SERIES 9510
CARBON DIOXIDE ANALYZER

INSTRUCTION MANUAL

ALPHA OMEGA INSTRUMENTS

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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 which are returned to it **prepaid** within 2 years from the date of shipment and found to Seller's satisfaction to have been so defective.

Alpha Omega Instrument's 2 year sensor warranty offers protection for 2 years from the date of shipment of the Series 9510 Carbon Dioxide Analyzer. Any sensor from a Series 9510 Carbon Dioxide Analyzer 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 analyzer 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. 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.

This warranty applies only if:

(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.

The warranties stated herein are exclusive. THERE ARE NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, BEYOND THOSE SET FORTH HEREIN, and Alpha Omega Instruments Corp. does not assume any other obligation or liability in connection with the sale or use of said products.

Disclaimer of Warranty

Alpha Omega Instruments makes no representation or warranties, either expressed or implied, by or with respect to anything in this manual, including, but not limited to, implied warranties of merchantability or fitness for a particular purpose. In no event will Alpha Omega Instruments Corp. be liable for any damages, whether direct or indirect, special, consequential, or incidental arising from the use of this manual. Some states in the USA do not allow the exclusion of incidental or consequential damages. Alpha Omega Instruments Corp. also reserves the right to make any changes to improve the performance of its products at any time and without notice.

WARNINGS

Explanation of graphic symbols

THIS SYMBOL IS INTENDED TO ALERT THE USER TO THE PRESENCE OF IMPORTANT OPERATING AND MAINTENANCE INSTRUCTIONS.

To avoid the risk of fire or electric shock, do not expose the Series 9510 Carbon Dioxide Analyzer to rain or water spray.

WHEN POWERED, THE PRESENCE OF DANGEROUS VOLTAGES WITHIN THE INSTRUMENT MAY BE OF SUFFICIENT MAGNITUDE TO CONSTITUTE A RISK OF ELECTRICAL SHOCK RESULTING IN INJURY OR DEATH. LEAVE ALL SERVICING TO QUALIFIED PERSONNEL.

REMOVE ALL POWER SOURCES WHEN INSTALLING OR REMOVING AC POWER OR DATA SIGNAL CONNECTIONS AND WHEN PERFORMING ANY WORK INSIDE THE INSTRUMENT ENCLOSURE.

RF Disclaimer

This instrument generates and uses small amounts of radio frequency energy, and there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, try to correct the interference by one of more of the following steps:

1. Reorient the receiving antenna.
2. Relocate the instrument with respect to the receiver.
3. Change the AC outlet of the instrument so the instrument and receiver are on different branch circuits.

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SECTION 1.0
INTRODUCTION

1.1 General Description

The Series 9510 Carbon Dioxide (CO_2) Analyzer is a microprocessor based instrument providing accurate and repeatable trace or percent carbon dioxide measurements. The sensor used in the Series 9510 is a non-dispersive infrared type, which does not react chemically with the sample gas. Due to its robust design, a comparatively low frequency of re-calibration is required.

The standard analyzer is housed in a NEMA 1 enclosure rated for general purpose use. The front panel contains five switches that provide access to the analyzer's settings. Carbon dioxide values are displayed on a 10.2 mm (0.4") high 4-1/2 digit liquid crystal display (LCD). The instrument is equipped with three CO_2 alarm relays and one instrument status alarm relay. All four relays are Form C (SPDT) types rated at 10 amps at 115/230 VAC / 30 VDC. The relays are user configurable for fail-safe operation. In addition to the four alarm relays, the Series 9510 Carbon Dioxide Analyzer has a built-in audible alarm and three red LEDs for audible and visual indication of a CO_2 alarm condition. The audible alarm may be manually canceled at any time. If the audible alarm is canceled and the alarm event continues, indications of this condition will still be available through the front panel LEDs and relay contact(s).

The Series 9510 Carbon Dioxide Analyzer comes equipped with two standard analog outputs, 4-20 mADC and 0-2 VDC, which are scalable by the user. For communications capability, the Series 9510 Carbon Dioxide Analyzer can be equipped with optional RS-232C serial communications. RS-485 is also available as an option. The analyzer can be powered from either 115/230 VAC @ 50-60Hz or 18-32 VDC input, with battery operation an option for the AC powered versions (not available in explosion proof configurations).

The Series 9510 Carbon Dioxide Analyzer offers users a choice of PPM or PERCENT measurement ranges.Consult the factory for the appropriate range designations prior to ordering.

1.2 Optional Equipment Descriptions *

The Series 9510 Carbon Dioxide Analyzer incorporates standard features that make it immediately suitable for many applications. However, for certain requirements, the user may desire to augment the capabilities of the instrument by equipping it with one or more of the available options, as described below. Please note that some of these options are not available with the open diffuser sensor configuration

1.2.1 Optional Open Diffuser Configuration

The Series 9510 Carbon Dioxide Analyzer comes in two sample gas configurations, depending upon customer requirements. It is normally configured for process applications as a flow through system with sample input and sample output fittings. It can also be supplied with an optional open diffuser configuration for measurement of carbon dioxide in the air and/or gas surrounding the instrument.

1.2.2 Optional Battery Operation P/N 95BAT

The Series 9510 can be equipped so that it may be powered from a normal AC/DC source as well as an optional built-in battery pack.The batteries are installed at the factory and are designed for applications where the user desires to power the analyzer for short periods using the batteries. With this option, the Series 9510 Carbon Dioxide Analyzer will operate for a period of at least 8 hours. If equipped with a sample pump, operating time will be reduced to less than four hours of continuous use. The Series 9510 Carbon Dioxide Analyzer is equipped with a "smart charging" capability for the Nickel Metal Hydride (NiMH) battery pack. Smart charging eliminates the risk of the battery pack being over-charged (not available with explosion proof systems). To acheive a full-charge after the batteries have been discharged, allow for approximately 16 hours of charging time. See cautionary note on page 12.

1.2.3 Optional Serial Communications / RS232C P/N 9RS2

The RS-232C serial communications option is installed at the factory and is designed for applications where enhanced serial communications is required between the analyzer and a host system. The maximum distance between the analyzer and host system is 50 feet

1.2.4 Optional Serial Communications / RS485 P/N 9RS4

The RS-485 serial communications option is installed at the factory and is designed for applications where enhanced serial communications is required between one or several analyzers and a host system over the same communications channel. The RS-485 format allows both sending and receiving of signals over greater distances than RS-232C, making it ideal for installations where the analyzer(s) are located at distances greater than 50 feet from the host. The maximum distance recommended between devices is 4,000 feet

The following options are only available with the flow through system configuration only:

1.2.5 Optional Particulate Sample Filter P/N 995S

Miniature T-type 316 stainless steel filter with 1/8" NPT in-line ports. Recommended when particle loading exceeds 3 mg/ft^3 and hydrocarbon mist exceeds 0.7 mg/ft^3. Installed at the factory unless otherwise specified by the customer.

1.2.6 Optional Low Capacity Pressure Regulator P/N 9LPR

Pressure Regulator with aluminum body recommended for use when sample pressure is below 100 PSIG. The regulator does not include a gauge (can be ordered separately).

1.2.7 Optional Sample Pump P/N 9PMP

Addition of a sample pump is designed for those applications where the sample pressure or flow is insufficient to transport the sample through the sensor housing.

1.2.8 Optional Coalescing Filter P/N 9CF

Coalescing filter recommended when the sample may contain a light mist together with particles.

1.2.9 Optional Horn & Strobe P/N Spec-HnSt

The Series 9510 can be equipped with an optional 24 VDC or 115 VAC Horn & Strobe for remote alarm indication (separate from the Series 9510 Electronics that has its own audible and visual alarm indicators).

* Please contact the factory for other options and accessories.

1.3 Non-Dispersive Infrared Sensor for Carbon Dioxide

Alpha Omega Instruments uses a non-dispersive infrared (NDIR) sensor to determine carbon dioxide concentrations in gases. Infrared gas sensors, which are comprised of solid state devices, do not chemically react with the gas.

Infrared radiation is a part of the electromagnetic radiation spectrum which also contains visible and ultraviolet radiation. Since electromagnetic radiation is wavelike, infrared radiation has wavelengths ranging from 0.8 to 100 microns. Gas molecules are made up of atoms which are bonded together. These bonds constantly undergo vibrations and rotations. The frequencies of these vibrational and rotational motions are a strong function of the size of the atoms and bond strengths. By nature, these frequencies match with the frequency of the middle portion of the infrared spectrum (called mid IR). When exposed to a beam of infrared radiation, most gas molecules will absorb IR radiation at their vibration/rotation frequencies. The unique structure of each compound means that it will have a unique IR fingerprint which can often be used to identify it with an IR instrument.

The ability of certain gases to absorb infrared radiation has been successfully utilized in developing instruments for gas sensing. An infrared gas sensor consists of an infrared source (emitting broad band radiation including the wavelength absorbed by the target gas) and an infrared detector that are separated by a gas cell. In non-dispersive IR (NDIR) sensors, an IR source and an IR detector are separated by a gas sample cell. An optical "band pass" filter is placed either in front of the source or the detector to screen out all radiation except for the wavelength that is absorbed by the target gas.

The characteristic output of the sensor element is called "absorption" and is the percentage loss between the IR radiation that reaches the detector with and without the target gas in the gas cell. The absorption is calculated for the infrared signals measured under zero gas (gas that does not have infrared absorption, i.e. Nitrogen) I_o, and under the gas of interest I_G using the relationship:

$$A = \frac{I_O - I_G}{L_O}$$

Absorption increases with increasing gas concentration and increasing optical path length between the detector and the source. Knowing the dependence of absorption on the gas concentration for a given path length, a sensor will measure an unknown gas concentration based on the measured absorption.

A simple, single channel sensor interprets that any loss in infrared signal is due to increasing absorption by the target gas. Therefore, the sensor design should ensure that the signal loss is not due to any other means such as infrared source or detector deterioration, changes in the optical assembly, or temperature variations. In practice, a reference channel is added to the sensor to correct for these potential problems. A reference channel is employed to optically measure change in infrared radiation that are not caused by the gas being analyzed.

Alpha Omega Instrument's infrared gas sensor design utilizes a "virtual reference" channel at the absorbing wavelength that eliminates the need for locating a non absorbing infrared region for the reference channel. The optical design and the absorption theory are described in detail as follows.

The sensor is comprised of two infrared sources (Lamp 1 and Lamp 2), one infrared detector, and a narrow band optical filter that passes infrared radiation only at the wavelength absorbed by the gas of interest. For example, carbon dioxide (CO_2) is absorbed at a wavelength of 4.2 microns. Lamps 1 and 2 are placed in the gas cell at distances L_1 and L_2 respectively from the detector. When a gas concentration C is present in the cell, it will absorb the infrared radiation emitted by both the sources according to Beer's Law.

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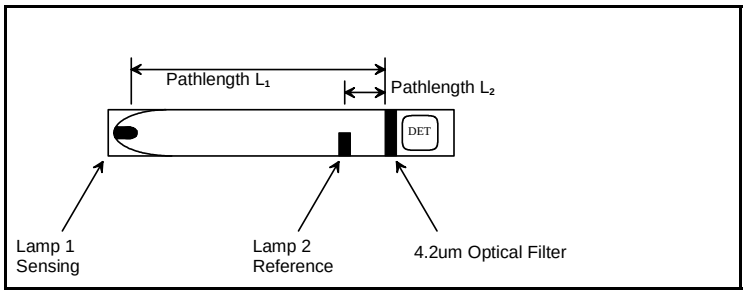
Sensing lamp signal $S_1=I_1e^{(-KCL_1)}$
Reference lamp signal $S_2=I_2e^{(-KCL_2)}$
K= absorption constant
C= gas concentration
I= IR intensity emitted by the source
The ratio "R" $(S_1/S_2) = (I_1/I_2)e^{\{-KC(L_1-L_2)\}}$



Since the radiation from Lamp 2 travels a much shorter path through the gas, it will be absorbed less than the radiation from Lamp 1. The ratio of these signals shows the same absorption characteristics with an equivalent cell length of (L_1-L_2). However, the signal from Lamp 2 will be equally effected by environmental factors, system aging, and other unwanted factors. The absorption calculated from this ratio for the differential path system can be used to sense the gas concentration while referencing out non-signal impacts. Lamp 2 acts as a "virtual reference" to the system at the absorption wave length.

A key factor in traditional IR sensors is the temperature dependence of the detector/filter pair. The use of a single detector and single optical filter in calculating the absorption ratio in Alpha Omega Instrument's sensor provides excellent temperature immunity. Movements in output due to temperature dependence of the detector/filter pair are effectively referenced out. Furthermore, this design is considered to be optically efficient. IR radiation is provided by incandescent lamps that are operated at a fraction of their recommended power. This provides the sensor with a long mean time between failure (MTBF). It also adds stability since the heated elements age at an insignificant rate. Utilizing signal ratios with proprietary signal processing schemes adds higher resolution and provides more stable output from the sensor.

1.4 General Specifications

Measurement Ranges	Trace: 0-5,000 Parts Per Million Percent: 0-20%, 0-10%, and 0-5%.
Accuracy	Trace: ± 100 PPM CO_2 or ± 5% of reading., whichever is greater. Percent: ± 5% of reading or 0.15% CO_2, whichever is greater.
Sensor Type	Non-Dispersive Infrared
Response Time	< 35 seconds to 63% of step change
Display	10.2 mm (0.4") high 4-1/2 digit liquid crystal display
Input Power	115/230 VAC, 50-60Hz, or 18-32 VDC (Battery Operation is optional with AC Power Sources)
Standard Outputs	4-20 mADC and 0-2 VDC.
Optional Digital Interfaces	RS-232 or RS-485
Audible Alarm	Internal audible alarm
Audible Alarm Cancel	Front panel switch
CO_2 Alarm Relays	Three (3) SPDT Form C contacts rated 10 A @ 30V DC / 115/230 VAC. Alarms may be cleared manually or automatically, by user selection.
Instrument Status Alarm Relay	1 SPDT Form C contact rated 10 A @ 30V DC / 115/230 VAC.
4-20 mA Open Loop Status Alarm	Open collector (drain) output at terminal #10
Operating Temperature	0° to 50°C (32° to 122°F)
Enclosure	Enclosure is a light gray polycarbonate with a hinged clear front cover rated NEMA 1.
Dimensions for the Standard Polycarbonate Electronics Enclosure.	9.35 inches (237.5 mm) length 6.29 inches (159.8 mm) width 3.54 inches (89.9 mm) height
Weight (BTP Configuration)	5 pounds (2.26 kg.)

