set at 80 PSIG.
3. Set the sample flow rate between 1-2 SCFH by adjusting the Pressure Regulator setting. Ideal flow 1-2 SCFH.
4. Allow the analyzer sample system to purge for about 5 minutes (this step is required only if the analyzer has been installed for the first time).
5. From Main Menu, select Calibration, Enter sensor serial number located on the box the sensor is shipped in.
6. Loosen the hex screw (or thumbwheel) at the bottom of the sensor housing by using 5/16" ranch provided or by turning the thumb wheel. Remove the upper section of the sensor housing by turning it 90 degree and then lifting it straight up.
7. Remove sensor from the sealed bag. Use a sharp pair of scissor to cut the bag. Do not use a spike to poke the bag (this method may accidently damage sensor).
8. Place sensor with sensor's sensing surface facing down in the bottom section of the sensor housing immediately (with gold color two ring PCB facing up). Remove the two red colored taps from the PCB of the sensor. Place upper section of the sensor housing on top of sensor and gently lower it down until it sits on the bottom section of the housing. Turn the upper section of the housing 90 degree and then tighten the screw at the bottom of the sensor housing (after finger tight, turn the screw one full turn) or tighten by turning the thumb wheel.
9. Confirm that sample flow rate is between 1-2 SCFH (adjust flow by turning the knob of the pressure regulator as necessary). Ideal Sample flow is 1-2 SCFH.

Caution: Do not attempt to calibrate analyzer until it has reached a stable base line. This process may take up to 12-24 hours period. However, you may confirm that the newly installed sensor has the proper output by using a span gas; with span gas flowing, analyzer will display an oxygen reading close to the span gas value plus the O2 reading before span gas was introduced. If the difference in the oxygen reading before and after introducing span gas is not close to the span gas value (+/-30% of the span gas value with Factory Default Span setting, see details later in this Section), you may consider replacing with another sensor.

What to Expect During the First 24 Hours

After analyzer installation has been completed, sample and span gas lines have been connected and purged, install sensor as instructed in the section above. After sensor installation, analyzer should demonstrate a downward trend for several hours. Generally, analyzer reading should drop below 100 PPM in less than 10-15 minutes and below 1 PPM in less than 1-2 hours. It is strongly recommended that the user record analyzer output on a recording device, e.g., chart recorder or a PLC, to confirm downward trending of the analyzer.

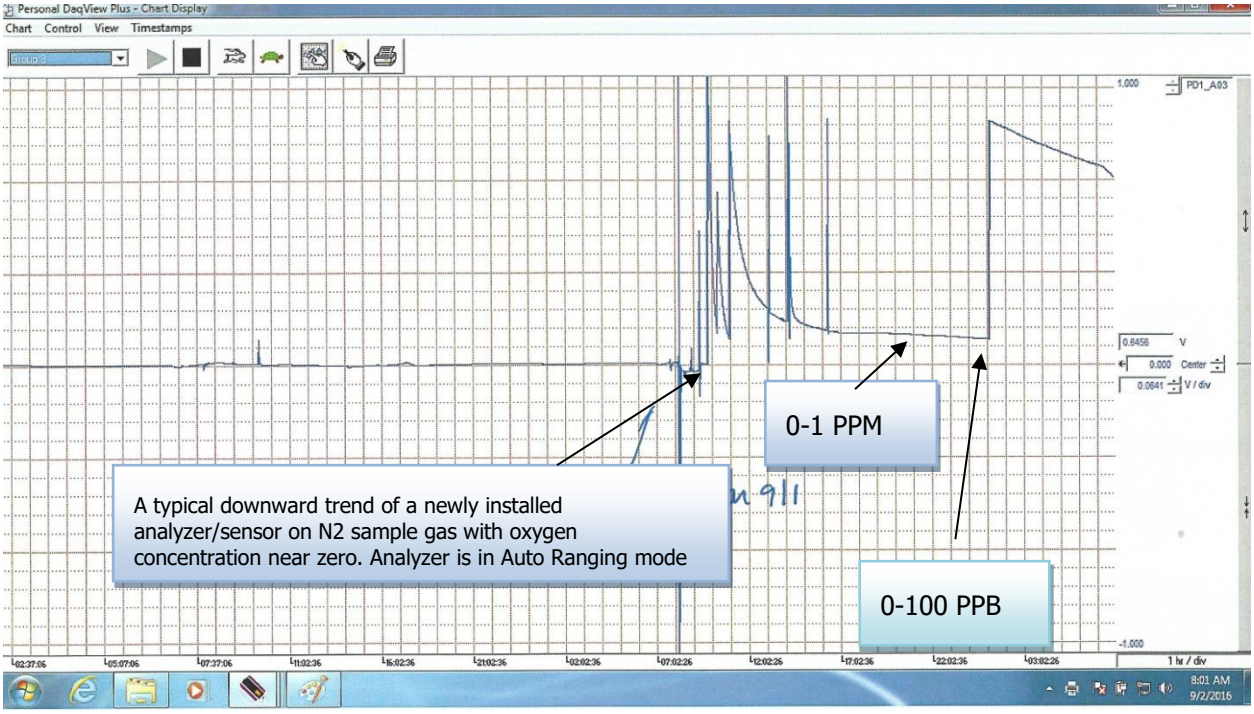
Caution: This "clean-up time" or "recovery time" or "purge down time" depends on the user – the length of time sensor has been exposed to ambient air before it was installed and how well sample gas line was purged before it was connected to the analyzer sample input.

