



SERIES 9600

OXYGEN AND CARBON DIOXIDE ANALYZER

USER MANUAL

CAUTION

Please read this manual before starting to use the Series 9600 Oxygen and Carbon Dioxide Analyzer. Instructions within the manual are essential for the proper operation of the product.



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Explanation of graphic symbols

The information listed below is essential to the proper operation of the analyzer. Please review the following safety precautions prior to using the analyzer. Cautionary notes are included throughout this manual.



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



THIS SYMBOL IS INTENDED TO ALERT THE USER TO POTENTIALLY DANGEROUS SITUATIONS OR ITEMS THAT SHOULD BE AVOIDED

Important Safety Information



DANGER

POTENTIALLY HAZARDOUS AC VOLTAGES EXIST WITHIN THE ANALYZER, IF NOT AVOIDED, COULD POTENTIALLY RESULT IN SERIOUS INJURY OR DEATH. DISCONNECT ALL SOURCES OF POWER AND EXTERNAL CONNECTIONS BEFORE REMOVING THE COVER TO THE ANALYZER



RISK OF SHOCK

TO AVOID THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THE SERIES 9600 OXYGEN AND CARBON DIOXIDE ANALYZER TO RAIN, WATER SPRAY, OR ANY OTHER LIQUIDS.

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 or 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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1 Overview

1.1 Instrument Description

The Series 9600 Oxygen and Carbon Dioxide Analyzer provides an accurate and repeatable measurement of both oxygen and carbon dioxide in a variety of gas streams. The instrument is powered from a universal power supply equipped to accept 90-264 VAC, 47-63Hz. Optional equipment includes pressure regulators, particulate and coalescing filters, and a vacuum pump for conditions when the sample gas lacks sufficient pressure to move the sample through the instrument's plumbing.

The analyzer is housed in a NEMA 1 equivalent enclosure rated for general purpose indoor use. Oxygen and carbon dioxide values are displayed on a 4 line by 20 character liquid crystal display (LCD) with a total height of 0.81" (20.8 mm). The front panel also includes a membrane panel with seven buttons that provide access to the analyzer's settings. The instrument is equipped with two alarm relays (see specifications) which are user configurable and can optionally be set for fail-safe operation. In addition to the alarm relays, the Series 9600 Oxygen and Carbon Dioxide Analyzer has a built-in audible alarm and two front panel light emitting diodes (LEDs) for visual indication of an alarm condition. The audible alarm can be canceled by the user, however the alarm event will still be in effect and indications of the alarm condition will still be available through the front panel LEDs and relay contact(s). A flow meter is mounted on the front panel of the instrument and is standard equipment for the Series 9600 Oxygen and Carbon Dioxide Analyzer. A flow meter with integrated flow control needle valve is available as optional equipment. The standard Series 9600 Oxygen and Carbon Dioxide Analyzer comes equipped with two direct current (DC) analog outputs. These analog outputs can be independently configured for 0-20 mA or 4-20 mA. Both are scalable over the operating range of the instrument's sensors. Using a terminating resistor on either of these outputs can also provide any analog voltage in the range of 0-10 volts (see general specifications on page 4 for maximum resistance).

1.1.1 Oxygen Sensor

The Series 9600 Oxygen and Carbon Dioxide Analyzer features an ambient temperature electrochemical sensor with an Enhanced Electrolyte System (EES). One of the features of the EES is the use of a weak acid electrolyte in place of potassium hydroxide. This produces a sensor with a greatly extended useful life and excellent measurement stability.

1.1.2 CO₂ Sensor

The Series 9600 Oxygen and Carbon Dioxide Analyzer uses a non-dispersive infrared (NDIR) sensor to determine the carbon dioxide concentrations in gases. Infrared gas sensors, which are comprised of solid state devices, do not chemically react with the gas.

1.1.3 Water Vapor

The Series 9600 Oxygen and Carbon Dioxide Analyzer incorporates a CO₂ sensor that uses a high precision optical system. Therefore, in order to provide accurate and repeatable data, it is essential that the CO₂ sensor not be exposed to condensed water or liquids of any type. The dew point temperature of the sample gas should always be lower than the temperature of the NDIR sensor, thus helping to prevent the condensation of water vapor on the sensor's optics. If it is anticipated that the sample gas may be saturated with water vapor, provisions should be made to remove the water by

filtration/coalescing, refrigeration, vortex cooling, etc. Consult Alpha Omega Instruments Corp. for more information on this subject.

1.2 Optional Equipment Descriptions

The Series 9600 Oxygen and 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.

1.2.1 Low Pressure Regulator

P/N 96-LPR

Aluminum body with a maximum input pressure of 145 PSIG.

1.2.2 High Pressure Regulator

P/N 96-PRR

High capacity stainless steel pressure regulator with 3000 PSIG inlet capacity and an adjustable output pressure range of 0-5 PSIG. Note: Typically used with the optional needle valve (P/N 9NV).

1.2.3 Sample Pump Option

P/N 96-PMP

Sample pump designed for applications where the sample pressure is insufficient to transport the sample gas through the instrument's plumbing.

1.2.4 Particulate Filter

P/N 96-95S

Miniature T-type 316 stainless steel filter with 1/4" compression fittings. Recommended when particle sizes are greater than 5 microns.

1.2.5 Needle Valve

P/N 96-NV

Stainless steel needle valve for high pressure sample source (greater than 1 PSIG). Also used in bypass style plumbing arrangements for applications where the instrument will be used to measure both positive and negative pressure sources using a sample pump.

1.2.6 Isolated RS-232C Serial Communications

P/N 96-RS2

The RS-232C Serial Communications option is installed at the factory and is designed for applications where enhanced serial communications is required between the Series 9600 Oxygen and Carbon Dioxide Analyzer and a host system. The maximum distance from the host system is 50 feet.

1.2.7 Isolated RS-485C Serial Communications

P/N 96-RS4

The RS-485 Serial Communications option is installed at the factory and is designed for applications where enhanced serial communications is required between the Series 9600 Oxygen and Carbon Dioxide Analyzer and a host system over a distance greater than 50 feet. The maximum distance from the host system is 4000 feet.

1.2.8 Coalescing Filter

P/N 96-CF

Filter with aluminum housing. Rated for nominal 0.3 microns (95%).

Spare filter elements for P/N 96-CF.

P/N 96-CFE

1.2 Optional Equipment Descriptions (continued)

1.2.9 Data Logger

P/N 9DL

Internally mounted four channel data logger (no display). The data logger can be used to record the O₂ and CO₂ concentrations and operates in a wrap-around mode so that when the memory is full, the oldest data will be replaced with the newest. Recording frequency is adjustable from once every 0.5 seconds to once every 9 hours (user selectable). Memory is non-volatile EEPROM with 32,000 readings kept in storage. Software will be provided that allows downloading of the data to a PC via serial port.

1.2.10 Flow Meter

P/N 9FLMA

Durable one-piece acrylic flow meter without flow control adjustment. Standard equipment.

1.2.11 Flow Meter with Integral Valve

P/N 9FLMC

Durable one-piece acrylic flow meter with flow control adjustment. Optional equipment.

1.2.12 Bypass Plumbing Assembly

P/N 9BYPASS

Plumbing arrangement used when the instrument will be used for both positive and negative pressure source applications. Includes a needle valve and a bypass “tee” on the inlet of the instrument. This is typically used in conjunction with 9PMP Sample Pump Option. Some high pressure applications will also make use of such a plumbing arrangement. Details are discussed later in the manual.

1.2.13 Analog Output Isolation.

P/N 9AOISO

Installed at the factory, galvanic isolation of both analog outputs.

1.2.14 Rack / Panel Mounting Kit

P/N 96-RMK

Used for mounting the instrument in either a Rack configuration or inside a panel cutout.

1.3 Standard Features¹

Analog Outputs:	Two 0/4-20 mA, configurable for voltage or direct current Individually configurable for either O ₂ or CO ₂ monitoring Maximum load: less than 950 ohms @ 25C
Alarm Relays:	Two (2) SPDT Form C contacts rated 10 A (250 VAC) / 5A (100 VDC). Alarms may be cleared manually or automatically, by user selection. Individually configurable to be set as high or low alarms for either O ₂ or CO ₂ levels.
Input Power:	Universal 90-264 VAC, 47-63 Hz
Audible Alarms:	Internal audible alarm (user configurable per alarm)
Audible Alarm Canceling:	Individual front panel buttons
Operating Temperature:	50° to 104°F (10° to 40°C) / 99% max humidity (non-condensing)
Enclosure:	Aluminum, equivalent to NEMA 1
Enclosure Dimensions:	13 inches (330 mm) – length 11 Inches (280 mm) – width 7 Inches (178 mm) - height
Sample Delivery:	Pressure or optional pump
Display:	4 Line by 20 character LCD

¹ All specifications are based on a temperature of 77°F (25°C) at standard pressure of 29.9 inches of mercury (1 atmosphere).

1.4 General Specifications

Oxygen Sensor

Measurement Range:	Percent: 0-100
Resolution:	Greater than 10% = 0.1% Less than 10% = 0.01%
Accuracy:	±1% for full scale ranges >10% . ±5% for full scale ranges <10%
Sensor Type:	Long-life electrochemical sensor
Recommended Sample Pressure:	<1.0 PSIG ¹
Response Time:	90% of full scale response in < 20 seconds.
Warm Up Time:	Instantaneous
Sample Flow Rate:	0.1-0.5 liters per minute (LPM) optimum
Operating Humidity Range:	0-99% RH (non-condensing)
Calibration:	Ambient air or calibration gas

¹ The actual pressure of the sample can be much higher, however higher pressure sampling requires different plumbing arrangements that are described later in the manual.

General Specifications (continued)

Carbon Dioxide Sensor

Measurement Range¹:	Percent: 0-20 Trace: 0-5,000 PPM (determined at order placement)
Resolution:	Greater than 10% = 0.1% Less than 10% = 0.01% Less than 10,000ppm = 1 ppm
Accuracy:	Percent: $\pm 0.5\%$ full scale or $\pm 5\%$ of reading, whichever is greater Trace: ± 30 ppm or $\pm 2\%$ of reading, whichever is greater.
Sensor Type:	Non Dispersive Infrared (NDIR)
Recommended Sample Pressure :	<1.0 PSIG (see footnote 1 opposite page)
Response Time:	< 35 seconds to 63% step change at a sample flow of 0.5 liters per minute
Warm Up Time:	< 90 seconds
Sample Flow Rate:	0.1-0.5 liters per minute (SLPM) optimum
Operating Humidity Range:	5-95% RH (non-condensing)
Calibration:	Calibration gas

¹ Other ranges for CO₂ covering ppm and percent to 100% are available. Please contact the factory for details.