Alpha Omega Instruments Corp. reserves the right to change or modify its product specifications without notice

SECTION 2.0
INSTALLATION PROCEDURES

2.1 Unpacking the Analyzer

Upon receiving the shipping container, carefully examine the packaging to check if the outer surfaces have been damaged. If so, report the findings immediately to Alpha Omega Instruments who will, in turn, provide further instructions.

NOTE: IF DAMAGE TO THE SHIPPING CONTAINER HAS BEEN FOUND, DO NOT PROCEED FURTHER. CONTACT THE FACTORY IMMEDIATELY.

If there is no apparent damage, check the contents to ensure all items were shipped. In some cases, items may be back-ordered. Retain the shipping material in the event that the unit has to be returned to the factory for repair or calibration. **All damage and shortage claims must be made known to Alpha Omega Instruments within 10 days after receipt of shipment.**

There are six screws on the standard Series 9510 Carbon Dioxide Analyzer that fasten the clear cover to the polycarbonate enclosure. Loosen these screws to disengage them from the enclosure, and open the cover exposing the front panel membrane switches. The membrane panel is installed on a metal backing plate that is hinged and swings out in the same direction as the cover. Swing out the membrane panel and check inside the control unit to make sure no components have been loosened or dislodged. **If there are loose or dislodged components, contact the factory for further instructions.** If all is found to be satisfactory, the installation procedure can begin.

2.2 Electrical Installation

ELECTRICAL INSTALLATION SHOULD BE PERFORMED BY A LICENSED ELECTRICIAN AND SHOULD COMPLY WITH APPLICABLE FEDERAL, STATE, OR LOCAL ELECTRICAL SAFETY CODES.

NOTE: For Explosion Proof Systems please refer to Appendix D in the back of this manual.

The Series 9510 Carbon Dioxide Analyzer is shipped with a power cord. Some installations may require wiring through conduit into an electrical hub on the rear panel (where the existing power cord is installed). For such installations, removal of the existing power cord can be easily accomplished as described in section 2.2.1. The position of jumpers S02, located at the lower left quadrant of the printed circuit board determines the line voltage setting. The default setting is 115 VAC, 50-60Hz. **If the AC input voltage is changed in the field, please refer to Section 3.1.1 for instructions.**

2.2.1 Wiring the AC/DC Power in Place of the Existing Power Cord

Referring to the printed circuit board diagram (FIGURE 1.0) on page 5, locate the AC power terminals 31,32, and 33. Each connector is equipped with a screw terminal wire holder to facilitate insertion or removal of the wire from the connector. Strip approximately 6.0 mm (1/4 inch) of insulation from each of the three conductors and then connect AC line, AC neutral, and chassis ground to each connector. Tighten down on each screw turning clockwise to securely fasten each conductor. If the primary power to the instrument is direct current (18-32 VDC), wire to terminals 29 (BAT+) and 30 (BAT-). ***For safe connections, make sure that there is no un-insulated wire extending outside of the connectors.***

MAIN PRINTED CIRCUIT BOARD

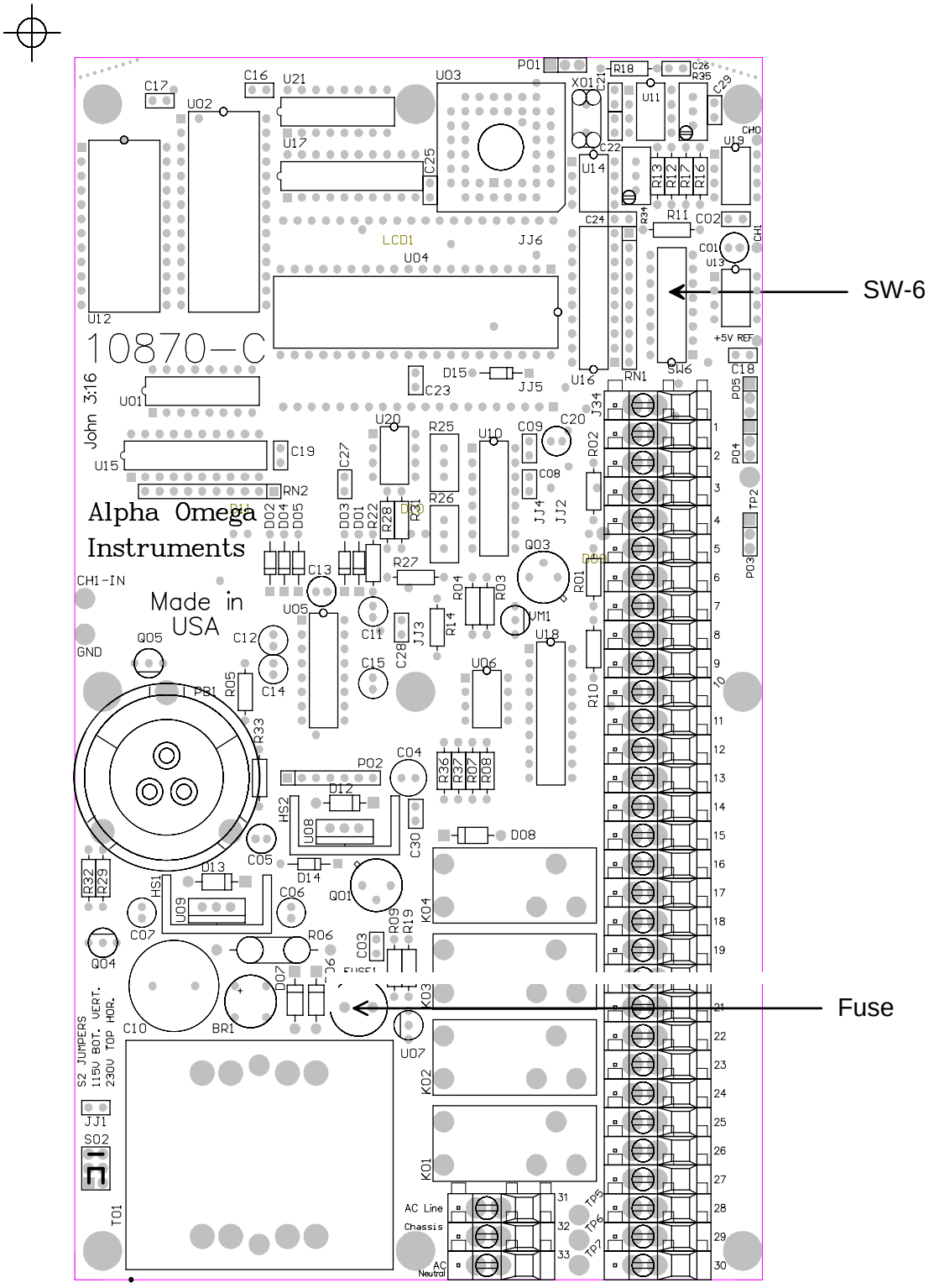


FIGURE 1.0

2.2.2 CO_2 Sensor

Wiring of the CO_2 sensor has been done at the factory.

2.2.3 Wiring Alarm Relays

Access to the control signals generated from the Series 9510 Carbon Dioxide Analyzer is accomplished using customer-supplied signal cable. This cable is installed through an output cable strain relief on the rear of the electronics enclosure. The number of conductors needed is determined by the number of signals to be interfaced.

The Series 9510 Carbon Dioxide Analyzer is equipped with four single pole double throw (SPDT) relays with Form C contacts rated at 10 amperes @ 30 VDC and 115/230 VAC. All alarm relays are user configurable with the three CO_2 alarms defaulting to factory setting of low CO_2 alarms. To configure any of the three CO_2 alarm relays to act as low alarms, please refer to Section 3.3. Alarm 4 is the instrument status alarm, which is not displayed as a discrete alarm on the front panel,.

The technique for wiring to the connectors is identical to that discussed in Section 2.2.1. The wiring configuration is as follows:

Terminal	***CO_2 Alarm 1 Relay***
26	Common Contact
27	Normally Open Contact
28	Normally Closed Contact
	CO_2 Alarm 2 Relay
23	Common Contact
24	Normally Open Contact
25	Normally Closed Contact
	CO_2 Alarm 3 Relay
20	Common Contact
21	Normally Open Contact
22	Normally Closed Contact
	Instrument Status Alarm (Alarm 4 Relay)
17	Common Contact
18	Normally Open Contact
19	Normally Closed Contact

TABLE 1.0 illustrates the various wiring configurations for the four alarms in the a nalyzer based on whether the alarms are going to be configured for fail-safe or non fail-safe operation.

Contacts shorted for each Alarm Relay	**Alarm ON**	
	Fail-safe ON	Fail-safe OFF
High or Low CO_2 Alarm1 / **Relay 1**	28(NC) to 26(COM)	27(NO) to 26(COM)
High or Low CO_2 Alarm2 / **Relay 2**	25(NC) to 23(COM)	24(NO) to 23(COM)
High or Low CO_2 Alarm3 / **Relay 3**	22(NC) to 20(COM)	21(NO) to 20(COM)
Low Battery or Instrument Status/ **Relay 4**	19(NC) to 17(COM)	18(NO) to 17(COM)

TABLE 1.0

2.2.4 Wiring 4-20 mADC and 0-2 VDC Outputs

The Series 9510 Carbon Dioxide Analyzer has two linear outputs, 4-20 mADC and 0-2 VDC over the instrument's range. These outputs can be measured simultaneously. To wire to the 4-20 mADC output, wire to terminals 12 (4-20) and 13 (AGND). To wire to the 0-2 VDC output, use terminals 8 (positive, labeled DAC) and 9 (negative, labeled AGND). The terminals can be found on the right side of the printed circuit board (refer to FIGURE 1.0) ***Note: If a jumper wire is in place between terminals 12 and 13, it must be removed prior to using the 4-20 mADC output***..

NOTE: IF THE 4-20MA DC OUTPUT IS NOT GOING TO BE USED, IT SHOULD BE SHORTED TO AVOID AN OPEN LOOP WARNING VIA TERMINAL 10 (B-LO)

2.2.5 Wiring to the Optional RS-232C or RS-485 Outputs.

The Series 9510 Carbon Dioxide Analyzer can be equipped with either RS-232C or RS-485 digital communications. To wire for either the RS-232 or RS-485, use terminal 14 (TXD) for transmit and 15 (RXD) for receive. You must connect the GND terminal for RS-232C for the instrument to work properly. Further details on these communication channels are contained in Section 6.0.

SECTION 3.0
OPERATION

3.1 Preparation for Operation

3.1.1 AC Input Voltage Selection

The Series 9510 Carbon Dioxide Analyzer has an ON/OFF power switch on the side of the instrument. The instrument is shipped to operate on the line voltage specified in the purchase order. If the line voltage is not specified, the instrument will be configured for operation at 115 VAC, 50-60Hz. If the instrument is going to be powered from an external DC power source, please refer to section 2.2.1 . Please note that if an option such as a sample pump has been ordered, the power to instrument must be in accordance with the power requirements of the option in question. For instance, you cannot power the Series 9510 with 115 VAC if it has been equipped with a 24 VDC sample pump. Please check the original purchase order.

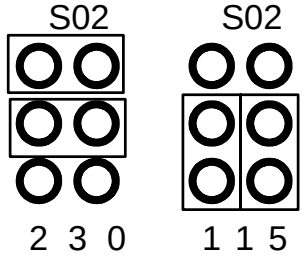
The input voltage can be changed in the field by changing the S02 jumpers located on the lower left quadrant of the printed circuit board (refer to FIGURE 1.0). The Series 9510 Carbon Dioxide Analyzer is configured for operation with a .5 ampere slo-blow fuse. The Fuse type is Wickman WK4041BK.

Changing the AC input voltage can be done as follows:

1. Turn Power off and disconnect the Series 9510 Carbon Dioxide Analyzer from all AC power.

2. Swing out the front panel to gain access to the main printed circuit board (refer to Section 2.1 for instructions).

3. Remove the cover on the lower left of the main circuit board, and examine the jumpers on the main circuit board. Shown below are the two ways of installing the AC input selection jumpers at S02.



4. To change the AC configuration, remove the jumpers and place them according to the above diagram. Be sure to replace the cover.

5. Reassemble the instrument and proceed to the next section.

3.1.2 Mounting Configurations

Bench Top / Portable (BTP Configuration) The BTP is the basic configuration for the Series 9510 Carbon Dioxide Analyzer, designed for either bench top or portable applications. All gas and electrical connections are located on the instrument's rear panel for ease of access.

Panel Mounting (PNL)- In the PNL configuration, a panel mounting frame is supplied. Make the appropriate panel modifications as indicated in the drawing in Appendix B.

Explosion Proof Enclosure (EXX). Please refer to the Appendix C

Wall Mounted Electronics with Remote Sensor Enclosure. Please refer to Appendix D

3.1.3 Initial Check

The Series 9510 Carbon Dioxide Analyzer is ready to use out of the shipping container. The analyzer has been calibrated at the factory and, under normal conditions, re-calibration is not required at initial start-up. In the case of explosion proof systems, some wiring to meet local electrical codes will be required Please refer to Section 4.0 for details regarding routine calibration checks.