In the above graph, trending shown is very typical after a new sensor installation. Within 24 hours of installation of new sensor, output dropped to less than 60 PPB and continued to trend down. This downward trend would continue but the degree of trending down will decrease with time and eventually get to a stable reading.

NOTE: If after 2 hours of installation, oxygen value displayed is not below 1-2 PPM, perform a complete check of all external sample system connections and allow a low ppm gas to flow overnight before concluding that sensor is defective and notifying the factory.

Caution: Allow approximately 24 hours to stabilize the sensor before attempting initial Zero and/or Span calibration of analyzer.

General guidelines for Analyzer Calibration



Zero Calibration

Theoretically, with zero gas, analyzer should display 0 PPB. However, even with pure gas (no oxygen), analyzer will display a signal anywhere from 5-60 PPB. This oxygen value is called as the "Zero Offset" This offset is contributed by

1. Minor leakage in the sample line connections.
2. Residual oxygen dissolved in sensor's electrolyte
3. Tolerances in electronics components

In order to achieve accurate results in the low PPB levels, analyzer must be "Zero calibrated" before accurate measurements could be made.

Zero Calibration Procedure

PI-MS-500/1000 analyzer has no integral oxygen scrubber to produce zero gas from sample gas. An external source of zero gas is required to perform zero calibration. To perform Zero calibration, follow the steps below.

In order to perform a ZERO calibration,

- From the MAIN MENU screen, select Calibration.
- From CALIBRATION menu, select Zero Calibrate.
- On the bottom left of the LCD Zero Cal will appear with Up = Accept, Down = Abort. A timer of 30 minutes will appear underneath the valve mode selected. After the 30-minute timer is up then the analyzer will attempt to perform the zero calibration. The user may Accept or Abort the calibration at any time. Ensure reading is stable before prematurely accepting the zero calibration.

After ZERO calibration, analyzer will automatically return to the previous valve mode selected.
CAUTION: If zero calibration is performed pre-maturely (analyzer still trending down), analyzer may show a negative reading in the SAMPLE mode.

Span Calibration

Oxygen sensors produce a certain amount of current per unit of oxygen concentration. However, due to the tolerances involved in various components of the sensor, sensor's current signal may vary from one sensor to another. This variation, however, is within approximately +/- 30-50% of the nominal sensor signal. In order to achieve accurate results, sensor must be calibrated by using a certified span gas.

Span Calibration Procedure

Analyzer may be calibrated by using a certified span gas with oxygen content 5-8 PPM balance nitrogen.

To enter a span gas value:

- Go to the Calibration Menu.
- Select Span Gas: 08.00 PPM
- Using the Up/Down and Enter keys select the span gas value listed on the gas tank.
- Once the span gas value has been selected, select Span Background Gas: Nitrogen.
- Select span background gas and press Enter.

