

PI2- MS-500

PPB OXYGEN ANALYZER



OWNERS MANUAL

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1. Introduction

Your new PI2-MS 500/1000 PPB oxygen analyzer is a precision device designed to give you years of use for analyzing single digit PPB (parts per billion) level oxygen concentrations. This micro-processor based analyzer features the new breakthrough "Pico-Ion" Sensor Technology developed exclusively by Advanced Instruments Inc. and an extensive sample system digitally controlled to offer the user the utmost in performance and simplicity. The sample system consists of 316L stainless steel pneumatic valves with orbital welded or VCR type connections.

The sample system features separate sample and span inlets, a pressure regulator and flow control orifice, sample bypass loop for isolating the sensor and an integral oxygen scrubber (PI2-MS 500/1000 only) for consistent zero gas, all of which are controlled by the user friendly micro-processor based electronics.

The digital electronics also feature auto or manual ranging, auto-zero and auto-calibration at user specified intervals, data acquisition, temperature compensated output, user selected signal averaging and temperature coefficient for fine tuning the sensor performance in varying temperature environments.

This analyzer is designed to measure the 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 and at the back of the analyzer. You should note the serial number in the space provided below 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.

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

2. Quality Control Certificate

Quality Control & Calibration Certification

Customer: _____		Date: _____	
Order No.: _____			
Model No.: PI2-MS-500 PPB Oxygen Analyzer		S/N: _____	
Configuration :	A-1146-24-rG-500 PCB Assembly, Main/Display	Batch: _____	
	() A-1147-24-rG4 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: 0-500ppb, 0-1000ppb, 0-10ppm, 0-100ppm, 0-1000ppm	Software Ver: _____	
Wetted parts: 316SS sensor housing, flow resistor, pneumatic isolation valves, fittings, 1/8" dia tubing and 1/4" compression type fittings for vent outlet and air. Pressure regulator (VCR type), Sample inlet (1/4" VCR); Sample, Span and Bypass pneumatic valves (VCR type). Note: Pneumatic valves require a constant air supply at minimum 80 psig System Power: 110 VAC - 220 VAC Temperature Controller set at 85 deg. F Enclosure: Std. Bench 13.9x9.9x13.4" () A-2829 Bezel, 19" Rack			
Sensor:	() GPR-12-2000 MS-2E PPBOxygen 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 ±0.05 low range		
Default span @ 25 µA	110 PPM±3 PPM		
After sensor installation, reading on continued zero gas purge is < 1 PPM after	< 1 hour	hrs	
Reading after calibration with _____ PPM oxygen span gas	±2% of _____ PPM		
Baseline drift on zero gas over 24 hour period (±5% FS)	±5 PPB of reading		
Noise level (±1% FS)	±1 PPB of reading		
Reading after 24 hours in static (no flow to sensor) condition	< 20 PPM		
Analog signal output 4-20 mA full scale			
Analog Range ID output 1-5VDC full scale			
	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: Correction Factors He, Ar and H2			
Sample, Zero, Bypass and Standby enable from the rear of the analyzer			
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 Sample Pressure: Recommended 30-50 PSIG, 100 PSIG maximum.

Outlet Pressure: The sample gas must be vented atmospheric pressure.

Instrument Air Pressure: Operation of the pneumatic valves which require a dedicated source of compressed air with a minimum of 80-100 psig; Note: Do not attempt to use the sample gas to operate the pneumatic valves.

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 the analyzer 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 INCLUDES "SURGE PROTECTOR" AND RFI/EMI FILTER TO PREVENT INTERFERENCE FROM EXCESSIVE LINE VOLTAGE VARIATIONS

Operating Temperature: The maximum recommended operating temperature is 45 °C. However, an operating temperature of less than 35 °C is ideal to obtain maximum life of the oxygen sensor.

Heat: Situate and store the analyzer away from a direct source 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 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.



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.

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: Keep oxygen sensor from exposure to high oxygen levels as described in this manual (see section Operation). Disconnect the power when the analyzer is left unused.

Warning: The analyzer must not be disconnected from power and gas line for more than a few hours to a day. **If it becomes necessary to disconnect power for extended period, remove sensor cable from PCB A-1146 to disconnect sensor from electronic circuit.** Failure to do so will keep sensor reacting with oxygen that will continue to diffuse through sensor housing and may damage the sensor (with sample gas flowing, oxygen diffusion through sensor housing becomes insignificant as it dilutes with sample gas).

It is recommended that the analyzer remain powered with gas flowing (if high purity sample gas is not available, a gas with low PPM gas may be used with a flow rate as low as 0.1 SCFH). This will keep the sensor ready for sampling a gas.

If it becomes necessary to transport the analyzer from one place to another, disconnect analyzer power only when analyzer is to be transported and re-installed within a few hours to a day.

Caution: PI2-MS-M analyzer is equipped with MANUAL VALVE, turn sample inlet and sample outlet valves to OFF position before removing sample gas connection. Failure to adhere to this instruction may result in permanent damage to the sensor.

4. Specifications


Advanced Instruments Inc.

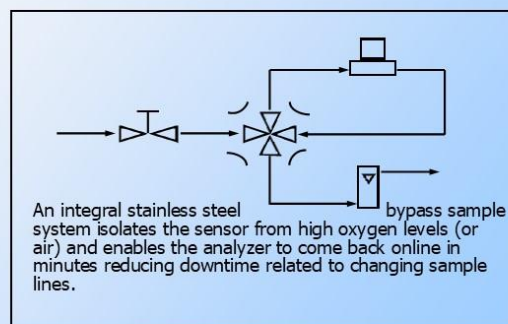
Technical Specifications *

	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 O2 in high purity N2, He, Ar, H2	Analyze PPB O2 in high purity N2, He, Ar, H2	
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 wall mount 12" x 12" x 8"		
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:	O2 Level	Duration	O2 Target Recovery on N2
	9 ppm	2 minute	10 PPB 10 minutes
	Air	30 seconds	1 PPM 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:	0° to 45°C		
Warranty:	12 months analyzer; 12 months sensor		
Wetted Parts:	Stainless Steel		