Optional Battery Operation

NOTE FOR BATTERY OPERATION

If the Series 9510 has been equipped with optional NiMH batteries, it is designed to provide up to eight hours of operation on a fully charged set of batteries (without pump). With a pump, one may expect to obtain up to 3-4 hours of continuous operation before charging of the batteries will be necessary. The batteries should be fully charged upon receipt of the analyzer. If not, the user should recharge the batteries upon initial startup by powering the analyzer from AC power. Allow at least 16 hours of recharging time.
NOTE: THE POWER ON SWITCH MUST BE KEPT IN THE "ON" POSITION DURING CHARGING.

The battery option should *never be* used when the analyzer is powered from a separate DC source. This will cause the batteries to overcharge which may cause the batteries to explode. Be certain all wiring (alarms, remote sensor, RS-232C, etc.) has been done before applying AC power to the instrument

3.2 Operating Procedures

3.2.1 Power ON

Power to the instrument is applied when the power cord is plugged into an AC outlet and the power switch on the left side of the instrument is switched ON. The Series 9510 Carbon Dioxide Analyzer is equipped with battery backed RAM so when the instrument is initialized, all values set by the user via the front panel or optional RS-232C or RS-485 inputs will be maintained if switch #8 of SW6 is set to the "ON" position. This power on initialization gives the user the opportunity to make sure the microprocessor, internal memory, front panel LEDs, and the audible alarm are functioning normally. During an initialization sequence, the instrument's front panel liquid crystal display (LCD) will display a series of dashes in series like [‾‾‾‾][----][____], each of the three front panel LED's will blink simultaneously for approximately 5 seconds, and the audible alarm will sound intermittently for as long as the LEDs are blinking. After this, the display will briefly show the onboard switch settings such as [|||||||]. In this example, switch #8 of SW6 is ON and switches # 1-7 are in the OFF positions.

To read the on-board switch settings, set SW6 - switch # 8 to "OFF" and push the front panel UP, DOWN, and Alarm 3 buttons simultaneously. This causes an initialization without the power cycling (referred to in the industry as a “warm boot”). Do not hold the buttons down very long after the display shows the dashes described above. You will see the same sequence as above, with switch #8 indicating low. Powering on with switch #8 in the "OFF" position will cause the Series 9510 Carbon Dioxide analyzer to configure system alarm operation by the settings of SW6. In this case, all CO_2 alarms will default to low**,** and non fail-safe operation will be selected.

3.2.2 Front Panel Controls and Indicators

The front panel of the Series 9510 Carbon Dioxide Analyzer contains a 4-1/2 digit liquid crystal display (LCD), three (3) alarm set membrane switches, three (3) alarm LEDs, and up and down membrane switches. An Audible Alert Indicator is located behind the front panel of the instrument.

Liquid Crystal Display: The 4-1/2 digit LCD display shows the concentration of CO_2 in the sample being measured by volume, and displays messages or alerts from the microprocessor. Within 90 seconds after the analyzer is powered on, the analyzer will measure and display the CO_2 concentration of the sample gas being exposed to the sensor.

When the Series 9510 Carbon Dioxide Analyzer is equipped with the Battery Option, the LCD will display [LOBAT] when battery power has reached the point when normal instrument operation is in jeopardy. **To protect important information stored in the analyzer’s memory [monitor’s memory], the analyzer [monitor] suspends operation of the microprocessor when further operation could corrupt that memory. The microprocessor displays the word HALT on the LCD, then suspends further operation. The microprocessor does not resume operation until power is reapplied and the battery voltage is verified to be high enough to safely take over operation for a short time in the event of a recurring power failure.**

When calibrating the Series 9510 Carbon Dioxide Analyzer, the liquid crystal display momentarily reads [CAL] and then the value of the CO_2 concentration of the gas being measured. For further information on calibrating the analyzer, please refer to Section 4.0.

The Series 9510 Carbon Dioxide Analyzer alarms are set at the factory as low alarms. Anyone of these alarms can be set by the user for operation as low alarms also. Please refer to Section 3.3, Alarm System, for instructions on how to set Alarms for either high or low operation and how to adjust the levels of the alarms.

3.2.3 Scaling Analog Outputs of the Analyzer

For certain applications, it may be desirable to change the analog output of the Series 9510 Carbon Dioxide Analyzer over a narrower range of measurement. Users wishing to do so can make this change quite easily using the instrument's front panel adjustment. As stated previously, the analyzer is equipped with two analog outputs, 0-2 VDC and 4-20 mADC. It is shipped from the factory with the 0 PPM / % CO_2 equivalent to 0 VDC and 4 ma respectively, and the maximum scale value PPM / % CO_2 equivalent to 2 VDC and 20 mADC.

In order to adjust the zero points of the two analog outputs of the 9510, the instrument must be placed in the scaling mode. To do so, press the "A2 & A3" buttons simultaneously and the front panel display will respond by alternating the display [outL] or [outH] followed by the display of the existing CO_2 concentration that is equivalent to 0 VDC. Adjust this value up or down by using the front panel up and down arrow keys until the desired value is achieved. To adjust the span points of the two analog outputs of the Series 9510, press the UP and DN buttons simultaneously, and the instrument will toggle to the "span" adjustment mode. The instrument will respond by alternating the display [outH] followed by the display of the existing CO_2 concentration that is equivalent to 2 VDC and 20 mADC. Adjust this value up or down by using the up and down arrow keys until the high value desired is displayed.

There are a few shortcuts for entering new values:

Pressing the [A1] key sets the value to 0;
Pressing the [A2] key sets the value to mid-scale for the range selected;
Pressing the [A1] and [A2] keys simultaneously sets the value to the maximum value for the range of the analyzer.
Pressing the [A3] key will exit and display [CANCELLED]; the old values will not be changed.

The scaling software in the Series 9510 has built-in safeguards that will not allow the analyzer to be adjusted so that the "outL" value is set above that of the current "outH" value, or have the "outH" value set below that of the current "outL" value. To toggle from one mode to the other, depress the UP and DN buttons simultaneously and make the required change. When the desired scaling values have been set, press "A2 & A3" buttons simultaneously to leave the scaling mode. If you wish to exit the scaling mode without any changes to the values currently entered, just press [A3]. If the analyzer is left in a "change pending" state for over two minutes, the analyzer will automatically revert to the previous settings, and exit the scaling mode.

NOTE: Regardless of how the analog outputs are scaled, the analyzer will always be capable of displaying CO_2 concentrations up to the instrument's maximum range. **Scaling the outputs does not scale the front panel digital display.** Furthermore, CO_2 alarm relays, if not adjusted for the scaled range of interest, will change state if the CO_2 values they are set at are met or exceeded.

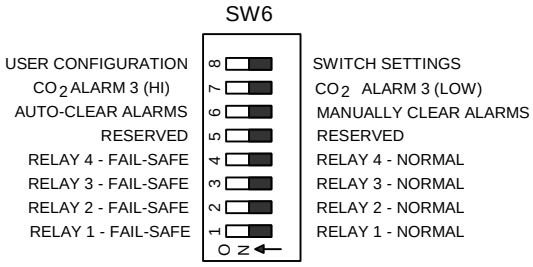
3.3 Alarm System

3.3.1 General Description of Alarm Processing

The Series 9510 Carbon Dioxide Analyzer is equipped with four single pole double throw (SPDT) relays with Form C contacts rated at 10 amperes @ 30 VDC and 115/230 VAC. All alarm relays are user configurable with the front panel controls of the instrument and the configuration switch SW6. When an alarm event takes place, several indications are provided by the analyzer:

1. The LED associated with the CO_2 alarm in question will light.
2. An audible alarm will sound.
3. The relay associated with the CO_2 alarm in question will change state.

If the alarm event was associated with the instrument status, only the relay associated with the instrument status alarm will change state. Alarm processing and behavior is controlled via SW6 (Figure 3.0) and/or the user settings saved in the battery backed-up RAM associated with the microprocessor.



SW6 SWITCH SETTINGS
FIGURE 3.0

3.3.2 Default / User Settings

With switch #8 of SW6 in the "OFF" position, the Series 9510 Carbon Dioxide Analyzer uses the settings of switches #1 - #7 for instrument alarm configuration. This includes the default alarm level for Alarm #3, determined by the position of switch #7 (Alarms #1 & #2 are factory defaulted to LOW alarm levels). With switch #8 in the "ON" position, all user settings will be retained, whether determined through the switch settings or the optional communications interface. Note: to read the switches while operating, initiate a "warm boot". (See Section 3.2.1)

IF ANY ALARM IS NOT GOING TO BE USED, IT SHOULD BE DISABLED. TO DO SO, FIRST CONFIGURE EACH ALARM AS A LOW ALARM, AND THEN SET THE ALARM TO 0.00.

3.3.3 Fail Safe

Switches #1 through #4 control the fail-safe operation for each of the four alarm relays. Each switch must be turned "ON" to be fail-safe (refer to FIGURE 3.0). In the fail-safe mode, the normal or non-alarm state of each of the four (4) alarm relays is energized. When an alarm signal is generated, the respective relay for the alarm is de-energized. This would be the same relay state (de-energized) that would be achieved if the power source (AC, DC, or Battery) were interrupted. The factory default setting for switches #1 through #4 is "OFF" (normal operation or non fail-safe). **Please remember that when Fail Safe Behavior is selected for the relays, the drain from the optional NiMH battery back-up is approximately doubled, and the analyzer operating time is approximately halved.**

3.3.4 Manual Clear / Auto Clear

There are two possible conditions that effect the way the instrument will respond to alarm cancellation. One is Auto-Clear operation and the other is Manual Clear. The mode of operation is determined by the setting switch #6 of SW6.

When switch 6 of DIP Switch 6 is placed in the “Off” or ‘”Manually Clear Alarms” position, the user is required to manually clear the alarm indication from the analyzer even if the original alarm condition has returned to a non-alarm level. When the switch is in the “On” or “Auto-Clear Alarms” position, the analyzer will automatically clear the three (3) alarm indications (LED, Audible Alarm, and Relay) when the original alarm condition returns to a non-alarm level.

3.3.4.1 Manual Clear Operation

In the Manual Clear mode (SW6, switch #6 is "OFF), the analyzer will not automatically clear the three (3) alarm indicators. The user must first cancel the audible alarm by pushing the appropriate alarm button. Only after the audible alarm has been canceled can the user clear the alarm condition by again pushing the appropriate alarm button. If the set-point is to remain the same, simply push the appropriate alarm button a third time.

Note: If the audible alarm is activated, pressing any alarm button that is not associated with an alarm condition will temporarily quiet the audible alarm. Upon exiting the alarm set condition or if the monitor times out because of no user input, the audible alarm will resume awaiting a manual clear operation as described above

3.3.4.2 Auto Clear Operation

In the Auto Clear mode (SW6, switch #6 is ON), the Series 9510 Carbon Dioxide Analyzer will automatically reset the 3 alarm indications mentioned above when the alarm condition clears. Under Auto-Clear operation, the silenced audible alarm may automatically come back on if the CO_2 reading should go out of alarm range and then back into alarm condition. Also, after silencing the audible alarm, all alarms must be cleared to re-enable the audible alarm.

3.3.5 Setting the Alarm Levels

Assuming that no alarms are currently activated (no LEDs are lit), press the desired alarm switch on the front panel, "Alarm 1", "Alarm 2", or "Alarm 3" . The numerical value in the LCD is the existing alarm value associated with that alarm channel. When the alarm switch is pressed, the LED directly above the switch will light indicating that channel is in the alarm set mode. Any of the three CO_2 Alarms can be changed from low to high level or vice versa by pressing the UP and DOWN arrows simultaneously. To set the CO_2 alarm values, press the DOWN arrow to lower the CO_2 alarm value or the UP arrow to increase the value. The longer either arrow is held down, the more rapidly the alarm values will scroll in the display. When the value in the display is close to the desired CO_2 set point value, it is recommended that pressure be released from the switch. To obtain the final value, apply momentary pressure to the switch to change values in small increments. When finished setting the alarm, press the associated alarm switch. The LED

will go off, and the display will indicate the actual CO_2 concentration. If more than one alarm value or level is to be changed, repeat this procedure on the desired alarm channel.

3.3.6 Timing out during Alarm Setting

If the user is adjusting the alarm values and levels in the Series 9510 Carbon Dioxide Analyzer and no adjustment has been made for approximately 2 minutes, the analyzer will automatically revert back to normal operation. This feature helps to prevent the user from inadvertently keeping the analyzer off-line for a prolonged period of time. If the user is in an alarm setting sequence and the instrument times out, the alarm value will be that which was last displayed in the LCD.

3.4 Sample Gas Handling

3.4.1 Sample Connections

The Series 9510 Carbon Dioxide Analyzer is normally equipped with either quick connect sample gas fittings or 1/4" SS compression fittings on the sample input. An open diffuser sensor configuration is available. These fittings are designed to be used with 1/4" OD plastic tubing in the case of the quick connect or ¼ " metal tubing. The CO_2 sensor used in the Series 9510 is a partial pressure measuring device and any changes to the total pressure will affect each of the partial pressures of the sample gas, CO_2 being one. Fluctuations in sample pressure are not corrected for and could lead to an error in the CO_2 measurement.

3.4.2 Gas System Pressure and Flow Limits

For sample gases and/or calibration gases that are under pressure, it is imperative that the input pressure to the sensor be kept under 2 pounds per square inch (PSI). If the pressure is expected to be in excess of 2 psi, it is advisable to use a pressure regulator (Alpha Omega Instruments Model Number 9PRR or 9LPR). Flow rates through the analyzer should be between 100 to 300 milliliters per minute (ml/min.) for precent systems and approximately 150 millimeters a minute for trace systems.