2 Installation Procedures

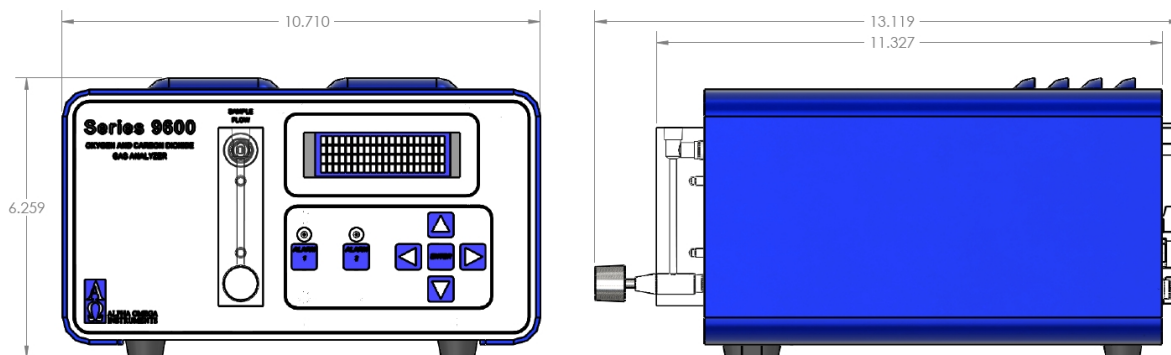


Figure 2.1 Mechanical Dimensions

2.1 Unpacking the Instrument

Upon opening the shipping container, carefully unpack the instrument 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 HAS BEEN FOUND, DO NOT PROCEED FURTHER, BUT INSTEAD, CONTACT THE FACTORY.

If there is no apparent damage, check the contents to ensure all items were shipped. In some cases, items may be back ordered. **All damage and shortage claims must be made known to Alpha Omega Instruments within 10 days after receipt of shipment.** Carefully rotate the analyzer and check to make sure no components have been loosened or dislodged. **If there are loose or dislodged components (rattling of any kind), contact the factory for further instructions.** If there is no evidence of loose or dislodged components, the installation procedure can begin.

2.2 Electrical Installation



WARNING

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

The Series 9600 Oxygen and Carbon Dioxide Analyzer is shipped with a standard North American power cord NEMA style 5-15P. The mating receptacle on the rear panel of the analyzer is an IEC style 60320 C13/C14. The analyzer accepts a power input of 90 VAC to 264 VAC @ 50/60 Hz. There is an On/Off switch located on the rear of the instrument.

2.3 Mechanical Configuration

The Series 9600 Oxygen and Carbon Dioxide Analyzer requires no internal configuration and is “ready to use”. The instrument's cover should not be removed except to replace the oxygen sensor or in rare case, to adjust the volume of the internal pump. Note: carbon dioxide sensors must be replaced at the factory.

2.4 Wiring Alarm Relays

Access to the control signals generated from the Series 9600 Oxygen and Carbon Dioxide Analyzer is accomplished using the user interface connectors on the rear panel of the analyzer. These connectors are shown below labeled “I/O”. There are three (3) connectors labeled “A”, “B”, and “C” as shown. Each connector has 6 pins. Reference Table 2.2 for details on the connector pin outs.

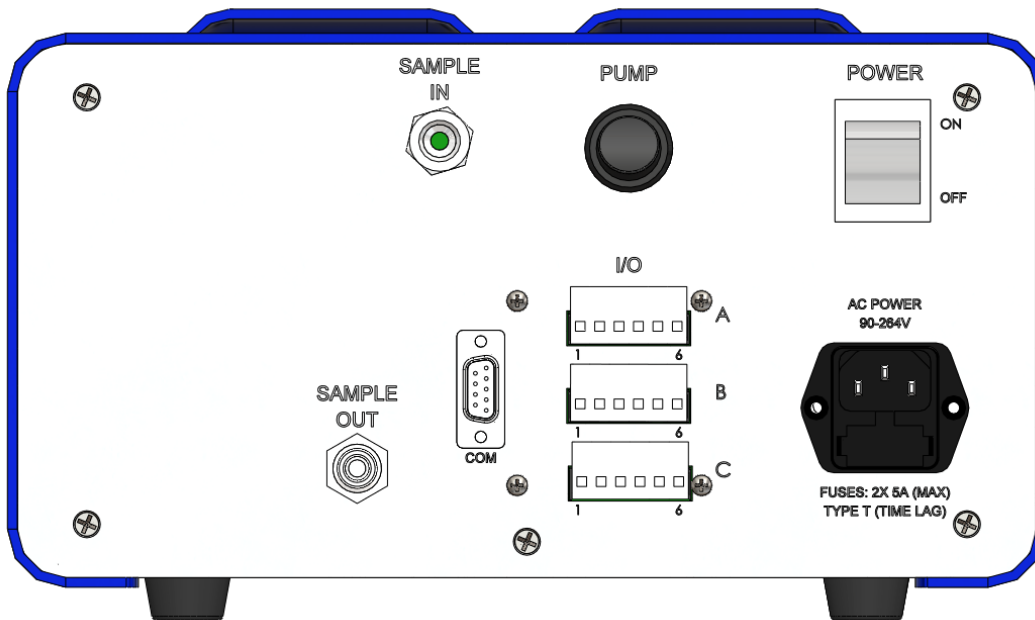


FIGURE 2.2
Rear View

The Series 9600 Oxygen and Carbon Dioxide Analyzer is equipped with two (2) single pole double throw (SPDT) relays (see specifications). Each alarm relay can be configured by the user, both alarms default to a factory setting of 0.0 low. To configure the alarm relays, please refer to Section 3.6

Contacts shorted for each Active Alarm Relay	Alarm ON	
	Fail-safe ON	Fail-safe OFF
Alarm 1 / Relay 1	NC (C-3) to COM (C-1)	NO (C-2) to COM (C-1)
Alarm 2 / Relay 2	NC (C-6) to COM (C-4)	NO (C-5) to COM (C-4)

TABLE 2.1 RELAY CONFIGURATIONS

TABLE 2.1 illustrates the various wiring configurations for the two alarms in the Series 9600 Oxygen and Carbon Dioxide Analyzer based on whether the alarms are going to be configured for fail-safe or non fail-safe operation.

2.5 Wiring the mA Outputs

The Series 9600 Oxygen and Carbon Dioxide Analyzer is equipped with two (2) analog outputs, both of which can be set to either 0-20 mA or 4-20 mA from the front panel. In addition, each of the two analog outputs can be scaled over a user selectable range. Reference Table 2.2 below to wire one or both of the mA output(s).

Terminal-Pin #	Description	Notes
A-1	Reserved for Future Use	Do not connect
A-2		
A-3		
A-4		
A-5		
A-6		
B-1	Analog Output 1	0/4-20 mA
B-2	Analog Output 1 Return	
B-3	Analog Output 2	0/4-20 mA
B-4	Analog Output 2 Return	
B-5	Reserved for Future Use	Do not connect
B-6		
C-1	Alarm 1 Common Contact	
C-2	Alarm 1 Normally Open Contact	
C-3	Alarm 1 Normally Closed Contact	
C-4	Alarm 2 Common Contact	
C-5	Alarm 2 Normally Open Contact	
C-6	Alarm 2 Normally Closed Contact	

TABLE 2.2 CUSTOMER WIRING

Notes:

1. Do not connect anything to the unused outputs of the analyzer.
2. For voltage outputs, choose the 0-20 mA option. First determine the desired voltage output. For this example we selected a range of 0-5 volts. Take the 5V and divide it by 20 mA (0.020). This yields a resistance of 250 ohms which is the resistance necessary to terminate the analog output to obtain a 0-5 volt full scale output. Please remember that the maximum resistance across the output (including the wiring) is nominally 950 ohms.

3 Operation

3.1 Preparation for Operation

3.1.1 Mounting Configurations

Bench Top / Portable (BTP Configuration) The BTP is the basic configuration for the Series 9600 Oxygen and Carbon Dioxide Analyzer, designed for either bench top or portable applications. All gas and electrical connections are located on the instrument's rear panel. See Appendix A for detailed dimensional drawings.

Optional Rack / Panel Mounting (RMK Configuration) The RMK is a "Rack Mount Kit" that allows the instrument to be mounted on an aluminum frame suitable for either rack or panel mounting.

3.1.2 Initial Check

The Series 9600 Oxygen and Carbon Dioxide Analyzer is ready to be used out of the shipping container. The analyzer has been calibrated at the factory and re-calibration is not required at initial start up¹. Please refer to Section 5.1 for details regarding routine calibration.

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 rear of the instrument is switched ON. The Series 9600 Oxygen and Carbon Dioxide Analyzer has non-volatile flash memory so that all the values set by the user via the front panel will be maintained. Upon powering the Series 9600 Oxygen and Carbon Dioxide Analyzer, the instrument will immediately start to display the oxygen level and will show "warming up..." to indicate that it will begin showing the carbon dioxide levels as soon as the carbon dioxide sensor has warmed up. This will only take a minute or so. This first screen is called the "Home" screen.

3.2.2 Front Panel Controls and Indicators

The front panel of the Series 9600 Oxygen and Carbon Dioxide Analyzer contains a 4 Line liquid crystal display (LCD), seven (7) membrane panel buttons ("Alarm 1", "Alarm 2", up, down, left, right, and "Enter"), and two (2) alarm LEDs. An audible indicator is located inside of the instrument. The 4 Line LCD display shows the concentration of oxygen and carbon dioxide in the sample being measured in terms of percent oxygen and percent or ppm carbon dioxide by volume and also displays messages or alerts from the microprocessor. After the analyzer is powered on and the carbon dioxide sensor warms up, the Series 9600 Oxygen and Carbon Dioxide Analyzer will immediately begin to measure and display the oxygen and carbon dioxide concentration of the sample gas being exposed to the sensors.

Note: For optimum results, the analyzer should be powered on for at least 20 minutes prior to all calibrations. The sample gas should also be flowing for at least 5 minutes prior to calibration.

The Series 9600 Oxygen and Carbon Dioxide Analyzer alarms are set at the factory as low alarms². Each of the alarms can be set by the user for operation as high or low alarms. Please refer to Section 3.6 (Alarm System) for instructions on how to set the alarms.

¹ At higher elevations it may become necessary to recalibrate. Please refer to section 5.1 for details on calibration.

² Alarms are disabled at the factory by setting each alarm to be a "low alarm" and setting each set point to zero.