To initiate a span calibration

- Select Span Calibrate on the Calibration Menu.
- The valves will actuate to Span Bypass for 30 seconds to ensure the line is purged down before continuing to Span Calibration.
- On the bottom left of the LCD Span Cal will appear with Up = Accept, Down = Abort. A timer of 30 minutes will appear underneath the valve mode selected. After the 30-minute timer is up then the analyzer will attempt to perform the span calibration. The user may Accept or Abort the calibration at any time. Ensure reading is stable before prematurely Accepting the span calibration.

Sampling the Gas

After successful SPAN and ZERO calibration, place the analyzer in SAMPLE mode. You may select MANUAL RANGING or AUTO RANGING option.
Analyzer will continue to analyze the sample gas unless otherwise instructed by the user.

Sampling Different gases

GPR-12-2000-MS-2/2E sensor is recommended for N2, Ar, He and H2 background gases. When switching analyzer from one sample gas to another, allow sufficient time for the sensor to stabilize with new sample gas before commencing analysis.

When sampling He or H2, the analyzer is recommended to be SPAN calibrated with 5-8 PPM O2 balance the gas being sampled. NOTE: Correction factors for various gases will be available within the next few weeks, with correction factors, the analyzer will be allowed to calibrate with a span gas in any four background gases and used to sample any of the four gases.

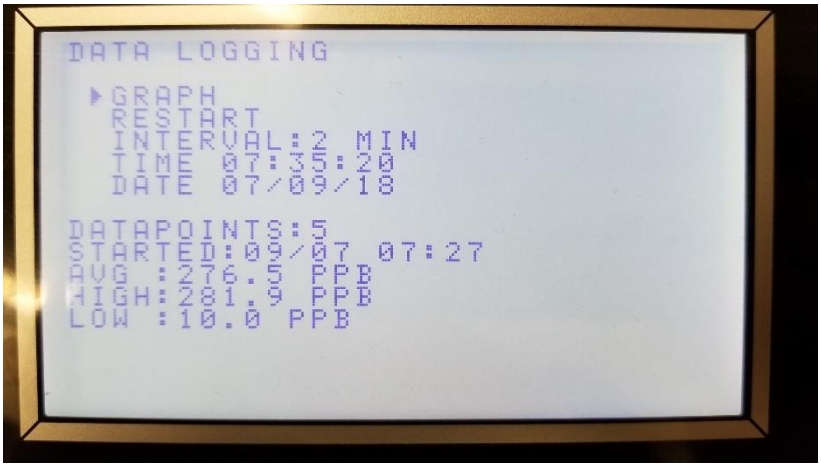
Analyzer Transportation

For moveable cart applications - Before transporting the analyzer from one place to another, make sure the second installation site is ready to install the analyzer. Follow the steps below

1. Place analyzer in Bypass mode.
2. Disconnect analyzer power
3. Disconnect sample, span gas lines and instrument air from analyzer.
4. Transport analyzer to new site as soon as possible
5. Establish sample connections at the new installation site. **CAUTION:** Purge sample and span gas lines before connecting to analyzer ports, failure to do so will increase the trending down time.
6. Establish power to analyzer
7. Select BYPASS mode, set sample flow between 1-2 SCFH and purge for 5 minutes
8. Select Sample mode and let sample purge for 5 minutes
9. The analyzer will begin trending down
10. It is not necessary to re-calibrate the analyzer

Data Logging

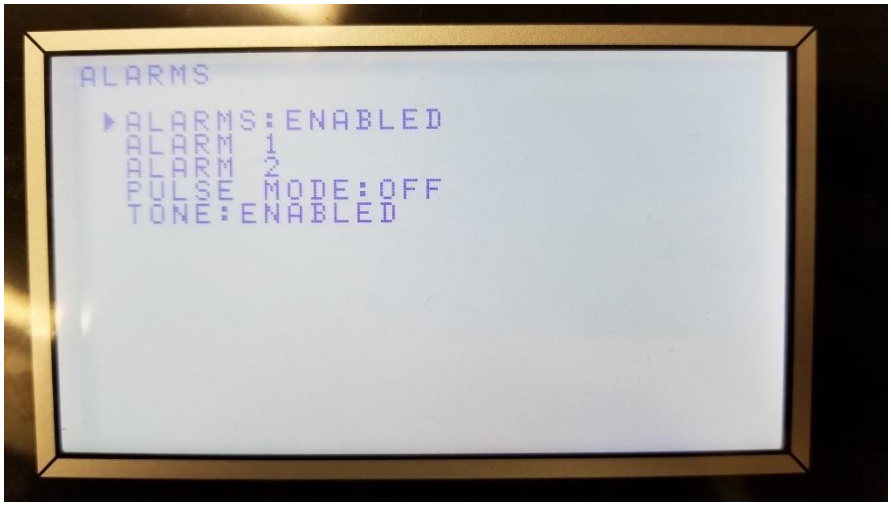
In the Data Logging Menu the user can select the following options.



