

SERIES 2510 PERCENT OXYGEN TRANSMITTER



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SERIES 2510 Percent Oxygen Transmitter Instruction Manual

WARRANTY

Alpha Omega Instruments Corp. warrants the products delivered to be free from defects in material and workmanship at the time of delivery to the FOB. point specified in the purchase order, its liability under this warranty being limited to repairing or replacing, at Alpha Omega Instruments option, items (excluding the oxygen sensor) which are returned to it **prepaid** within two (2) years from the date of shipment and found to Seller's satisfaction to be defective.

Alpha Omega Instruments one (1) year sensor warranty offers protection for one full year from the date of shipment of the Series 2510 Percent Oxygen Transmitter. Any sensor from a Series 2510 Percent Oxygen Transmitter that fails under normal use must be returned to Seller prepaid and, if such sensor is determined by Seller to be defective, Seller shall provide Buyer a replacement sensor. Buyer must provide the serial number of the transmitter from which the sensor has been removed. If a sensor is found to be defective and a new one issued, the warranty of the replacement sensor (s) is for a period of one year from the date of shipment. At times, it may be necessary to ship a replacement sensor in advance of receiving one returned for warranty claim. In such cases, if the returned sensor is not covered under warranty, the user will be charged the full price of a replacement sensor. **In no event shall Alpha Omega Instruments Corp. be liable for consequential damages. NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY.**

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- (i) the items are used solely under the operating conditions and manner recommended in this manual, specifications, or other literature;
- (ii) the items have not been misused or abused in any manner or repairs attempted thereon;
- (iii) written notice of the failure within the warranty period is forwarded to Alpha Omega Instruments Corp. and, the directions received for properly identifying items returned under warranty are followed;
- (iv) the return notice authorizes Alpha Omega Instruments Corp. to examine and disassemble returned products to the extent the Company deems necessary to ascertain the cause of failure.

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SECTION 1.0
SPECIFICATIONS

PERFORMANCE

Measurement Ranges in Percent

0-2, 0-5, 0-10, 0-25, 0-50, and 0-100 (range determined at the time of order placement).

Accuracy ¹	± 1% of full scale.
Linearity	± 1% of full scale.
Response Time	90% of full scale in less than 20 seconds (typical).
Sensor Type	Patented Electrochemical Sensor.
Temperature Compensation	Standard.
Operating Temp. Range	32° to 122°F (0° to 50°C)
Sample Gas Pressure Limits.	0.1 to 1.0 psig (1.4 to 14.2 kg/cm ²)
Sample Flow Rate	1.0 to 2.0 standard cubic feet per hour (SCFH) 0.5 to 1.0 liters/ minute (LPM)
Input Power	115 VAC/60 Hz
Analog Output	4-20 mADC (0-10 VDC optional)
Warranty	Two years for the electronics and one year for the sensor.

CONSTRUCTION

Enclosure	Polycarbonate, rated NEMA 1 General Purpose.
Gas Connections:	Quick connect 1/4" OD for plastic tubing or compression fittings for installations with metal sample lines.
Dimensions	6.5 in height 7.0 in width. 3.9 in depth.

¹ Stated at constant temperature and pressure.

SECTION 2.0
SYSTEM DESCRIPTION

General Description

The Series 2510 Percent Oxygen Transmitter is an AC powered blind transmitter designed to provide accurate and dependable percent oxygen measurements in a variety of gases. The transmitter enclosure is made from durable polycarbonate and is rated watertight (NEMA 4). If the Series 2510 is equipped with optional sample pump or digital panel meter the enclosure is rated for general purpose (NEMA 1) service. The transmitter is powered from 115 VAC/60 Hz. Options include a pressure regulator, flow meter, in-line filter, digital meter, pump 0-10 VDC output, and 1/4" compression gas fitting on the sensor inlet.

Patented Ambient Temperature Electrochemical Sensor with EES

The Series 2510 Percent Oxygen Transmitter features an extended life oxygen sensor with EES (enhanced electrolyte system) a patented weak acid electrolyte system. The weak acid electrolyte system retards passivation of the sensor anode by allowing the products of oxidation to dissolve in the acid electrolyte. In effect, the sensor is renewed continuously as the weak acid electrolyte tolerates over **20 times** the lead oxide (PbO) than potassium hydroxide (KOH) based sensors. The result is a sensor with a greatly extended useful life.