3.3 Navigating the Front Panel and Menu System

3.3.1 General Navigation

The Series 9600 Oxygen and Carbon Dioxide Analyzer has four distinct display screens. The "Home" screen displays the sensor values. The "Message" screen displays sensor status information. The "Alarm status" screen displays the status of the selected alarm. The "Main Menu" screen displays all the available user adjustable parameters available on the instrument in an easy to use scrollable menu system using the front panel buttons.

The "Home" screen is a read only screen, there are no adjustable parameters on this screen. This screen displays the output of each sensor in the instrument.

The "Message" screen is a read only screen, there are no adjustable parameters on this screen. This screen displays information related to the sensor status, such as when the oxygen sensor needs replacing. Use the left and right buttons to navigate between the "Home" and "Message" screens. The screen will display either "A T T E N T I O N !" when a message is displayed, or "N O A L E R T S" when the sensor status is normal.

The "Alarm Status" screen displays the status of each alarm. The "Alarm Status" screen is accessed by pressing either the Alarm 1 button or the Alarm 2 button while viewing the "Home" screen. Each status screen will display only the information relevant to that particular alarm. Pressing the alarm button a second time while viewing the "Alarm Status" screen will exit the "Alarm Status" screen and return the user to the "Home" screen. Pressing the Enter button while in the "Alarm Status" screen will display the alarm settings within the "Main Menu", allowing the user to change the alarm parameters.

The "Main Menu" screen displays all of the user adjustable options available on the instrument. To enter the "Main Menu", while on the "Home" screen, press the Enter button. Use the up and down buttons to navigate the menu. Using the left and right buttons will navigate between the "Main Menu"'s main headings, allowing for quicker navigation of the menu. To change a parameter in the menu, use the up or down button to navigate to the parameter and then press the Enter button to enter into edit mode for that parameter. The cursor will blink while in edit mode. Use the up, down, left, and right buttons to edit the parameter value. When finished, press the Enter button to store the new parameter value or press either the Alarm 1 or Alarm 2 button to cancel all changes and return to the "Main Menu". To exit the menu, use the up or down buttons to navigate to one of the " **EXIT** " options and press the Enter button, or simply press either the Alarm 1 or Alarm 2 button while not in edit mode.

3.3.2 Pass codes

There are 2 pass code levels in the "Main Menu". Each pass code level will block out all menu options below that particular pass code. "Pass code #1:" determines access to the Alarm and Analog Output settings as well as access to "Pass code #2". "Pass code #2:" determines access to the Calibration settings. These pass codes are a simple way to hide items that should not be inadvertently changed.

The pass codes are set at the factory to the following:

Pass code #1:	96
Pass code #2:	2642

The pass codes when shipped from the factory are set as shown above and enables complete access to the entire menu. Changing the pass codes to any other number than shown above will hide the menu items below each corresponding pass code. To show the menu items again, simply set the corresponding pass code back to the factory setting as shown above.

3.4 Miscellaneous Settings

The Series 9600 Oxygen and Carbon Dioxide Analyzer has basic system settings available for the user to edit. These settings include the baud rate for RS232/485 communication (optional), addressing for RS485 communications (optional), and setting or enabling/disabling of the internal software clock.

3.4.1 Setting the Baud Rate

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Misc Settings". Under the "Misc Settings" heading there is a list of parameters. Navigate to the "Baud Rate" parameter and press the Enter button to edit the parameter. This parameter can be set for 2400, 4800, 9600, 19.2K, 28.8K, 38.4K, 57.6K, or 115.2K. When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

Note: The baud rate will change immediately, therefore any communications equipment connected to the RS232/485 output should also be set accordingly to continue communicating correctly and avoid garbled data.

This option may not be available if the instrument is not ordered with serial communications.

3.4.2 Enabling and Setting Instrument Addresses in Optional RS485

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Misc Settings". Under the "Misc Settings" heading there is a list of parameters. Navigate to the "Addressing?" parameter and press the Enter button to edit the parameter. This parameter can be set for either "ON" or "OFF". When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. When the "Addressing?" parameter is set to ON, the parameter "Address" will appear under the menu heading "Misc Settings". To change the instrument's RS485 communications address, navigate to the "Address" parameter and press the Enter button to edit the parameter. The address can be set to any number from 1 to 32. Using the instrument address feature will allow the connection of multiple instruments onto a single RS485 communications bus. Up to 32 instruments can be connected with it's own unique address. For more information see section 8 Optional RS Serial Communications.

This option may not be available if the instrument is not ordered with RS485 serial communications

3.4.3 Enabling and Setting the System Software Clock

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Misc Settings". Under the "Misc Settings" heading there is a list of parameters. Navigate to the "Display Clock?" parameter. Here you can optionally turn the clock "ON/OFF". Turning the clock "OFF" will remove the clock from the "Home" screen as well as the menu options for hours, minutes, and seconds. Turning it "ON" will display the clock on the "Home" screen and display the menu options for hours, minutes, and seconds. To set these parameters, simply continue to navigate down to the "Hours", "Minutes", or "Seconds" parameter and press the Enter button to edit the parameter. Use the up and down buttons to change this parameter. Hours can be set for 0-23, minutes can be set for 0-59, and seconds can be set for 0-59. When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

3.5 Analog Outputs of the Analyzer

The Series 9600 Oxygen and Carbon Dioxide Analyzer is equipped with two (2) standard, non-isolated, analog outputs (isolated analog outputs are available as options). Each output can be selected to operate with either the oxygen sensor or the carbon dioxide sensor. The analog outputs can be set to correspond to a custom low to high range within the measurement range of the sensor. The standard analyzer is shipped from the factory as shown below:

Output	Associated Sensor "Type"	Analog Output Scaling (typical settings)	mA Offset Setting
Analog Output 1	Oxygen "O ₂ "	0 to full scale (0 to 100%)	4-20
Analog Output 2	Carbon dioxide "CO ₂ "	0 to full scale (0 to 20%) (0 to 5,000 ppm) ¹	4-20

TABLE 3.5.1 ANALOG OUTPUT FACTORY DEFAULT SETTINGS

The analog output offset settings determine whether the associated current output is 0-20 mA or 4-20 mA ("live" zero). The "live" zero allows equipment monitoring the current loop to know that something is wrong when the current falls below 4 mA. The 0 mA setting on the other hand allows for easy scaling when using a resistor to convert the current to a voltage. These options provide great flexibility in controlling the range of the analog outputs (see specifications for maximum load resistance).

3.5.1 Setting the Analog Output Sensor Association

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Analog Out 1" (or "Analog Out 2"). Under the "Analog Out #" heading there is a list of parameters. Navigate to the "Sensor" parameter and press the Enter button to edit the parameter. This parameter can be set for oxygen "O₂", or carbon dioxide "CO₂" using the up and down buttons. When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. Both analog outputs can be associated with the same sensor type.

3.5.2 Setting the Analog Output Range

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Analog Out 1" (or "Analog Out 2"). Under the "Analog Out #" heading there is a list of parameters, navigate to the "Scale High" parameter and press the Enter button to edit the parameter. Use the up, down, left, and right buttons to change this parameter for any number between the value of the "Scale Low" Parameter and the maximum operating range of the sensor type selected. This parameter represents the sensor value at which the analog output will be at its highest (20 mA). When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 buttons to cancel all changes. Navigate to the "Scale Low" parameter and press the Enter button to edit the parameter. Use the up, down, left, and right buttons to change this parameter for any number between the value of the "Scale High" parameter and zero. "Scale Low" represents the sensor value at which the analog output will be at its lowest (0 mA or 4 mA depending on the output's "Offset" setting). When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

¹ Other ranges for CO₂ covering ppm and percent to 100% are available. Please contact the factory for details.

Notes:

1. The “Scale High” value cannot be set lower than the “Scale Low” value. Likewise, the “Scale Low” value cannot be set higher than the “Scale High” value. If you are unable to adjust either parameter to the desired value, check that the other parameter’s value is not interfering.
2. Whenever changing the Analog Output Sensor Association, always check and rescale the “Scale High” and “Scale Low” parameters to avoid having the old sensors associated settings “left over” from a previous setting.

3.5.3 Setting the Analog Output Offset

Enter into the “Main Menu” by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading “Analog Out 1” (or “Analog Out 2”). Under the “Analog Out #” heading there is a list of parameters, navigate to the “Offset” parameter and press the Enter button to edit the parameter. Use the up and down buttons to change this parameter to either 0 mA or 4 mA. When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

NOTE: Regardless of how the analog outputs are scaled, the analyzer will always maintain the capability of displaying sensor concentrations over the instrument’s sensor range. Scaling the outputs does not scale the front panel digital display. Furthermore, sensor alarm relays can be expected to change state if the sensor values exceed the alarm setting (independent of the output scaling).

3.5.4 Analog Output Options Overview

Below is an overview with a brief description of each option for the Analog Outputs:

Option	Description
Sensor	Select either oxygen “O ₂ ” or carbon dioxide “CO ₂ ” as the sensor associated with this analog output
Scale High	Select the high end of the analog output (example: 20.0 %)
Scale Low	Select the low end of the analog output (example: 0.00 %)
Offset	Select the analog output to be either 0-20 mA or 4-20 mA

TABLE 3.5.2 OVERVIEW OF ANALOG OUTPUT SETTINGS

3.6 Alarm System

The Series 9600 Oxygen and Carbon Dioxide Analyzer is equipped with two (2) single pole double throw (SPDT) relays (see specifications). All alarm relays are user configurable with the front panel controls of the instrument. When an alarm event takes place, several indications are provided by the Series 9600 Oxygen and Carbon Dioxide Analyzer.

1. The front panel LED associated with the alarm in question will illuminate.
2. An audible alarm will sound (if not disabled by the user via the “Main menu”).
3. The relay associated with the alarm in question will change state.

The alarms can be associated with either the oxygen or the carbon dioxide sensor in the instrument. Both alarms have user selectable set points as well as high and low triggers for the set points. The alarms have the ability to latch if an alarm condition has occurred. A latched alarm requires that the user manually clear the alarm indication if the alarm condition no longer exists. The alarms can be placed into fail-safe (“ON” mode) in which the associated alarm relays will be

energized in a non-alarm condition and the associated alarm relays will NOT be energized in an alarm condition. This would be the same relay state (not energized) that would be achieved if the power source were interrupted. The factory default fail-safe setting is "OFF". The user also has the option to disable the built in audible alarm for each individual alarm.

3.6.1 Setting the Alarm Sensor Type Association

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and then press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "Sensor" parameter and press the Enter button to edit the parameter. Use the up and down buttons to set this parameter to oxygen "O₂" or carbon dioxide "CO₂". Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. Both alarms can be associated with the same sensor.