- **Graph Screen:**
  - Press **Enter** to cycle graph (O2, Temperature, Pressure)
  - Press **Menu/Esc** to return to sample screen or Data Logging menu
  - Press **Up/Down** to go to Next/Previous graph page (page number is displayed in upper-right corner, page 1 is most recent data)
  - Hold **Up/Down** for ½ second to zoom graph to next higher/lower range
- **Restart**: Clears any information on the graphs and starts from zero.
- **Interval**: Sets the logging interval in minutes.
- **Time**: The user can change to time to match the location the analyzer is located.
- **Date**: The user can change the date to match the location the analyzer is located.
- **Datapoints**: How many datapoints have been taken since the data logging has begun.
- **Started**: The date and time data logging began.
- **Avg:** Average O2 reading of the sensor.
- **High**: Highest O2 reading since beginning of data logging.
- **Low:** Lowest O2 reading since beginning of data logging.

Alarms

In the Alarms Menu the user has the following options.



- Alarms: Enable or Disable both alarms.
- Alarm 1:
    - Enable or Disable Function
    - Setpoint: Set the value that the user wishes for the alarm to trigger.
    - Mode: Low or High. If set Low the alarm will trigger when the reading travels below the setpoint. If set High the alarm will trigger when the reading travels above the setpoint.
    - Delay: Sets a timer delay for the alarm. When the O2 reading reaches the setpoint, the alarm will trigger once the delay timer has expired. Setting delay to 00 will trigger the alarms immediately when the O2 reading reaches the setpoint.
    - Latching: If YES, active alarm must be manually bypassed.
    - Failsafe: If YES, alarm relay is energized while inactive, de-energized while active.
- Alarm 2: Same as Alarm 1.
- Pulse Mode: Disables Alarm 2. Relay 1 energizes for 3 seconds on activate, relay 2 energizes for 3 seconds on de-activate.
- Tone: Enables/Disables the beeper when alarms are triggered.

System Menu

Security

- Lock Now: Will go to sample screen and require a user passcode to enter menus. (Default passcode: 2855).
- Set Passcode: Will allow the user to set a passcode.
- Auto Lock: Locks the menu if no keys are pressure for the set time. Setting to 0 disables Auto Lock.

Analog Output

- Output Hold:
    - Display: Analog output follows the displayed O2.
    - Freeze: Analog output stops updating and holds the last output reading.
    - Zero: Analog outputs 0V or 4mA.
    - Full-scale: Analog outputs 1V, 5V, or 20mA.
- Calibrate 0-1V: Allows the user to calibrate the 0-1V output.
- Calibrate 0-5V: Allows the user to calibrate the 0-5V output.
- Calibrate 4-20mA: Allows the user to calibrate the 4-20mA output.
- Test: Using Up/Down keys allows the user to test the analog outputs in increments of 20%.

Signal Conditioning

- None: No signal conditioning applied to the O2 signal.
- Average: Rolling average over the number of samples (N) provided by the user. A new sample is taken every second.
- Fast:
    - A: Attenuation. Change of reading divided by the attenuation equals final change in reading.
    - T: Threshold. Set % of full scale of the signal that would be attenuated. The threshold compares the current sample reading to the previous sample. i.e. T =2% of 500ppb range, 2% is 10ppb. Any reading change of less than 10ppb will divide the change of reading by the attenuation factor. So, if A = 100 and change of reading is 5ppb then the reading will only change by 0.05%.

Auto Bypass

When the O2 reading travels to 20% of the 3rd range the analyzer will automatically switch to bypass valves to ensure the sensor does not get exposed to high amounts of oxygen. Exposure to high amounts of oxygen will damage the sensor and auto bypass will help protect the sensor.