The extended life sensor is a lead-oxygen battery comprised of a lead anode, and gold cathode, and a weak acid electrolyte. A gold electrode is bonded onto a non-porous Teflon (FEP) membrane. A small amount of oxygen permeating through the membrane is reduced electrochemically at the gold electrode. A resistor and a thermistor (for temperature compensation) are connected between the cathode and anode. As a result, the lead-oxygen battery is always discharged.

Current flowing through the resistor and thermistor is proportional to the oxygen concentration of the gas in contact with the Teflon membrane. By measuring the voltage between the between the resistor and the thermistor, oxygen concentration can be accurately determined. The two electrode reactions are depicted below:



If PbO generated at the anode remains on the anode, the anode's potential will change and the output voltage of the sensor would become extremely low. However, in actuality the surface of the lead anode is continuously renewed because PbO is dissolved back into the electrolyte. There is a maximum solubility limit of PbO in the weak acid electrolyte. As a result, when the electrolyte becomes saturated with PbO, the sensitivity of the sensor will begin to drop signaling time for replacement of the sensor. When the extended life oxygen sensor is used in applications where carbon dioxide (CO₂) is present, the weak acid electrolyte provides protection from a rapid deterioration in sensor life due to CO₂ poisoning. Sensors that use potassium hydroxide electrolyte are adversely affected by CO₂. This is not the case with Alpha Omega Instruments extended life oxygen sensor.

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SECTION 3.0
INSTALLATION PROCEDURES

Unpacking the Instrument

Upon opening the shipping container, carefully unpack the transmitter to check if the outer surfaces have been damaged. If so, report the findings immediately to Alpha Omega Instruments who will provide further instructions. If there is no apparent damage, check the contents to ensure all items were shipped. In some cases, items may be backordered.

Electrical Installation

The Series 2510 Percent Oxygen Transmitter is powered from an internal 115 VAC, 60 Hz power source. There is no power cord supplied as wiring AC power is to be done by the user. Please refer to Figure 1.0 to view the terminals used to wire the AC power to the Series 2510 Percent Oxygen Transmitter. To gain access to the terminals the front cover must be removed by loosening the four screws at each corner of the enclosure. NOTE: When wiring the AC, be sure to connect the ground wire to the terminal provided next to the oxygen sensor. The position of the terminal may change based on the options ordered with the Series 2510 Percent Oxygen Transmitter.

Wiring to the 4-20 mADC

Figure 1.0 provides terminal designations used in connecting to the 4-20 mADC output. To gain access to the terminals the front cover must be removed by loosening the four screws at each corner of the enclosure.

Mounting the Series 2510 Percent Oxygen Transmitter

Removing the cover of the transmitter reveals the mounting holes located at each of the four corners. A template can be made using the back of the enclosure for hole mark designations. Or, using a sharp pencil the holes can be spotted from the front by running the pencil down the length of the mounting holes allowing the pencil graphite to mark the mounting surface. Refer to Figure 2.0 for dimensions.

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SECTION 4.0
OPERATING PROCEDURES

Gas System Pressure Limits

For sample gases and/or calibration gases that are under pressure, it is imperative that the sample gas pressure to the sensor be kept to under **1 pound per square inch**. If it is expected to be in excess of 1.0 psig a pressure regulator should be used.

Range Identification

The Series 2510 Percent Oxygen Transmitter is available in six (6) different ranges. To identify the specific range of the transmitter in question, please refer to the original purchase order document or invoice from Alpha Omega Instruments. In it, you will find a model number starting with the number 2510. The letter immediately following "2510" is the range identifier. The various ranges, with their associated identifier, are as follows:

<u>Range (%)</u>	<u>Identifier</u>
0-2	A
0-5	B
0-10	C
0-25	D
0-50	E
0-100	F

Sample Connections

The sample flow connections to the Series 2510 Percent Oxygen Transmitter are quick connect fittings to be used with 1/4" OD flex tubing such as polypropylene, nylon, etc. An optional 1/4" gas compression fitting on the gas inlet to the sensor is available.

Electrical Output

The Series 2510 Percent Oxygen Transmitter produces an analog output of 4-20 mADC that can be used with a recorder, datalogger, etc. An optional 0-10 VDC output is also available.

Transmitter Storage

When the Series 2510 is not in use, it should be stored indoors within a temperature range of 32° to 104° F.