3.6.2 Setting the Alarm Set point

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "Set point" parameter and press the Enter button to edit the parameter. Use the up, down, left, and right buttons to change this parameter to any value within the operating limits of the selected sensor type. Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

3.6.3 Setting the Alarm High or Low

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "HI/LO" parameter and press the Enter button to edit the parameter. This parameter can be set for high "HI", meaning when the sensor value is greater than or equal to the set point the alarm will activate, or the parameter can be set for low "LO", meaning when the sensor value is less than the set point, the alarm will activate. Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. Note: To disable an alarm, simply set it's "Set point" value to "0.00" and the "HI/LO" setting to "LO".

3.6.4 Setting the Alarm Latch

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "Latching" parameter and press the Enter button to edit the parameter. This parameter can be set for "ON" or "OFF". Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

When the "Latching" parameter is set to "ON", the user is required to manually clear the alarm indication even if the alarm condition no longer exists. To clear the alarm manually, enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #"

heading there is a list of parameters, press the Enter button to enter edit mode on any of the associated alarm parameters. Either edit or confirm the present parameter value to clear the latched alarm state.

For Example: Alarm 1 is set for oxygen at a value of 18% low. The oxygen sensor detects a drop in the oxygen value and the alarm condition is met, triggering Alarm 1. The oxygen value later returns to a value above 18%. At this time the alarm indication is still active because it has been latched. Pressing the Alarm 1 button will enter into the "Alarm 1 Status" screen, displaying that the alarm indication is on. The user must now access the "Alarm #" parameters in the "Main Menu" and enter into edit mode on any of the associated alarm parameters and either confirm or edit the value of the parameter to clear the latched alarm state. **Note:** If the alarm condition is still valid and an attempt is made to reset the alarm, the alarm will not be reset and will continue to be active. The audible alarm can optionally be muted while waiting for the alarm condition to clear by simply pressing the associated Alarm button while viewing the alarm status from the "Alarm Status" screen (see section 3.6.6 Setting the Alarm Audible).

When the "Latching" parameter is set to "OFF", the alarm indication will clear whenever the alarm condition no longer exists.

For Example: Alarm 1 is set for oxygen at a value of 18% low. The oxygen sensor detects a drop in the oxygen value and the alarm condition is met, triggering Alarm 1. The oxygen value later returns to a value above 18%. At this time all alarm indications will clear because the alarm "Latching" parameter is set to "OFF".

3.6.5 Setting the Alarm Failsafe

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "FailSafe" parameter and press the Enter button to edit the parameter. This parameter can be set for "ON" or "OFF". Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. With the "FailSafe" parameter set to "OFF", the alarm relay will energize when there is an alarm condition. When the "FailSafe" parameter is set to "ON", the alarm relay will be energized when there is **NO** alarm condition.

3.6.6 Setting the Alarm Audible

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen or press the associated Alarm button on the front panel and press the Enter button while in the "Alarm Status" screen. Navigate the menu until you reach the menu heading "Alarm 1" (or "Alarm 2"). Under the "Alarm #" heading there is a list of parameters, navigate to the "Audible" parameter and press the Enter button to edit the parameter. This parameter can be set for "ON" or "OFF". Press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes. When set to "ON", the internal audible alarm will sound when an alarm condition is met. When set to "OFF", the internal audible alarm is silenced during an alarm condition.

3.6.7 Alarm Options Overview

See Table 3.6.7 on the next page for an overview with a brief description of each option for the Alarms:

Option	Description
Type	Select oxygen "O ₂ " or carbon dioxide "CO ₂ "
Set point	Enter the value at which the alarm will activate
HI/LO	Select either High or Low level alarm
Latching	Select either "ON" or "OFF" for alarm latching
Failsafe	Select either "ON" or "OFF" for alarm fail-safe
Audible	Select either "ON" or "OFF" for audible alarm

TABLE 3.6.7 OVERVIEW OF ALARM SETTINGS

3.7 Timing Out

If the user has navigated to any of the instrument screens other than the "Home" screen in the Series 9600 Oxygen and Carbon Dioxide Analyzer and no navigation has been made for approximately 2 minutes, the analyzer will automatically revert back to displaying the "Home" screen on the LCD. Also, if the user is in the process of adjusting any of the instrument parameters (including calibration), and no adjustment has been made for approximately 2 minutes, the analyzer will automatically revert back to displaying the "Home" screen on the LCD. When the instrument times out while setting a parameter, the parameter value will revert to that which was previously set. This is equivalent to canceling any input by pressing the Alarm 1 or Alarm 2 button. This feature helps to prevent the user from inadvertently keeping the analyzer off-line for a prolonged period of time or changing a parameter to an undesirable value.

4 Sample Gas Handling

The standard Series 9600 Oxygen and Carbon Dioxide Analyzer has 1/4" quick connect sample gas fittings on the input and output. Stainless steel 1/4" compression fittings are also available as an option. A standard Series 9600 Oxygen and Carbon Dioxide Analyzer is shown in Figure 4.1 for use where the flow control will be done external to the analyzer with either a pressure regulator and/or needle valve. To the right shows the optional flow meter with integrated flow control which allows for higher pressure at the input.

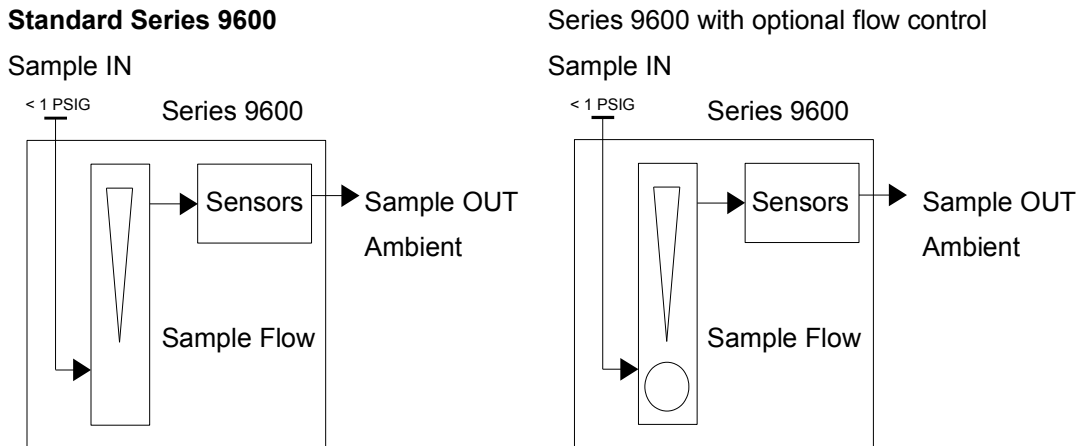


FIGURE 4.1 SIMPLE POSITIVE PRESSURE SAMPLING

It is highly recommended to reduce the pressure of the sample gas to less than 1 PSIG at the analyzer's input to significantly reduce the risk of damaging the sensors. See the Bypass Plumbing Assembly (P/N 9BYPASS) option later in the manual for a better plumbing arrangement for sampling pressurized inputs greater than 1 PSIG.

Note: Particular attention should be paid to ensure that there are no "Sample OUT" restrictions (or sources of back pressure) connected to the output of the analyzer to avoid pressure related errors.

The oxygen sensor used in the Series 9600 Oxygen and Carbon Dioxide Analyzer is a partial pressure measuring device and any changes to the total pressure will affect each of the partial pressures including oxygen. Fluctuations in sample back pressure could lead to a significant error in the oxygen measurement. Therefore, the most critical item to pay close attention to is the delta pressure across the sensors. This is easily handled by following the example plumbing arrangements shown on the following pages.

In relation to the two standard configurations shown, the instrument is typically operating in one of two ways:

1. Monitoring a pressure regulated source where the pressure is already controlled to less than 1 PSIG. This may or may not need a flow meter with integral flow control adjustment depending on the pressure of the sample and whether the control valve is external or not.

2. Drawing a sample from a source (using the optional internal pump). This sample source is usually at or very close to atmospheric pressure. This configuration can also come with or without a flow meter with integral flow control adjustment¹.

In both cases, the sample gas should be vented out the “Sample OUT” port to an ambient atmosphere to avoid any back pressure on the sensors.

In Figure 4.2, the optional internal sample pump has been added to the plumbing arrangement. Note that this configuration is used when drawing a sample gas that is at or near ambient pressure.

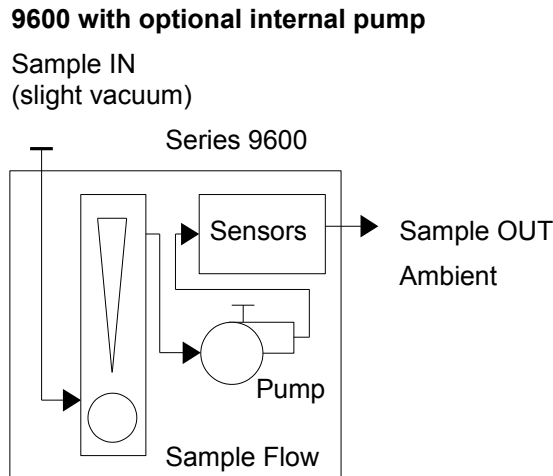


FIGURE 4.2 SIMPLE NEGATIVE PRESSURE SAMPLING WITH INTERNAL PUMP

Again, the control on the flow meter is optional depending on the application. For instance, when using a bypass arrangement as described later in this manual.

4.1 Positive Pressure Sampling

The standard Series 9600 Oxygen and Carbon Dioxide Analyzer does not come equipped with a sample pump. In this case, the sample must be under positive pressure and the “Sample Flow” must be adjusted by means of an external flow adjustment or by means of the optional flow adjustment on the front panel flow meter. As stated earlier, the factory strongly recommends the sample gas to be allowed to vent to atmosphere to avoid errors in the measurement due to back pressure.

DO NOT draw a sample through the “Sample OUT” exit fitting under vacuum as this could cause significant errors in the gas measurements.

Shown below is an example of using the Series 9600 Oxygen and Carbon Dioxide Analyzer in a positive pressure sampling mode with the capability of using higher than 1 PSIG sample sources.

¹ Depending on the pressure of the sample and whether the control valve is external or not.