If the sample flow is insufficient to move the sample gas through the analyzer housing, a diaphragm sample pump may be required (Alpha Omega Instruments P/N **9PMP**). The 9PMP has been designed to provide dampening of the sample to eliminate fluctuations in CO_2 readings due to pump pulsations. Alpha Omega Instruments does not recommend the use of any other type of diaphragm pump unless provisions for dampening have been included.

3.4.3 Corrosive Gases

For applications where the sample contains corrosive gases, please check with the factory prior to start-up.

3.4.4 Radioactive Sample Gases

Radioactive sample gases will attack the rubber sample tubing within the analyzer, causing deterioration at a rate proportional to the level of radioactivity. In applications where radioactive sample gasses are handled, the internal tubing must be examined periodically and replaced when required. Failure to observe this precaution could result in leakage of radioactive sample into the ambient atmosphere

3.4.5 Condensible Gas Constituents

In order to provide accurate and repeatable data, it is **essential** that the carbon dioxide sensor not be exposed to condensed water vapor or any other liquid. The dew point temperature of the sample gas should always be less than that of the NDIR sensor, thus preventing condensation of water vapor on the optics within the sensor. If it is anticipated that the sample gas may be saturated with water vapor, provisions should be make to remove the water by filtration / coalescing, refrigeration, vortex cooling, etc. Consult Alpha Omega Instruments Corp for more information on this subject.

SECTION 4.0
CALIBRATION PROCEDURES

4.1 Routine Calibration Check

All Series 9510 Carbon Dioxide Analyzers are fully calibrated at the factory prior to shipment. Alpha Omega Instruments CO_2 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 gas analyzers, 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 that a calibration check be made on an average of once every 6 months.

4.2 Calibration Gas

The CO_2 sensor used in the Series 9510 Carbon Dioxide Analyzer has a linear output. As a result, it can be calibrated using a single calibration gas as long as the calibration is performed accurately. The calibration gas should contain a defined concentration of CO_2 with a balance of nitrogen (N_2). The actual concentration of CO_2 should be chosen based on the range of the monitor that is being calibrated. For instance, if the monitor that is being calibrated has a range of 0-10 %, the calibration gas that you should use should be in the range of (60% - 90%) x (full scale range), or between 6% and 9% CO_2 with a balance gas of nitrogen.

4.3 Zero Check

The Series 9510 does not require periodic zero check.

4.4 Procedure for Checking Calibration with a Flow Through System

1. Select a cylinder or source of calibration gas as described in Section 4.2.

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 at under 1.0 PSIG. Connect the calibration gas to the fitting on the rear of the monitor labeled “INPUT”

3. Power up the Series 9510 Carbon Dioxide Analyzer as described in Section 3.2. and set the calibration gas flow rate between 100 and 300 ml/min. Monitor the analyzer response to the calibration gas, waiting until a stable reading has been established. (minimum of 90 seconds). If the displayed reading does not stabilize, check your plumbing for leaks or other obvious problems.

   Be sure to allow the CO_2 reading to come into equilibrium before making any adjustments.

4. The reading in the LCD will now display the CO_2 concentration of the calibration gas. If the CO_2 value read on the LCD differs from the calibration gas, a calibration offset adjustment should be made so that the value displayed in the LCD is identical to that of the calibration gas. If a n offset adjustment is to be made, the instrument must be placed in the calibration mode. To do so, **simultaneously** press the front panel buttons labeled **Alarm 1, Alarm 2, and Alarm 3**. The meter will temporarily display "CAL" and then the CO_2 value in the LCD display will appear. If the CO_2 value displayed is lower than the calibration gas value, press the up arrow to adjust the value in the LCD upwards. Conversely, if it is higher, use the down arrow to lower the reading. When finished, once again press **Alarm 1, Alarm 2, and Alarm 3** buttons **simultaneously** and the "CAL" will disappear within two (2) seconds indicating the calibration sequence has been completed.

   If after initiating a calibration sequence, it is decided not to make an adjustment, allow the instrument to time out (2 minutes), or select the “A3” pushbutton.. In doing so, the previous calibration settings will be used.

Note: calibration gas flowing through the carbon dioxide sensor is discharged inside the analyzer enclosure. Therefore, it is imperative that no combustible gases i.e. methane, hydrogen, etc. be used for calibration. Doing so increases the risk of generating an explosive mixture of gas within the analyzer.

5. During user calibration, if the amount of user calibration offset has exceeded a predetermined limit set at the factory, a message will be scrolled across the LCD display saying **"FACTORY CAL".** This message will be displayed only when the instrument has been taken out of calibration mode. In addition to the message, the instrument status alarm will actuate. If this is the first warning, the instrument will probably still function normally. However, it is an indication that the sensor should be factory calibrated as soon as possible. Though the message will only be displayed once per calibration cycle, the alarm relay will stay in the alarm state until the condition has been cleared. Clearing of this alarm condition requires the factory calibration of the sensor.

4.5 Procedure for Checking Calibration with an Open Diffuser System

As mentioned previously, the standard Series 9510 Carbon Dioxide Analyzer can be configured with a flow through sampling arrangement or with an optional open sensor diffuser. The open sensor diffuser is particularly suited for applications where the user desires to measure the carbon dioxide concentration in the environment the analyzer is placed in without having to use a sample pump. When equipped with an open diffuser, the Series 9510 is equipped with one 1/4" quick connect gas fitting suitable for rigid plastic tubing. This fitting is located either on the rear or bottom of the instrument, and is labeled, "Calibration Gas". Exercising the same precautionary measures outlined in Section 4.3, when a calibration gas flow rate of approximately 100 - 300 ml/min. @ < 1.0 psig is obtained, connect the calibration gas line to the 1/4" gas fitting and allow the calibration gas to flow through the carbon dioxide sensor for a minimum of five minutes. After that time, if the carbon dioxide reading from the instrument's front panel differs from the value of the calibration gas, follow step 4 in the previous section to make the required calibration adjustment. Once completed, remove the calibration gas line and proceed as usual in the operation of the analyzer.

4.6 Timing out during Calibration Checks

If the calibration check process is not completed in approximately 2 minutes, the analyzer will automatically revert back to the previous calibration offset settings. This feature helps to prevent the user from inadvertently keeping the analyzer off-line for a prolonged period of time.

SECTION 5.0
MAINTENANCE

The Series 9510 Carbon Dioxide Analyzer requires very little maintenance or checking.

5.1 Calibration Check

The user should check the calibration of the analyzer in accordance with established protocol, and adjust the sensor output as required (please refer to Section 4.0). If the Series 9510 Carbon Dioxide Analyzer displays the message **"FACTORY CAL"** following a routine calibration check and adjustment, call the factory to obtain a "Return Material Authorization" (RMA) number, and package the unit for shipment back to the factory. Your unit will be factory calibrated and returned to you as soon as possible.

5.2 Optional Battery Pack Replacement

If the Series 9510 is equipped with an optional battery pack, the NiMH batteries will require replacement every three (3) years so that maximum battery operation time is available when power is lost. To replace the NiMH battery pack:

1. Turn power off and disconnect or switch off the analyzer's source of AC voltage;

2. Open the clear polycarbonate cover and the membrane switch panel to expose the inside of the analyzer.

3. Loosen the two hex standoffs which hold the CO_2 sensor in place and lift up the sensor so that the battery housing cover can be removed.

4. Remove the four (4) screws that secure the battery cover in place, and remove the cover to expose the battery pack.

5. Disconnect the battery pack by separating the white plastic connector, and remove the old battery. Connect the replacement battery pack to the analyzer with the white plastic connector, and place the new battery pack into the battery housing.

6. Secure the battery housing cover by replacing the four (4) screws.

7. Replace the CO_2 sensor and secure it by replacing the two (2) hex standoffs.

8. Carefully close the membrane switch panel and the clear polycarbonate cover of the analyzer. Secure the polycarbonate cover with the six (6) screws. Please be careful to not over-tighten these screws.

9. Connect the analyzer to its power source, and turn the power switch on.

The new battery pack may not be fully charged at the time of installation. Please insure that the new battery pack is allowed to charge up for sixteen (16) hours prior to intentional use as a battery powered instrument for any length of time.

Please insure that the old batteries are disposed of in accordance with local regulations.

SECTION 6.0
BASIC SERIAL COMMUNICATIONS FOR OPTIONAL RS-232C OR RS-485

6.1 Baud Rates
The following baud rates may be used with the Series 9510 CO_2 Analyzer:

Baud Rates Available
9600
4800
2400
1200
600
300
150

6.2 Standard Commands
The following commands apply for both RS-232C OR RS-485 interfaces:

Please note that all letters typed can be upper or lower case. The only exception to this rule is the optional [string] (See note below under the 'D' command description). The Commands below are in upper case for clarity purposes only. Also any user input not in brackets is shown in lower case. Optional commands or strings are shown within brackets.

Command		Description
Aa=[bb.b][L/H]	<Enter>	Alarm set
Bccccc	<Enter>	Baud rate select
C[bb.b]	<Enter>	Calibrate [user to enter cal value]
D[string]	<Enter>	Disable Security
E[string]	<Enter>	Enable Security
FSd=[ON/OFF/1/0]	<Enter>	Fail-safe select
H	<Enter>	Help Screen
M	<Enter>	Manual clear toggle
O	<Enter>	Output
Q	<Enter>	Quiet mode (no beeps at all)
S	<Enter>	Output Scaling
V	<Enter>	View current Alarms and settings

Where: a = 1, 2, or 3 for different alarms
bb.b = 0 to 100.0% CO_2 for alarm setting
L/H = Optionally set to 'L'ow or 'H'igh alarm
ccccc = Baud rate number from 150 to 9600
d = Number designating Relay 1 to 4
ON/OFF/1/0 = 'ON' is the same as '1' etc.
name = String for accessing multiple units (see manual)
string = String for security protection (see manual)

An example of each command is as follows:

'A' Command - Alarm set point with low or high alarm option.
Alarm #1 will be set to go off in the case of the CO_2 level dropping below 20 ppm. Type:

A1=20.0L <Enter>

To change Alarm #1 to 18 ppm instead of 20 ppm you could type:

A1=18 <Enter>

Note how the 'L'ow alarm is optional unless changing to 'H'igh? As you can see, the decimal point is optional too, and if left out defaults to '.0'. Note how the command in the help screen says, "[bb.b]&/or[L/H]"? Examine the following example:

A1=H <Enter>

This is a valid command and will only effect the 'L'ow or 'H'igh status of Alarm 1. To set it back to a low alarm type:

A1=L <Enter>

'B' Command - Baud change. To change the baud from 300 bps (default) to 9600 bps type the following:
Make sure the instrument is responding at 300 bps first.

B9600 <Enter>

Note that you may have some garbled data output. Now you must change your terminal's baud rate and reestablish communication by pressing <Enter>.

'C' Command - Calibrate to known calibration standard (i.e. 40 ppm).
Using a calibration gas consisting of 40 ppm, type the following:

C40 <Enter>

'D' Command - Disable security with optional pass code. (See 'E' Command below for description of security)
In it's simplest form, to disable security protection type:

D <Enter>

Assuming an 'E' Command had been sent with a pass code of "mypass1" (see next command example) then type the following to disable the security option:
Dmypass1 <Enter>
Note: typing "DMYPASS1" will not disable the instrument if the original pass code was in lowercase! That means that the 'D' and 'E' commands are CASE SENSITIVE.

'E' Command - Enable security with optional pass code.
To keep others from changing any system settings, the 'E'nable Command is supplied as an optional security measure. In it's simplest form type the following:

E <Enter>

In this example, the user would just type 'E' by itself. This would keep people from inadvertently changing the system settings. However, if the need should arise to change a setting, all that would be necessary would be a 'D' command with no pass code. The following command shows the use of a pass code:

```
Emypass1 <Enter>
```

This will arm the security system and will ignore any requests for system changes until the user disarms the system with a 'D' Command followed by the correct pass code (See 'D' command above).

'FS' Command - Fail-safe select.
If the alarm relays should be energized in normal operation and release in the case of a power failure, type the following:

```
FS1=ON     <Enter>
FS2=1 <Enter>
FS3=on     <Enter>
fs4=On     <Enter>
```

Note the individual control over each alarm. Also, ON/on/OFF/off or 1/0 can be used to control the status of each. Commands are not case sensitive. Example: If only Alarm 2 needs to be in Fail-safe mode, then type:

```
FS1=off    <Enter>
FS3=0 <Enter>
FS4=Off    <Enter>
```

This turns off the Fail-safe mode for Alarms 1 and 3.

'H' Command - Help Screen
Displays a help screen.

```
H <Enter>
```

'M' Command - Manually clear all alarms toggle.
This command toggles between 'M'anual and Automatic clearing of alarms. The clearing of an alarm is simply when the condition causing the alarm has been corrected and the Series 9510 Carbon Dioxide Analyzer gives no indication that the alarm was on. The following two examples will explain the difference between 'M'anual and Automatic clearing of alarms:

Example #1: The Series 9510 Carbon Dioxide Analyzer is set up to analyze a sample of gas from a room that has a controlled concentration of CO_2. In this case it's 50 ppm. In our example, the lab technicians have a suspicion that the reason some of their samples in this room are failing is because of leaks in the room causing higher CO_2 concentrations! Unfortunately, these technicians don't have any ability to record the data from the CO_2 analyzer, so they set it up for an Alarm 1 setpoint of 50(H), alarm 2 setpoint of 51(H), and alarm 3 setpoint of 52(H). Before they leave for the night, they type:

```
M <Enter>
```

The analyzer responds with:
Alarms to be cleared Manually

The next morning, the technicians find the analyzer reading 50.0 ppm, but alarms are going off! Alarm 1 and Alarm 2 are both on. This is very meaningful to them, because it means the CO_2 level in the room increased to 52 ppm, but stayed below 53 ppm. This would not have been apparent to them if the alarms were cleared automatically (See example 2 below)

Example #2: The Series 9510 Carbon Dioxide Analyzer is set up in an environmental control situation where if the CO_2 level in a room goes below 15 ppm, then a window should automatically open. Also if the CO_2 level should get to 20 ppm, then the window should close and a pump should turn on. First, the user needs to set up his alarms as follows:

```
A1=15L <Enter>        This sets up a low alarm at 15.0 ppm
A2=20H <Enter>        This sets up a high alarm at 20.0 ppm
A3=20H <Enter>        This sets up another high alarm at 20.0 ppm
```

Now the user must toggle the 'M'anual clear command to allow for Automatic clearing:

```
M <Enter>
```

Series 9510 Carbon Dioxide Analyzer responds:

Alarms to be cleared Automatically
Now, assuming the CO_2 level to start out at 30.0 ppm, the system could operate as follows:

Alarm 1 would be off allowing the window to be closed.
Alarm 2 would be on which would tell the window to close.
Alarm 3 would be on which would tell the pump to turn on.
Eventually the CO_2 level will drop to under 20.0 ppm where Alarm 2 and Alarm 3 will automatically shut off! This could tell the pump to shut off, and allow for the window to be opened by Alarm 1. Eventually, due to some chemical reaction in the room, the CO_2 level continues to drop below 15.0 ppm when Alarm 1 goes off and tells the window to open! After a while the CO_2 level comes back up past 15.0 ppm and automatically shuts off Alarm 1. Therefore you have an automatically controlled process.