SECTION 5.0
CALIBRATION PROCEDURES

Routine Span Gas Calibration Checks

The Series 2510 Percent Oxygen Transmitter has been calibrated at the factory prior to shipment. Alpha Omega Instruments percent oxygen sensors feature high accuracy and excellent long term stability characteristics. As a result, routine maintenance is kept to a minimum. As is the case with all high precision gas measuring instruments, it is advisable to periodically check the overall system calibration. The frequency of these checks is often determined by in-house calibration protocols. If none exists, Alpha Omega Instruments Corp. recommends a calibration check be made once every 3-4 months.

Calibration Gas

The oxygen sensor used in the Series 2510 Percent Oxygen Transmitter has a linear output. As a result, it can be calibrated using a single calibration gas as long as the test is performed accurately. The calibration gas should contain a defined concentration of oxygen with a balance of nitrogen (N₂). For transmitters with a full scale ranges of 25% or greater, use of clean ambient air for calibration is recommended. The actual concentration of oxygen should be selected based on the range of the transmitter. Alpha Omega Instruments recommendation is to obtain a calibration gas that has a concentration of oxygen somewhere between 60-90% of full scale. For instance, if the transmitter has a measuring range of 0-10 percent, a calibration gas containing 6-9 percent oxygen/balance nitrogen should be used.

Procedure for Checking Calibration

- 1) If air is **not** going to be used for calibration, select a cylinder of calibration gas as described above.
- 2) When selecting a pressure regulator to use with the cylinder gas, it is advisable to use a two-stage regulator with the second stage capable of delivering a gas sample at a pressure of under 1.0 psig.
- 3) In addition to the selection of the pressure regulator, use of good quality rigid plastic tubing is acceptable.
- 4) Begin flowing the calibration gas to the transmitter by connecting the gas to the inlet of the sensor (Refer to Figure 3.0 for help in locating the sensor housing) If no pump, filter, or flow meters are attached to the sensor housing, the calibration gas can be connected to either of the two gas fittings on the sensor housing. The flow of calibration gas should be set to 1 liter per minute. If the optional flow meter has not been purchased, it is advisable to secure one for use during calibration. Begin monitoring the 4-20 mADC or **optional** 0-10 VDC output waiting until a stable reading has been established.
- 5) Once the oxygen reading has stabilized, check the system for gas leaks. This is best done when step 4 has been completed. An easy method of determining the leak integrity of the system is to vary the flow rate of the calibration gas. If increasing the flow rate from 1 liter per minute to 2 liters causes an appreciable drop (>10% of reading) in the oxygen reading, there is a good chance that somewhere between the gas source and inlet to the sensor there is a leak. Check all gas fittings, connections, etc. If the integrity of the sample delivery system appears to be good, move on to step 6.

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- 6) The milliamp current output (or optional 0-10 VDC output) controlled by the transmitter should reflect the oxygen concentration of the calibration gas. A readout device must be connected to the 4-20 mADC output to provide a reading of the oxygen concentration. A volt meter is usually very handy for this purpose as it can be placed close to the transmitter. If for example, a transmitter with a full scale range of 0-10% is being calibrated with a 5% calibration gas, an output of 12 mADC (5 VDC) should be obtained. The general form of the equation for determining the percent oxygen concentration reading from the reading in milliamps is:

$$mADC: \% = (mADC - 4) \times FSV/16$$

where *FSV* is the Full Scale Value for the oxygen range selected. In the example given above, $\% = (12 - 4) \times 10/16 = 5\%$.

- 7) If the oxygen value obtained from the 4-20 mADC output differs from that which is expected from the calibration gas, a span adjustment should be made. To accomplish this, locate the gain adjustment potentiometer (R43) on the board labeled "GAIN". Using a small blade screw driver, adjust R43 so the oxygen value reflected in the 4-20 mADC output is equal to the oxygen value represented by the calibration gas. Once step 7 has been completed, fasten the front cover of the instrument and resume normal operation.

Zero Adjustment

Alpha Omega Instrument's Percent Oxygen Sensor is specific for oxygen. When there is no oxygen present, the output from the sensor is zero. This coupled with the inherent linear characteristics of the sensor allow the user to use a single point calibration as means of calibrating the system. NO ZERO CALIBRATION IS REQUIRED.

SECTION 6.0
REPLACEMENT OF THE OXYGEN SENSOR

Alpha Omega Instruments oxygen sensor is designed to operate for prolonged periods of time without needing replacement. However, in time the sensor's output will drop to a level where replacement becomes the prudent course of action. A good indication of this is a marked increase in calibration frequency. When this happens, a replacement sensor should be ordered directly from the factory. The part number for a replacement sensor is **2SEN**.

To install a new sensor follow the directions below:

- 1.0 Remove all power from the instrument.
- 2.0 Locate the brass sensor housing located under the transmitter (Refer to Figure 2.0)
- 3.0 Remove the cover from the transmitter by loosening the four screws at each of the four corners of the cover.
- 4.0 Locate the oxygen sensor inside the transmitter and remove the two-wire connector.
- 5.0 Turn the sensor counterclockwise to unscrew it from its holder. Discard the old sensor (see precautionary note below) and install the replacement sensor being careful not to over-tighten the sensor. The sensor has an "O" ring seal that when **finger tightened**, will provide the required seal. Reattach the electrical connector and reinstall the cover.



**THE SENSOR CONTAINS A SMALL AMOUNT OF WEAK ACID.
WHEN DISCARDING SPENT SENSORS, CARE SHOULD BE GIVEN
NOT TO PUNCTURE THE SENSOR OR TO TAKE IT APART.
DISPOSE OF THE SPENT SENSOR ACCORDING TO LOCAL,
COUNTY, OR STATE GUIDELINES.**

- 6.0 Apply power and calibrate according to Section 5.0.

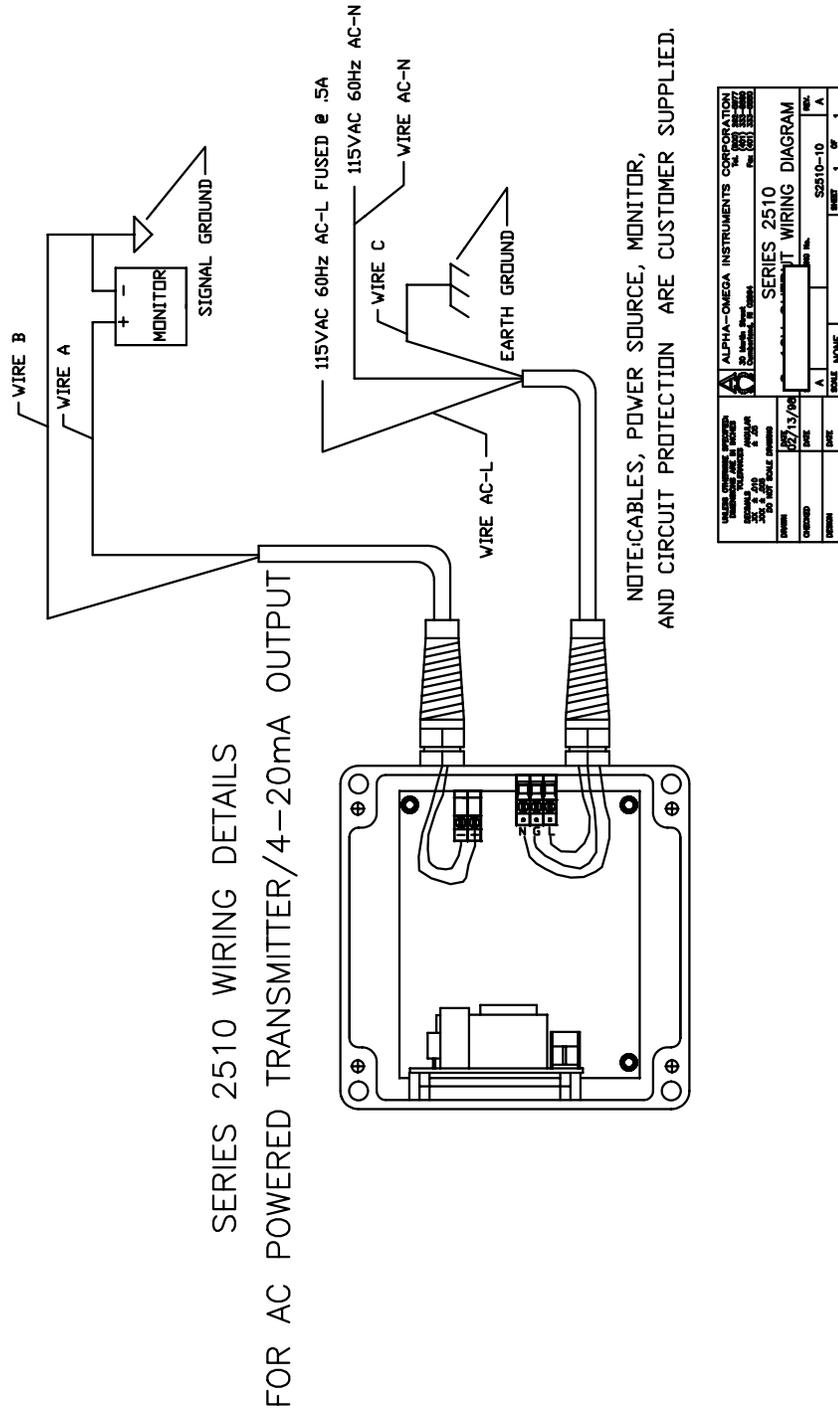
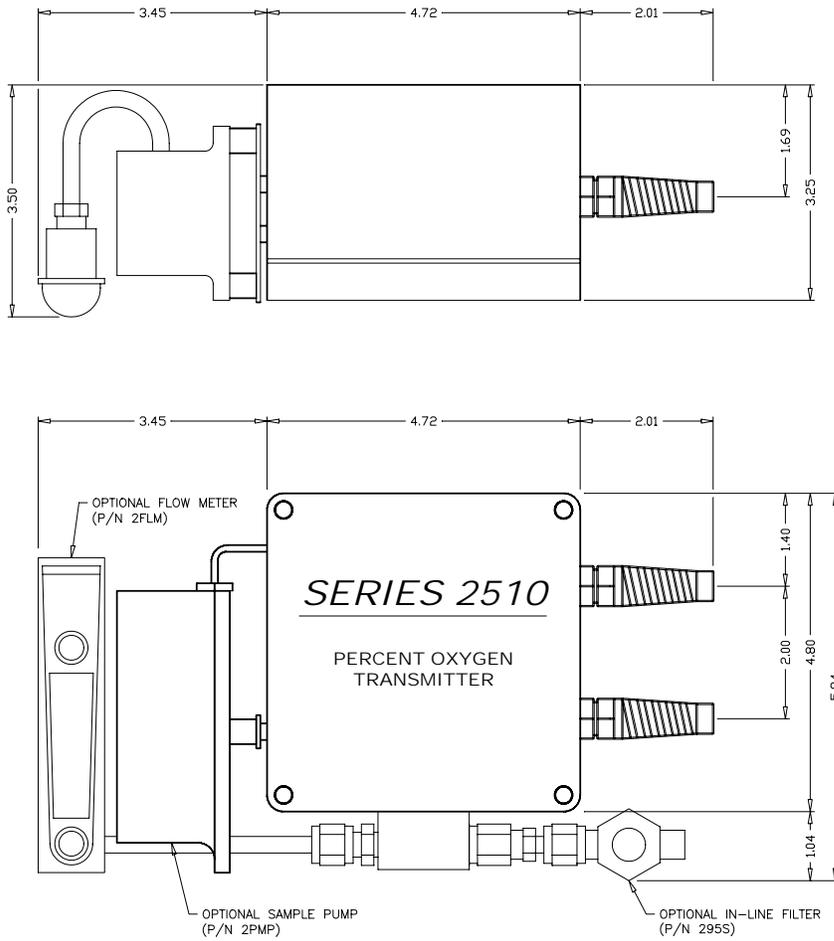


FIGURE 1.0

Configuration Drawing shown with Optional Pump, Filter, and Flowmeter



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		ALPHA—OMEGA INSTRUMENTS CORPORATION			
TOLERANCES		30 Martin Street Cumberland, RI 02864			
DECIMALS	ANGULAR	Tel. (800) 262-8977			
XX ± .010	± .05	(401) 333-8980			
XXX ± .005		Fax (401) 333-8550			
DO NOT SCALE DRAWING		SERIES 2510 CONFIGURATION DRAWING			
DRAWN	DATE 02/13/98				
CHECKED	DATE	SIZE A	FSCM No.	DRAWING No. S2510-10	REV. A
DESIGN	DATE	SCALE NONE		SHEET 1 OF 1	

FIGURE 2.0

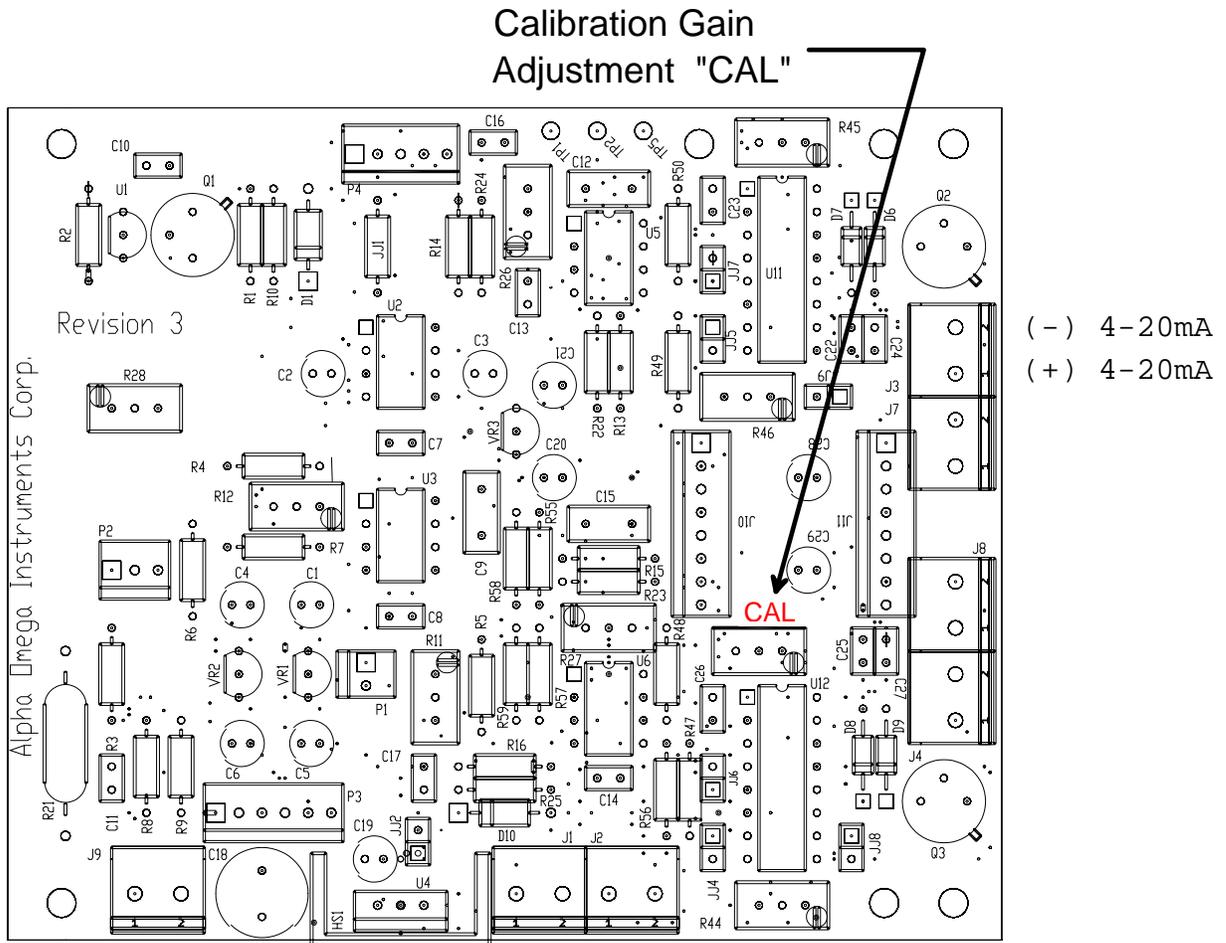


FIGURE 3.0

Appendix A
Material Safety Data Sheet for the 2SEN Oxygen Sensor

Hazardous Polymerization:	Will not occur
Conditions to Avoid:	Heat, flame, other sources of ignition
Incompatibles:	Strong acids, strong bases, strong oxidizing agents.
Decomposition Products:	Lead fumes, carbon monoxide, carbon dioxide.

SECTION V - HEALTH HAZARD DATA OF SOLUTION

Lead Acetate Component	Data is for lead, inorganic dusts and fumes as Pb
(TLV/TWA):	0.15 mg/m3
STEL:	Not Established
PEL:	0.05 mg/m3
Toxicity:	Intraperitoneal Rate LD50 for Lead Acetate Trihydrate is 200 mg/Kg
Carcinogenicity:	This substance is listed as a NTP anticipated human carcinogen and an IARC animal carcinogen.
Reproductive Effects:	None identified
Effects of Overexposure:	
INHALATION:	Tightness and pain in chest, coughing, difficult breathing.
SKIN CONTACT:	Irritation.
EYE CONTACT:	Irritation.
SKIN ABSORPTION:	May be harmful.
INGESTION:	Is harmful and may be fatal, headache, nausea, vomiting, dizziness, gastrointestinal irritation.
CHRONIC EFFECTS:	Anemia, kidney damage, blurred vision, lead build-up in the central nervous system.
Target Organs:	GI tract, central nervous system, kidneys, blood, gingival tissue.
Medical Conditions Generally Aggravated by Exposure:	None identified.
Primary Routes of Entry:	Ingestion, inhalation, eye contact, skin contact, absorption.

Emergency and First Aid Procedures:

INGESTION:	CALL A PHYSICIAN. Give large amounts of water.
INHALATION:	If inhaled, remove to fresh air.
SKIN CONTACT:	In case of contact, flush with water for at least 15 minutes.
EYE CONTACT:	In case of contact, flush with water for at least 15 minutes.

SECTION V - HEALTH HAZARD DATA OF SOLUTION cont'd

Acetic Acid	Data is for concentrated acid.
Threshold Limit value (TLV/TWA)	25 mg/m3
Short term exposure limit (STEL)	37 mg/m3
Permissible exposure limit (PEL)	25 mg/m3

Appendix A

Material Safety Data Sheet for the 2SEN Oxygen Sensor

Toxicity:

Oral rate LD50 for acetic acid:	3310 mg/kg
Intravenous mouse LD50 for acetic acid:	525 mg/kg
Skin rabbit LD50 for acetic acid:	1060 mg/kg
Inhalation mouse LD50 for acetic acid:	5620 mg/kg
Carcinogenicity NTP:	No
IARC	No
Z List:	No
OSHA Reg:	No

Carcinogenicity: None identified

Reproductive Effects: None identified

Effects of Overexposure:

INHALATION:	Severe irritation or burns of respiratory system
SKIN CONTACT:	Severe burns, may cause dermatitis
EYE CONTACT:	Severe burns, permanent eye damage.
SKIN ABSORPTION:	None identified
INGESTION:	Burns to mouth and throat, nausea, vomiting, gastrointestinal irritation, diarrhea, shock, may be fatal
CHRONIC EFFECTS:	Lung damage, teeth damage

Target Organs: Respiratory system, eyes, skin, teeth, lungs.

Medical Conditions Generally Aggravated by Exposure: Respiratory system disease, skin disorders.

Primary Routes of Entry: Inhalation, ingestion, skin contact, eye contact.

Emergency and First Aid Procedures:

INGESTION:	CALL A PHYSICIAN. Give large amounts of water.
INHALATION:	If inhaled, remove to fresh air.
SKIN CONTACT:	Immediately flush skin with plenty of water for at least 15 minutes.
EYE CONTACT:	Immediately flush with plenty of water for at least 15 minutes.

SECTION VI - SPILL AND DISPOSAL PROCEDURES

NOTE: The sensors are sealed, and under normal circumstances, the contents of the sensors do not present a health hazard. The following information is given as a guide in the event that a cell leaks.

Steps to be taken in the event of a spill or discharge:

- Wear respiratory protection and full protective clothing
- Neutralize spill with soda ash or lime
- Carefully place material into clean, dry container and cover.

Appendix A

Material Safety Data Sheet for the 2SEN Oxygen Sensor

Flush spill area with water.

Disposal Procedure:

Dispose in accordance with all applicable federal, state and local environmental regulations, with regards to lead or lead acetate.

EPA Hazardous Waste Numbers:

Lead	D008
Lead Acetate	U144 (Toxic Waste)
Acetic Acid, Glacial	D001, D002 (Ignitable, Waste)

SECTION VII - ENGINEERING AND WORK PRACTICES CONTROLS

VENTILATION: Use general or local exhaust ventilation to meet TLV requirements.

RESPIRATORY PROTECTION: Respiratory protection required if airborne concentration exceeds TLV.

EYE/SKIN PROTECTION: Safety goggles, uniform, apron, neoprene gloves are recommended.

Protective measures during cell replacement:

Before opening the packaging containing the sensor cell, check the sensor cell for leakage. If the sensor cell leaks, do not open the container. If there is liquid around the cell while in the instrument, use the protection listed above in this section.

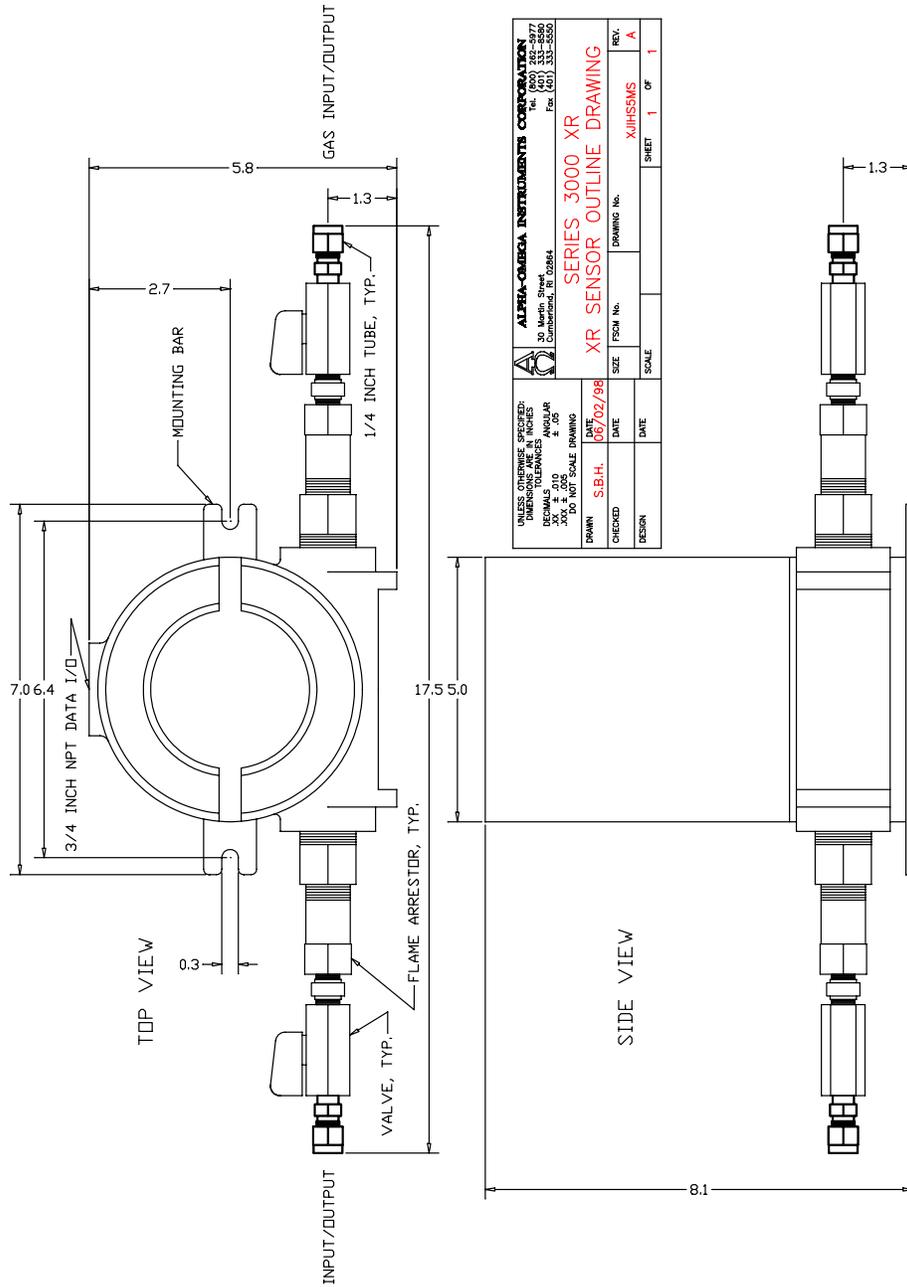
SECTION VIII - STORAGE AND HANDLING PRECAUTIONS

Storage Requirements: Store in a cool, well-ventilated area.

NOTE: The above data is based on tests and experience which Alpha Omega Instruments, Inc. believes reliable and are supplied for information purposes only. Alpha Omega Instruments Corp. disclaims any liability for damage or injury which results for the use of the data and nothing contained there in shall constitute a guarantee, warranty (including warranty of merchant ability) or representation (including freedom from patent liability) by Alpha Omega Instruments Corp. with respect to the data, the product described, or their use for any specific purpose, even if that purpose is known to Alpha Omega Instruments Corp.

APPENDIX B

SERIES 2510 PERCENT OXYGEN TRANSMITTER CONFIGURED WITH AN EXPLOSION PROOF ENCLOSURE



Note: Shown in the above diagram is the Series 3000 remote explosion proof sensor enclosure. The Series 3000 explosion proof sensor enclosure is identical dimensionally to the Series 2510 with the exception of the Gas Input/Output valves that are not required for the Series 2510.