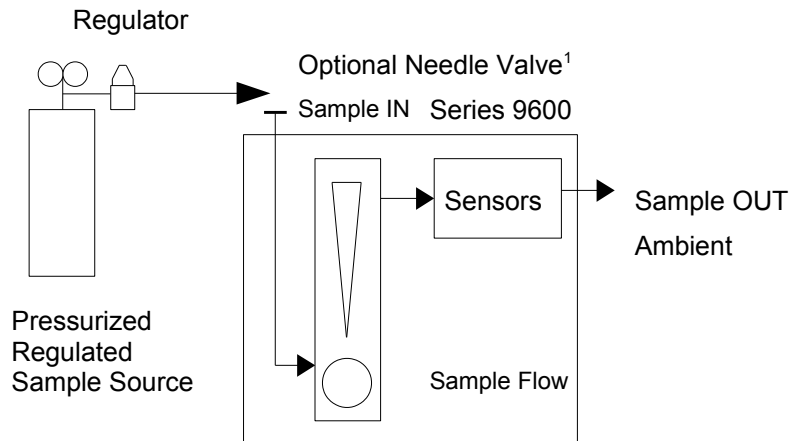


FIGURE 4.3 POSITIVE PRESSURE SAMPLING SYSTEM

Please note that in this example, the sample source is coming from a pressurized cylinder of gas and is then routed through a pressure regulator. The output is shown with an arrow pointing to the “Sample IN”. This is where an optional needle valve may be installed in series if necessary. As long as the pressure is regulated down to the recommend pressure of 1 PSIG, then the needle valve may not be necessary. A case where it might be necessary is when the Series 9600 Oxygen and Carbon Dioxide Analyzer is ordered without a flow meter with integral flow control adjustment. In this case, the needle valve will be used to control the final pressure drop and therefore the flow rate into the analyzer.

Note: In some cases the sample gas may be simply routed through a tee at the “Sample IN” and the flow controlled using either the optional flow meter with integral flow control adjustment or a needle valve on the “Sample IN”. This is called a “bypass”. On the opposite page under “Negative Pressure Sampling” there is a “Bypass Plumbing Assembly” (BPA) that is available for use when the Series 9600 Oxygen and Carbon Dioxide Analyzer is equipped with a pump and must draw a sample. This BPA can also be used for “Positive Pressure Sampling” as well. The only difference is that the pressurized sample gas source is split between the bypass flow and the “Sample IN” (no pump needed). This is useful when the pressurized sample gas source must be routed back to process.

As shown in Figure 4.4, there is typically some kind flow restriction or needle valve at the exit of the bypass to create enough pressure at the “Sample IN” of the analyzer to sample the gas source. See Figure 4.4 for more details (ignoring the pump).

4.2 Negative Pressure Sampling

The Series 9600 Oxygen and Carbon Dioxide Analyzer can also be ordered with an optional sample pump that is mounted inside the instrument. Alpha Omega Instruments Corp. strongly recommends using the optional pump supplied at the factory when drawing a sample from a source at or near atmosphere. The pump draws a slight vacuum from the “Sample IN” port (maximum of 0.5 atmosphere)². To adjust the proper flow rate, use either an external needle valve or the optional Sample Flow adjustment knob on the front panel flow meter. The instrument should not be used under

¹ Typically the needle valve is not necessary. A case where it might be necessary is when the Series 9600 Oxygen and Carbon Dioxide Analyzer is ordered without a flow meter with integral flow control adjustment. In this case, the needle valve will be used to control the final pressure drop and therefore the flow rate into the analyzer.

² This would be an extreme condition and would require the pump volume control inside the analyzer to be adjusted to maximum

positive pressures when equipped with a sample pump unless using a Bypass Plumbing Assembly (as shown in Figure 4.4 below) where the bypass is vented to ambient atmosphere.

Note: This is the recommended calibration procedure when using a cylinder of gas.

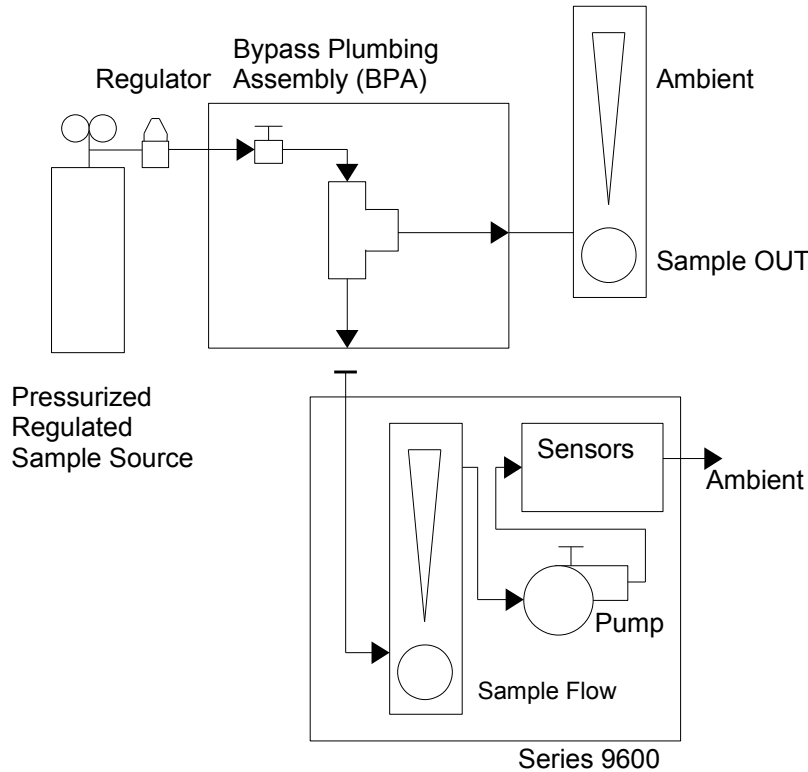


FIGURE 4.4 NEGATIVE PRESSURE SAMPLING SYSTEM

Note: The use of the Bypass Plumbing Assembly allows the analyzer to sample at much higher sample pressure inputs. **Never connect a vacuum source to the gas outlet of the Series 9600.**

The vacuum pump inside the instrument is factory set for enough flow to draw a sample from at or about ambient. This can be adjusted if necessary (never dead end the pump as excessive vacuum can damage the sensors). Please contact the factory for any special requirements. For specific sampling system questions, please contact the factory.

4.3 Gas System Pressure and Flow Limits

Alpha Omega Instrument's optional sample pump (P/N 9PMP) is designed to provide a sample flow rate of up to 1.0 standard liter per minute (SLPM). Optimum flow rates are between 0.2 to 0.5 SLPM. If flow rates are expected to be much higher, it is strongly advised to install a flow control up stream on the sample inlet. As shown in the previous diagrams, an optional "Bypass Plumbing Assembly" is available at the time of purchase to accommodate such a situation. For sample gases and/or calibration gases that are under pressure, it is imperative that the input pressure to the sensor be kept to under 1.0 pound per square inch (PSIG) or 0.07 kg/cm². If the pressure is expected to be in excess of 1.0 PSIG, it is advisable to use a pressure regulator and most likely a needle valve and/or a valved

flow meter. Alpha Omega Instruments offers a pressure regulator (P/N 9LPR) for use up to 100 PSIG (7.031 kg/cm²). Other regulators with higher capacities are available. Please consult the factory.

4.4 Corrosive Gases

It is not recommended that the Series 9600 Oxygen and Carbon Dioxide Analyzer be used when the sample contains corrosive gas components such as hydrogen sulfide, chlorine, hydrogen fluoride, et. al. If unsure as to the suitability of the gas components in question, please contact the factory prior to start up.

4.5 Orientation

The analyzer should be kept in its designed bench top orientation. Do not operate the analyzer in any position other than level or slightly angled for better viewing with the use of the equipped bail. Using the bail to tilt the analyzer will not effect the sensor reading, however the flow meter will indicate a slightly different flow rate due to the design of the flow meter, this is normal. In general, the Series 9600 Oxygen and Carbon Dioxide Analyzer is not flow sensitive.

4.6 Condensible Gas Constituents

The Series 9600 Oxygen and Carbon Dioxide Analyzer should not be used for applications where there is a likelihood that one or more gas constituents will condense (liquefy). Usually, sample gases with high dew point temperatures (water vapor concentration) can pose a problem. If the sample gas temperature is allowed to cool to the dew point temperature of the sample gas, condensation will take place. If the sensor(s) are exposed to liquids, even in small amounts, erroneous readings will occur and there may be permanent damage to the sensor. A water trap or absorbent system can be used to eliminate the condensate for some applications. Please consult the factory for additional assistance.

4.7 Sample Filtration

As a general cautionary note, if the sample gas contains gas borne particles, filtration of the sample is required. Contact the factory for specific recommendations. Damage to either or both sensors due to gas borne particulates is not covered under warranty.

5 Calibration Procedures

All Series 9600 Oxygen and Carbon Dioxide Analyzers have been fully calibrated at the factory prior to shipment. Alpha Omega Instruments gas measuring sensors feature high accuracy and excellent long term stability characteristics.

5.1 Routine Calibration Check

Routine maintenance is kept to a minimum. As is the case with all gas analyzers and monitors, 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 average once every 4-6 months. Individual calibration procedures are detailed on the following pages.

5.2 Oxygen Calibration

The oxygen sensor used in the Series 9600 Oxygen and Carbon Dioxide Analyzer has a linear output and as a result, it can be calibrated using one calibration gas. The calibration gas must contain a defined concentration of oxygen with a balance of nitrogen (N₂). The actual concentration of oxygen should be chosen based on the range of the instrument. Ideally, the calibration gas should have an oxygen value somewhere between 20-90% of the instrument's intended operating range. For example, if the Series 9600 Oxygen and Carbon Dioxide Analyzer is intended to be used within an oxygen range of 0-25%, use of ambient air (20.9% O₂), is an acceptable way to check the instrument calibration without having to use a cylinder of gas. When calibrating on air, if there is any reason to question the composition of the air, the monitor should be calibrated in an area where there is ample exchange of fresh air from an outside environment. In such cases, if the monitor has not been equipped with a pump, one should be used to provide adequate flow of sample gas to the monitor. Be sure to connect the pressure side of the pump to the sample gas inlet to the analyzer. If the location and/or installation of the monitor precludes the use of a fresh air supply, use of compressed air from a cylinder source is the next best choice (do not use plant air as oil vapors and/or water mist that may be entrained in the gas stream could damage the sensors).

5.2.1 Procedure for Checking Oxygen Calibration

1. Select a cylinder of calibration gas as described above. 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. In addition to the regulator, obtain clean polypropylene or Teflon tubing for delivering the sample gas to the monitor. Note: If the analyzer has an internal pump then the supplied gas should be through a bypass TEE¹ with a length of tubing vented to atmosphere. This is to avoid back diffusion into the sample inlet. Using a bypass TEE will allow the pump to sample the gas at or around atmospheric pressure and not cause any significant errors in the readings.
2. Apply power to the Series 9600 Oxygen and Carbon Dioxide Analyzer and set the calibration gas flow rate to a nominal 0.25 SLPM. Observe the response of the monitor to the calibration gas, waiting until a stable reading has been established. (The use of a

¹ The bypass TEE is available from the factory as P/N 9BYPASS

recorder or data logger can be very helpful in verifying that the analyzer has reached an equilibrium point).