'Q' Command - controls the Quiet mode, alternately enabling or disabling the audible alarms.
Warning! Disabling the audible alarms disables all sounds!

If the instrument is going to be in a test mode for a while, with sensors being removed and replaced (causing a lot of harmless alarms), you can remove the beeping altogether by typing **Q <Enter>**, putting the instrument into Quiet mode. To reinstate the beeping after testing is complete, type **Q <Enter>** again, turning the audible alarms back on.

'S' Command - controls the output Scaling mode of the analyzer, permitting the adjustment of the analog outputs over a narrower range of measurement than set at the factory. The analyzer is shipped with 0 (PPM or %) CO_2 equivalent to 0 VDC and 4 ma, and the full scale PPM or % output equivalent to 2 VDC and 20 ma.

To adjust the analog output:

```
SL#               Sets the LOW CO2 scaled output level
SH#               Sets the High CO2 scaled output level
S <Enter>         Displays the current output scale settings

Example:
SL10 <Enter>      Sets the LOW CO2 scaled output level to "10"
O.K.
```

```
SL100 <Enter>    Sets the High CO2 scaled output level to 100
O.K.
S <Enter>
Outl = 10
Outh = 100
```

For this example, at a CO2 level of 10 (PPM or %), the analog output reads 0.0 VDC and 4 ma, and at 100 (PPM or %, the analog output reads 2 VDC and 20 ma.

'V' Command - View current alarms and settings
To view the current status of the Series 9510 Carbon Dioxide Analyzer, type:

```
V <Enter>
```

Typical Response:

```
Alarm Settings
        #1:(HI) 22.0        Fail-safe: OFF
        #2:(LO) 19.0        Fail-safe: OFF
        #3:(LO) 10.0        Fail-safe: ON
        #4: N/A             Fail-safe: OFF

        CO2 Level = 21.0 ppm

        Alarm 1 is ON   Relay 1: Energized
        Alarm 2 is OFF  Relay 2: De-energized
        Alarm 3 is OFF  Relay 3: Energized

Conditions
        AC inp: ok          4-20mA: ok      Open Collector output:  off
        Batt:   ok (22)     Aux. Relay: De-energized
        Alarms to be cleared MANUALLY
        Signal Mode
```

Commands that affect the output of the 'V' command are as follows:

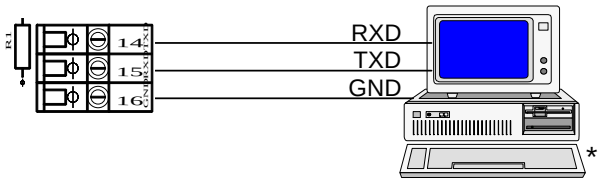
1. 'A' commands will update the Alarm Settings
2. 'FS' commands will update the Fail-safe settings on or off
3. 'Q' & 'S' commands will update the comment indicating the status of the 'Q'uiet / 'S'ignal mode
4. 'M' commands will toggle the word following the phrase, "Alarms to be cleared ", between 'manually' and 'automatically'.

Note: The number in parenthesis next to the Battery condition is simply the voltage detected by the battery circuit. This can be used for making sure the battery is fully charged.

6.3 RS232/485 Connections

Connect the Series 9510 Carbon Dioxide Analyzer to a terminal or computer as follows:

Series 9510 Computer



SECTION 7.0
ENHANCED REMOTE CONTROL COMMANDS WITH RS-485

7.1 General

Please read the section on serial communications **first** to familiarize yourself to the command structure. All commands under RS485 are either exactly the same or have slight enhancements over RS232C. This section is devoted to specifying only the enhancements associated with the RS485 protocol.
Below is a sample 'H'elp Screen using the 'H' Command.

```
A I   Aa=bb.b[L/H]     <Enter>   Alarm set
L N   Bccccc           <Enter>   Baud rate select
P S   C[bb.b]          <Enter>   Calibrate
H T   D[string]        <Enter>   Disable Security
A R   E[string]        <Enter>   Enable Security
  U   FSd=[ON/OFF/1/0] <Enter>   Fail-safe select
O M   Gcommand         <Enter>   Global set (be careful here)
M E   H                <Enter>   Help Screen
E N   L[name]          <Enter>   Local Name OR Number
G T   M[name]          <Enter>   Manual clear toggle
A S   Q[name]          <Enter>   Quiet mode (no beeps at all)
      S[name]          <Enter>   Signal mode (beeps audible)
      U[name]          <Enter>   Use analyzer with 'name' for all cmds
      V[name]          <Enter>   View current Alarms and settings

Where:     a = 1, 2, or 3 for different alarms
         bb.b = 0 to 30.0% CO2 for alarm setting
          L/H = Optionally set to 'L'ow or 'H'igh alarm
        ccccc = Baud rate number from 150 to 9600
            d = Number designating Relay 1 to 4
  ON/OFF/1/0 = 'ON' is the same as '1' etc.
         name = String for accessing multiple units (see manual)
       string = String for security protection (see manual)
      command = Any valid command (WARNING: G will act on all units!)
```

You will notice that there are three new commands here. 'G'lobal, 'L'ocal, and 'U'se. The first one is the 'G' Command. As it states above, this is the 'G'lobal Set command. This command is very powerful and must be discussed in detail.

RS485 gives the user the ability to connect multiple Series 9510 Carbon Dioxide Analyzer's together and communicate to them simultaneously. Therefore, it may become necessary or convenient to have certain Setpoints be 'G'lobally set. Instead of setting all instruments up one by one, use the 'G'lobal Command to control all Series 9510 Carbon Dioxide Analyzer units at the same time!

Each command will be discussed here, taking into consideration that there is most likely more than one unit to be controlled over the RS485 communications lines (twisted pair).

Please refer to Section 6.2 for information on the following commands.

'A' Command - Same as RS232

'B' Command - Same as RS232

'C' Command - Same as RS232

'D' Command - Same as RS232

'E' Command - Same as RS232

'F' Command - Same as RS232

'H' Command - Same as RS232

7.2 Special Commands for RS-485

'G' Command - Global Set command.
This command will cause all units tied into the RS485 communications line to respond to whatever command comes after it. For example, typing:

```
G <Enter>
```

will do nothing! This is because no command was given after the 'G'. However, typing:

```
GA1=20.5h <Enter>
```

will set up every Series 9510 Carbon Dioxide Analyzer connected to the RS485 line to have a High Alarm1 Setting of 20.5 ppm
Now let's try the 'G' command with the 'B' command for setting the baud rate. This is a handy little time saver! For instance, to set all units to 9600 bps just type:

```
GB9600
```

Or in other words, "Global Baud 9600". Make sure you change your terminal baud rate after using a 'B' command.

Globally Calibrating is not allowed.

The next two commands function just like RS232C, only they function on all units connected to the communications line.

```
GD[string] and
GE[string]
```

"Globally Disable" and "Globally Enable". Refer to RS232C section for more detail.
Note: Remember, if you are adding units to the RS485 line, and you don't make sure of your security codes, you could end up with multiple security codes! To be sure, have all units on line before enabling a global security code.
If you need all instruments to operate in the Fail-safe mode, just use the 'G'lobal command:

```
GFS1=1 <Enter>
GFS2=1 <Enter>
GFS3=1 <Enter>
GFS4=1 <Enter>
```

Note how each Alarm is treated individually. The following commands are not available:

```
GH <Enter> does nothing.
GI <Enter> does nothing.
GL <Enter> does nothing.
```

The next available 'G'lobal command would be the 'Q'uiet command. Note: No optional name is required and if supplied will cause the Series 9510 Carbon Dioxide Analyzer (if enabled) to respond with an 'Error!' message. (See description of 'Q' command below)

```
GQ <Enter>
```

Preceding this command with the 'G'lobal command does exactly what you would expect. 'G'lobally 'Q'uiet all audible sounds. See the 'S'ignal command below for setting the audible sounds back to normal. To make all alarms audible, type the following command:

```
GS <Enter>
```

This puts all Series 9510 Carbon Dioxide Analyzers into 'S'ignal mode. This means that any alarm condition will result in an audible alarm signal. No other commands are available for 'G'lobal setting.

7.3 Added RS485 Commands

'L' Command - Local name assignment.
This command allows the user to name each Series 9510 that might be on the RS485 communications line. For instance, an example might be that there are two rooms that need to be monitored using a Series 9510 in each room. From the factory, the Series 9510 is set up to have a blank 'name'. This is equivalent to typing:

```
L <Enter>
```

If the unit has been enabled using the 'U' command or has been set up to the factory default, the instrument will respond:

```
'' O.K.
```

The unit's name is displayed in single quotation marks. Note how the name is blank above.
In our example, we want to put two Series 9510's on line. First connect ONE Series 9510 Carbon Dioxide Analyzer to the RS485 line, and get it up and running. After the unit is responding, type the following just as an example:

L Unit#1 <Enter>
This comes back with a message stating:

```
'' changed to: ' Unit#1'
' Unit#1' O.K.
```

You can substitute the above, "Unit#1" with any string you like. Usually the shorter the better for purposes of saving keystrokes when accessing the unit. Now type the following:

```
U <Enter>       See next command for description
```

This basically 'disables' Unit#1 so we can talk to the next unit we put on the line.
Now we are ready to add another unit. Connect the second Series 9510 to the line. If you haven't already, you may have to type 'L' followed by <Enter> (Factory Default) to communicate with the new unit that was just put on the line. (Note: if the unit does not respond then a factory boot may be necessary. To perform a factory boot which will return the unit to it's shipping state, push the UP, DOWN, and Alarm 3 buttons simultaneously as above while holding at least one button down. The button(s) pushed will very briefly show on the display(i.e. while holding the Alarm 1 button down the display will read [A1] briefly) until [[Fb]] shows up on the display. This means you have successfully performed a Factory boot. The instrument will then proceed to a normal warm boot to read the switch settings etc. - At this time you can name the second unit. Maybe it would look something like this:

```
L Unit#2 <Enter>
```

WARNING! If you put two or more units on an RS485 line with the same name and ask for output, anything can happen! You can change the currently responding unit's name, just don't set it to a name that currently exists because the next time you type "Uname", you will select two units at one time!

'U' Command - Use command.
This command is used for selecting a different Series 9510 that has already been set up using the 'L' command. For instance, using the above example of Unit #1 and Unit #2, to access Unit #1 you would type:

```
U Unit#1
```

You should get a response of:

```
Using: ' Unit#1'
```

Note the 'extra' space after the single quote at the beginning ot the string. This is not mandatory and can be removed by renaming it using the 'L' command as follows:

```
LUnit#1 <Enter>
Note: no space between 'L' and 'U'
```

7.4 RS-485 Enhanced Commands

'M' Command - Manual / Automatic clearing of alarms.
The enhancement to this command is using the 'name' as a variable. For instance, no matter what unit is enabled and responding to commands, you can address a specific unit for toggling this function as follows:

```
M#1 <Enter>
```

If a unit with the 'name' "#1" assigned to it exists, then only that unit will act upon the command. Note: Only the unit that is enabled can respond via RS485, so when using this addressing scheme you may want to verify that the command was received by the specific instrument by giving it a 'V'name command (See below).

'Q' Command - Quiet Mode select
Same enhancement as above in that you can selectively 'Q'uiet any unit by following the command with a valid unit name.

'S' Command - Signal Mode select
Same enhancement as above.