* Specifications subject to change without notice



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



5. Operation

Principle of Operation

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

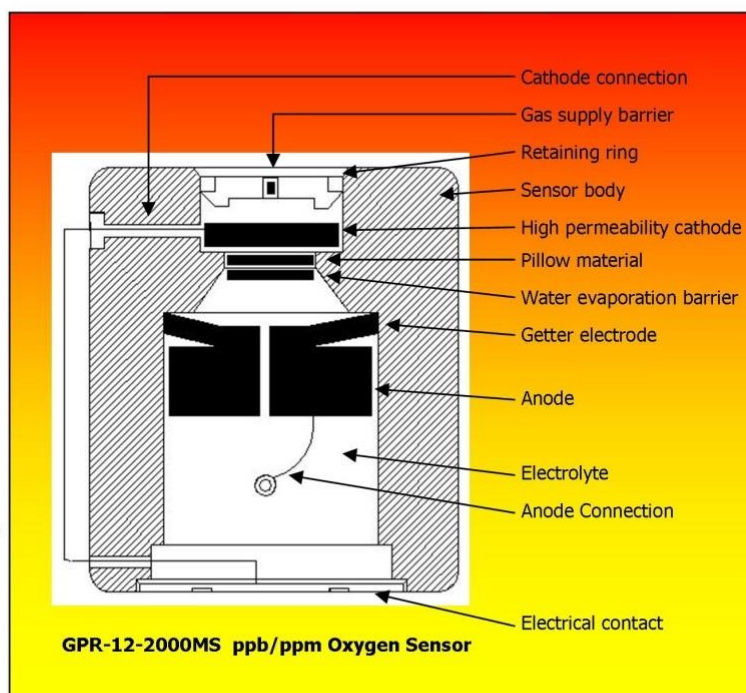
Design Criteria

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

<u>O₂ Exposure</u>	<u>Duration</u>	<u>O₂ Target</u>	<u>Recovery</u>
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 < $\pm 1\%$
- 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

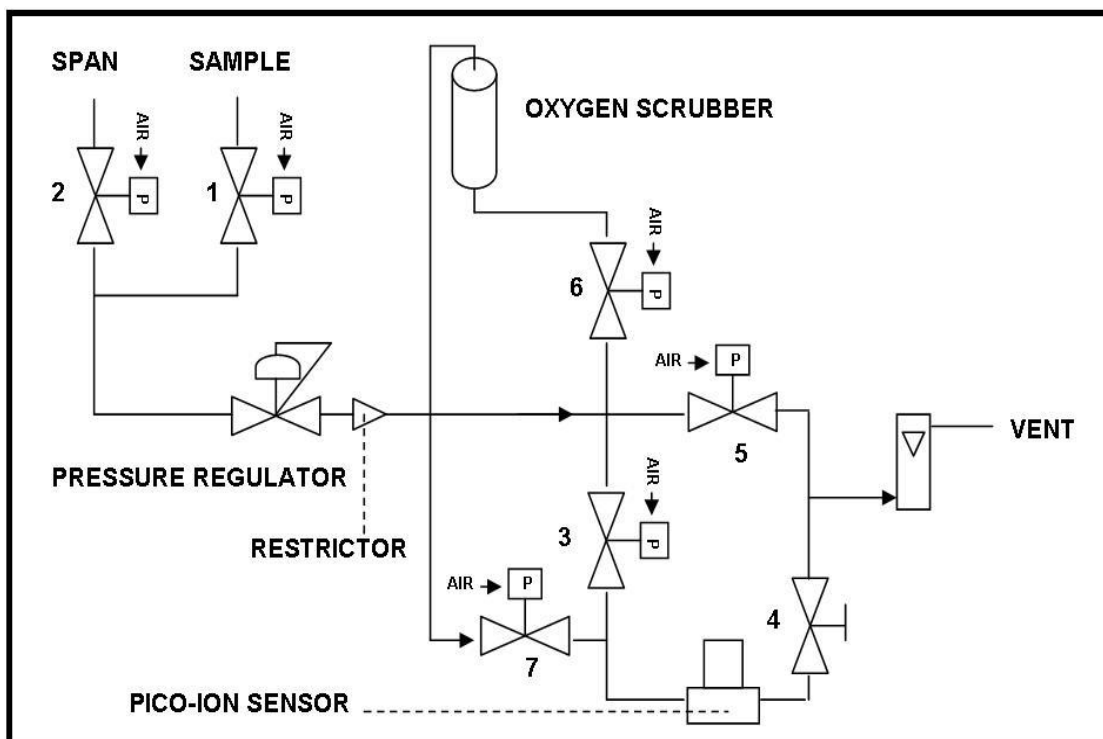


Oxygen, the fuel for this electrochemical transducer, reacts chemically at the sensing electrode to produce an electrical current output proportional to the oxygen concentration in the gas phase. The sensor's signal output is linear over all four ranges and remains virtually constant over its useful life. The sensor requires no maintenance or electrolyte addition and is easily and safely replaced at the end of its useful life.

Sample System Flow Schematic

The PI2-MS 500/1000 analyzer is equipped with a micro-processor controlled sample system that features precise flow control and pneumatic valves for introducing sample or span gases, isolating the sensor with an integral bypass loop during standby and upset conditions and an oxygen scrubber for delivering consistent zero gas (during zero calibration) to the sensor.

Note: The pneumatic valves require a minimum of 80 psig pressure to open. The maximum pressure allowed is 100 psig.