Show Negative

The analyzer provides the user with the option to choose whether they wish to display negative readings. This feature is useful if the user prematurely zeroes the analyzer either inadvertently or knowingly during a quick start situation.

Unit ID

User customizable identification of the analyzer. The name given to the analyzer displays on the top center of the sample screen.

Temperature

User selectable temperature units, to display the temperature in either Fahrenheit or Celsius.

Pressure

User selectable pressure units, to display the pressure in either PSI or KPA.

Date Format

User selectable data format:

- YY/MM/DD
- DD/MM/YY
- MM/DD/YY

Info

The information screen displays the analyzer characteristics such as model number, serial number, firmware version, and more.

Standby and Storage

Short term shutdown

This procedure is for momentarily shutting down and moving the analyzer from one site to another or for a temporary shutdown.

1. After short term shutdown, to restart,
    1.1. Establish power to analyzer
    1.2. Set sample flow rate to 1-2 SCFH
    1.3. Allow sample line to purge for 5 minutes
    1.4. Move crossover valve to Sample and begin sampling

If the **analyzer is not to be used** for analyzing a sample gas, it is recommended that you keep the analyzer running and have pure nitrogen (at least 99.999) flow through analyzer (to preserve gas, a flow rate as low as 0.1 SCFH should be sufficient). This will always keep analyzer in "ready state" for analyzing sample gases.

Long term Shutdown

If analyzer is to be stored for a long period of time (greater than 30 days), it is recommended to remove sensor from analyzer and store analyzer in a clean environment. This is to prevent the likelihood of electrolyte leaking out of sensor and damaging the sensor housing. WHEN STARTING ANALYZER AGAIN, YOU MUST INSTALL A NEW SENSOR

7. Maintenance

Periodically, the oxygen sensor and oxygen scrubber will require replacement. The operating life of each is determined by a number of factors that are influenced by the user and therefore difficult to predict. Under normal operating conditions where the sensor and scrubber are exposed to oxygen levels below 10 PPM, expect a sensor life of approximately 12-18 months and a scrubber life of several years.

Cleaning the electrical contacts of the sensor housing (when replacing the sensor) is the extent of the maintenance requirements of this analyzer.

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.

Caution: DO NOT open/dissect the oxygen sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet 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.

Sensor Replacement Procedure

To replace sensor, refer to section OPERATION of this manual.

8. Spare Parts

Recommended spare parts for the PI2-MS-500/1000 PPB O_2 Analyzer:

Item No.	Description
GPR-12-2000 MS-2/2E	PPB Oxygen Sensor for inert gases.

Other spare parts:

CTRL-1004	Controller Temperature PID
HTR-1006	Heater
A-4541-4	Housing Sensor Bottom Assembly Stainless Steel
B-2762-B-3-16	Housing Sensor Upper Assembly Stainless Steel
MTR-1008	LCD Graphical Display 5" x 2.75"
ORNG-1007	O-ring 3/32 x 1-3/8 x 1-9/16 Viton
A-1146-24-rG-500	PCB Assembly Micro-processor / Display 0-50 PPB
A-1146-24-rG-1000	PCB Assembly Micro-Processor / Display 0-100 PPB
SNSR-1006	RTD Temperature Sensor
SNSR-1002	Runaway Protector J-2

9. Troubleshooting

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

	Sensor nearing end of life	Consult factory
		Replace sensor, obtain authorized service
		Replace sensor
Erratic, negative or no O2 reading possibly accompanied by electrolyte leakage	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	Replace sensor re-calibrate the analyzer.
		Remove any restriction on sample vent line.
		Vent sample to atmospheric pressure.
	Senor exposed to high O2 at time of installation or during normal use	Watch O2 signal for 24-48 hours, if the spikes persist, replace sensor
O2 signal shows periodic spikes	Zero offset beyond acceptable limit	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	Contaminated sample/zero gas or exhausted O2 scrubber	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)
Cannot perform zero calibration even after replacing sensor		
O2 reading drifts slowly upward	Sensor exposed to high O2 for an extended period of time or Sensor is nearing end of its useful life	Replace sensor
span requires large gain adjustment	Low sensor output signal possibly due to moisture condensation on sensor from liquid in sample gas or electrolyte leakage from sensor	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
	Liquid covering sensing area of sensor	Sensor: Replace if leaking and return it to the factory for warranty determination
	Presence of interference gases, e.g., CO_2 ,Cl_2, HCl	Consult factory
O2 reading swings too much with minor variation in ambient temperature	Sensor exposed to high O2 for an extended period of time, sensor is damaged	Replace sensor
	Software bug	