3. The reading from the LCD should reflect the oxygen concentration of the calibration gas. Be sure to allow the reading to come into equilibrium¹ before making any adjustments.
4. If the oxygen value read from the LCD differs from the calibration gas, a calibration adjustment should be made so the value displayed in the LCD is identical to that of the value of the calibration gas. Enter into the "Main Menu" by pressing the "Enter" button while on the "Home" screen. Navigate the menu until you reach the menu heading "Calibrate O₂". Under the "Calibrate O₂" heading there are 2 parameters, "O₂ Sensor" and "Cal Value". The first parameter "O₂ Sensor" shows the current level of oxygen being detected by the sensor. The second parameter "Cal Value" is the value to which the oxygen sensor will be calibrated. To calibrate, navigate to the "Cal Value" parameter and press the Enter button to edit the "Cal Value" parameter. Use the up, down, left, and right button to set this parameter to the level of the calibration gas being sampled by the sensor. Press enter again to set this value as the new oxygen level.

5.2.2 Zero Adjustment for Oxygen

Alpha Omega Instrument's electrochemical oxygen sensor has been zero adjusted at the factory. One of the features associated with the oxygen sensor is its specificity for oxygen molecules. When no oxygen is present in the sample gas, the output of the sensor is zero. As a result, zero calibration is not recommended.

5.2.3 Change Oxygen Sensor Notice

If the oxygen sensor has been calibrated outside of a predetermined range, the instrument will display the "Message" screen which will show "A T T E N T I O N ! Change O₂ Sensor" on the display. The "Message" screen will also appear for about 30 seconds once every hour after the initial message. Use either the left or right button while on the "Home" screen to navigate to the "Message" screen. This message is used to inform the user that a calibration has been performed beyond a predetermined value and is indicating that the output of the sensor has deteriorated to the point that the oxygen sensor should be replaced. Be aware that this message will also appear if the sensor has been accidentally calibrated to a value beyond a predetermined point. For example, if the oxygen sensor was being exposed to a 90% gas and was accidentally calibrated to a value of 20%, the "Change O₂ Sensor" message will appear, simply recalibrating the oxygen sensor to the correct value will clear the message. A typical example of a deteriorated sensor is when the oxygen sensor is displaying a value of 12% when exposed to a 30% gas. A calibration to 30% at this point will show the "Change O₂ Sensor".

5.3 Carbon Dioxide Calibration

To check the calibration of the Series 9600's carbon dioxide sensor, a cylinder of calibration gas will be required. The carbon dioxide content of the cylinder should be within approximately 60-90% of the full scale range of the carbon dioxide sensor. When ordering the calibration gas from a supplier, specify the carbon dioxide range desired and specifying the balance of the gas as nitrogen. Follow the procedure below for calibration.

¹ Allow the instrument to warm up for 20 minutes or more after power on. Wait at least 5 minutes to allow the gas to stabilize before checking the value of the oxygen reading

5.3.1 Procedure for Checking Carbon Dioxide Calibration

1. Select a cylinder of calibration gas as described above. 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. Note: If the analyzer has an internal pump, then the supplied gas should be through a bypass TEE¹ with a length of tubing vented to atmosphere (this is to avoid back diffusion into the sample inlet). Using a bypass TEE will allow the pump to sample the gas at or around atmospheric pressure and avoid errors in the readings due to pressure variations.
2. Apply power to the Series 9600 Oxygen and Carbon Dioxide Analyzer and set the calibration gas flow rate to a nominal 0.25 SLPM. Observe the response of the monitor to the calibration gas, waiting (at least 5 minutes) until a stable reading has been established. (The use of a recorder or data logger can be very helpful in verifying that the monitor has reached an equilibrium point).
3. If the carbon dioxide value read from the LCD differs from the calibration gas, a calibration adjustment should be made so the value displayed in the LCD is identical to that of the value of the calibration gas. Enter into the "Main Menu" by pressing the "Enter" button while on the "Home" screen. Navigate the menu until you reach the menu heading "Calibrate CO₂". Under the "Calibrate CO₂" heading there are 2 parameters, "CO₂ Sensor" and "Cal Value". "CO₂ Sensor" is calculated value of carbon dioxide being sampled by the sensor, "Cal Value" is the value to which the carbon dioxide sensor will be calibrated. To calibrate, navigate to the "Cal Value" parameter and press the Enter button to edit the "Cal Value" parameter. Use the up, down, left, and right button to set this parameter to the level of the calibration gas being sampled by the sensor. Press enter again to set this value as the new carbon dioxide level.

5.3.2 Zero Check of the Carbon Dioxide Channel

The Series 9600 Oxygen and Carbon Dioxide Analyzer does not require zero adjustment.

¹ The bypass TEE is available from the factory as P/N 9BYPASS

6 Menu System

The menu system is comprised of a simple rotating menu that shows the individual items that can be set or viewed by the user. There is only one menu - the "Main Menu".

6.1 Main Menu

The "Main Menu" is where all of the settings will be changed or viewed. The following table shows the "Main Menu" and the options available. Press the Enter button while in the "Home" screen to display the "Main Menu" as shown below. Pressing the Enter button on any adjustable parameter will enter into edit mode. Use the up, down, left, and right buttons to change the parameter values, press the Enter button to save the new parameter value, or press either the Alarm 1 button or the Alarm 2 button to cancel all changes. **Note:** Depending on system configuration, not all options may be available, such options include "Baud Rate?" and "Addressing?", available only if RS communications is installed in the instrument. The "Clock Set" options will only appear if the "Display Clock?" option is turned ON.

Misc Settings	Values	Description
Baud Rate?	2400, 4800, 9600, 19.2K, 28.8K, 38.4K, 57.6K, 115.2K	Select Baud Rate for RS232 Communications
Addressing?	ON, OFF	Allow RS485 Addressing
Address	1 to 32	Select RS485 Communications Address
Display Clock?	ON, OFF	Turn Clock On/Off
Clock Set Hours:	0-23	Set Clock Hours (Clock ON)
Clock Set Minutes:	0-59	Set Clock Minutes (Clock ON)
Clock Set Seconds:	0-59	Set Clock Seconds (Clock ON)
EXIT		
Passcode #1:	XXXXX	Pass code to allow access to Alarm and Output options
----ALARM 1----	Values	Description
Sensor:	O ₂ , CO ₂	Associated Alarm Sensor
Set Point:	XXX.XX	Within limits of instrument sensor range
HI/LO?	HI, LO	Alarm trigger greater or less than setpoint
Latching?	ON, OFF	Latching or Non-Latching Alarm
Failsafe?	ON, OFF	Fail-Safe or Non-Fail-Safe Alarm Relay
Audible?	ON, OFF	Audible Alarm
EXIT		
----ALARM 2----	Values	Description
Sensor:	O ₂ , CO ₂	Associated Alarm Sensor
Set Point:	XXX.XX	Within limits of instrument sensor range
HI/LO?	HI, LO	Alarm trigger greater or less than setpoint
Latching?	ON, OFF	Latching or Non-Latching Alarm
Failsafe?	ON, OFF	Fail-Safe or Non-Fail-Safe Alarm Relay
Audible?	ON, OFF	Audible Alarm
EXIT		

TABLE 6.1 MAIN MENU SETTINGS, VALUES, AND DESCRIPTIONS

Continued on Next Page

Continued from Previous Page

- Analog Out 1 -	Values	Description
Sensor:	O ₂ , CO ₂	Select Sensor for Analog Output
Scale High:	XXX.XX	Select High end of custom range for Analog Output within limits of the sensor
Scale Low:	XXX.XX	Select Low end of custom range for Analog Output within limits of the sensor
Offset:	0 mA, 4 mA	Select mA Output offset of either 0 mA or 4 mA for 0-20 mA or 4-20 mA
EXIT		
- Analog Out 2 -	Values	Description
Sensor:	O ₂ , CO ₂	Select Sensor for Analog Output
Scale High:	XXX.XX	Select High end of custom range for Analog Output within limits of the sensor
Scale Low:	XXX.XX	Select Low end of custom range for Analog Output within limits of the sensor
Offset:	0 mA, 4 mA	Select mA Output offset of either 0 mA or 4 mA for 0-20 mA or 4-20 mA
EXIT		
Passcode #2:	XXXXX	Pass code to allow access to Calibration Options
- CALIBRATE O₂ -	Values	Description
O ₂ Sensor:	XXX.XX	Calculated Oxygen value being sampled by the sensor
Cal Value:	XXX.XX	Value to Calibrate the Oxygen sensor to
EXIT		
- CALIBRATE CO₂ -	Values	Description
CO ₂ Sensor:	XXX.XX	Calculated carbon dioxide value being sampled by the sensor
Cal Value:	XXX.XX	Value to Calibrate the carbon dioxide sensor to
EXIT		
Elevation	XXXXX	Sets instrument elevation

TABLE 6.1 MAIN MENU SETTINGS, VALUES, AND DESCRIPTIONS (CONTINUED)

7 Maintenance and Troubleshooting

7.1 User Maintenance

The Series 9600 Oxygen and Carbon Dioxide Analyzer requires minimum user maintenance. The user should check the calibration of the analyzer in accordance with established protocol. If no protocol exists, Alpha Omega Instruments recommends that the analyzer be calibrated every 4-6 months.

7.2 Serviceable Items

End user serviceable items located inside the chassis include the oxygen sensor and the optional pump. Do not open the chassis except in rare cases when the oxygen sensor needs to be replaced or the flow rate by way of the pump needs adjustment. Please contact the factory for more information on adjusting the pump/flow rate in special circumstances.



**WARNING:
RISK OF
SHOCK**

WARNING: ELECTRICAL SHOCK HAZARD: DANGEROUS VOLTAGES ARE PRESENT WITHIN THE INSTRUMENT. THIS PARTICULAR WARNING SYMBOL IS SPECIFIC TO AN ELECTRICAL HAZARD EXISTING AT OR NEARBY THE COMPONENT AND/OR PROCEDURE UNDER DISCUSSION. FAILURE TO HEED THE WARNINGS MAY RESULT IN INJURY AND/OR DEATH. REMOVE ALL POWER SOURCES WHEN INSTALLING OR REMOVING AC POWER OR DATA SIGNAL CONNECTIONS AND WHEN PERFORMING ANY WORK INSIDE THE INSTRUMENT ENCLOSURE.