'V' Command - View settings
This has the same enhancement as the 'M', 'Q', and 'S' commands and can be used to verify that each of those commands work properly. For example: With two units, one named "One" and the other named "Two" you could do the following:

```
UOne <Enter>
```

This selects unit "One". Now lets check the status of unit "Two":

```
VTwo <Enter>
```

We will just notice that part of the 'V'iew screen shows:

```
Alarms to be cleared MANUALLY
```

Now try changing the MANUAL clearing to AUTOMATIC without 'U'sing unit #2:

```
MTwo <Enter>
VTwo <Enter>
```

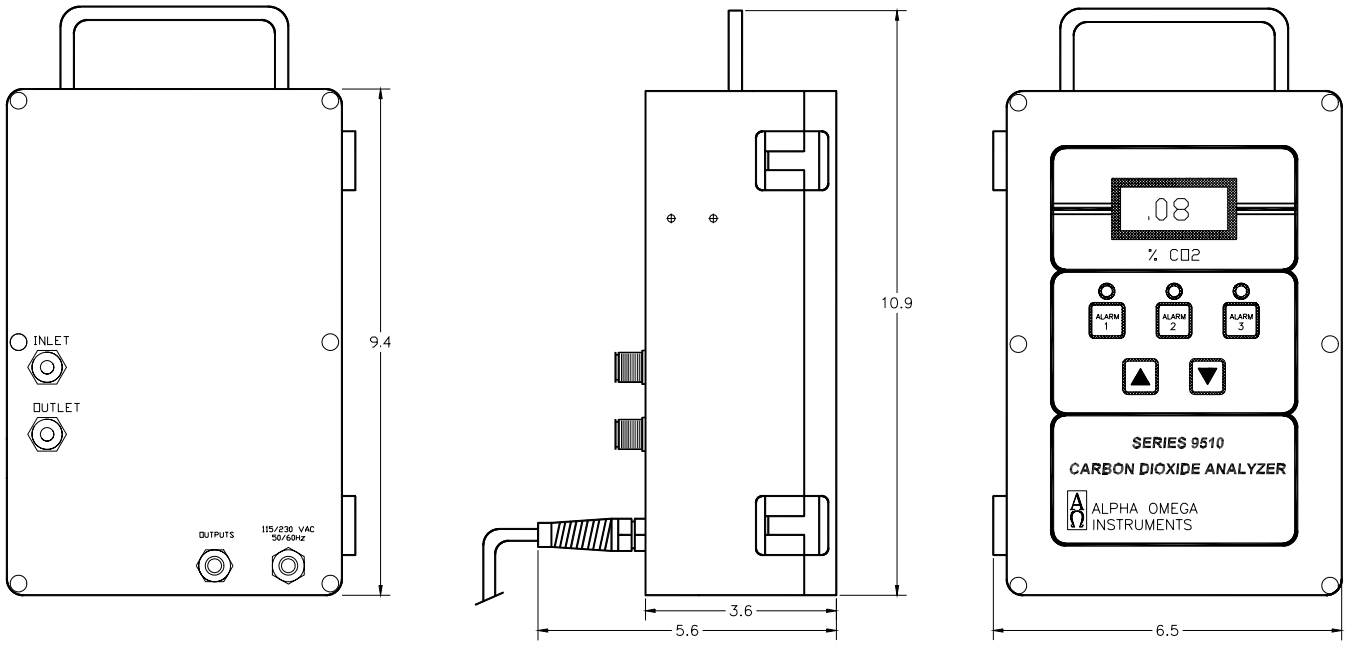
Now we can see that the 'V'iew screen shows:

```
Alarms to be cleared AUTOMATICALLY
```

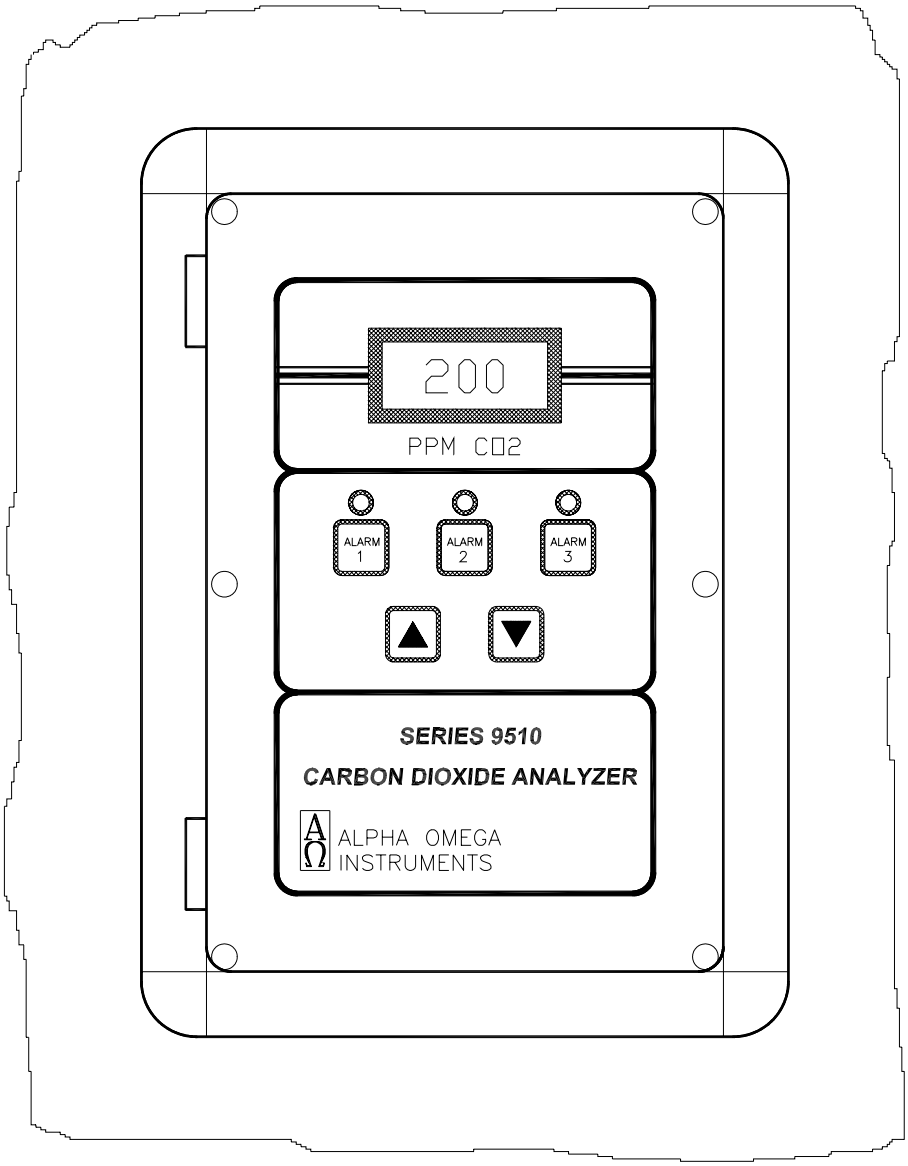
Note that while we entered these commands the unit would respond to an <Enter> with:

```
'One' O.K.
```

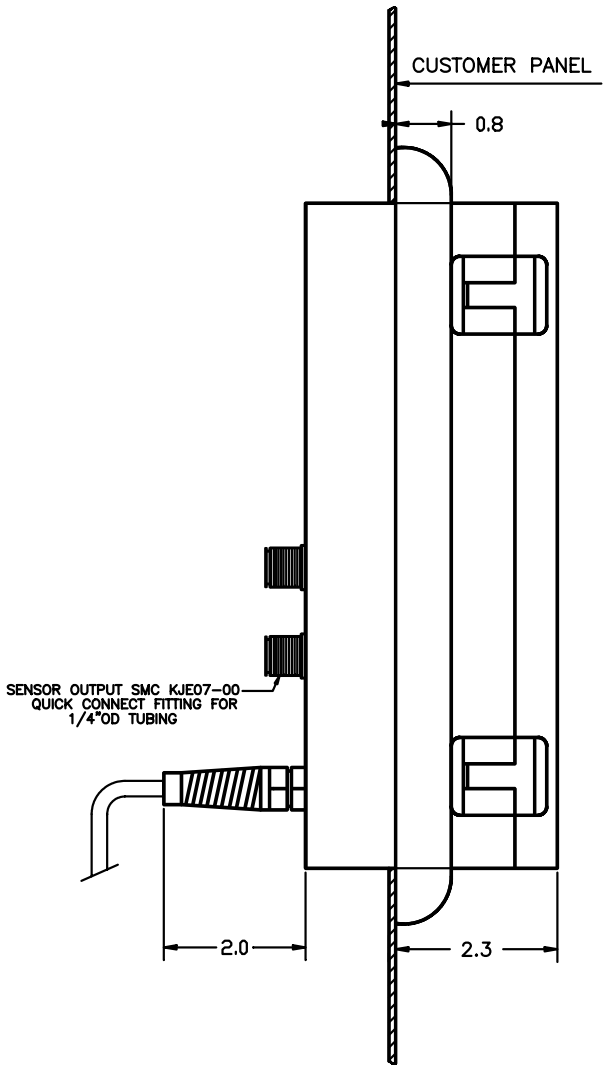
APPENDIX A
BENCH TOP/PORTABLE
CONFIGURATION
PART NUMBER "BTP"



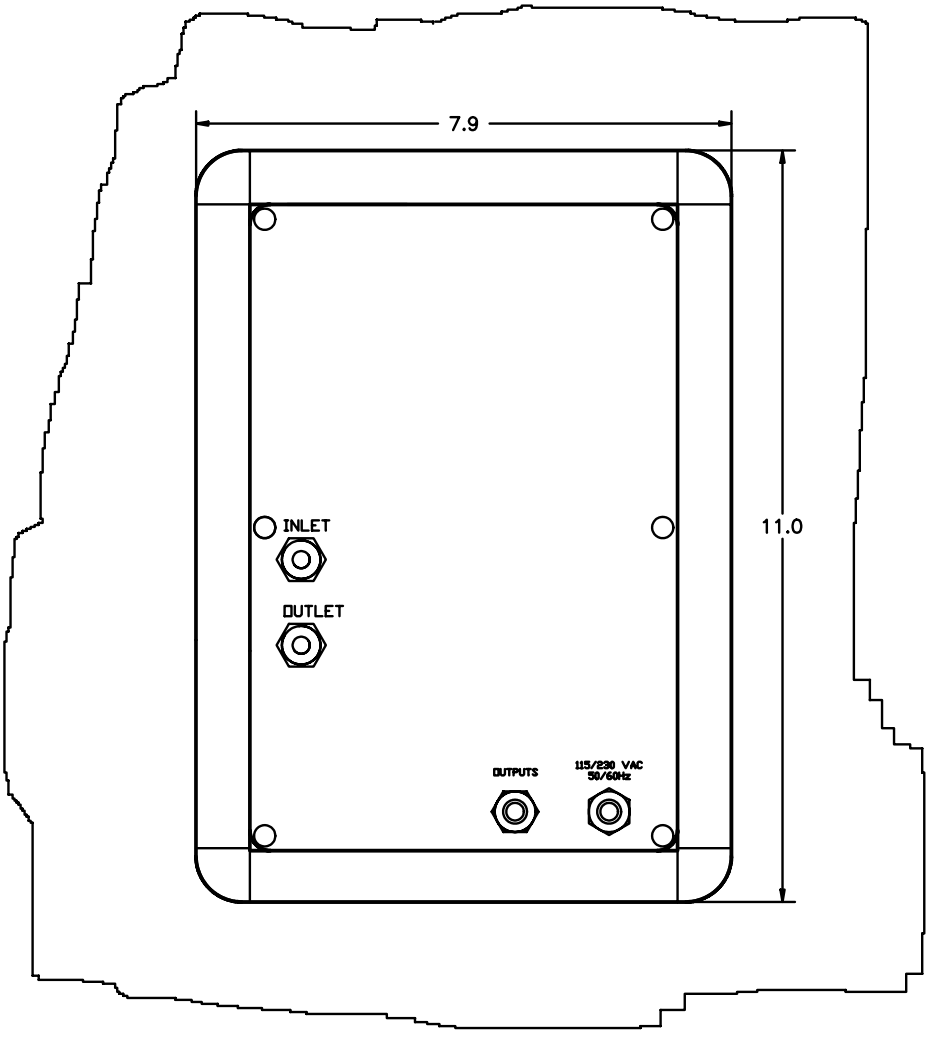
APPENDIX B
PANEL MOUNTING CONFIGURATION
PART NUMBERS PNL, PNR, & PTX
FRONT VIEW



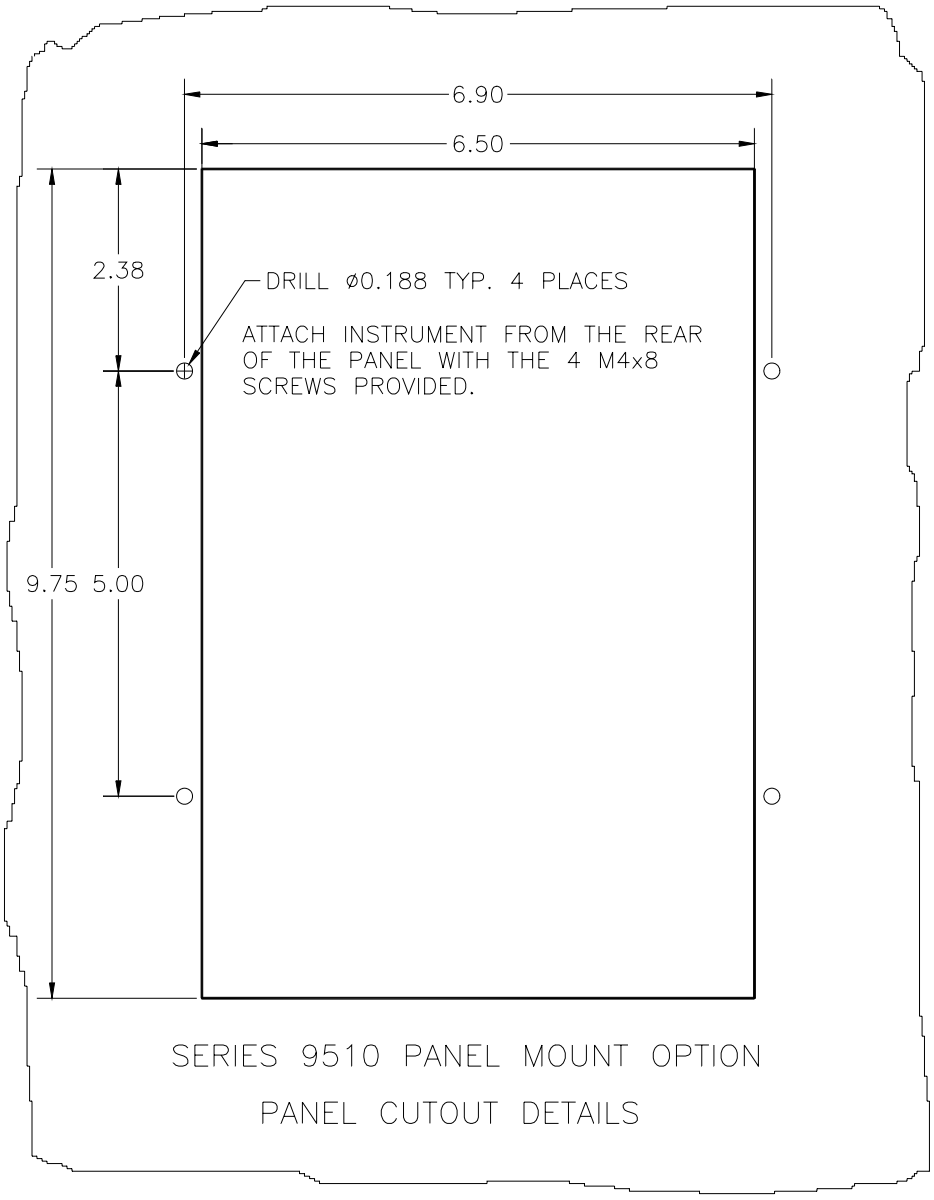
APPENDIX B
PANEL MOUNTING CONFIGURATION
PART NUMBERS PNL, PNR, & PTX
SIDE VIEW



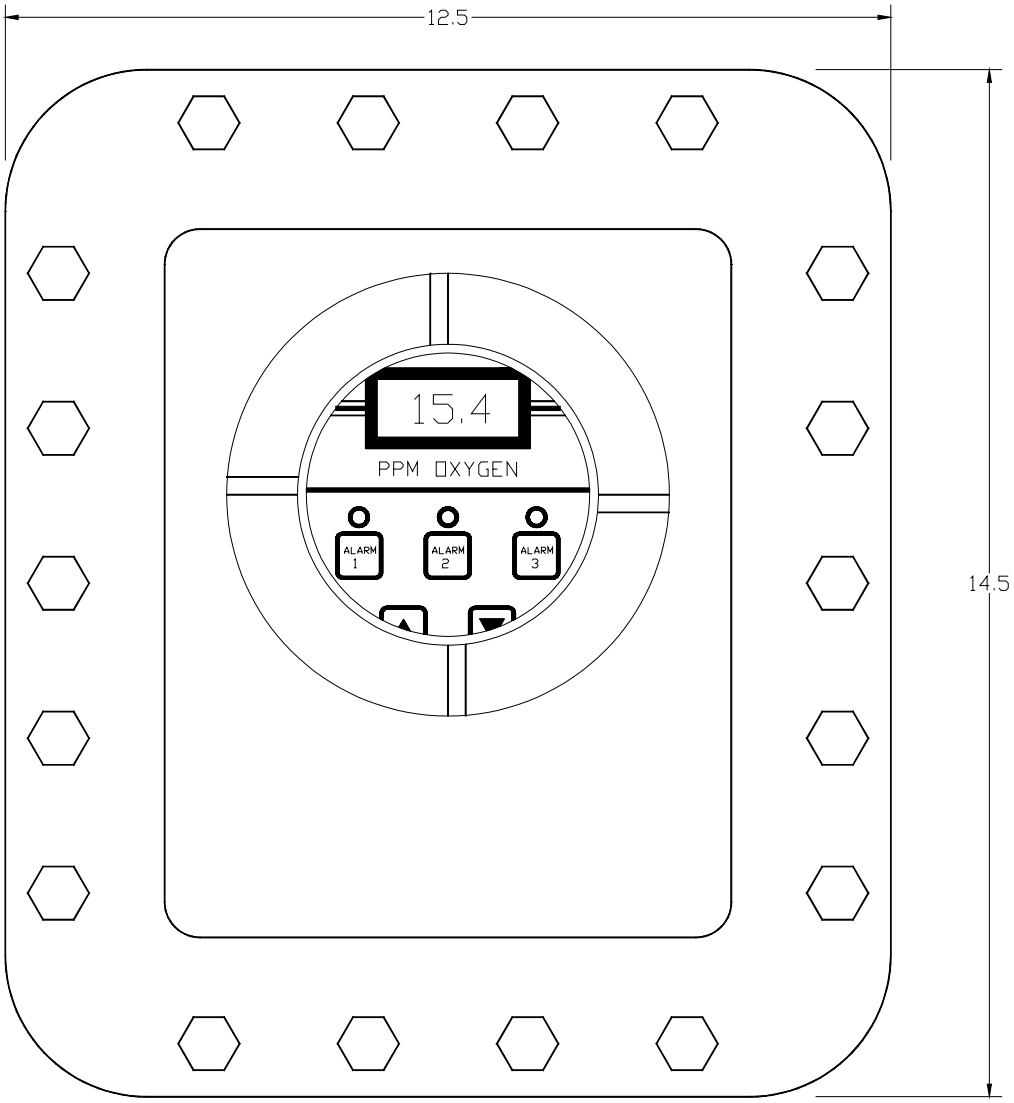
APPENDIX B
PANEL MOUNTING CONFIGURATION
PART NUMBERS PNL, PNR, & PTX
REAR VIEW



APPENDIX B
PANEL MOUNTING CONFIGURATION
PART NUMBERS PNL, PNR, & PTX
PANEL CUT-OUT DETAILS



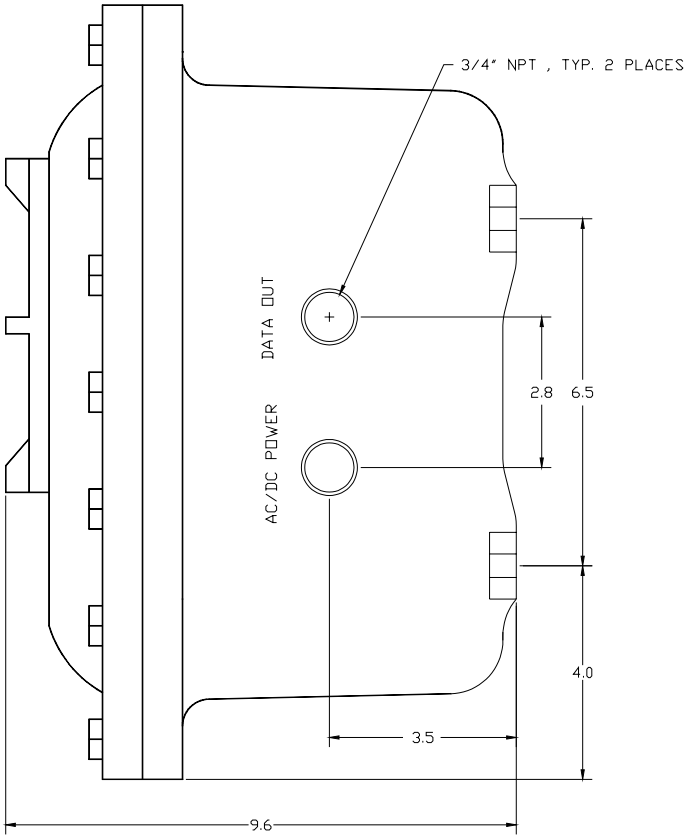
APPENDIX C
EXPLOSION PROOF ELECTRONICS/SENSOR CONFIGURATION
PART NUMBER EXX
FRONT VIEW



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ± .010 .XXX ± .005 ANGULAR ± .05 DO NOT SCALE DRAWING		ALPHA-OMEGA INSTRUMENTS CORP. 30 Martin Street Cumberland, RI 02864 Tel. (800) 262-5977 (401) 333-8580 Fax (401) 333-8686			
DRAWN	DATE	SERIES 3000 CONFIGURATION DRAWING			
CHECKED	DATE	SIZE	FSCM No.	DRAWING No. 3000H	REV. A
DESIGN	DATE	SCALE		SHEET 1 OF 1	

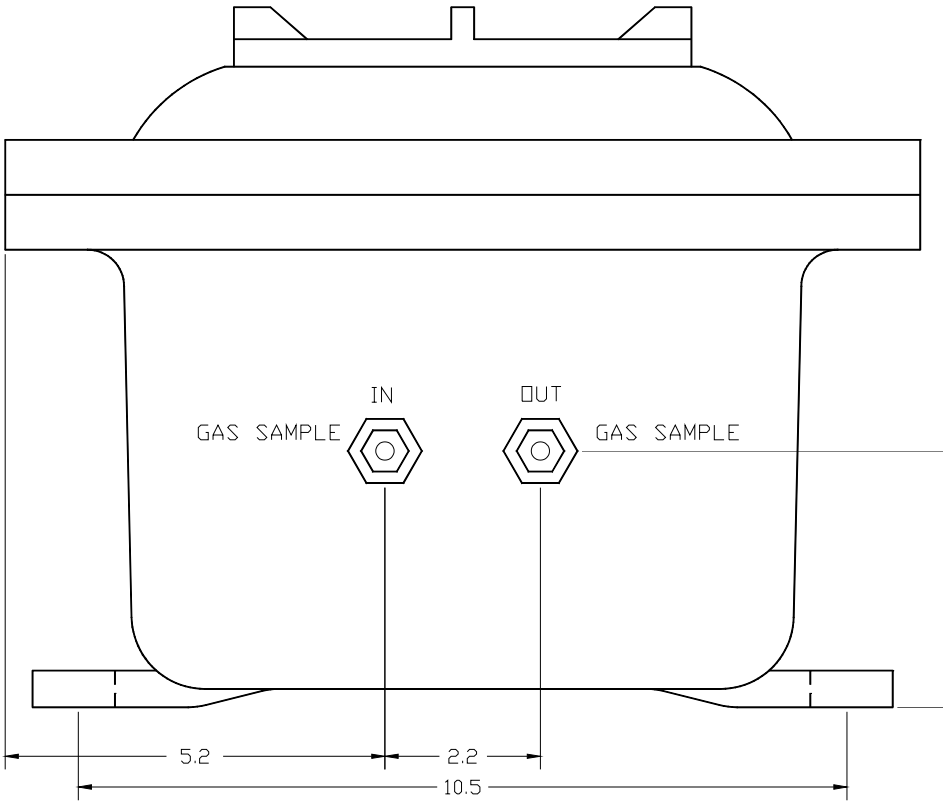
Note: The item shown above is an explosion proof oxygen measuring system. The Series 9510 Carbon Dioxide Analyzer is identical to that shown above in terms of mechanical layout.

APPENDIX C
EXPLOSION PROOF ELECTRONICS/SENSOR CONFIGURATION
PART NUMBER EXX
SIDE VIEW-ELECTRICAL CONNECTIONS



Note: The item shown above is an explosion proof oxygen measuring system. The Series 9510 Carbon Dioxide Analyzer is identical to that shown above in terms of mechanical layout. Due to options ordered with the Series 9510 Carbon Dioxide Analyzer, the overall depth of the enclosure may be approximately 2" deeper than shown. All other dimensions stay the same.

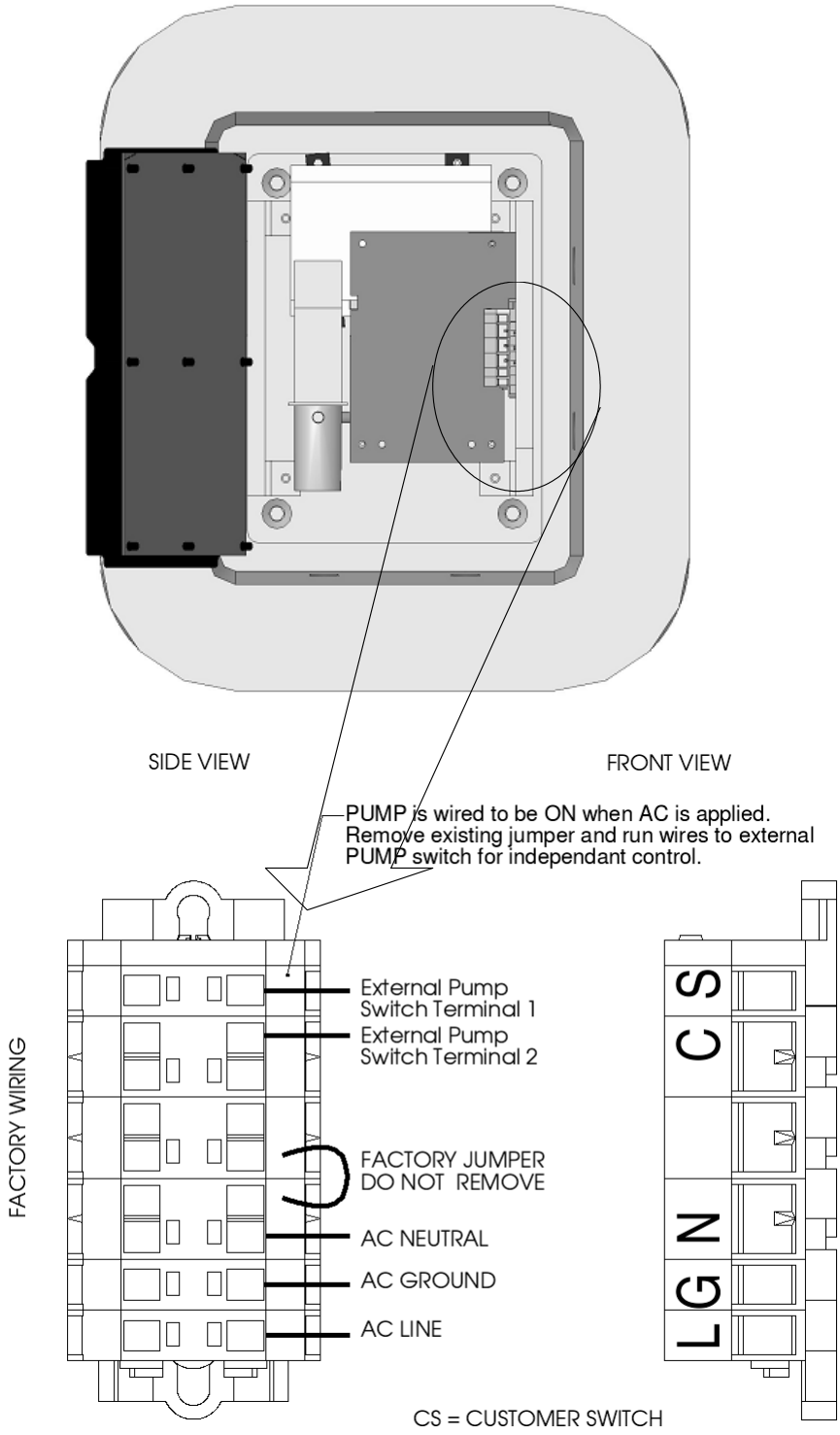
APPENDIX C
EXPLOSION PROOF ELECTRONICS/SENSOR CONFIGURATION
PART NUMBER EXX
SIDE VIEW-GAS CONNECTIONS



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES DECIMALS .XX ± .010 .XXX ± .005 ANGULAR ± .05 DO NOT SCALE DRAWING		ALPHA-OMEGA INSTRUMENTS CORP. 30 Martin Street Cumberland, RI 02864 Tel. (800) 262-5977 (401) 333-8580 Fax (401) 333-5550	
DRAWN	DATE	SERIES 3000 CONFIGURATION DRAWING	
CHECKED	DATE	SIZE FSCM No. DRAWING No. 3000J	REV. A
DESIGN	DATE	SCALE	SHEET 1 OF 1

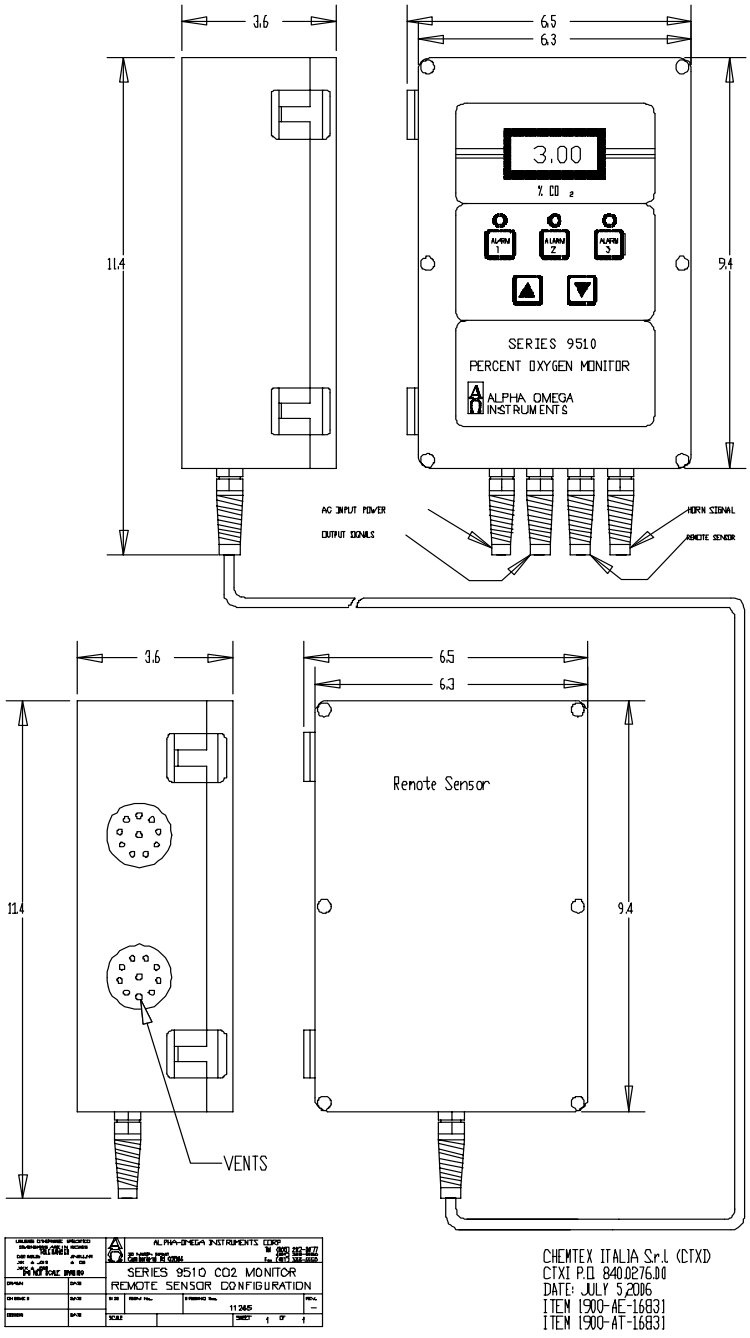
Note: The item shown above is an explosion proof oxygen measuring system. The Series 9510 Carbon Dioxide Analyzer is identical to that shown above in terms of mechanical layout.

APPENDIX D
WIRING INSTRUCTIONS FOR EXPLOSION
PROOOF ENCLOSURE (EXX TYPE)

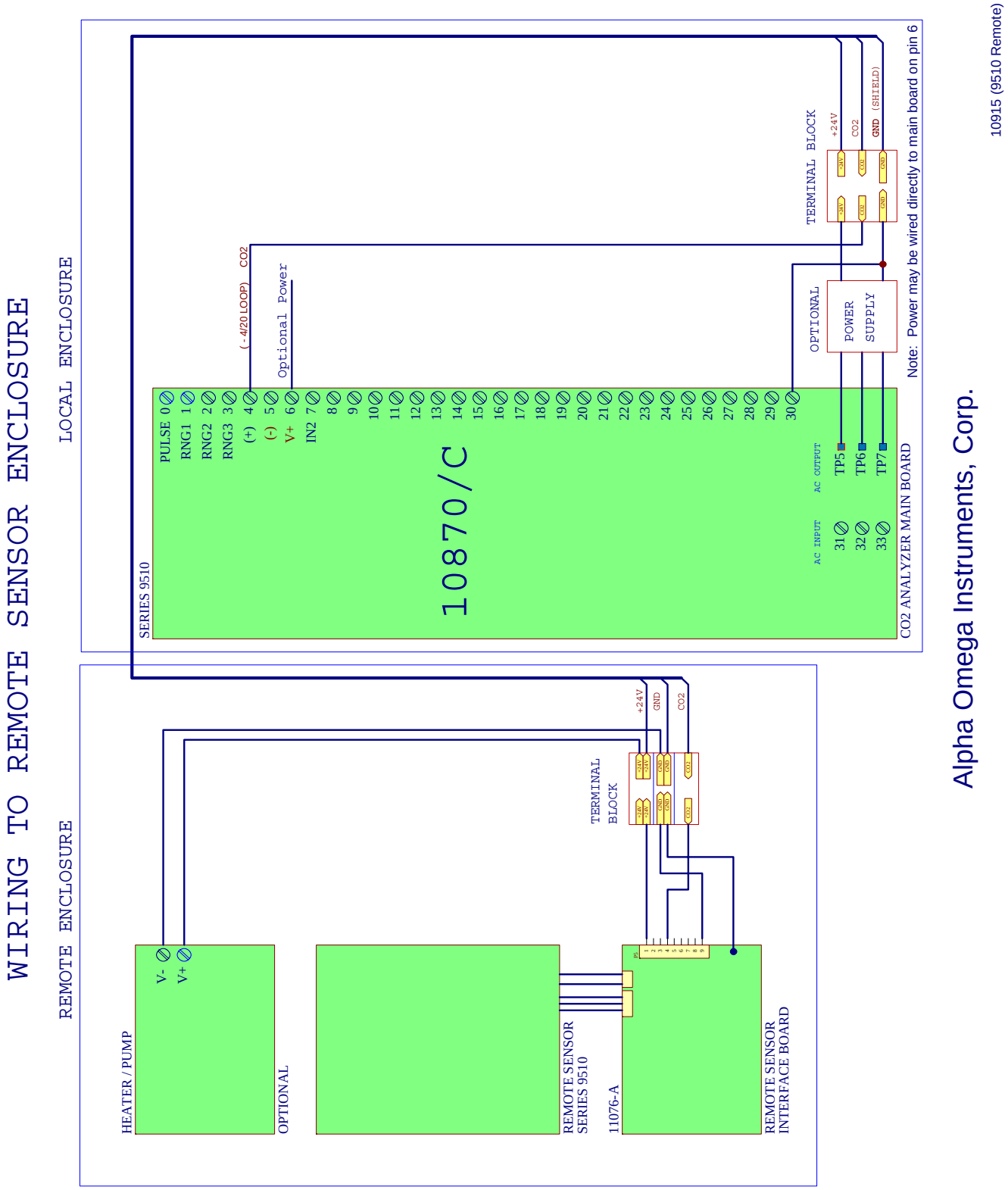

SIDE VIEW
FRONT VIEW
PUMP is wired to be ON when AC is applied.
Remove existing jumper and run wires to external
PUMP switch for independant control.
FACTORY WIRING
External Pump
Switch Terminal 1
External Pump
Switch Terminal 2
FACTORY JUMPER
DO NOT REMOVE
AC NEUTRAL
AC GROUND
AC LINE
L G N C S
CS = CUSTOMER SWITCH

APPENDIX E

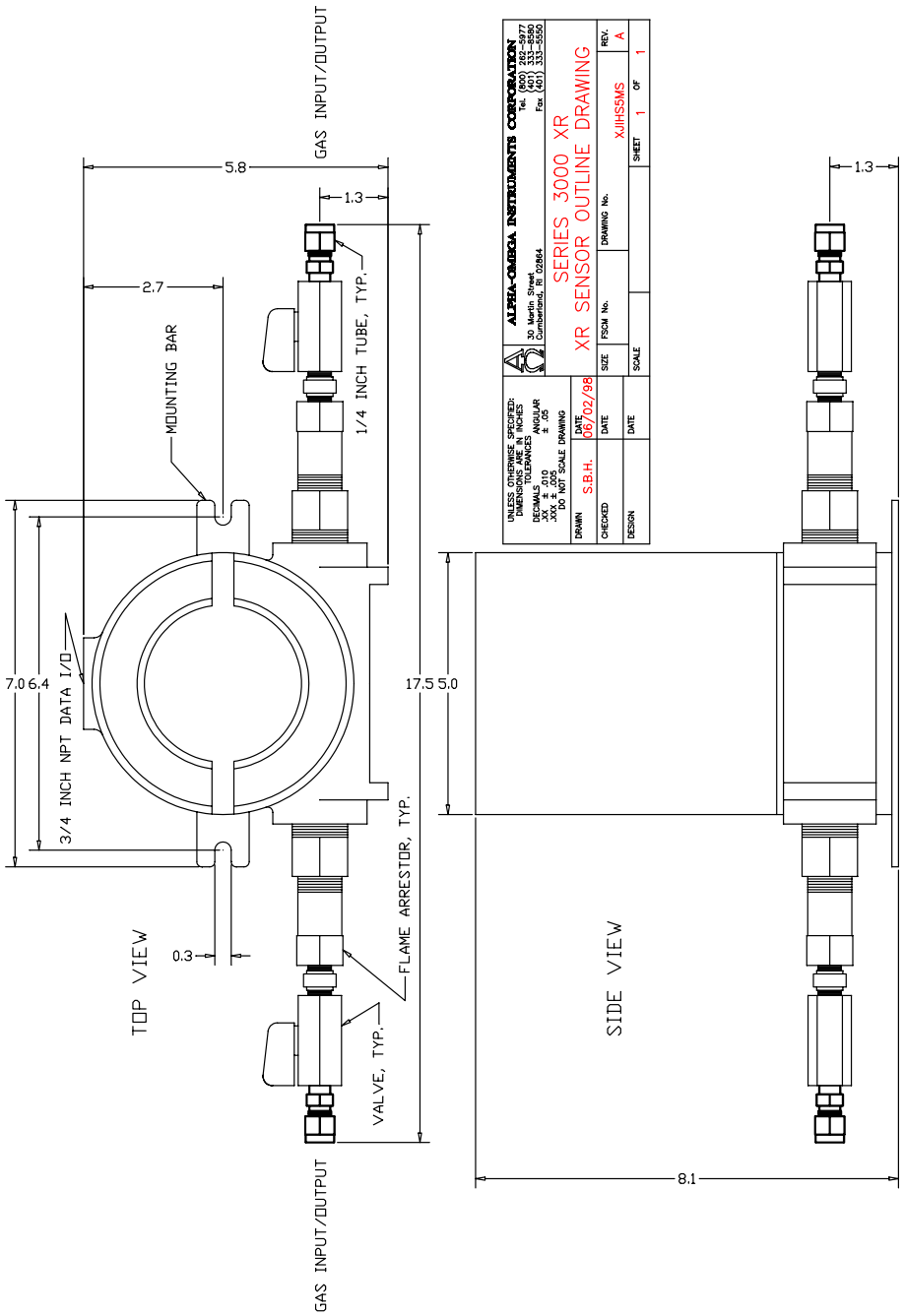
WALL MOUNTED ELECTRONICS WITH REMOTE SENSOR ENCLOSURE



APPENDIX F
WIRING DIAGRAM FOR THE REMOTE EXPLOSION PROOF SENSOR ENCLOSURE



APPENDIX G
EXPLOSION PROOF SENSOR ENCLOSURE (REMOTE SENSOR TYPE)



Note: The explosion proof remote enclosure shown is identical to the one used for the Series 9510 Carbon Dioxide Analyzer with one exception. The Series 9510 enclosure will not have the Isolation valves as shown in the above drawing.

APPENDIX H
EXPLOSION PROOF REMOTE SENSOR ENCLOSURE SHOWING INTERNALLY MOUNTED ELECTRICAL TERMINAL BLOCK