The O2 reading freezes even though O2 in sample is changing.		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.
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	Defective component or PCB	Contact the factory.
No graphic on LCD but has the analog signal output	Electrostatic discharge could cause graphic to disappear	Reset electronic by pressing RESET button on A-1146 or turn the power the analyzer OFF and then ON again.

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

If your 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 Analytical Industries Inc. analyzer, we may replace it with a new or reconditioned one of the same or upgraded design. This warranty applies to all monitors, analyzers and sensors purchased worldwide. It is the only one we will give and it sets forth all our responsibilities. There are no other express warranties. This warranty is limited to the first customer who submits a claim for a given serial number and/or the above warranty period. Under no circumstances will the warranty extend to more than one customer or beyond the warranty period.

Limitations

Analytical Industries Inc. will not pay for: loss of time; inconvenience; loss of use of your Analytical Industries Inc. analyzer or property damage caused by your Analytical Industries Inc. analyzer or its failure to work; any special, incidental or consequential damages; or any damage resulting from alterations, misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the analyzer; affixing of any attachment not provided with the analyzer or other failure to follow the Owner's Manual. Some states and provinces do not allow

limitations on how an implied warranty lasts or the exclusion of incidental or consequential damages, 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 Analytical Industries Inc. at 909-392-6900 (or e-mail info@aii1.com) between 8:00am and 5:30pm Pacific Time Monday thru Thursday or before 12:00 pm on Friday. Trained technicians will assist you in diagnosing the problem and arrange to supply you with the required parts. You may obtain warranty service by returning your analyzer, postage prepaid to:

Analytical Industries, 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 the analyzer, we will ship it to you at no cost for parts and labor.

11. Material Safety Data Sheet – MSDS

Product Identification

Product Name	Oxygen Sensor Series - PSR, GPR, AII, XLT
Synonyms	Electrochemical Sensor, Galvanic Fuel Cell
Manufacturer	Analytical Industries Inc., 2855 Metropolitan Place, Pomona, CA 91767 USA
Emergency Phone Number	909-392-6900
Preparation / Revision Date	January 1, 1995
Notes	Oxygen sensors are sealed, contain protective coverings and in normal conditions do not present a health hazard. Information applies to electrolyte unless otherwise noted.

Specific Generic Ingredients

Carcinogens at levels > 0.1%	None
Others at levels > 1.0%	Potassium Hydroxide or Acetic Acid, Lead
CAS Number	Potassium Hydroxide = KOH 1310-58-3 or Acetic Acid = 64-19-7, Lead = Pb 7439-92-1
Chemical (Synonym) and Family	Potassium Hydroxide (KOH) – Base or Acetic Acid (CH_3CO_2H) – Acid, Lead (Pb) – Metal

General Requirements

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

Physical Properties

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

Fire and Explosion Data

Flash and Fire Points	Not applicable
Flammable Limits	Not flammable
Extinguishing Method	Not applicable
Special Fire Fighting Procedures	Not applicable
Unusual Fire and Explosion Hazards	Not applicable

Reactivity Data

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

Spill or Leak

Steps if material is released	Sensor is packaged in a sealed plastic bag, check the sensor inside for electrolyte leakage. If the sensor leaks inside the plastic bag or inside an analyzer sensor housing do not remove it without rubber or latex gloves and safety glasses and a source of water. Flush or wipe all surfaces repeatedly with water or wet paper towel (fresh each time).
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 Protective Equipment	None

Special Precautions

Precautions	Do not remove the sensor's protective Teflon and PCB coverings. Do not probe the sensor with sharp objects. Wash hands thoroughly after handling. Avoid contact with eyes, skin and clothing. Empty sensor body may contain hazardous residue.
Transportation	Not applicable