7.3 Troubleshooting

In the case that readings are incorrect, please consider the following while using the Series 9600 Oxygen and Carbon Dioxide Analyzer:

- Leaks in the sample lines are the most common source of error when it comes to the gas sample readings. If there are leaks in the sampling system, the readings could display as high or low depending on the gas concentration being measured. This is due to the fact that there is 20.9% oxygen and typically less than 500 ppm of CO₂ in the ambient air. Ambient air, if allowed to leak into the sampling system, will cause erroneous readings on the display. For example, if the analyzer is monitoring a tank of 100% oxygen and there is a leak in the upstream plumbing, the sensor will be exposed to a portion of the ambient air mixed with the 100% sample and show a lower reading. The same is true for the CO₂.
- Another source of error is improperly calibrated sensors. It is recommended to first check the calibration of the sensor in question before investigating any other source of error.
- Readings on the 4-20 mA outputs may also be incorrectly scaled. Be sure to check the scaling on the outputs to insure that the range of gas is properly indicating while on a known gas. Note: using ambient air is a good way to make a quick check of the system. The oxygen should read close to 20.9% and the CO₂ should read closer to zero (in the 100 to 300 ppm range).

8 Optional RS Serial Communications

8.1 Baud Rates

RS-232 Serial communication baud rates are 115200, 57600, 38400, 28800, 19200, 9600, 4800, and 2400. Rates for RS485 are the same.

8.1.1 To set the RS-232/485 baud rate

Enter into the "Main Menu" by pressing the Enter button while on the "Home" screen. Navigate the menu until you reach the menu heading "Misc Settings". Under the "Misc Settings" heading there is a list of parameters. Navigate to the "Baud Rate?" parameter and press the Enter button to edit the parameter. Use the up and down buttons to change this parameter to any of the available baud rates listed above. When finished, press the Enter button to save this parameter or press either the Alarm 1 or Alarm 2 button to cancel all changes.

8.1.2 RS485 Commands

As noted in the Help screen, instruments equipped with RS485 communications that have addressing enabled in the "Main Menu" require the prefix of #[#]: where #[#] is a number between 1 and 32 representing the instrument's address. This is set in the "Main Menu" using the instruments front panel controls. For example: to retrieve the status of an instrument with address 15, the command would be **15:V <Enter>**, to retrieve the status of an instrument with address 3, the command would be

3:V <Enter>. The instrument addressing can be enabled/disabled in the "Main Menu", instruments with addressing disabled will respond to commands without the addressing prefix. When addressing is disabled, only one instrument should be connected to the communications bus.

8.2 Standard Commands

This section describes standard RS-232/485 commands. The commands can be entered in either upper or lower case. Optional strings are case-sensitive, such as naming the instrument with the 'N' command, or enabling a security password with the 'E' command.

Standard commands are not case-sensitive, such as when setting a parameter to 'on' or 'off'. Letters may be in either upper or lower case.

The special text: **<Enter>** simply denotes pressing the ENTER key on the keyboard.

Table 8.1 on the next page shows the Help screen which is accessed by pressing:

H <Enter>

This screen includes a list of all commands available to the user. Optional command parameters are shown in brackets for example: [ON|OFF] simply means "ON" or "OFF" as an optional command. "[string]" is used to denote a string of text to be entered by the user.

Some command have a letter in between brackets. These letters are simply placeholders for a specific input required for that command. These inputs are listed under "Where:" in Table 8.1. Please see the details in the table for descriptions of these letter placeholders.

Command	Description
Aa=[#[.#]][L H]	Alarm value set
B=[baud]	Baud rate
Cb=#[.#]	Calibrate selected sensor
D=[string]	Disable Security
E=[string]	Enable Security
Fd=[ON OFF]	Fail-safe for Alarm Relays
G[b]	Get Sensor Output(s)
H	Help screen (this screen)
La=[ON OFF]	Latching/Non-Latching for alarms
Mc=[O2 CO2]	mA output, assign associated sensor
N=[string]	Optionally name the instrument
Oc=[ON OFF]	Offset for mA Outputs (ON=4 mA)
Pa=[O2 CO2]	Program alarm, assign associated sensor
Q=[ON OFF]	Quiet mode (mutes the audible)
Rc=#[.#]L H	Range low high for mA outputs
Sa=[ON OFF]	Sound audible alarms
T=[ON OFF]	Time display
T##:##[:##]	Set clock time in HH:MM:[SS]
V	View current Alarms and settings
Where:	
a	1' or '2' for Alarm 1 or Alarm 2
b	1' or '2' for Sensor 1 (O ₂) or Sensor 2 (CO ₂) respectively
c	1' or '2' for Output Channel Number
d	1' or '2' for Relay 1 or 2
#[.#]	Whole or Decimal number
L/H	'L'ow or 'H'igh alarm or output range setting
baud	Baud rate number from 2400 to 115200
string	String for security protection (see manual)
Notes:	
OFF/O2/0 are interchangeable	
ON/CO2/1 are interchangeable	
RS485 requires a prefix of ##: where ## is 1 to 32 for instrument's address when addressing is enabled	
Some models have only one sensor (see manual)	

TABLE 8.1 STANDARD RS COMMANDS

Single Letter Commands:

All single letter commands, with the exception of 'D' and 'E', will return current status information related to that command, even when security is enabled. Single letter commands can include a '1' or a '2' to denote the specific letter placeholder ('a','b','c', and 'd' as noted in the help screen).

For example a single letter command to find out which sensor is associated with which analog output would be:

M <Enter>

This preceding command will return:

```
Output 1 O2 Range Low(0 mA) - High: 0.00-100.00 %  
Output 2 CO2 Range Low(0 mA) - High: 0.00-20.00 %
```

While

```
M1 <Enter>
```

Will return:

```
Output 1 O2 Range Low(0 mA) - High: 0.00-100.00 %
```

The single letter command of 'M' will return the settings for both Output 1 and Output 2, while 'M1' will only return the settings for Output 1.

8.3 Detailed RS Command Descriptions

'A' Command - Alarm setting

Set the alarm level and high or low trigger.

For example: Alarm #1 will be set to go off in the case of the sensor concentration dropping below 20%. Type the following:

```
A1=20.0L <Enter>
```

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

```
A1=18 <Enter>
```

The low alarm is optional unless changing to high. As you can see, the decimal point is optional too, and if left out, the digits to the right of the decimal default to '0'. Notice how the command in the help screen says, "[#[.#]][L/H]"? Examine the following example:

```
A1=H <Enter>
```

This is a valid command and will only effect the low or high (H) status of Alarm 1. To set it back to a low alarm type:

```
A1=L <Enter>
```

Single Letter Commands: **A** **A1** **A2**

'B' Command - Baud Rate.

Set the communications baud rate of the instrument

To change the baud from 57600bps (default) to 38400bps, first establish communication at 57600bps then type the following:

```
B=38400 <Enter>
```

A message will be displayed informing you to change the terminals baud rate. You must change your terminal's baud rate to reestablish communication with the instrument

Single Letter Commands: **B**

'C' Command – Calibration

Calibrate either the O₂ sensor or the CO₂ sensor. C1 is the O₂ sensor, C2 is the CO₂ sensor.

To calibrate the O₂ sensor using a calibration gas consisting of 10% O₂ / balance nitrogen as an example, type the following:

C1=10 <Enter>

To calibrate the CO₂ sensor using a calibration gas consisting of 8.35% CO₂/ balance nitrogen as an example, type the following:

C2=8.35 <Enter>

Note: When calibrating using RS commands, be sure to enter the calibration value in the same units as the sensor being calibrated. If the sensor is percent, a decimal point may be used. If the sensor is ppm, do not use a decimal point in the calibration value.

Single Letter Commands: C C1 C2

'D' Command – Disable security with optional pass code.

Disable security with optional pass code. (See 'E' command below for description of security)

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:

D=mypass1 <Enter>

Note: Typing "D=MYPASS1" will not disable the instrument if the original pass code was in lowercase! The 'D' and 'E' commands are CASE SENSITIVE.

'E' Command - Enable security with optional pass code.

To keep others from changing system settings, the 'E'nable command is supplied as an optional security measure. When security is enabled, all front panel access will be locked out as well as all RS communications commands that are not single letter commands with the exception of the 'D' command.

The following command shows the use of a pass code:

E=mypass1 <Enter>

This arms the security system and ignores 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). The 'D' and 'E' commands are CASE SENSITIVE.

'F' Command - Fail-safe select.

If the alarm relays should be energized in normal operation and released in the case of a power failure, type the following:

F1=ON <Enter>

F2=1 <Enter>

F1 corresponds to alarm relay #1, F2 corresponds to alarm relay #2. 'ON' and '1' are interchangeable. Each alarm can be controlled individually. 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:

F1=OFF <Enter>

F2=0 <Enter>

F1 corresponds to alarm relay #1, F2 corresponds to alarm relay #2. 'OFF' and '0' are interchangeable.

Single Letter Commands: **F** **F1** **F2**

'G' Command – Display Sensor Concentration

Display either the oxygen, carbon dioxide, or both sensor concentration values.

G **<Enter>**

Will return:

O2, 29.5, %
CO2, 0.12, %

Time will also be displayed if "Time Display" is ON

Single Letter Commands: **G** **G1** **G2**

'H' Command - Help Screen

Displays a help screen as shown in the table above.

H **<Enter>**

'L' Command – Latching/Non-Latching Alarm condition.

Select alarm latching or non-latching for alarm conditions. L1 is for Alarm 1, L2 is for Alarm 2.

Default setting is non-latching. For example, to turn on latching for Alarm 1, type the following:

L1=1 **<Enter>**
or
L1=ON **<Enter>**

To switch to non-latching for Alarm 2, type the following:

L2=0 **<Enter>**
or
L2=OFF **<Enter>**

Note: If an alarm condition no longer exists, to clear a latched alarm send the command "A1=" or "A2=". This is similar to clearing the alarm from the front panel in that the alarm setting is being verified. Please note section 3.6.4 for more information about latching alarms.

Single Letter Commands: **L** **L1** **L2**

'M' Command – Select Analog Output sensor type.

Set analog output 1 or 2 to be associated with either the O₂ or CO₂ sensor. 'M1' is analog output 1, 'M2' is analog output 2. For example, to set analog output 2 to be associated with the CO₂ sensor, type the following:

M2=CO2 **<Enter>**

CAUTION: Whenever changing the Analog Output Sensor Association, always check and rescale the "Scale High" and "Scale Low" parameters using the 'R' Command.

Single Letter Commands: **M** **M1** **M2**

'N' Command – Name of the instrument.

Optional name which can be assigned to the instrument. The name will appear after the OK response from the instrument as OK 'Name'. This can be used to easily determine which instrument is communicating, especially when using multiple instruments connected to an RS485 communications bus. The name is limited to 18 characters, this can be any letter, number, or special character such as @ or &.

To name the instrument “Series 9600”, type:

```
N=Series 9600 <Enter>
```

Single Letter Commands: **N**

'O' Command – Output mA offset

Set the associated sensor mA output offset for either 4 mA or 0 mA. O1 is associated with the analog output 1, O₂ is associated with analog output 2. 'ON' or '1' will set the output offset to 4 mA. 'OFF' or '0' will set the output offset to 0 mA.

For example, to set analog output 2 to 4-20 mA, type the following:

```
O2=1 <Enter>
or
O2=ON <Enter>
```

To set analog output 1 to 0-20ma, type:

```
O1=0 <Enter>
or
O1=OFF <Enter>
```

Single Letter Commands: **O** **O1** **O2**

'P' Command – Select Alarm Sensor type.

Set Alarm 1 or 2 to be associated with either the O₂ or CO₂ sensor. P1 is Alarm 1, P2 is Alarm 2. For example, to set Alarm 2 to be associated with the O₂ sensor, type the following:

```
P2=O2 <Enter>
```

Single Letter Commands: **P** **P1** **P2**

'Q' Command – Quiet mode

Set the “Quiet mode” to “ON” or “OFF” which if set to “ON” disables the audible alarms. Turning it “OFF” will enable “Audible mode” which enables the audible alarms. To enable “Quiet mode”, type the following:

```
Q=ON <Enter>
or
Q=1 <Enter>
```

To turn “Quiet mode” to “OFF” or return to “Audible mode”, Type the following:

```
Q=OFF <Enter>
or
Q=0 <Enter>
```

Single Letter Commands: Q



CAUTION

QUIET MODE DISABLES ALL SOUNDS, INCLUDING THE ALARMS! PLEASE BE SURE TO SET “QUIET MODE” BACK TO “OFF” UNLESS INTENTIONALLY DISABLING ALL THE AUDIBLE ALARMS

This command is useful if the instrument will be in test mode for an extended period of time or any condition causing false alarms. A message will appear under the 'V' command displaying the current mode. **This setting will be reset if the power is turned OFF to avoid accidentally silencing the alarms.**

'R' Command – Set the analog output scale for the associated sensor.

Set the value of the “H”igh and “L”ow scales for the analog outputs. R1 is analog output 1, R2 is analog output 2. For example, to set analog output 1 to have a range of 10 to 20% of the sensor value, type the following:

```
R1=10L <Enter>
R1=20H <Enter>
```

The “L” and “H” are not optional, they must be specified.

Analog output 1 will now be scaled to where 0ma (or 4ma depending on offset) will be at a sensor concentration of 10%, and 20 mA will be at a sensor concentration of 20%.

These values are limited to within the maximum operating range of the associated sensor.

Use the 'P' command to change the associated sensor.

Single Letter Commands: R R1 R2

'S' Command – Alarm condition audible.

Turn alarm condition audible On/Off. S1 is for Alarm 1, S2 is for Alarm 2.

Default setting is ON. For example, to turn off the audible associated with Alarm 2, type the following:

```
S2=0 <Enter>
or
S2=OFF <Enter>
```

To turn on the audible associated with Alarm 1, type the following:

```
S1=1 <Enter>
or
S1=ON <Enter>
```

Single Letter Commands: S S1 S2

'T' Command – Time Display and Time Set

Turn the software clock display On/Off from the instrument's front panel. Also use to set the time on the software clock. For example, to turn the clock display on, type the following:

```
T=ON <Enter>
```

The clock is set in the format of hours, minutes, and seconds, with seconds being optional. For example, to set the clock to 8:30AM, type the following:

T08:30 <Enter>

The clock is in 24 hour format, to set the clock to 8:30:55PM, type the following:

T20:30:55 <Enter>

Single Letter Commands: **T**

'V' Command - View instrument status

This command will display the instrument status including sensor levels, alarm settings, and alarm status. To view the status of the Series 9600, type:

V <Enter>

Typical Response:

```

12:34:02.2, O2    20.9 %
12:34:02.3, CO2   0.10 %
Alarm 1 is OFF, Relay De-Energized
Alarm 2 is OFF, Relay De-Energized
Alarm 1: O2    0.00 % (LO) (Autoreset) (Audible) Failsafe: OFF
Alarm 2: CO2   0.00 % (LO) (Autoreset) (Audible) Failsafe: OFF
Output 1 O2   Range Low(4 mA) - High: 0.00-100.00 %
Output 2 CO2  Range Low(4 mA) - High: 0.00-20.00 %
Quiet mode OFF
O2 status: OK
    
```

8.4 RS232/485 CONNECTIONS

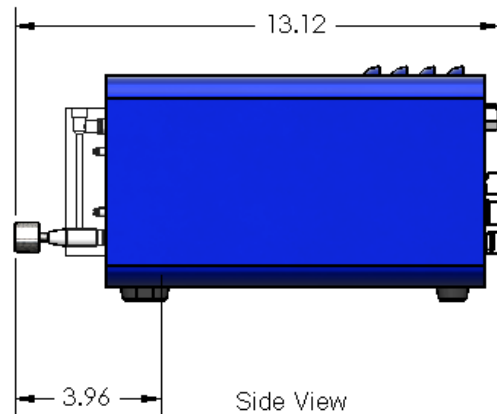
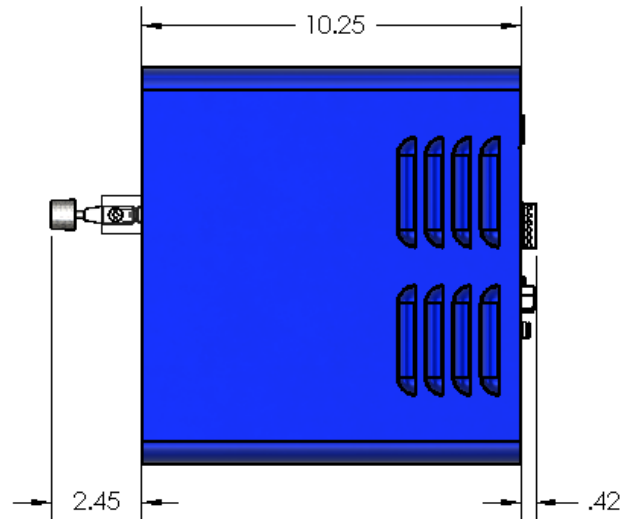
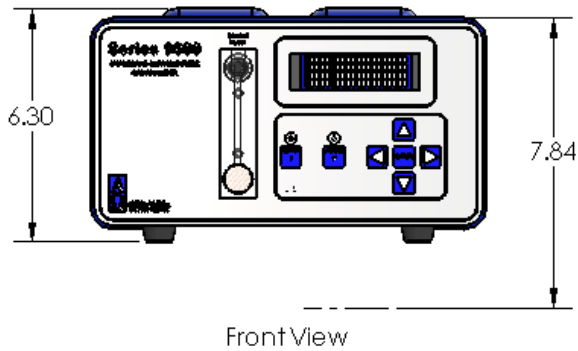
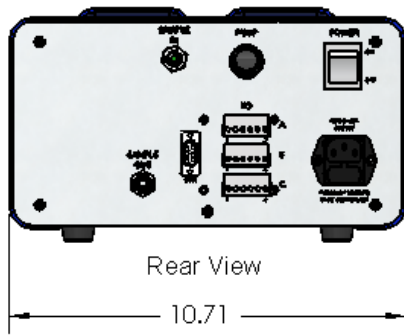
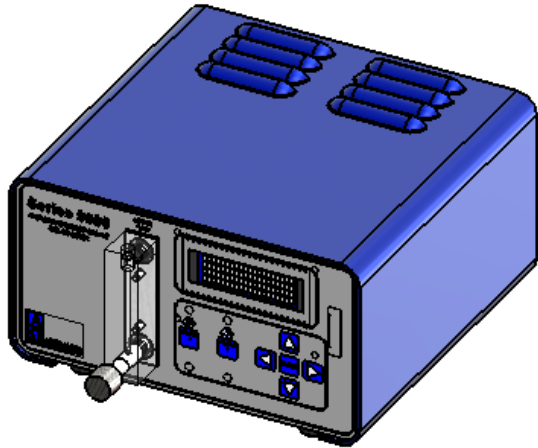
Wire the Series 9600 RS232/485 communications using the table below as a reference.

Series 9610 9 pin "D"	SIGNAL	COMPUTER
Pin 2	TxD	RxD
Pin 3	RxD	TxD
Pin 5	COM	COM

TABLE 8.2 RS232/485 WIRING

Note: If you have an RS485 output and have trouble communicating, try swapping over the input and output lines. Some are called T+ / T- or maybe A / B. Whatever the case, the communications link will not work unless these are correct. The COM (or ground) pin MUST be connected to insure proper communications.

Appendix A



**BENCH TOP
CONFIGURATION
PART NUMBER "BTP"**

Appendix B

Oxygen Sensor Material Safety Data Sheet

SECTION I - PRODUCT IDENTIFICATION

	Alpha Omega Instruments Corp
Address	30 Martin Street
Telephone	401-333-8580
Date Prepared	September 3, 1998
Date Revised	April 12, 2001
Trade Name	2SEN
Description	Weak acidic solution encapsulated in plastic housing.

SECTION II - HAZARDOUS INGREDIENTS OF SOLUTION

Lead Acetate, Trihydrate	CAS # 6080-56-4 OSHA/PEL 0.05 mg/m3 ACGIH/TLV 0.15 mg/m3
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TLV and PEL are for lead, inorganic dusts and fumes, as Pb
 Note: Lead has been reported as causing cancer in laboratory animals, exercise due care.

Acetic Acid, Glacial	CAS # 64-19-7 OSHA/PEL 10 PPM ACGIH/TLV 10 PPM
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NOTE: TLV and PEL are for concentrated (90% - 100%) Acetic Acid, actual solution is less than 50%.

Lead	CAS # 7439-92-1 OSHA/PEL 0.03mg/m3
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SECTION III - PHYSICAL & CHEMICAL CHARACTERISTICS

Boiling Point: Not Available	Specific Gravity: Not Available
Vapor Pressure: Not Available	Vapor Density: Not Available
Evaporation Rate: Not Available	Physical State: Liquid
Melting Point: Not Available	pH: 3.5 - 7.0 Flash Point: > 100 degrees C
Appearance & Odor: Colorless Liquid: Vinegar like odor	
Extinguisher Media: Use water spray, alcohol foam, dry chemical or carbon dioxide	

Special Fire Fighting Procedures: Respiratory protection should be used to avoid breathing fumes.

Unusual Fire & