Advanced Instruments Inc.

GPR-1200

Portable ppm Oxygen Analyzer

Owner's Manual

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Advanced Instruments Inc.

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1 Introduction

Your new portable oxygen analyzer incorporates an advanced electrochemical sensor specific to oxygen along with state-of-the-art digital electronics designed to give you years of reliable precise oxygen measurements in variety of industrial oxygen applications. To obtain maximum performance from your new oxygen analyzer, please read and follow the guidelines provided in this Owner's Manual.

Every effort has been made to select the most reliable state of the art materials and components; and, to design the analyzer for superior performance and minimal cost of ownership. This analyzer was tested thoroughly by the manufacturer prior to shipment for best performance.

However, 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.

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 retains this Owner's Manual as a permanent record of your purchase, for future reference and for warranty considerations.

Serial Number: _____

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

2 Quality Control Certification

Date:	**Customer:**	**Order No.:**	**Pass**
Model	GPR-1200 Portable ppm Oxygen Analyzer	S/N _____	_____
Sensor	( ) GPR-12-333 ppm Oxygen Sensor ( ) XLT-12-333 ppm Oxygen Sensor	S/N _____	_____
Accessories	Owner's Manual		_____
	( ) PWRS-1002 9VDC Battery Charger/Adapter 110VAC ( ) PWRS-1003 9VDC Battery Charger/Adapter 220VAC ( ) PWRS-1008 9VDC Battery Charger/Adapter 12VDC Auto Cigarette Lighter		_____
	CONN-1034 Plug Mini Phone .141 dia. Black Handle		_____
	FITN-1003 (3x) Plug Male Quick Disconnect Fittings		_____
	TOOL-1001 5/16 Combination Wrench		_____
			_____
Configuration	A-1151-E-B1 PCB Assembly		_____
	Range: 0-10 ppm, 0-100 ppm, 0-1000 ppm, 0-25%		_____
	Wetted parts: stainless steel		
Electronics Test	LED indicators: Low battery, charge		_____
	Electronic offset		_____
	Analog signal output 0-1V		_____
			_____
Gas Phase Test	Recovery from air to < 10 ppm in < 1 hour		_____
	Baseline drift on zero gas < ± 2% FS over 24 hour period on 0-1% range		_____
	Noise level < ± 0.5% FS		_____
	Span adjustment within 10-50% FS		_____
Final	Overall inspection for physical defects		_____
Options			_____
Notes			_____

3 General Safety & Installation

Safety

This section summarizes the basic precautions applicable to all analyzers. Additional precautions specific to individual analyzer are contained in the following sections of this manual. To operate the analyzer safely and obtain maximum performance follow the basic guidelines outlined in this Owner's Manual.

Caution: This symbol is used throughout the Owner's Manual to **Caution** and alert the user to recommended safety and/or operating guidelines.

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

Read Instructions: Before operating the analyzer read the instructions.

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

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

Liquid and Object Entry: The analyzer should not be immersed in any liquid. Care should be taken so that liquids are not spilled into and objects do not fall into the inside of the analyzer.

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

Maintenance

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

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

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

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

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

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

Installation

Gas Sample Stream: Ensure the gas stream composition of the application is consistent with the specifications and review the application conditions before initiating the installation. Consult the factory to ensure the sample is suitable for analysis. **Note:** In natural gas applications such as extraction and transmission, a low voltage current is applied to the pipeline itself to inhibit corrosion. As a result, electronic devices can be affected unless adequately grounded.

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

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

Accuracy & Calibration: Refer to section 5 Operation.

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

Operating Temperature: The sample must be sufficiently cooled before it enters the analyzer and any optional components. A coiled 10 foot length of ¼" stainless steel tubing is sufficient for cooling sample gases as high as 1,800ºF to ambient. The maximum operating temperature is 45º C on an intermittent basis unless the user is willing to accept a reduction in expected sensor life – refer to analyzer specification - where expected sensor life is specified at an oxygen concentration less than 1000 ppm oxygen for ppm analyzers and air (20.9% oxygen) for percent analyzers, but in all instances at 25°C and 1 atmosphere of pressure. Expected sensor varies inversely with changes in these parameters.

Pressure & Flow
All electrochemical oxygen sensors respond to partial pressure changes in oxygen. The sensors are equally capable of analyzing the oxygen content of a flowing sample gas stream or monitoring the oxygen concentration in ambient air (such as a confined space such in a control room or an open area such as a landfill or bio-pond). The following is applicable to analyzers equipped with fuel cell type oxygen sensors. With respect to analyzers equipped with Pico-Ion UHP and MS oxygen sensors, refer to the analyzer's specifications.

Analyzers designed for in-situ ambient or area monitoring have no real inlet and vent pressure because the sensor is exposed directly to the sample gas and intended to operate at atmospheric pressure, however, slightly positive pressure has minimal effect on accuracy.

Inlet Pressure: Analyzers designed for flowing samples under positive pressure or pump vacuum (for samples at atmospheric or slightly negative atmospheres) that does not exceed 14" water column are equipped with bulkhead tube fitting connections on the side of the unit (unless otherwise indicated, either fitting can serve as inlet or vent) and are intended to operate at positive pressure regulated to between 5-30 psig although their particular rating is considerably higher. **Caution:** If the analyzer is equipped with an optional H2S scrubber, inlet pressure must not exceed 30 psig.

Outlet Pressure: In positive pressure applications the vent pressure must be less than the inlet, preferably atmospheric.

Sample systems and flowing gas samples are generally required for applications involving oxygen measurements at a pressure other than ambient air. In these situations, the use of stainless steel tubing and fittings is critical to maintaining the integrity of the gas stream to be sampled and the inlet pressure must always be higher than the pressure at the outlet vent which is normally at atmospheric pressure. Flow Through Configuration: The sensor is exposed to sample gas that must flow or be

drawn through metal tubing inside the analyzer. The internal sample system includes 1/8" compression inlet and vent fittings, a stainless steel sensor housing with an o-ring seal to prevent the leakage of air and stainless steel tubing.

Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate backpressure and erroneous oxygen readings because the diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate. The direction the sample gas flows is not important, thus either tube fitting can serve as the inlet or vent – just not simultaneously.

A flow indicator with an integral metering valve upstream of the sensor is recommended as a means of controlling the flow rate of the sample gas. A flow rate of 2 SCFH or 1 liter per minute is recommended for optimum performance.

Caution: Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (voiding the sensor warranty). To avoid generating a vacuum on the sensor (as described above) during operation, always select and install the vent fitting first and remove the vent fitting last.

Application Pressure - Positive: A flow indicator with integral metering valve positioned upstream of the sensor is recommended for controlling the sample flow rate between 1-5 SCFH. To reduce the possibility of leakage for low ppm measurements, position a metering needle valve upstream of the sensor to control the flow rate and position a flow indicator downstream of the sensor. If necessary, a pressure regulator (with a metallic diaphragm is recommended for optimum accuracy, the use of diaphragms of more permeable materials may result in erroneous readings) upstream of the flow control valve should be used to regulate the inlet pressure between 5-30 psig.

Caution: If the analyzer is equipped with a H2S scrubber as part of an optional sample conditioning system, inlet pressure must not exceed 30 psig.

Application Pressure - Atmospheric or Slightly Negative: For accurate ppm range oxygen measurements, an optional external sampling pump should be positioned downstream of the sensor to draw the sample from the process, by the sensor and out to atmosphere. A flow meter is generally not necessary to obtain the recommended flow rate with most sampling pumps.

Caution: If the analyzer is equipped with an optional flow indicator with integral metering valve or a metering flow control valve upstream of the sensor - open the metering valve completely to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

If pump loading is a consideration, a second throttle valve on the pump's inlet side may be necessary to provide a bypass path so the sample flow rate is within the above parameters.

Recommendations to avoid erroneous oxygen readings and damaging the sensor:

- Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (thus voiding the sensor warranty).
- Assure there are no restrictions in the sample or vent lines
- Avoid drawing a vacuum that exceeds 14" of water column pressure – unless done gradually
- Avoid excessive flow rates above 5 SCFH which generate backpressure on the sensor.
- Avoid sudden releases of backpressure that can severely damage the sensor.
- Avoid the collection of liquids or particulates on the sensor, they block the diffusion of oxygen into the sensor - wipe away.
- If the analyzer is equipped with an optional integral sampling pump (positioned downstream of the sensor) and a flow control metering valve (positioned upstream of the sensor), completely open the flow control metering valve to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

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

Moisture and/or particulates generally can be removed from the sensor by opening the sensor housing and either blowing on the sensing surface or gently wiping or brushing the sensing surface with damp cloth. **Caution:** Minimize the exposure of ppm sensors to air during this cleaning process. Air calibration followed by purging with zero or a gas with a low ppm oxygen concentration is recommended following the cleaning process. Moisture and/or particulates generally can be removed from the sample system by flowing the purge gas through the analyzer at a flow rate of 4.5-5 SCFH for an hour.

Mounting: The analyzer is approved for indoor use, outdoor use requires optional enclosures, consult factory. Mount as recommended by the manufacturer.

Gas Connections: Inlet and outlet vent gas lines for ppm analysis require 1/8" or ¼" stainless steel compression fittings; hard plastic tubing with a low permeability factor can be used percentage range measurements.

Power: Supply power to the analyzer only as rated by the specification or markings on the analyzer enclosure. The wiring that connects the analyzer to the power source should be installed in accordance with recognized electrical standards. Ensure that is properly grounded and meets the requirements for area classification. Never yank wiring to remove it from a terminal connection. AC powered analog analyzers consume 5 watts, digital analyzers 50 watts without optional heaters. Optional 110V and 220V heaters AC powered heaters consume an additional 100-150 watts; DC powered digital analyzers consume 30 watts, 40 watts with the optional DC powered heater.

4 Specifications *

Accuracy:	< 1% of FS range under constant conditions
Analysis Ranges:	0-10 ppm, 0-100, 0-1000 ppm, 0-1% plus 0-25% FS range for air calibration; auto-ranging or lock on single range
Application:	Analyze oxygen concentrations from 100 ppb to 1% in inert, hydrocarbon, helium, hydrogen, mixed and acid (CO_2) gas streams
Approvals:	CE, Intrinsic Safety (pending, void with optional general purpose sampling pump)
Area Classification:	Meets standards for Class 1, Division 1, Group C, D hazardous areas (void with optional general purpose pump)
Calibration:	Certified gas of O_2 balance N_2 approximating 80% of analysis range or one range above analysis range
Compensation:	Temperature and barometric pressure
Connections:	1/8" compression tube fittings
Controls:	Water resistant keypad; menu driven range selection, calibration and system functions
Display:	Graphical LCD 2.75 x 1.375"; resolution .01 ppm; displays real time ambient temperature and pressure
Enclosure:	Painted aluminum NEMA 4X, 8.6 x 9 x 3", 12 lbs.
Flow Sensitivity:	None between 0.5-5 SCFH, 2 SCFH recommended
LED Indicators:	LOW BATT (72 hr. warning); CHARGE mode
Linearity:	> .995 over all ranges
Pressure:	Inlet - regulate to 5-30 psig; vent - atmospheric
Power:	Rechargeable battery, 60 day duty cycle (pump 1 day)
Recovery Time:	60 seconds in air to < 10 ppm in < 1 hr on N_2 purge
Response Time:	90% of final FS reading in 10 seconds
Sample System:	Flow control and sample/bypass valves; flow indicator
Sensitivity:	< 0.5% of FS range
Sensor Model:	GPR-12-333
Sensor Life:	24 months at 25ºC, 1 atm and average O_2 < 1,000 ppm
Signal Output:	0-1V
Temp. Range:	5º to 45ºC (GPR sensor), -20º to 45ºC (XLT sensor)
Warranty:	12 months analyzer; 12 months sensor
Wetted Parts:	Stainless steel

Optional Equipment

XLT-12-333 sensor with > 0.5% CO_2 present

Integral sampling pump - general purpose or intrinsically safe designs

Carrying case with custom foam insert

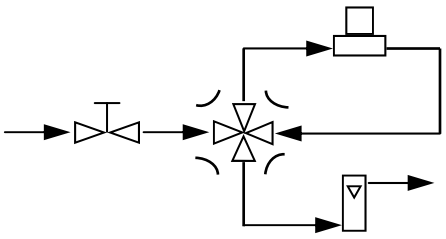
Sample conditioning accessories - contact factory

* Specifications subject to change without notice

GPR-1200
Portable ppm O_2 Analyzer

Advanced Sensor Technology
- **Accuracy < 1% FS Range**
- **Sensitivity < 0.5% FS Range**
- **Fast Recovery to < 10 ppm**
- **24 Month Expected Life**
- **No Maintenance**
- **Compatible in 0-100% CO_2**

Intrinsically Safe Design
Auto or Manual Ranging
4 Standard Analysis Ranges
0-25% Range for Air Calibration
SS Bypass Sample System
ISO 9001:2008 Certified QA System



Integral bypass sample system increases productivity.

5 Operation

Principle of Operation

The GPR-1200 portable oxygen analyzer incorporates a variety of ppm range advanced galvanic fuel cell type sensors. The analyzer is configured in a general purpose NEMA 4 rated enclosure and meets the intrinsic safety standards required for use in Class 1, Division 1, Groups A, B, C, D hazardous areas. Two integral sampling pump options are available – one that meets the intrinsic safety standards and a less expensive option for general purpose service.

Advanced Galvanic Sensor Technology

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

Proprietary advancements in design and chemistry add significant advantages to an extremely versatile oxygen sensing technology. Sensors for low ppm analysis recover from air to ppm levels in minutes, exhibit longer life, extended operating range of -20°C to 50°C, excellent compatibility with CO_2 and acid gases (XLT series) and reliable quality giving them a significant advantage over the competition.

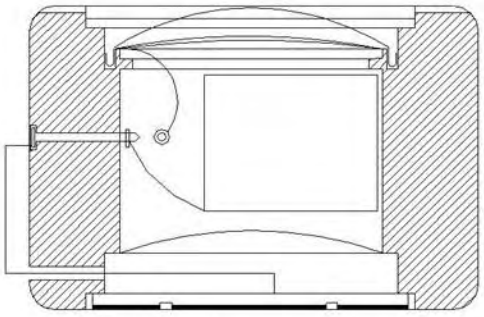
The expected life of our new generation of percentage range sensors now range to five and ten years with faster response times and greater stability. Other significant developments involve the first galvanic oxygen sensor capability of continuous oxygen purity measurements and expanding the operating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

Design Objectives

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

ppm Oxygen Sensors

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



GPR/XLT 12 Series ppm Oxygen Sensor

Electronics

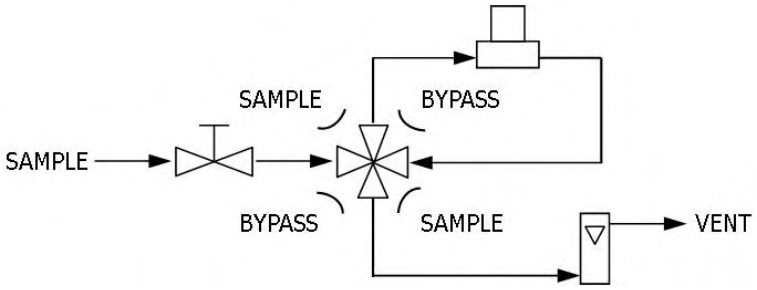
The signal generated by the sensor is processed by state of the art low power micro-processor based digital circuitry. The first stage amplifies the signal. The second stage eliminates the low frequency noise. The third stage employs a high frequency filter and compensates for signal output variations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

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

Sample System

The GPR-1200 is supplied with a unique bypass sample system which enables the user to isolate the sensor from exposure to high oxygen concentration which results in a substantial increase is user productivity. However the sample must be properly presented to the sensor to ensure an accurate measurement.

For ppm trace oxygen measurements, the sensor is exposed to sample gas that must flow or be drawn through the analyzer's internal sample system. This unique sample system, when operated accordingly to the instructions in this Owner's Manual, can significantly increase user productivity by minimizing the sensor's exposure to ambient air or high oxygen concentrations which contribute to the significant amount of downtime associated with competitive analyzers.



As illustrated above, the GPR-1200's internal sample system includes:

- 1/8" tube fittings for the inlet and outlet
- flow control metering valve
- 4-way sample/bypass valve to purge lines and isolate the sensor
- Stainless steel sensor housing with an o-ring seal to prevent the leakage of air
- Flow indicator common to bypass and sample lines

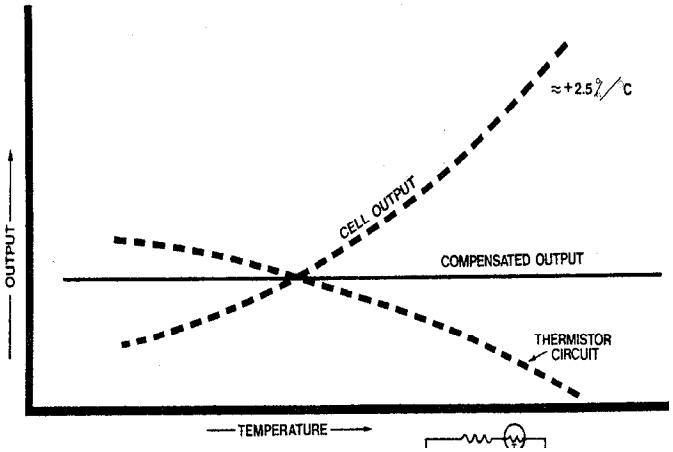
Users interested in adding their own sample conditioning system should consult the factory. Advanced Instruments Inc. offers a full line of sample handling, conditioning and expertise to meet your application requirements. Contact us at 909-392-6900 or e-mail us at info@aii1.com

Accuracy & Calibration

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

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

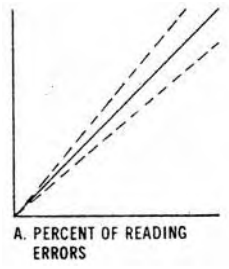
Pressure: Because sensors are sensitive to the partial pressure of oxygen in the sample gas their output is a function of the number of molecules of oxygen 'per unit volume'. Readouts in percent are permissible only when the total pressure of the sample gas being analyzed remains constant. The pressure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

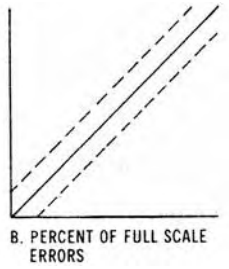


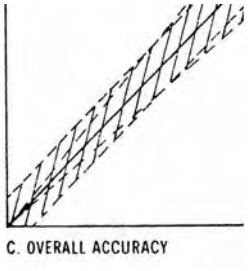
Temperature: The rate oxygen molecules diffuse into the sensor is controlled by a Teflon membrane otherwise known as an 'oxygen diffusion limiting barrier' and all diffusion processes are temperature sensitive, the fact the sensor's electrical output will vary with temperature is normal. This variation is relatively constant 2.5% per ºC.

A temperature compensation circuit employing a thermistor offsets this effect with an accuracy of better than ±5% (over the entire Operating Range of the analyzer) and generates an output function that is independent of temperature. There is no error if the calibration and sampling are performed at the same temperature or if the measurement is made immediately after calibration. Lastly, small temperature variations of 10-15º produce < 1% error.

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


A. PERCENT OF READING ERRORS


B. PERCENT OF FULL SCALE ERRORS


C. OVERALL ACCURACY

Example: 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.

Mounting the Analyzer

Normally mounting a portable analyzer is not a consideration. However, the analyzer enclosure is cast with four (4) holes in the bottom section specifically intended for wall mounting. The GPR-1200 analyzer can operate continuously when connected to AC power using the appropriate charging adapter.

Gas Connections

The GPR-1200 flow through configuration is designed for positive pressure samples and requires connections to incoming sample and vent 1/8" diameter tube fittings. The user is responsible for making provision for calibration gases, see Calibration section of the analyzer specification and Installing Span Gas below.

Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate backpressure and erroneous oxygen readings because the diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate. A flow control valve upstream of the sensor controls the flow rate of the sample gas which is displayed by the flow indicator downstream of the sensor. A flow rate of 2 SCFH or 1liter per minute is recommended for optimum performance.

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

Procedure:

1. **Caution:** Do not change the factory setting until instructed, leave the SAMPLE/BYPASS valve in the BYPASS position.
2. Locate the inlet and vent fittings respectively on the right side of the analyzer. Note: The instructions related to proper operation of the valves is silk-screened on the right side of the analyzer.
3. Regulate the pressure and flow as described in Pressure & Flow above.
4. Connect the 1/8" dia. metal vent line to the fitting designated VENT.
5. Connect the 1/8" dia. metal sample gas line to the fitting designated SAMPLE IN.
6. Set the flow rate to 2 SCFH
7. Open the flow control valve completely if using an external sampling pump positioned downstream of the sensor.
8. Allow gas to flow through the analyzer for 3-5 minutes in the BYPASS mode to purge air trapped in the sample gas line before proceeding to Calibration or Sampling.

Electrical Connections

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

Procedure:

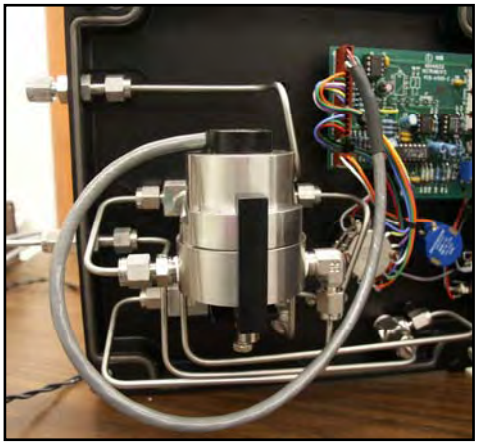
1. Locate a source of AC power to meet the area classification, plug in the appropriate charging adapter to the outlet
2. Connect the jack at the other end to the mating receptacle identified on the analyzer.

The analyzer provides a 0-1V full scale signal output for external recording devices.

Procedure:

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

Installing the Oxygen Sensor



GPR-1200 Portable ppm Oxygen Analyzer is equipped with an integral oxygen sensor that has been tested and calibrated by the manufacturer prior to shipment and is fully operational from the shipping container. Should it be necessary to install the oxygen sensor – see section 6 Maintenance which covers replacing the oxygen sensor.

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

Caution: DO NOT open the oxygen sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet in section 10. Avoid contact with any liquid or crystal type powder in or around the sensor or sensor housing, as either could be a form of electrolyte. Leaking sensors should be disposed of in accordance with local regulations.

Span Gas Preparation

Caution: Do not contaminate the span gas cylinder when connecting the regulator. Bleed the air filled regulator (faster and more reliable than simply flowing the span gas) before attempting the initial calibration of the instrument.

Required components:

- Certified span gas cylinder with an oxygen concentration, balance nitrogen, approximating 80% of the full scale range above the intended measuring range.
- Regulator to reduce pressure to between 5 and 30 psig.
- Flow meter to set the flow between 1-5 SCFH,
- 2 lengths of 1/8" dia. metal tubing measuring 4-6 ft. in length.
- Suitable fittings and 1/8" dia. metal tubing to connect the regulator to the flow meter inlet
- Suitable fitting and 1/8" dia. metal tubing to connect from the flow meter vent to tube fitting designated SAMPLE IN on the GPR-1200.

Procedure:

1. With the span gas cylinder valve closed, install the regulator on the cylinder.
2. Open the regulator's exit valve and partially open the pressure regulator's control knob.
3. Open slightly the cylinder valve.
4. Loosen the nut connecting the regulator to the cylinder and bleed the pressure regulator.
5. Retighten the nut connecting the regulator to the cylinder
6. Adjust the regulator exit valve and slowly bleed the pressure regulator.
7. Open the cylinder valve completely.
8. Set the pressure between 5-30 psig using the pressure regulator's control knob.

Caution: Do not exceed the recommended flow rate. Excessive flow rate could cause the backpressure on the sensor and may result in erroneous readings and permanent damage to the sensor.

Establishing Power to the Electronics

The analyzer is fully operational from the shipping container with the oxygen sensor installed and calibrated at the factory prior to shipment. Once installed, we recommend the user allow the analyzer to stabilize for 10-15 minutes and then recalibrate the device as instructed below.

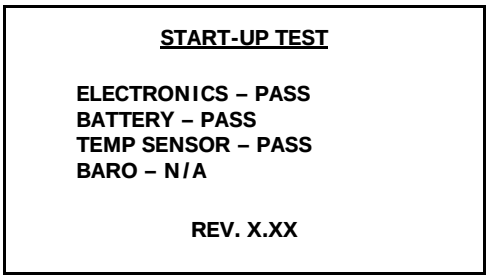
Establish power to the analyzer electronics by pushing the red ON/OFF key. The digital display responds instantaneously. When power is applied, the analyzer performs several diagnostic system status checks termed “START-UP TEST” as illustrated below.

If equipped with an optional integral sampling pump, it is operated by a separate toggle switch located on the front of the analyzer.

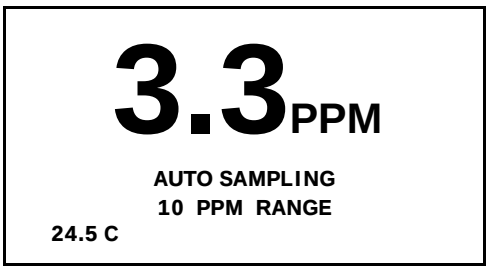
Note: In the unlikely event the LED warning indicator LOW BATT comes on when the analyzer is turned on – proceed immediately to section 6 Maintenance Battery.

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

Once the power to the electronics is established, the digital display responds instantaneously. When power is applied, the analyzer performs several diagnostic system status checks termed “START-UP TEST” as illustrated below:



Note: The analyzer display defaults to the sampling mode when 30 seconds elapses without user interface.



Menu Navigation

The five (5) pushbuttons located on the front of the analyzer operate the micro-processor:

1. Blue ENTER (select)
2. Yellow UP ARROW
3. Yellow DOWN ARROW
4. Green MENU (escape)
5. Red ON/OFF

Main Menu

Access the MAIN MENU by pressing the MENU key:

```
MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION
```

Range Selection

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

Note: For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can select the full scale MANUAL SAMPLE RANGE for calibration as dictated by the accuracy of the analysis required – for example, a span gas with an 80 ppm oxygen concentration with the balance nitrogen would dictate the use of the 0-100 ppm full scale range for calibration and a 0-10 ppm measuring range.

Auto Sampling:

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

```
MAIN MENU

AUTO SAMPLE
MANUAL SAMPLE
CALIBRATION
```

>>>

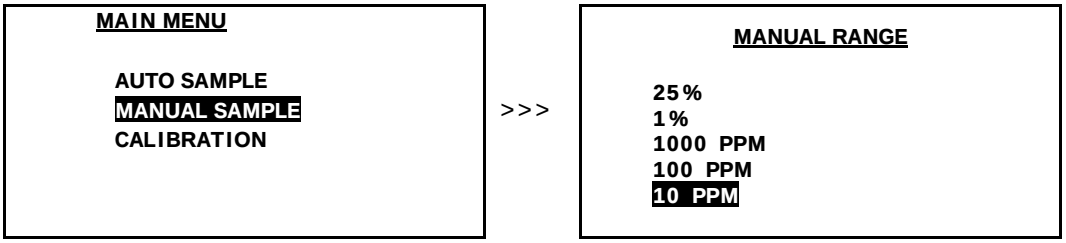
```
3.3PPM

AUTO SAMPLING
10 PPM RANGE

24.5 C
```

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

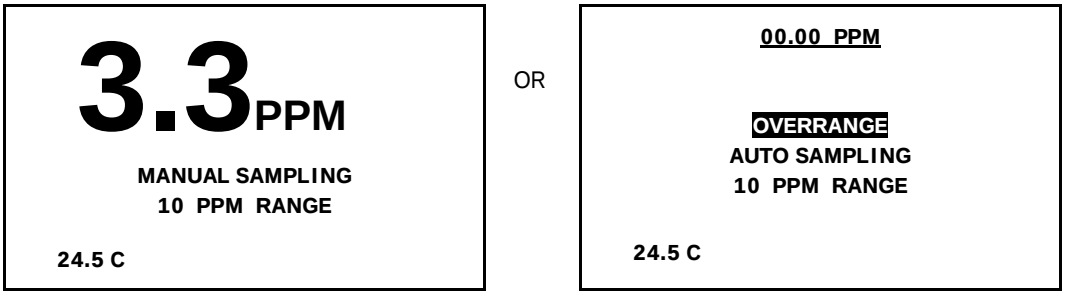
For example, if the analyzer is reading 1% on the 0-10% range and an upset occurs, the display will shift to the 0-25% range when the oxygen reading exceeds 9.9%. Conversely, once the upset condition is corrected, the display will shift back to the 0-10% range when the oxygen reading drops to 8.5%.

Manual Sampling:

1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor to highlight MANUAL SAMPLE.
3. Press the ENTER key to select the highlighted menu option and the following displays appear:



4. Advance the reverse shade cursor to highlight the desired RANGE.
5. Press the ENTER key to select the highlighted menu option.
6. The following display(s) appear depending on the range selected and oxygen concentration of the sample gas:



7. The display will not shift automatically. Instead, when the oxygen reading (actually the sensor's signal output) exceeds 110% of the upper limit of the current range an OVER RANGE warning will be displayed.
8. Once the OVER RANGE warning appears the user must advance the analyzer to the next higher range via the menu and keypad Press MENU, select MANUAL SAMPLING, press ENTER, select the appropriate MANUAL RANGE and press ENTER again.

Start-Up is complete . . .

Zero Calibration

In theory, the galvanic fuel cell type oxygen has an absolute zero meaning it produces no signal output when exposed to an oxygen free sample gas. In reality, expect the analyzer to generate an oxygen reading when sampling a zero gas due to:

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

The Zero Offset capability of the analyzer is limited to 50% of lowest most sensitive range available with the analyzer.
As part of our Quality Control Certification process, the zero capability of every ppm analyzer is qualified prior to shipment. However, because the factory sample system conditions differ from that of the user, no ZERO OFFSET adjustment is made to analyzer by the factory

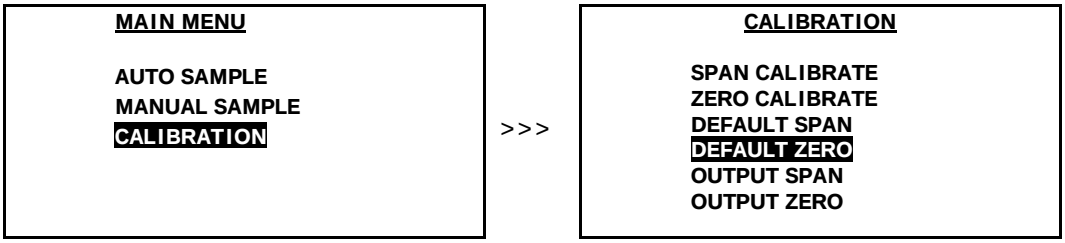
Recommendations:

- Zero calibration is recommended only for online analyzers performing continuous analysis below 5% of the lowest most sensitive range available with a ppm analyzer, e.g. analysis below 0.05 ppm on the 0-1 ppm range, 0.5 ppm on the 10 ppm range, or below 0.1% (1000 ppm) with a percent analyzer.
- Determining the true Zero Offset requires approximately 24 hours to assure the galvanic fuel cell sensor has consumed the oxygen that has dissolved into the electrolyte inside the sensor while exposed to air or percentage levels of oxygen. Allow the analyzer to stabilize with flowing zero gas as evidenced by a stable reading or horizontal trend on an external recording device. For optimum accuracy, utilize as much of the actual sample system as possible.
- Zero calibration is not practical and not recommended for portable analyzers or measurements on higher ranges. However, satisfying these users that the zero offset is acceptable for their application without the 24 hour wait can be accomplished by introducing a zero gas (or sample gas with a low ppm oxygen concentration) to the analyzer. Unless the zero gas is contaminated or there is a significant leak in the sample connections, the analyzer should read less than 100 ppm oxygen within 10 minutes after being placed on zero gas thereby indicating it is operating normally.
- Zero calibration should precede span calibration.
- Initiate the DEFAULT ZERO and DEFAULT SPAN procedures before performing either a ZERO or SPAN CALIBRATION.
- **Caution:** Prematurely initiating the ZERO CALIBRATION function can result in negative readings near zero.
- Once the zero offset adjustment is made, zero calibration is normally not required again until the sample system connections are modified, or, when installing a new oxygen sensor.

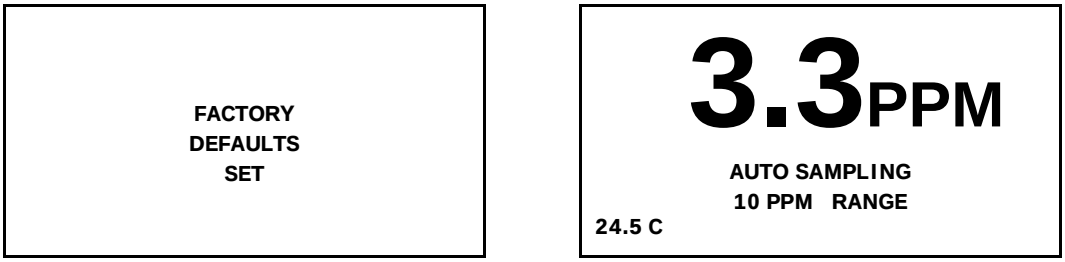
Procedure:
Refer to Span Calibration below for the detailed procedure. Differences include the displays illustrated below, substituting a suitable zero gas for the span gas and the time required to determine the true zero offset of specific oxygen sensor, analyzer and sample system combination.

Default Zero:
The software will eliminate any previous zero calibration adjustment and display the actual the signal output of the sensor at any specific oxygen concentration. For example, assuming a zero gas is introduced, the display will reflect an oxygen reading representing the previous zero calibration adjustment (s) as described above. Performing the DEFAULT ZERO feature allows the user to test the sensor's signal output when exposed to a specific oxygen standard (without removing the sensor from the sensor housing).

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



4. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT ZERO.
5. Press the ENTER key to select the highlighted menu option.
6. The following display appears and after 3 seconds the system returns to the SAMPLING mode:

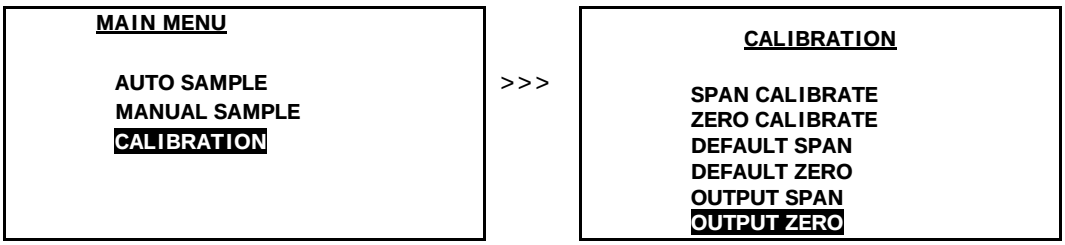


Output Zero

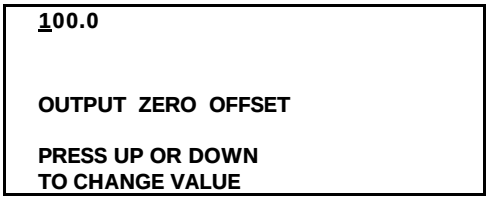
Accuracy due to manufacturer tolerances may result in a slight difference between the LCD display and the 0-1V analog output. However, the difference is less than 0.25% of range and falls well below the specified accuracy of the analyzer. In rare instances the 0-1V analog signal output may not agree to the reading displayed by the LCD. This feature enables the user to adjust the 0V analog signal output when the LCD displays 00.00. **Note:** Adjust the 1V analog signal output with the OUTPUT SPAN option described below.

Procedure:

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



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



```
ENTER TO SAVE
MENU TO RETURN
```

7. Compute the adjustment value as described in Appendix B or consult the factory. The true adjustment value must be determined empirically by trial and error. Adjust the initial adjustment value for additional percent errors.

```
0_0.0

OUTPUT  ZERO  OFFSET

PRESS UP OR DOWN
TO CHANGE VALUE
ENTER TO SAVE
MENU TO RETURN
```

8. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the OUTPUT ZERO OFFSET value.
9. Press the ARROW keys to enter the OUTPUT ZERO OFFSET value.
10. Repeat until the complete OUTPUT ZERO OFFSET value has been entered.
11. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
12. The system returns to the SAMPLING mode.

Span Calibration

Span Calibration involves adjusting the transmitter electronics to the sensor's signal output at a given oxygen standard. Maximum drift from calibration temperature is approximately 0.11% of reading per °C. The frequency of calibration varies with the application conditions, the degree of accuracy required by the application and the quality requirements of the user. However, the interval between span calibrations should not exceed three (3) months.

Note: Regardless of the oxygen concentration of the standard used, the span calibration process takes approximately 10 minutes, however, the time required to bring the analyzer back on-line can vary depending on a combination of factors and assume exposure to a zero/purge/sample gas** with an oxygen content below the stated thresholds immediately after span calibration:

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

* Refer to analyzer specifications for comparable data on the Pico-Ion UHP and MS oxygen sensors.

Recommendations General:

- The interval between span calibrations should not exceed three (3) months.
- Initiate the DEFAULT ZERO and DEFAULT SPAN procedures before performing either a ZERO or SPAN CALIBRATION.
- **Caution:** Prematurely initiating the SPAN CALIBRATION function before the analyzer reading has stabilized can result in erroneous readings. This is especially true when installing a new sensor that must adjust to the difference in oxygen concentrations. It should take about 2 minutes for the sensor to equilibrate in ambient air from storage packaging.

- Always calibrate at the same temperature and pressure of the sample gas stream.
- For 'optimum calibration accuracy' calibrate with a span gas approximating 80% of the full scale range one or a higher range than the full scale range of interest (normal use) to achieve the effect of “narrowing the error” by moving downscale as illustrated by Graph A in the Accuracy & Calibration section.
- Calibrating with a span gas approximating 5-10% of the full scale range near the expected oxygen concentration of the sample gas is acceptable but less accurate than ‘optimum calibration accuracy’ method recommended – the method usually depends on the gas available.
- Calibrating at the same 5-10% of the full scale range for measurements at the higher end of the range (example: calibrating an Oxygen Purity Analyzer in air at 20.9% oxygen with the intention of measuring oxygen levels of 50-100%) results in the effect of “expanding the error” by moving upscale as illustrated by Graph A and Example 1 in the Accuracy & Calibration section above and is not recommended. Of course the user can always elect at his discretion to accept an accuracy error of $\pm$2-3% of full scale range if no other span gas is available.

Recommendations Air Calibration:

- Do not calibrate an analyzer employing the Pico-Ion UHP or MS sensor, or, an oxygen purity sensor with air.
- The inherent linearity of the galvanic fuel cell type oxygen sensor enables the user to calibrate any analyzer with ambient air (20.9% oxygen) and operate the analyzer within the stated accuracy spec on the lowest most sensitive range available with the analyzer – it is not necessary to recalibrate the analyzer with span gas containing a lower oxygen concentration.
- When installing or replacing a ppm or percent oxygen sensor.
- To verify the oxygen content of a certified span gas.
- When certified span gas is not available to calibrate a ppm analyzer (immediately following air calibration reintroduce a gas with a low oxygen concentration to expedite the return to ppm level measurements as described above **).

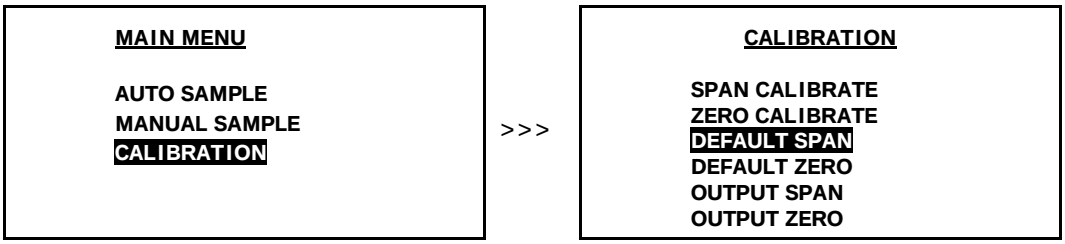
Required components: Refer to Installing Span Gas section above.

Default Span

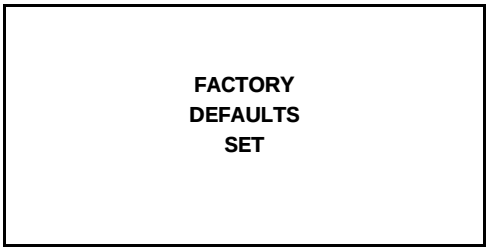
The software will eliminate any previous SPAN CALIBRATE adjustment(s) and display the actual the signal output of the sensor at any specific oxygen concentration. This feature allows the user to assess the sensor’s signal output without removing it from the sensor housing. For example, performing the DEFAULT SPAN feature followed by the introduction of a span gas, the display will reflect an oxygen reading within $\pm$50% of the span gas value. representing the sensor’s “actual” signal output and allows the user to test the sensor’s signal output when exposed to a specific oxygen standard (without removing the sensor from the sensor housing).