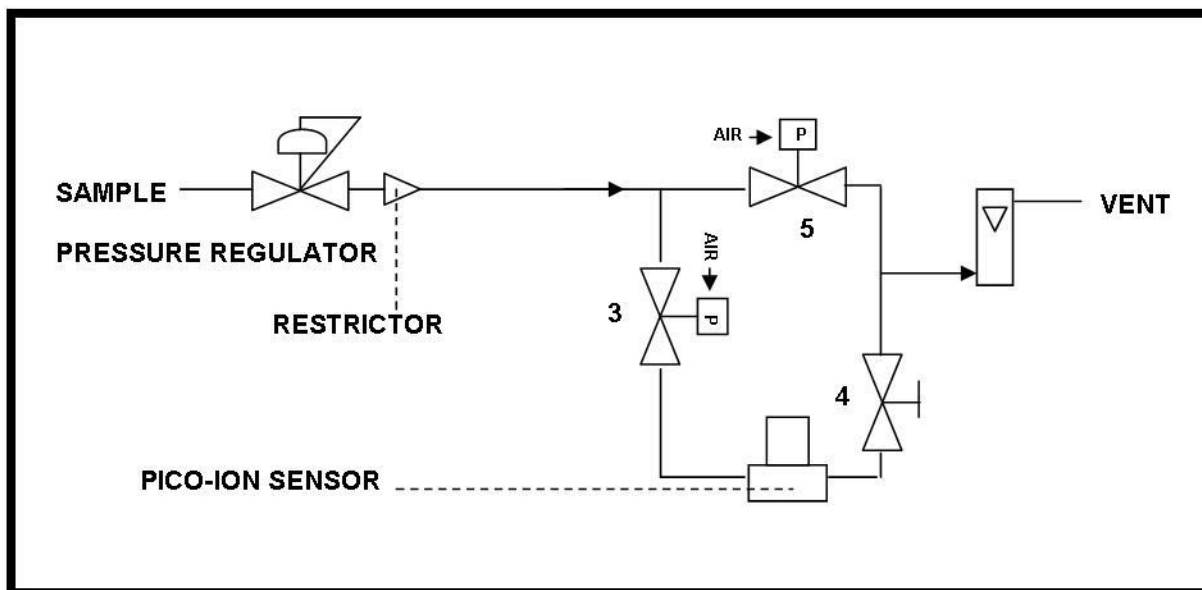


Valve Operation:	OPEN	CLOSED
Mode: BYPASS	1, 5	2, 3,4,6,7
ZERO	1,4,6,7	2,3,5
SPAN	2,3,4	1,5,6,7
SAMPLE	1,3,4	2,5,6,7
STANDBY	NONE	1,2,3,4,5,6,7

Flow schematic of PI2-MS 500/1000

The PI2-MS 500/1000-B analyzer is equipped with a micro-processor controlled sample system that except that these models do not have integral oxygen scrubber and separate Span gas inlet.

Note: The menus displayed by the PI2-MS-500/1000 B have been modified to reflect the absence of the span inlet port and zero scrubber system.



Valve Operation:	OPEN	CLOSED
Mode: BYPASS	5	3,4
ZERO	3,4	5
SPAN	3,4	5
SAMPLE	3,4	5
STANDBY	NONE	3,4,5

Flow Schematic of PI2-MS 500/1000-B

Caution: Do not change the valve positions until instructed to do so in this manual.

Other Sample Handling Considerations

The sample system may include optional components positioned upstream of the analyzer such as additional pressure regulator, particulate filter, isolation/directional flow control valves etc. Check the QC sheet to confirm the Sample System of your analyzer.

To avoid damaging the sensor or sample system, observe the following guidelines:

1. Do not draw a vacuum or over-pressure the sensor. When sample gas flows into the analyzer, any restriction on the vent line will cause a pressure build up within the analyzer sample system, a sudden release of the sample pressure will draw a vacuum on the sensor.
2. The vacuum generated in 1 above may cause the sensor to leak electrolyte (voiding the sensor warranty). The electrolyte leakage may damage the electrical contacts of the upper section of the sensor housing assembly, the electrolyte might enter in the sample system and if it does, it will require a complete overhaul of the sample system.
3. Do not supply sample gas with pressure above the recommended limit. High positive pressure can damage the integral pressure regulator, the sensor and or other sample system components.
4. Do not introduce calibration span gas from a pressurized cylinder without first regulating the pressure to within the recommended limits (30-50 PSIG).

CAUTION: Do not vent the sample to a line with pressure above atmospheric pressure. If the vent line pressure is above atmospheric (below 10-20 inches of water and is varying, use a back-pressure regulator set at 20 inches of water to stabilize the pressure at the sensor.

Installation

The PI2-MS 500/1000 series Oxygen Analyzers consist of an electronic module, sensor housing and sample system housed in a 13.9"W x 9.9"H x 13.4"D enclosure suitable for bench-top or cart applications. The enclosure can be panel or rack mounted with an optional bezel. The analyzer includes a temperature controlled heating system to maintain the temperature of the sensor at a pre-set temperature of 85 °F. The analyzer has been tested and calibrated by the manufacturer prior to shipment.

Note: Analyzer is shipped from the factory with sensor placed in a separate bag sealed under nitrogen. Install sensor as instructed later in this section.

Caution: Do not change the factory settings of the analyzer until instructed to do so in this manual.



Sample/Span Gas Connections Considerations

Assemble the necessary hardware for mounting the analyzer and optional components (if provided or required by the user). Perform the following steps

1. Use ¼" stainless steel compression type fittings for air input and sample vent line connections. Use ¼" Face Seal type fittings for sample and span gas inlet connections. **Caution:** use clean/fresh gaskets for making Face Seal type connections.
2. Use cleaned, preferably electro polished SS tubing for all sample/span gas connections. Plastic tubing rated at 150 psig may be used to provide instrument air.
3. Review the application/sample analysis conditions to ensure the sample gas is suitable for analysis.

Sample and Span gas pressure 30-50 psig

Recommended sample and span gas pressure 30-50 PSIG (maximum pressure of 150 psig is acceptable). The 30-50 psig pressure is recommended for ease of controlling of the gas flow rate by using the integral pressure regulator.

Caution: The integral pressure regulator is rated at a maximum of 150 psig input pressure. Excessive pressure may permanently damage the pressure regulator and may also introduce undue pressure on the oxygen sensor.

Instrument air pressure - 80 psig

Analyzer sampling system consists of seven pneumatically controlled diaphragm valves. The valves are actuated by solenoid valves that deliver air to the pneumatic valves. Minimum pressure required to activate the pneumatic valve is 80 psig. Set the instrument air at 80 PSIG. A maximum air pressure of 100 psig may be used. However, do not use air pressure above 100 psig. Excessive pressure may damage the solenoid valves controlling the pneumatic valves.

Caution: The pneumatic valves require a dedicated source of instrument air at a minimum of 80 psig. Do not attempt to split the sample gas feed to operate the pneumatic valves.

Power Requirement

The analyzer is rated at 100-240 VAC. Before establishing power to the analyzer, check the rating printed at the back of the analyzer to ensure that the power available meets the required ratings.

Caution: Incorrect power may result in safety hazard and damage to the analyzer.

Establish power to the analyzer by the power cable provided with the analyzer. **Ensure that EMI/RFI filter is attached as close as possible to the analyzer power input terminal.**

ENSURE THAT POWER LINE INCULDES "SURGE PROTECTOR" AND RFI/EMI FILTER TO PREVENT INTERFERENCE FROM EXCESSIVE LINE VOLTAGE VARIATIONS

Signal Output

The analyzer provides 0-1 VDC, 0-5 VDC and 4-20 mA isolated full scale output. **Keep signal output lines separate from AC power lines. For optimum results when connecting signal output to an external recording device, e.g., a printer or a PLC, do not bundle signal output wires with power cable (bundling signal output and AC power line may introduce excessive noise on the signal output line). Keep wire lengths taking signal output to a recording device to less than three meters.**

Mounting the Analyzer

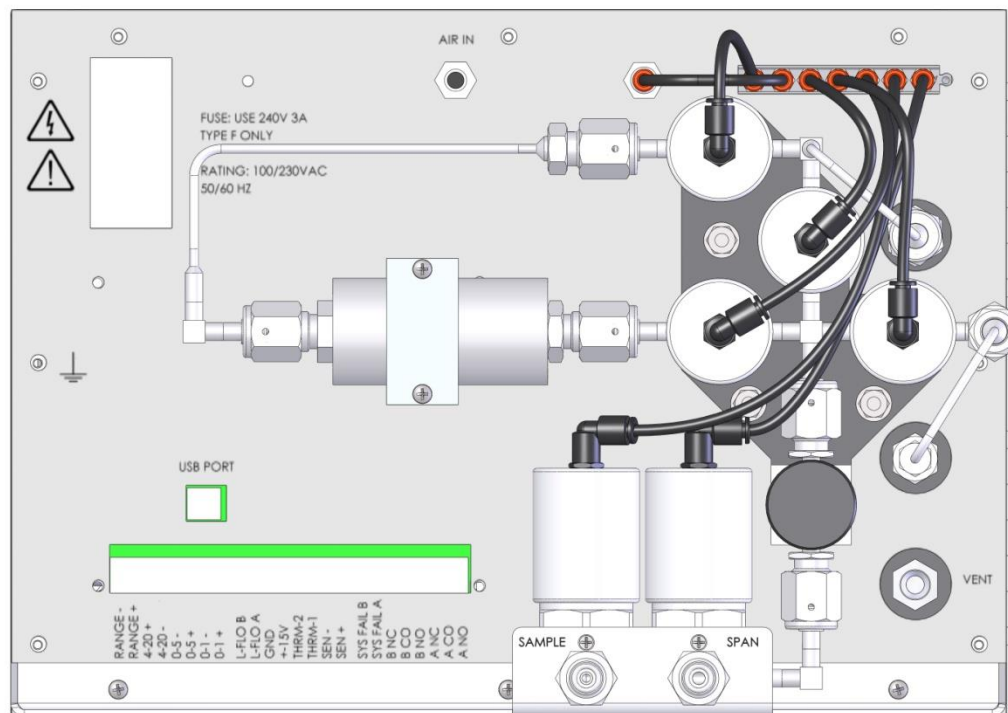
The PI2- MS 13.9"Wx9.9"Hx13.4"D configuration is designed for bench-top or cart use. The analyzer can be panel 15"Wx12"H or rack 19"Wx12"H mounted with the optional bezels. When mounting the analyzer in a 19" rack, allow sufficient room to access terminal connections at the rear of the enclosure.

When equipped with the optional bezels, the PI2- MS bolts directly to any flat vertical surface, wall or bulkhead plate with the appropriate cutout. To facilitate servicing the interior of the analyzer, position it approximately 5 feet off the floor.

Establishing Gas Connections

The PI2-MS is designed for positive pressured samples and requires connections for incoming sample, span calibration gas, instrument air (for the solenoid valves controlling the pneumatic valves) and the sample/span gas vent.

NOTE: PI2-MS-B does not have a separate Span inlet port. For these models, the user must connect the Span gas to the Sample inlet port by using a TEE adaptor and a THREE-WAY valve for manually selecting the Sample or Span gas.



Note: The preset of the integral pressure regulator and a restrictor in the sample line regulate the flow of the incoming sample and span gas.

Procedure

1. Connect the instrument air supply to the tube fitting labeled AIR. **Set air pressure at 80-100 psig.**
2. Connect sample vent line to the tube fitting labeled SAMPLE VENT. **Caution:** Vent sample to atmosphere. Use minimum ¼ inch tubing and keep the vent tube as short as possible (to minimize the back pressure on the sensor)
3. Connect sample line to the face seal fitting connection labeled SAMPLE IN. **Set sample input pressure at 30-50 psig.**
4. Connect span gas line to the face seal fitting connection labeled SPAN IN. **Set the span pressure at 30-50 psig.**

Caution: When making Face Seal sample and span gas connections, use fresh, clean and unscratched gaskets to ensure leak free connections. To tighten connections, always use two wrenches to prevent twisting of bulkhead fittings.

Purging Sample and Span Gas Lines

It is recommended that before tightening the Face Seal connection, bleed the sample/span tubing up to the sample/span port of the analyzer for 5-10 minutes to remove air trapped in the sample/span gas tubing.

Establishing Power to the Analyzer

Power to the analyzers is supplied by an integral universal 100-240VAC power supply. The appropriate AC line voltage is supplied by using a standard power cord connected to the universal power entry module. **Ensure that EMI/RFI filter on the power cord remains intact and close to the power entry module.**

ENSURE THAT POWER LINE INCULDES "SURGE PROTECTOR" AND RFI/EMI FILTER TO PREVENT INTERFERENCE FROM EXCESSIVE LINE VOLTAGE VARIATIONS



Check power rating of the analyzer printed at the back of the analyzer and make sure that a proper AC voltage supply is available. Incorrect AC power may cause safety hazard and damage to the analyzer.

Electrical Connections

ALL CONNECTIONS ARE MADE VIA TERMINAL BLOCKS AND ARE MARKED AS BELOW. TO MAKE ELECTRICAL CONNECTIONS, PUSH THE LEVER WITH SMALL SCREW DRIVER, INSERT WIRE WHEN SLOT OPENS

RANGE ID -V

RANGE ID +V

4-20 + mA

4-20 - mA

0-5 -V

0-5+V

-V

+V

L-FLO B (optional)

L-FLO A (optional)

GND

+ 15 VDC

THRM 2

THRM 1

SEN -

SEN +

SYS FAIL B

SYS FAIL A

BNC Alarm contact normally closed

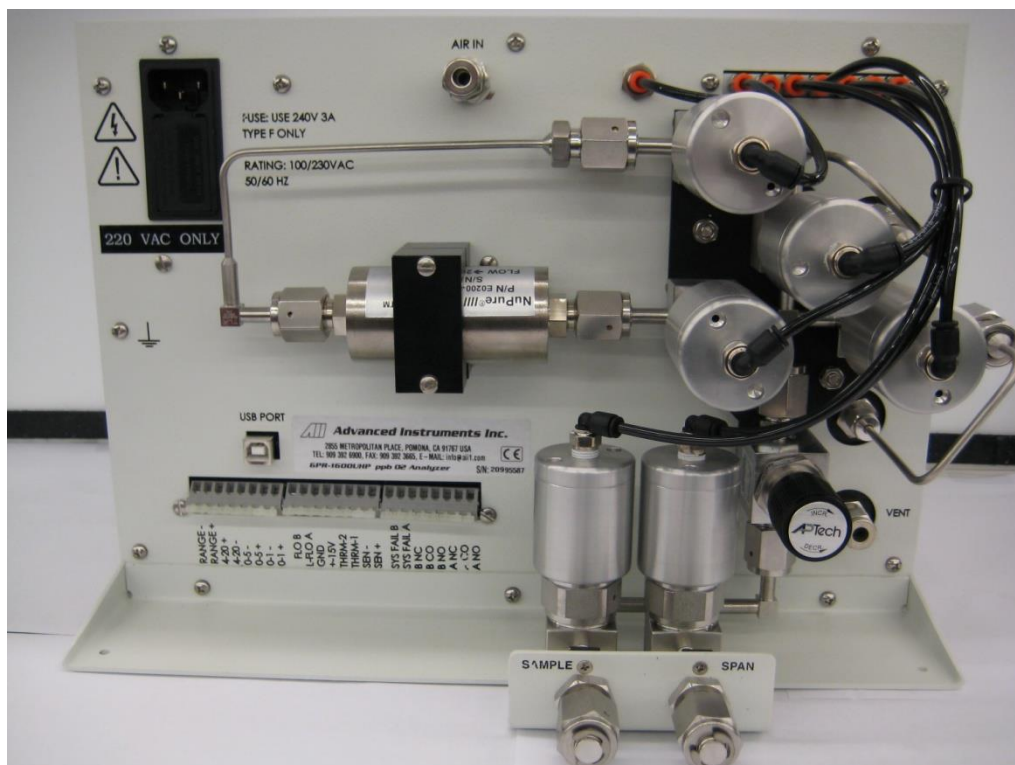
BC Alarm contact common

BNO Alarm contact normally open

ANC Alarm contact normally closed

AC Alarm contact common

ANO Alarm contact normally open



Alarm Relays and Signal Output Connections

As illustrated above the signal output (0-1 V, 0-5 V and 4-20 mA full scale), range ID voltage output, low and high oxygen alarm relay contacts, low flow alarm contacts (optional feature), external sensor input (optional feature) system fail alarm contact and +15 VDC auxiliary power (to actuate external solenoid valve option) are hard wired (PCB mounted) terminal blocks located at the rear of the analyzer.

Remote Switch Functions (Optional)

The Remote Switch option allows the user to control the analyzer remotely through the back of the analyzer. Remote switch function logic:

FUNCTION	INPUT A	INPUT B	INPUT C
SPAN CAL	OPEN	OPEN	SHORTED
ZERO CAL	OPEN	SHORTED	OPEN
BYPASS	OPEN	SHORTED	SHORTED
SAMPLE	SHORTED	OPEN	OPEN
STANDBY	SHORTED	OPEN	SHORTED

Shorted = Contact connected to +15V for 2 seconds

Inserting/Connecting Wires to Terminal Blocks

The terminal blocks have push-levers. When push-levers are pressed downward, the slots open to allow insertion of wires in the slots. Use a small bladed screwdriver and press one lever of the terminal block down to open contact slot. Insert the appropriate contact wire into the slot and release the lever to secure the wire in the terminal block.

Caution: Use wires with proper ratings. Strip the insulation of the wires no more than 3/16". 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.

Run signal and AC power lines separately to avoid EMI/RFI interference.

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

To make a connection upon relay activation, connect live cable to the common terminal C and secondary cable to the normally open NO terminal. To break a connection upon relay activation, connect live cable to the common C and connect secondary cable to the normally closed NC terminal.

High and Low Oxygen Alarm Relays

The analyzer is equipped with two user adjustable alarms. When activated the alarms trigger SPDT Form C non-latching relays @ 5A, 30VDC or 240VAC resistive. The alarms are fully adjustable by selecting the appropriate ALARM menu option.

The alarm set point represents a value of oxygen. 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.

Note: 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.

Note: The alarms may be deactivated by selecting the appropriate ALARM menu option (explained later in this chapter). This 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.

Power/System Failure Alarm

A dry contact rated at 30VDC @ 1A is provided as a power failure alarm. The contact is normally closed but opens when the power to the analyzer is switched off or interrupted.

4-20 mA, 0-1 V and 0-5 V Full Scale Signal Output

The analyzer provides 0-1 V and 0-5 V full scale with negative ground and a 4-20mA full scale (isolated ground) signals for external recording devices.

Caution: The integral 4-20mA voltage to current converter is internally powered and does not require external power. DO NOT supply any voltage to either of the two terminals of the 4-20mA signal output. Failure to do so will permanently damage the signal processing PCB.

Range Identification Voltage and 4-20 mA Output

A voltage output corresponding to each range is provided. The range ID voltage for first range is 5V and it decreases by 1 V (to 4V, 3V and 2V) as the range shifts to the second, third and fourth range. An optional 4-20 mA range ID is also available. With 4-20 mA range ID, first range corresponds to 20 mA and dropping by 4 mA with each range. Consult factory for this option.

Low Flow Alarm Option

An optional low flow alarm is available. The contact of the low flow alarm closes when gas flow falls below a preset value, for example, below 1 SCFH. The alarm contact is rated at 30VDC @ 1A. Consult factory for this option.

Two-way USB Communication Port

A real time bi-directional data lines is provided via USB port. This allows the access to the analyzer from a remote computer to obtain status of the analyzer and/or initiate analyzer functions remotely.

Caution: In order to access the analyzer through a computer, you will require the proprietary optional software (**AII Configuration Software**) from the factory. The software is available at a nominal charge.

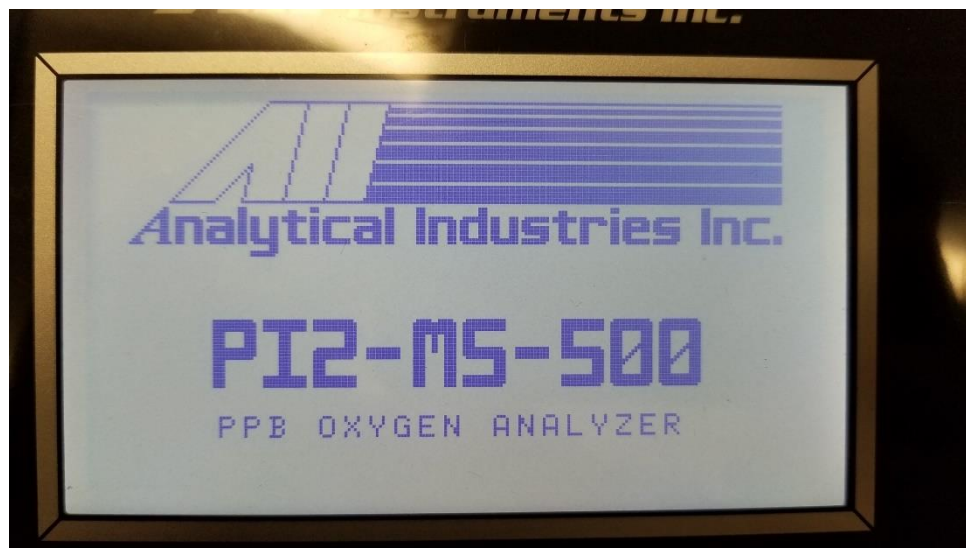
By connecting a computer to the analyzer, all analyzer operational features can be accessed through the computer, including the ability to store unlimited analyzer data on the computer hard disk.

RS-232 or RS-484 Communication Port

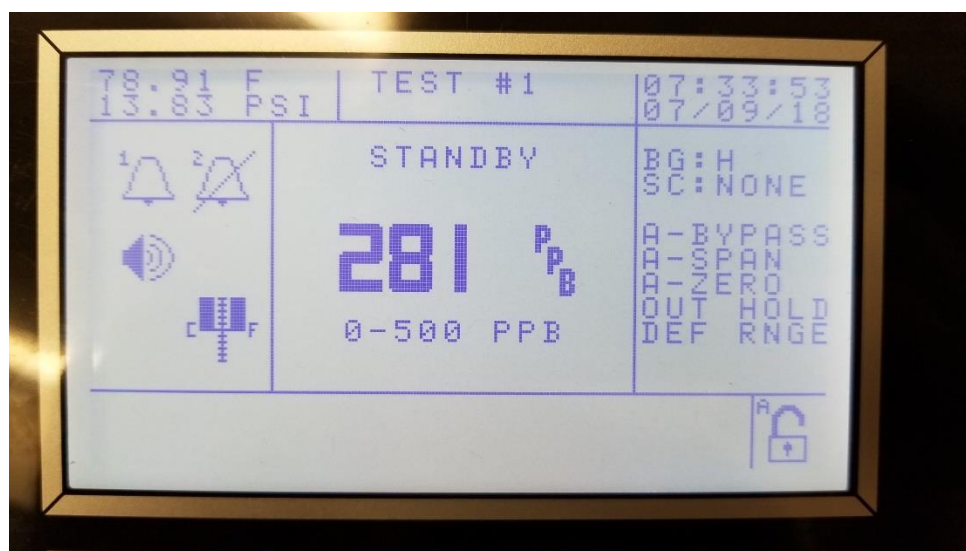
Optional RS-232 or RS-485 communication ports are available

Establishing Power to the Electronics

Once the power cord is inserted into 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 analyzer will automatically go into the STANDBY mode



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.

What if Power to the Analyzer is interrupted?

In the event power to the analyzer is interrupted, all pneumatic valves will close. When power is restored, the analyzer will return to operation in the STANDBY mode. The analyzer requires user intervention to bring analyzer back to the same conditions that existed prior to power interruption.

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

Temperature Controlled Heater System

The PI2-MS-500/1000 series analyzers are equipped with a PID temperature control system. The controller is programmed to maintain the temperature inside of the analyzer enclosure 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 temperature controller, the controller tunes itself and control the temperature at the pre-set temperature. It is recommended that when analyzer door is to open (for example during trouble shooting), set the temperature set point at 60°F to turn the heater off to prevent overheating the analyzer. When operating the analyzer under normal conditions, set the temperature between 85°F.

To changing the Temperature set point:

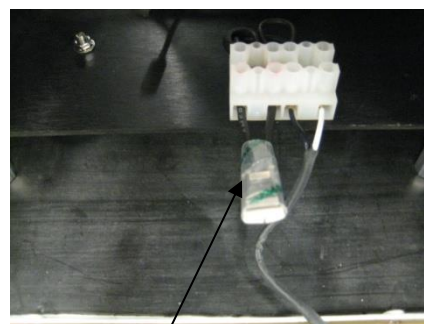
1. Press SEL to display the current set point
2. Press the UP/DOWN arrows until the desired value is displayed
3. Press SEL to accept the new set point value



Heater Runaway Protection

Part of the temperature controlled heater system is a runaway protection circuit. The analyzer is protected in the event the temperature controller should fail and thereby allowing the heater to runaway thus damaging the interior of the analysis unit.

The runaway protection is provided by a J2 type device (a closed circuit contact) positioned between the temperature controller and the heater. This device cuts the power to the heater if the temperature inside the analysis unit exceeds 70°C (158 °F). Should the J2 device cut power to the heater, correct the problem and replace the J2 device (the J2 device is a single shot device and can't be reset; once it is in an open circuit, it must be replaced to restore power to heater)

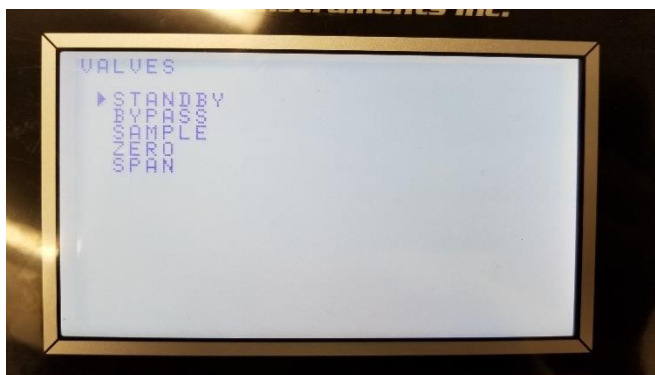
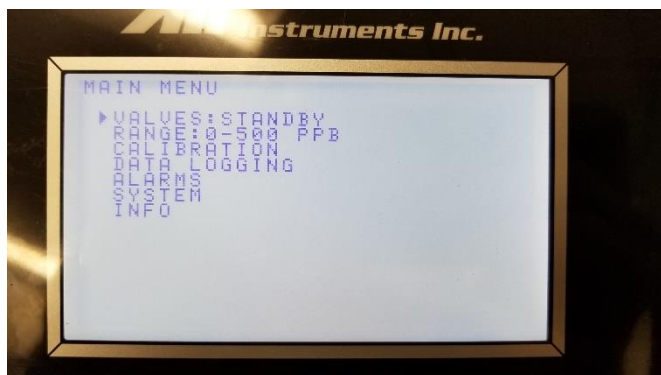


J2 Heater runaway protection

Normal Operation of Analyzer

Sample Mode

Press **Menu/Esc** to advance to the main menu. Move cursor to select Valves: Standby and press **Enter**. Using **Up/Down**, select Sample.



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 process 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.

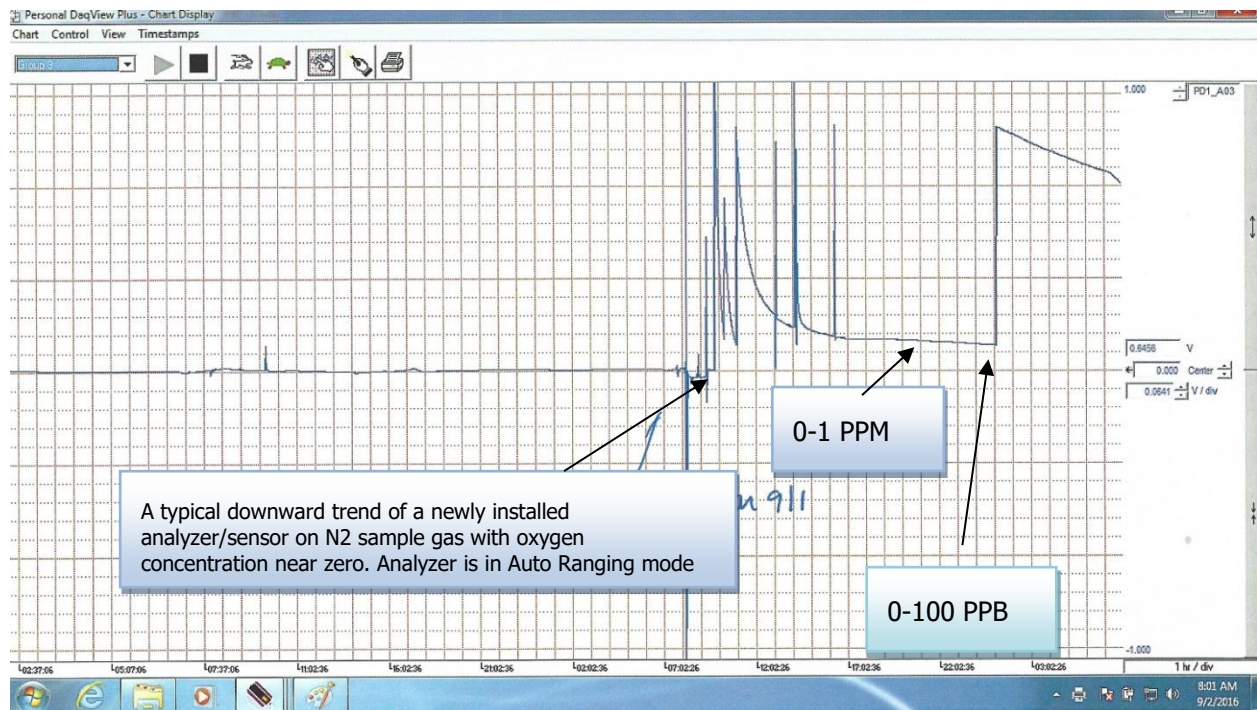
Caution: This “clean-up time” or “recovery time” or “purge down time” depends on the user – the length of time sensor has been exposed to ambient air before it was installed and how well sample gas line was purged before it was connected to the analyzer sample input.

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

PI2-MS-500/1000 analyzer has an integral oxygen scrubber/purifier that removes oxygen from sample gas and produces a zero gas for zero calibration; the scrubber can remove oxygen from a sample gas containing 1-2 PPM oxygen down to less than 1 PPB.

The PI2-MS-B and PI2-MS-M do not have the integral Zero scrubber. To perform Zero calibration with PI2-MS-B or PI2-MS-M, user must provide a true zero gas.

In order to perform a ZERO calibration,

- From the MAIN MENU screen, select Calibration.
- From CALIBRATION menu, select Zero Calibrate.
- The valves will actuate to Zero Bypass for 30 seconds to ensure the line is purged down before continuing to Zero Calibration.
- On the bottom left of the LCD Zero Cal will appear with Up = Accept, Down = Abort. A timer of 15 minutes will appear underneath the valve mode selected. After the 15-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.

AUTO ZERO option may be used at subsequent ZERO calibrations. With AUTO ZERO calibration enabled, the analyzer will count down from the user selected value to automatically perform a zero calibration every X amount of days (i.e. 30 days). If the auto zero fails the analyzer will attempt to calibrate 24 hours after the failed calibration. Passed/Failed calibrations are stored in the calibration log.

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. If analyzer is being used for He or Ar or H₂ application, ideal span gas should contain 5-8 PPM oxygen balance the gas being sampled.

Note: During SPAN calibration process, analyzer automatically switches to the SPAN BYPASS mode for 30 seconds to purge SPAN gas line and then automatically switches to the SPAN mode.

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 15 minutes will appear underneath the valve mode selected. After the 15-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.**

NOTE: When span calibration routine is initiated, analyzer closes sample gas valve, opens span gas valve (PI2-MS-500/1000 ONLY) and turns itself into the SPAN BYPASS mode for 30 seconds (to purge span gas line before span gas enters the sensor housing). After purging span gas line, analyzer will automatically close BYPASS valve and allow span gas to flow through the sensor housing.

CAUTION: The actual oxygen value detected must be between 30%-50% of the span gas value entered. If actual oxygen reading is outside these limits, by pressing ENTER to accept calibration will result in **"FAILED CALIBRATION"** and analyzer will return to the previous valve mode without completing SPAN calibration.

AUTO SPAN option may be used at subsequent SPAN calibrations. With AUTO SPAN calibration enabled, the analyzer will count down from the user selected value to automatically perform a span calibration every X amount of days (i.e. 30 days). If the auto span fails the analyzer will attempt to calibrate 24 hours after the failed calibration. Passed/Failed calibrations are stored in the calibration log.

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.

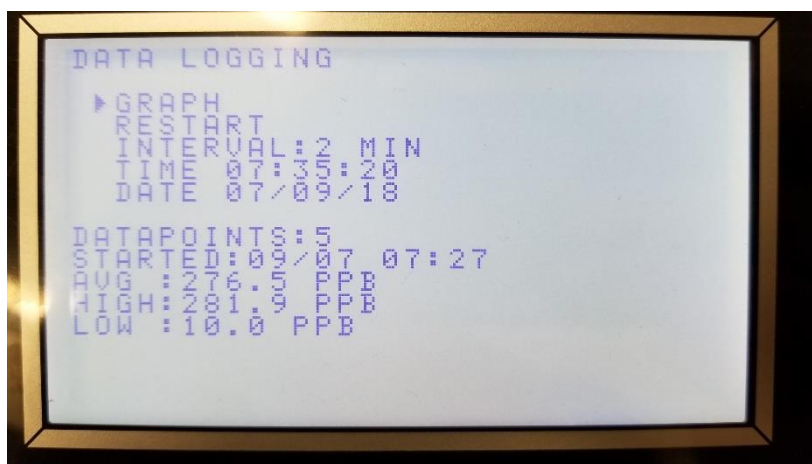
Analyzer Transportation

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, span and instrument air 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

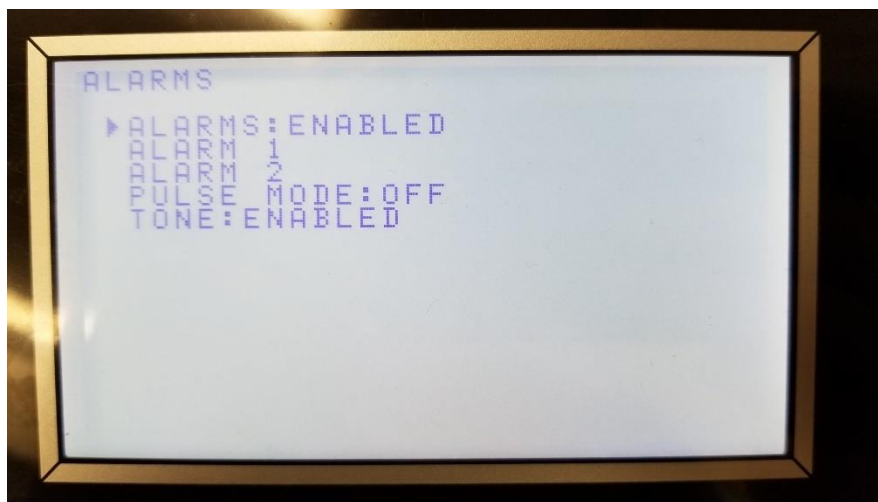
In the Data Logging Menu the user can select the following options.



- **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%.

Background Gas Factor

When sampling in other than Nitrogen the user needs to select the appropriate background gas.

- Argon
- Helium
- Hydrogen

When sampling a gas other than N₂, for example, He or Ar, the analyzer is recommended to be SPAN calibrated with 5-8 PPM O₂ balance the gas being sampled.

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. Place the analyzer in the STANDBY mode. In the STANDBY mode, all pneumatic valves are closed and the sensor is isolated from the ambient air.
2. After short term shutdown, to restart,
 - 2.1. Establish power to analyzer
 - 2.2. Select Bypass mode
 - 2.3. Set sample flow rate to 1-2 SCFH
 - 2.4. Allow sample line to purge for 5 minutes
 - 2.5. Select Sample valve 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

6. 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.

O₂ Scrubber Replacement (PI2-MS-500/1000 only)

Oxygen scrubber is designed to provide up to 10 years of continuous service provided it is not exposed to high levels of oxygen (greater than 1000 PPM) repeatedly or for extended periods of time. Should it become necessary to replace oxygen scrubber, consult factory for recommendations.

7. Spare Parts

Recommended spare parts for the PI2-MS-500/1000 PPB O₂ Analyzer:

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

Other spare parts

CABL-1015	Cable Assembly for Solenoid Valves
CTRL-1004	Controller Temperature PID
HTR-1006	Heater
A-3919	Housing Sensor Bottom Assembly Stainless Steel
B-3048-1	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
A-1147-24-rG4-USB	PCB Assembly Power Supply / Interconnection USB Port
A-1146-24-rG4-500-S	PCB Assembly Micro-processor / Display 0-50 PPB RS-232
A-1146-24-rG4-1000-S	PCB Assembly Micro-processor / Display 0-100 PPB RS-232
A-1147-24-rG4-RS232	PCB Assembly Power Supply / Interconnection RS-232
SNSR-1006	RTD Temperature Sensor
SNSR-1002	Runaway Protector J-2
VALV-1020	Valve Pneumatic 1/4" Butt Weld Connections (replaces top assembly only)
VALV-1023	Valve Solenoid with Mtg. Screws 3 or 7 Position Manifold

8. 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
O ₂ reading doesn't agree with expected O ₂ 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 Sensor exposed to high O2 at time of installation or during normal use	Replace sensor re-calibrate the analyzer. Remove any restriction on sample vent line. Vent sample to atmospheric pressure. 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 Liquid covering sensing area of sensor Presence of interference gases, e.g., CO ₂ , Cl ₂ , HCl	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 Sensor: Replace if leaking and return it to the factory for warranty determination 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 Software bug	Replace sensor

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.

O2 reading same in Sample and Zero mode (Model PI2--UHP only) with known O2 in sample gas

Defective O2 scrubber

Replace O2 scrubber

No O2 reading with known O2 sample gas.

Lost electrical contact between sensor housing and PCB

Test the continuity of sensor housing contact pins and sensor cable wiring using a voltmeter as follows:

Set the voltmeter to the audible continuity Ohm "Ω" setting (common on Fluke devices)

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

Check the continuity between the RED wire and to the outer spring loaded contact pin inside the upper section of the sensor housing

Replace the upper section of the sensor housing if either of continuity tests fails.

Check resistance between WHITE and GREEN wires

Replace the upper section of the sensor housing if the voltmeter reads outside the range of 15-19K resistance

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

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.

9. Warranty

The design and manufacture of PI2 Series Oxygen Analyzers AND oxygen sensors are TESTED 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@aai1.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.

10. 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 ₃ CO ₂ H) – 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 ₂ O	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).
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Disposal	In accordance with federal, state and local regulations.
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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