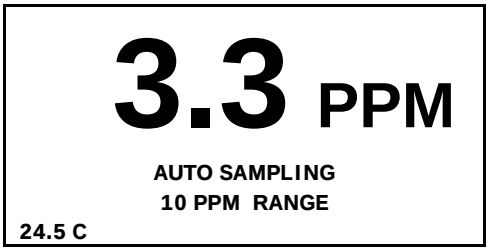
Procedure:

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



5. Advance the reverse shade cursor using the ARROW keys to highlight DEFAULT SPAN.
6. Press the ENTER key to select the highlighted menu option.
7. The following displays appear and after 3 seconds the system returns to the SAMPLING mode:





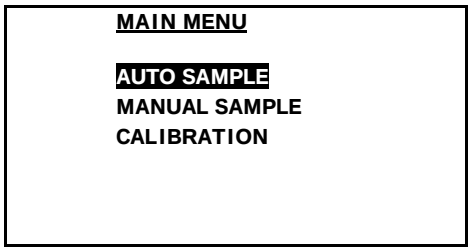
Procedure Span Calibration:
This procedure assumes the span gas is under positive pressure.

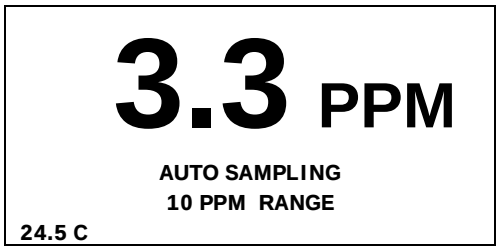
Caution: The user must ascertain that the oxygen reading (actually the sensor's signal output) has reached a stable value before initiating the SPAN CALIBRATE function. Failure to do so will result in an error.

For calibration purposes, use of the AUTO SAMPLE mode is recommended. However, the user can select the full scale MANUAL SAMPLE RANGE for calibration as dictated by the accuracy of the analysis required –

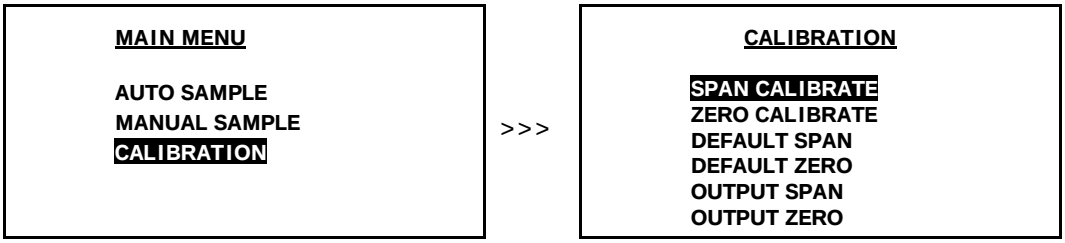
- ppm analyzer: Span gas with an 80 ppm oxygen concentration with the balance nitrogen would dictate the use of the 0-100 ppm full scale range for calibration and a 0-10 ppm measuring range.
- Percent analyzer: Span gas with a 4% oxygen concentration with the balance nitrogen would dictate the use of the 0-5% full scale range for calibration.
- Select as described in Range Selection above.

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

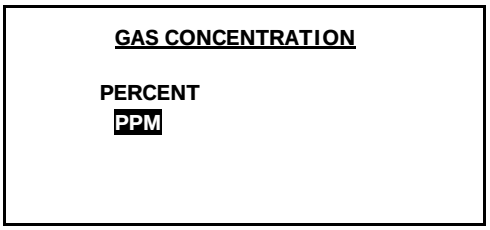




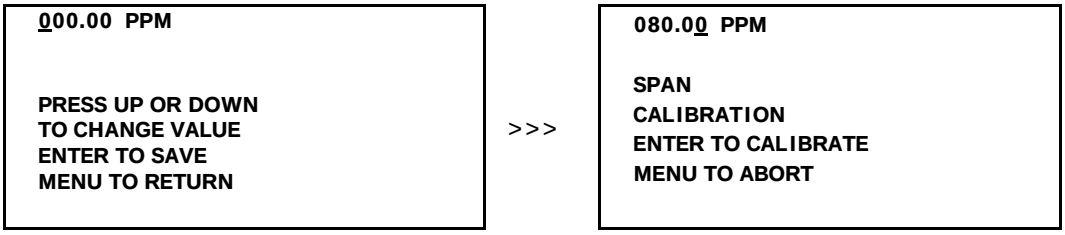
5. Assure there are no restrictions in vent line.
6. If the analyzer is equipped with an integral sampling pump, toggle the pump's ON/OFF switch to the OFF position.
7. Regulate the pressure and control the flow rate as described above at 5-30 psig and a 2 SCFH flow rate.
8. Place the SAMPLE/BYPASS valve in the BYPASS position.
9. Disconnect the sample gas line and install the span gas line.
10. Allow the span gas to flow for 1-2 minutes to purge the air trapped in the span gas line.
11. Place the SAMPLE/BYPASS valve in the SAMPLE position.
12. **Caution: Wait until the reading is stable before proceeding with calibration**. The wait time will vary depending on the amount oxygen introduced to the sensor when the gas lines were switched.
13. Return to the MAIN MENU by pressing the MENU key.
14. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
15. Press the ENTER key to select the highlighted menu option.
16. Repeat to select SPAN CALIBRATE and the following displays appear:



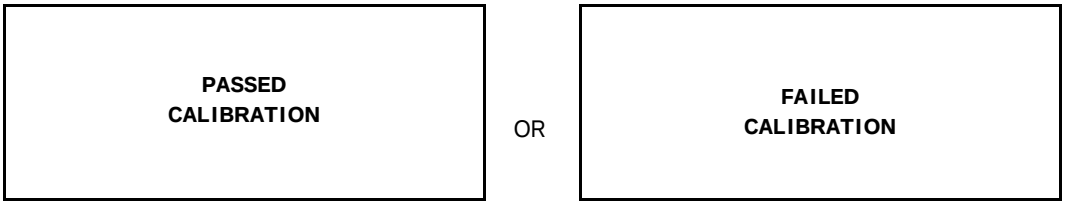
17. Press the ENTER key to select the SPAN CALIBRATE option.
18. **Note:** A span gas concentration above 1000 ppm dictates the selection of the PERCENT option.
19. Advance the reverse shade cursor using the ARROW keys to highlight the desired GAS CONCENTRATION.
20. Press the ENTER key to select the highlighted menu option.



21. The following displays appear:



22. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the alarm value.
23. Press the ARROW keys to enter the alarm value.
24. Repeat until the complete SPAN value has been entered.
25. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
26. Allow approximately 60 seconds for the calibration process while the processor determines whether the signal output or reading has stabilized within 60% of the full scale low range. Both the Zero Calibrate and Span Calibrate functions result in the following displays:

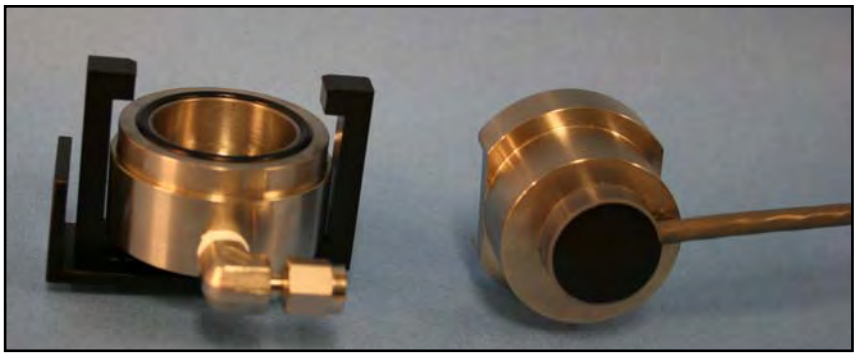


27. If the calibration is successful, the analyzer returns to the SAMPLING mode after 30 seconds.
28. If the calibration is unsuccessful, return to the SAMPLING mode with span gas flowing through the analyzer, make sure the reading stabilizes and repeat the calibration before concluding the equipment is defective.
29. Before disconnecting the span gas line, place the SAMPLE/BYPASS valve in the BYPASS position.

30. Disconnect the span gas line.
31. Connect a purge gas line of either zero or sample gas with a low oxygen concentration.
32. Allow the purge gas to flow for 1-2 minutes to purge the air trapped in the span gas line.
33. Place the SAMPLE/BYPASS valve in the SAMPLE position.
34. Allow the purge gas to flow in order to purge the sensor of the oxygen trapped inside from the calibration gas and bring the analyzer online to desired the measurement range.
35. **Caution: Wait until the reading is stable before proceeding with sampling**. The wait time will vary depending on the amount oxygen introduced to the sensor during calibration and/or when the gas lines were switched.
36. Once the reading is stable, place the SAMPLE/BYPASS valve in the BYPASS position.
37. Disconnect the purge gas line.
38. Connect the sample gas line.
39. Allow the sample gas to flow for 1-2 minutes to purge the air trapped in the sample gas line.
40. Place the SAMPLE/BYPASS valve in the SAMPLE position.
41. Wait until the reading is stable and proceed to sampling.

Procedure Air Calibration – Without Integral Pump:

1. Review the above Span Calibration procedure and the following instructions before proceeding:
   (a) Range selection and menu operation – note steps #7-9, #29-30 and #32-33 do not apply.
   (b) Section 6 Maintenance – instructions for removing the sensor explain how to expose the sensor to ambient air.
2. Access the interior of the analyzer by removing the four (4) screws securing the front panel of the analyzer.
3. **Caution:** Do not remove the gaskets from the enclosure. Failure to reinstall the gasket will void the NEMA rating.
4. Remove the sensor from the sensor housing as described in section 6 Maintenance.
5. Hold the sensor and upper sensor housing with cable between your thumb and first two fingers.
6. The thumb should be on the front of the sensor and to the side – do not cover sensing area.
7. Ensure the PCB at the rear of the sensor makes contact with the pins inside the sensor housing with the connecting cable and rest the back of the sensor housing with the connecting cable against the first two fingers.



8. With the sensor exposed to ambient air in the manner described above – resume the procedure and perform steps #10-28.
9. Reinstall the sensor as described in section 6 Maintenance.
10. Remember steps #29-30 and #32-33 do not apply because for air calibration the SAMPLE/BYPASS valve should already be in the SAMPLE position.
11. Perform step #31.
12. Skip to step #34 and perform the remainder of the procedure.
13. Replace the front cover of the analyzer and ensure that the gasket is replaced to maintain CE approval and NEMA 4 rating.
14. Tighten the four (4) screws to secure the front cover.

Procedure Air Calibration – with Integral Pump:

1. Review the above Span Calibration procedure and the following instructions before proceeding:
   (a) Range selection and menu operation – note steps #6-10, #29-30 and #32-33 do not apply.
2. Select a source of good ambient air.
3. Ensure the step #5 is performed and the SAMPLE/BYPASS valve is in the SAMPLE position.
4. Open the FLOW VALVE completely – to prevent the pump from drawing a vacuum on the sensor.
5. Disconnect any tubing connected to the inlet fitting located on the left side of the analyzer.
6. Toggle the PUMP ON/OFF switch to the ON position to operate the integral sampling pump and draw the ambient air span gas into the analyzer.
7. With the integral pump operating – resume the above procedure and perform steps #10-28.

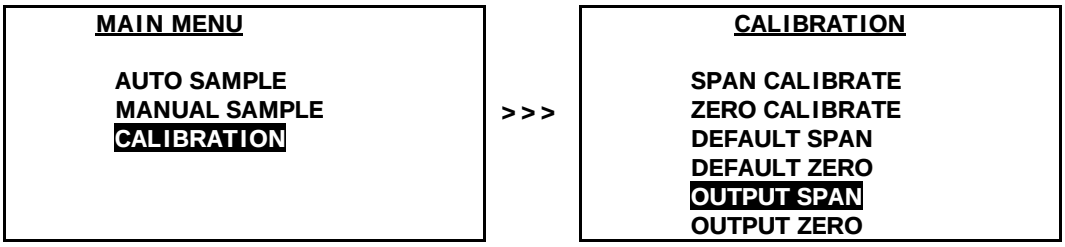
8. Remember steps #29-30 and #32-33 do not apply because for air calibration the SAMPLE/BYPASS valve should already be in the SAMPLE position.
9. Perform step #31.
10. Skip to step #34 and perform the remainder of the procedure.

Output Span

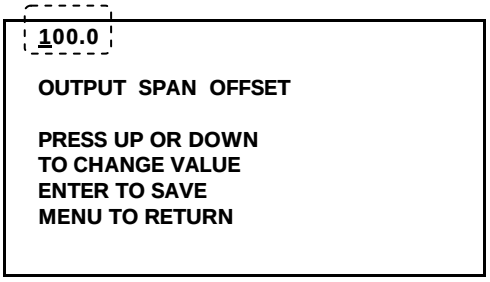
Accuracy due to manufacturer tolerances may result in a slight difference between the LCD display and the 0-1V analog output. However, the difference is less than 0.25% of range and falls well below the specified accuracy of the analyzer. In rare instances the 0-1V signal output may not agree to the reading displayed by the LCD. This feature enables the user to adjust the 1V signal output should the LCD display not agree. **Note:** Adjust the 0V signal output with the OUTPUT ZERO option described above.

Procedure:

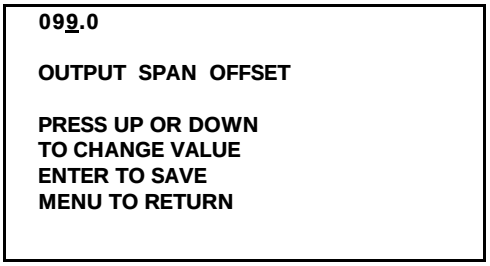
1. Access the MAIN MENU by pressing the MENU key.
2. Advance the reverse shade cursor using the ARROW keys to highlight CALIBRATION.
3. Press the ENTER key to select the highlighted menu option and the following displays appear:



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



7. Compute the adjustment value as described in Appendix B or consult the factory. The true adjustment value must be determined empirically by trial and error. Adjust the initial adjustment value for additional percent errors.

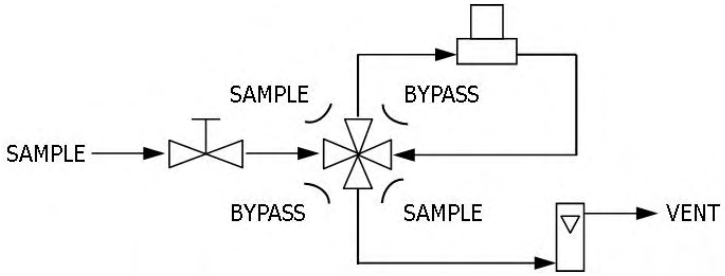


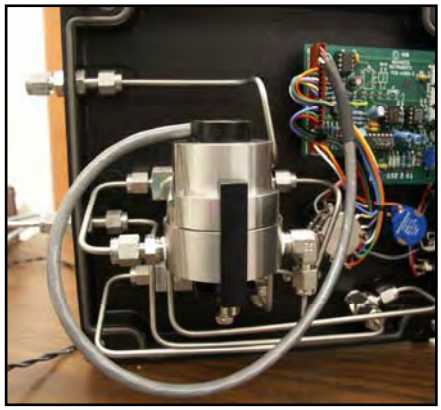
8. Press the ENTER key to advance the underline cursor right or press the MENU key to advance the underline cursor left to reach to the desired digit of the OUTPUT SPAN OFFSET value.

9. Press the ARROW keys to enter the OUTPUT SPAN OFFSET value.
10. Repeat until the complete OUTPUT SPAN OFFSET value has been entered.
11. **Save the adjustment value by pressing the ENTER key or abort by pressing the MENU key.**
12. The system returns to the SAMPLING mode.

Sampling

The sensor is exposed to sample gas that must flow or be drawn through the analyzer's internal sample system.





As illustrated above, the GPR-1200's internal sample system includes:

- 1/8" tube fittings for the inlet and outlet
- flow control metering valve
- 4-way SAMPLE/BYPASS bypass valve
- Stainless steel sensor housing with an o-ring seal to prevent the leakage of air
- Tee to combine the sample and bypass lines
- Flow indicator common to bypass and sample lines

Flow rates of 1-5 SCFH cause no appreciable change in the oxygen reading. However, flow rates above 5 SCFH generate backpressure and erroneous oxygen readings because the diameter of the integral tubing cannot evacuate the sample gas at the higher flow rate. A FLOW upstream of the sensor controls the flow rate of the sample gas which is displayed by the flow indicator downstream of the sensor. A flow rate of 2 SCFH or 1liter per minute is recommended for optimum performance.

Application Pressure - Positive:
A flow control metering valve positioned upstream of the sensor controls the sample flow rate between 1-5 SCFH. If necessary, a pressure regulator (with a metallic diaphragm is recommended for optimum accuracy, the use of diaphragms of more permeable materials may result in erroneous readings) upstream of the flow control valve should be used to regulate the inlet pressure between 5-30 psig.

Application Pressure - Atmospheric or Slightly Negative:
For accurate ppm range oxygen measurements, an optional integral sampling pump is positioned downstream of the sensor to draw the sample from the process, by the sensor and out to atmosphere.

Caution: If the analyzer is equipped with an optional integral sampling pump (positioned downstream of the sensor), completely open the flow control metering valve (positioned upstream of the sensor) to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.

Procedure:
1. Review the end of the Span Calibration procedure beginning with step #28 and section on Pressure & Flow in section 3.
2. Select the desired sampling mode - auto or if manual, the range that provides maximum resolution.
3. Use metal tubing to transport the sample gas to the analyzer.
4. The main consideration is to eliminate air leaks which can affect oxygen measurements above or below the 20.9% oxygen concentration in ambient air - ensure the sample gas tubing connections fit tightly into the 1/8" male NPT to tube adapter,

and, the NPT end is taped and securely tightened into the mating male quick disconnect fittings which mate with the female fittings on the analyzer

5. Assure there are no restrictions in the sample gas lines – inlet or vent.
6. For sample gases under positive pressure the user must provide a means of regulating the inlet pressure between 5-30 psig, the analyzer is equipped with a FLOW VALVE to set the flow rate at the recommended 2 SCHF.
7. For sample gases under atmospheric or slightly negative pressure an optional sampling pump is recommended to draw the sample into the analyzer. Generally, no pressure regulation or flow control device is involved. **Caution:** If the analyzer is equipped with both a FLOW VALVE upstream of the sensor and an integral SAMPLING PUMP downstream of the sensor, always open the FLOW VALVE completely before operating the pump (avoid drawing a vacuum on the sensor).
8. Assure the sample is adequately vented for optimum response and recovery – and safety.

To avoid erroneous oxygen readings and damaging the sensor:

- Do not place your finger over the vent (it pressurizes the sensor) to test the flow indicator when gas is flowing to the sensor. Removing your finger (the restriction) generates a vacuum on the sensor and may damage the sensor (voiding the sensor warranty).
- If the analyzer is equipped with an optional integral sampling pump (positioned downstream of the sensor), completely open the flow control metering valve (positioned upstream of the sensor) to avoid drawing a vacuum on the sensor and placing an undue burden on the pump.
- Assure there are no restrictions in the sample or vent lines
- Avoid drawing a vacuum that exceeds 14" of water column pressure – unless done gradually
- Avoid excessive flow rates above 5 SCFH which generate backpressure on the sensor.
- Avoid sudden releases of backpressure that can severely damage the sensor.
- Avoid the collection of particulates, liquids or condensation collect on the sensor that could block the diffusion of oxygen into the sensor.

Standby

The analyzer has no special storage requirements.

1. The sensor should remain connected during storage periods.
2. Store the analyzer with the power OFF.
3. If storing for an extended period of time, charge before operating.

6 Maintenance

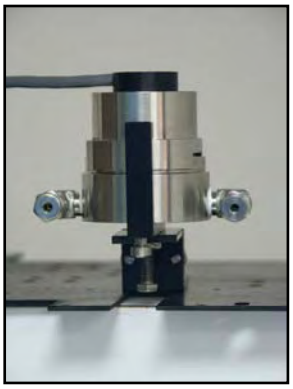
With exception of components related to optional equipment and charging the battery of portable analyzers, cleaning the electrical contacts when replacing the sensor is the extent of the maintenance requirements of this analyzer as there are no serviceable parts in the analyzer given the nature of the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

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

Sensor Replacement

Periodically, the oxygen sensor will require replacement. The operating life is determined by a number of factors that are influenced by the user and therefore difficult to predict. The Features & Specifications define the normal operating conditions and expected life of the standard sensor utilized by the GPR-1200 Series analyzer. Expected sensor life is inversely proportional to changes in oxygen concentration, pressure and temperature.

Caution: DO NOT open the oxygen sensor. The sensor contains a corrosive liquid electrolyte that could be harmful if touched or ingested, refer to the Material Safety Data Sheet contained in the Owner's Manual.



Procedure:

1. Remove the four (4) screws securing the analyzer's front panel.
2. **Caution:** Do not discard the gaskets from the enclosure.
3. Using the 5/16 wrench supplied loosen but do not remove the clamp bolt located in the center of the housing with the elbows attached.
4. Rotate the upper section of the sensor housing 90º to disengage from the clamp.
5. Remove the upper section by pulling it straight up and place it on a smooth surface.
6. Remove the old oxygen sensor and dispose of it as you would a battery.
7. Place the SAMPLE/BYPASS valve in the SAMPLE position, connect zero gas or low oxygen content sample gas line to purge the sensor of oxygen and begin the flow at 2 SCFH.
8. Remove the new oxygen sensor from the shipping bag.
9. Remove the red label and the gold ribbon (shorting device) from the PCB at the rear of the sensor.
10. **Caution:** Minimize the time the sensor is exposed to ambient air.
11. Once the reading stabilizes – see above.
12. Span Calibrate the analyzer in 20.9% ambient air.
13. Place the new sensor in the bottom section of the sensor housing with the PCB facing up.
14. Place the upper section of the sensor housing over the sensor.
15. Gently push the upper section downward and rotate 90º to engage the clamp.
16. Finger tighten the clamp bolt and one full turn with the 5/16 wrench to compressed the o-ring seal.
17. With a zero gas containing less than 1 ppm oxygen concentration flowing (see #7 above), expect the analyzer reading to recover to the 0-100 ppm range in 15 minutes and the 0-10 ppm range within 60 minutes.
18. Begin sampling once the analyzer has reached the value of the purge gas.
19. **Note:** If a sample gas containing a lower oxygen concentration is subsequently introduced into the analyzer expect the analyzer reading to continue to decrease gradually.

Battery Replacement

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

Procedure:

1. Unless the analyzer is to be operated while charging, turn the analyzer OFF when charging the battery for the shortest charging cycle.
2. Connect the appropriate 9VDC adapter supplied with the analyzer to an 110V or 220V outlet.
3. Insert the male phone plug from the 9VDC adapter into the integral female CHARGE jack located on the bottom of the enclosure.
4. **Caution:** The analyzer is designed to operate in the charging mode, however, operating the analyzer in hazardous or explosive atmospheres while charging the battery IS NOT recommended despite the intrinsically safe design.

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

Warning indicators:

An LED indicator located on the front panel will light continuously during the CHARGE cycle.
A second LED indicator located on the front panel provides a blinking 72 hour warning LOW BATT of the need to recharge the battery. **Caution:** Operating the analyzer beyond this 72 hour warning may permanently damage the battery.

7 Spare Parts

Recommended spare parts for the GPR-1200 Series Portable Oxygen Analyzer:

Item No.	Description
GPR-12-333	ppm Oxygen Sensor
XLT-12-333	ppm Oxygen Sensor

Other spare parts:

Item No.	Description
A-1163	Battery Assembly (without integral sampling pump)
A-1157	Battery Assembly (general purpose integral sampling pump)
A-1158	Battery Assembly (intrinsically safe integral sampling pump)
A-1004-3-14	Housing Sensor Stainless Steel
A-1016-A-1	Housing Sensor Bottom Assembly Stainless Steel
B-2762-A-3-14	Housing Sensor Upper Assembly Stainless Steel
MTR-1011	Meter Digital Panel LCD Backlight
ORNG-1007	O-ring 3/32 x 1-3/8 x 1-9/16 Viton
A-1151-E-B1	PCB Assembly Main / Display
PWRS-1002	Power Source Plug-in 9VDC 110V Battery Charger
PWRS-1003	Power Source Plug-in 9VDC 220V Battery Charger

8 Troubleshooting

Symptom	Possible Cause	Recommended Action
Slow recovery	At installation – extended exposure to air	Continue purging sensor with preferably N2 zero gas or sample gas with low ppm oxygen concentration
	At installation – sensor housing not properly tightened	Check and tighten bolt in center of bottom section of sensor housing, purge sensor as above
		Replace sensor if recovery unacceptable or O_2 reading fails to reach 10% of lowest range
	Air leak in sample system connection(s)	Leak test the entire sample system: Vary the flow rate, if the O_2 reading changes inversely with the change in flow rate indicates an air leak - correct source of leak
	Abnormality in zero gas	Qualify zero gas (using portable analyzer)
	Damaged in service - prolonged exposure to air, electrolyte leak	Replace sensor
	Sensor nearing end of life	Replace sensor
High O_2 reading after installing or replacing sensor	Analyzer calibrated before sensor stabilized caused by: 1) Prolonged exposure to ambient air, worse if sensor was **unshorted** 2) Air leak in sample system connection(s) 3) Abnormality in zero gas	Allow O_2 reading to stabilize before making the span/calibration adjustment Continue purge with zero gas Leak test the entire sample system (above) Qualify zero gas (using portable analyzer)
High O_2 reading Sampling	Flow rate exceeds limits Pressurized sensor	Correct pressure and flow rate Remove restriction on vent line or open SHUT OFF valve completely
	Improper sensor selection	Replace GPR/PSR sensor with XLT sensor when CO_2 or acid gases are present
	Abnormality in gas	Qualify the gas (use a portable analyzer)
Response time slow	Air leak, dead legs, distance of sample line, low flow rate, volume of optional filters and scrubbers	Leak test (above), reduce dead volume or increase flow rate
O_2 reading doesn't agree to expected O_2 values	Pressure and temperature of the sample is different than span gas Abnormality in gas	Calibrate the analyzer (calibrate at pressure and temperature of sample) Qualify the gas (use a portable analyzer)

Symptom	Possible Cause	Recommended Action
Erratic O_2 reading or No O_2 reading	Test sensor independent from analyzer	Remove sensor from housing. Using a volt-meter set to uA output; apply the (+) lead to the outer ring of the sensor PCB and the (-) lead to the center circle to obtain the sensor's output in air. Contact factory with result. Sensors without PCB use mV setting.
	Change in sample pressure	Calibrate the analyzer (calibrate at pressure and temperature of sample)
	Dirty electrical contacts in upper section of sensor housing	Clean contacts with alcohol (minimize exposure time of MS sensor to ambient air to extent possible)
	Corroded solder joints on sensor PCB from corrosive sample or electrolyte leakage from sensor	Replace sensor and return sensor to the factory for warranty determination
	Corroded spring loaded contact in upper section of sensor housing from liquid in sample or electrolyte leakage from sensor	Upper section of sensor housing: Clean contacts with alcohol, flow sample or zero gas for 2-3 hours to flush sample system and sensor housing Sensor: Replace if leaking and return it to the factory for warranty determination
	Liquid covering sensing area	Wipe with alcohol and lint free towel or flow sample or zero gas for 2-3 hours to flush
	Improper sensor selection	Replace GPR/PSR sensor with XLT sensor when CO_2 or acid gases are present
	Presence of interference gases	Consult factory
	Presence of sulfur gases	Replace sensor and install scrubber
	Unauthorized maintenance	Replace sensor, obtain authorized service
	Sensor nearing end of life	Replace sensor
Erratic O_2 reading or Negative O_2 reading or No O_2 reading possibly accompanied by electrolyte leakage	Pressurizing the sensor by flowing gas to the sensor with: the vent restricted or SHUT OFF valve closed and suddenly removing the restriction draws a vacuum on the sensor or partially opening the valves upstream of the analyzer when using a pump downstream of the analyzer to draw sample from a process at atmospheric pressure or a slight vacuum A pressurized sensor may not leak but still produce negative readings. Placing a vacuum on the sensor in excess 4" of water column is strongly discouraged. The front sensing membrane is .000625 thick, heat sealed to the sensor body and subject to tearing when vacuum is suddenly applied. A premature adjustment of the ZERO OFFSET potentiometer is a common problem	Zero the analyzer. If not successful replace the sensor Avoid drawing a vacuum on the sensor From MAIN MENU select DEFAULT ZERO

9 Warranty

The design and manufacture of Advanced Instruments Inc. oxygen analyzers and oxygen sensors are performed under a certified Quality Assurance System that conforms to established standards and incorporates state of the art materials and components for superior performance and minimal cost of ownership. Prior to shipment every analyzer is thoroughly tested by the manufacturer and documented in the form of a Quality Control Certification that is included in the Owner's Manual accompanying every analyzer. When operated and maintained in accordance with the Owner's Manual, the units will provide many years of reliable service.

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

If your Advanced Instruments Inc. monitor, analyzer and/or oxygen sensor is determined to be defective with respect to material and/or workmanship, we will repair it or, at our option, replace it at no charge to you. If we choose to repair your purchase, we may use new or reconditioned replacement parts. If we choose to replace your Advanced Instruments Inc. analyzer, we may replace it with a new or reconditioned one of the same or upgraded design. This warranty applies to all monitors, analyzers and sensors purchased worldwide. It is the only one we will give and it sets forth all our responsibilities.

There are no other express warranties. This warranty is limited to the first customer who submits a claim for a given serial number and/or the above warranty period. Under no circumstances will the warranty extend to more than one customer or beyond the warranty period.

Limitations
Advanced Instruments Inc. will not pay for: loss of time; inconvenience; loss of use of your Advanced Instruments Inc. analyzer or property damage caused by your Advanced Instruments Inc. analyzer or its failure to work; any special, incidental or consequential damages; or any damage resulting from alterations, misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the analyzer; affixing of any attachment not provided with the analyzer or other failure to follow the Owner's Manual. Some states and provinces do not allow limitations on how an implied warranty lasts or the exclusion of incidental or consequential damages, these exclusions may not apply.

Exclusions
This warranty does not cover installation; defects resulting from accidents; damage while in transit to our service location; damage resulting from alterations, misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the analyzer; affixing of any label or attachment not provided with the analyzer; fire, flood, or acts of God; or other failure to follow the Owner's Manual.

Service
Call Advanced Instruments 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 you analyzer, postage prepaid to:

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

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

10 MSDS – Material Safety Data Sheet

Product Identification

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

Specific Generic Ingredients

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

General Requirements

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

Physical Properties

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

Fire and Explosion Data

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

Reactivity Data

Stability	Stable
Conditions Contributing to Instability	None

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

Spill or Leak

Steps if material is released	Sensor is packaged in a sealed plastic bag, check the sensor inside for electrolyte leakage. If the sensor leaks inside the plastic bag or inside an analyzer sensor housing do not remove it without rubber or latex gloves and safety glasses and a source of water. Flush or wipe all surfaces repeatedly with water or wet paper towel (fresh each time).

Disposal

In accordance with federal, state and local regulations.

Health Hazard Information

Primary Route(s) of Entry	Ingestion, eye and skin contact
Exposure Limits	Potassium Hydroxide - ACGIH TLV 2 mg/cubic meter or Acetic Acid - ACGIH TLV / OSHA PEL 10 ppm (TWA), Lead - OSHA PEL .05 mg/cubic meter
Ingestion	Electrolyte could be harmful or fatal if swallowed. KOH = Oral LD50 (RAT) = 2433 mg/kg or Acetic Acid = Oral LD50 (RAT) = 6620 mg/kg
Eye	Electrolyte is corrosive and eye contact could result in permanent loss of vision.
Skin	Electrolyte is corrosive and skin contact could result in a chemical burn.
Inhalation	Liquid inhalation is unlikely.
Symptoms	Eye contact - burning sensation. Skin contact - soapy slick feeling.
Medical Conditions Aggravated	None
Carcinogenic Reference Data	KOH and Acetic Acid = NTP Annual Report on Carcinogens - not listed; LARC Monographs - not listed; OSHA - not listed
Other	Lead is listed as a chemical known to the State of California to cause birth defects or other reproductive harm.

Special Protection

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

Special Precautions

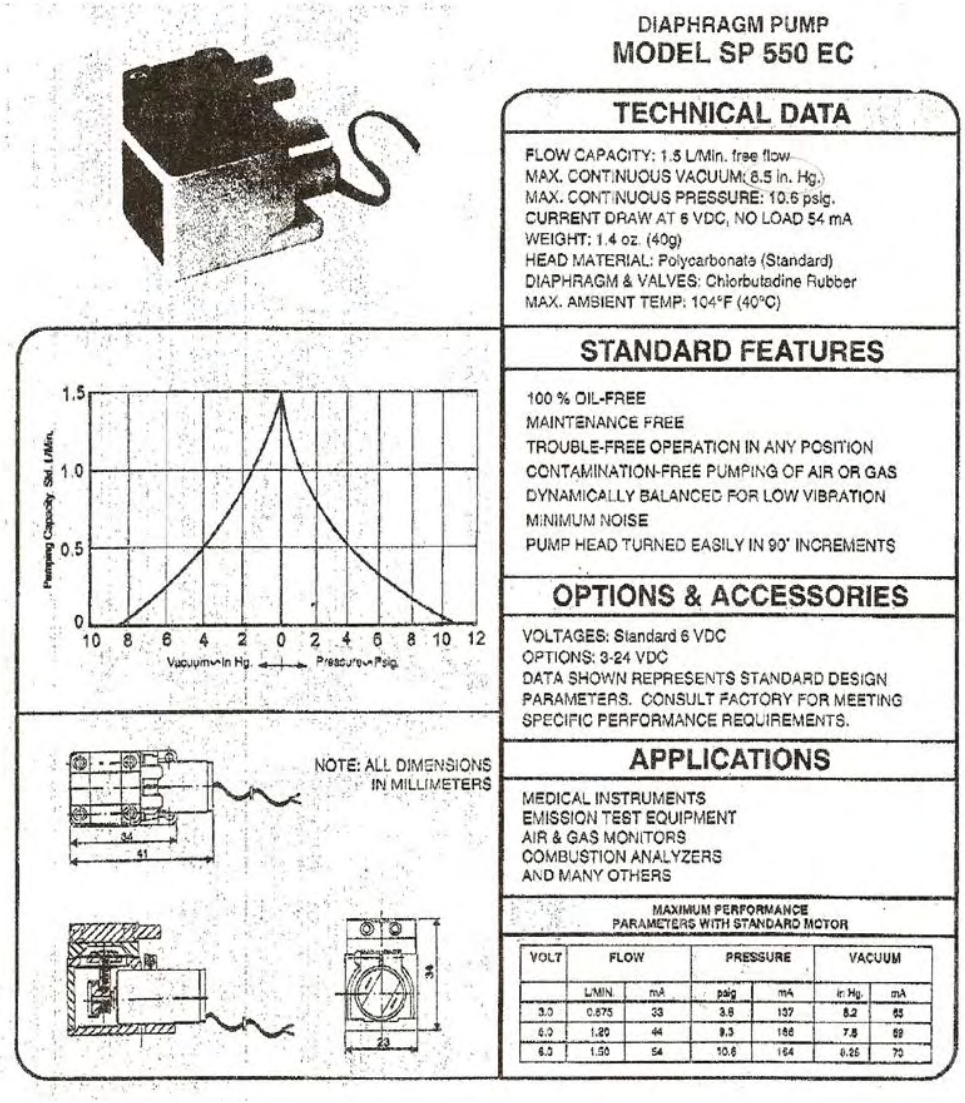
Precautions	Do not remove the sensor's protective Teflon and PCB coverings. Do not probe the sensor with sharp objects. Wash hands thoroughly after handling. Avoid contact with eyes, skin and clothing. Empty sensor body may contain hazardous residue.
Transportation	Not applicable

Appendix C

Portable Pump Options

Coreless skew wound motors are used in all these standard the eccentric driven diaphragm pumps. Features include small compact size, high efficiency, low noise operation, low power consumption, chemically resistant materials, oil free operation and no maintenance. The compact size and low power consumption are ideal for installation in portable analyzer enclosures:

Analyzer	Assembly P/N	Component P/N	Area Class
GPR-1200	A-2166-4	PUMP-1013	General Purpose
	A-2166-5	PUMP-1010	Intrinsically Safe
GPR-35	A-2501	PUMP-1005	General Purpose



DIAPHRAGM PUMP
MODEL SP 550 EC

TECHNICAL DATA

FLOW CAPACITY: 1.5 L/Min. free flow
MAX. CONTINUOUS VACUUM: 8.5 in. Hg.
MAX. CONTINUOUS PRESSURE: 10.6 psig.
CURRENT DRAW AT 6 VDC, NO LOAD 54 mA
WEIGHT: 1.4 oz. (40g)
HEAD MATERIAL: Polycarbonate (Standard)
DIAPHRAGM & VALVES: Chlorbutadine Rubber
MAX. AMBIENT TEMP: 104°F (40°C)

STANDARD FEATURES

100 % OIL-FREE
MAINTENANCE FREE
TROUBLE-FREE OPERATION IN ANY POSITION
CONTAMINATION-FREE PUMPING OF AIR OR GAS
DYNAMICALLY BALANCED FOR LOW VIBRATION
MINIMUM NOISE
PUMP HEAD TURNED EASILY IN 90° INCREMENTS

OPTIONS & ACCESSORIES

VOLTAGES: Standard 6 VDC
OPTIONS: 3-24 VDC
DATA SHOWN REPRESENTS STANDARD DESIGN PARAMETERS. CONSULT FACTORY FOR MEETING SPECIFIC PERFORMANCE REQUIREMENTS.

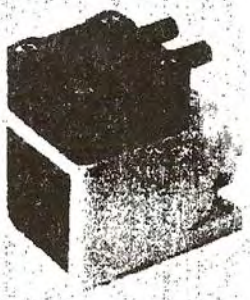
APPLICATIONS

MEDICAL INSTRUMENTS
EMISSION TEST EQUIPMENT
AIR & GAS MONITORS
COMBUSTION ANALYZERS
AND MANY OTHERS

MAXIMUM PERFORMANCE
PARAMETERS WITH STANDARD MOTOR

VOLT	FLOW		PRESSURE		VACUUM	
	L/MIN.	mA	psig	mA	in Hg.	mA
3.0	0.675	33	3.8	137	8.2	65
6.0	1.20	44	9.3	186	7.8	99
6.0	1.50	54	10.6	164	8.25	70

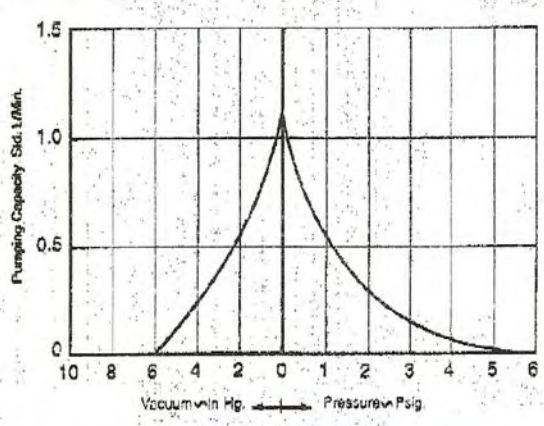
Analyzer	Assembly P/N	Component P/N	Area Class
GPR-2000 / 980	A-2166-1	PUMP-10011	General Purpose
	A-2166-5	PUMP-1010	Intrinsically Safe



DIAPHRAGM PUMP
MODEL SP 500 EC-LC

TECHNICAL DATA

FLOW CAPACITY: 1.1 L/Min. free flow
MAX. CONTINUOUS VACUUM: 6 in. Hg.
MAX. CONTINUOUS PRESSURE: 5.5 psig.
CURRENT DRAW AT 4.5 VDC, NO LOAD 70 mA.
WEIGHT: 1.1 oz. (30g)
HEAD MATERIAL: Polycarbonate (Standard)
DIAPHRAGM & VALVES: Chlorbutadine Rubber
MAX. AMBIENT TEMP: 104°F (40°C)

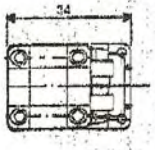


STANDARD FEATURES

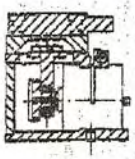
100 % OIL-FREE
MAINTENANCE FREE
TROUBLE-FREE OPERATION IN ANY POSITION
CONTAMINATION-FREE PUMPING OF AIR OR GAS
DYNAMICALLY BALANCED FOR LOW VIBRATION
MINIMUM NOISE
PUMP HEAD TURNED EASILY IN 90° INCREMENTS

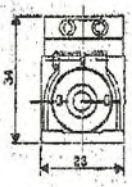
OPTIONS & ACCESSORIES

VOLTAGES: Standard 4.5 VDC
DATA SHOWN REPRESENTS STANDARD DESIGN PARAMETERS. CONSULT FACTORY FOR MEETING SPECIFIC PERFORMANCE REQUIREMENTS.



NOTE: ALL DIMENSIONS IN MILLIMETERS





APPLICATIONS

MEDICAL INSTRUMENTS
EMISSION TEST EQUIPMENT
AIR & GAS MONITORS
COMBUSTION ANALYZERS
AND MANY OTHERS

MAXIMUM PERFORMANCE PARAMETERS WITH 4.5 VDC MOTOR

VOLT	FLOW		PRESSURE		VACUUM	
	L/MIN.	mA	psig	mA	in Hg.	mA
3.0	0.65	51	3.30	82	5.10	80
4.5	1.15	70	5.50	102	9.30	97
6.0	1.50	78	5.20	114	8.90	108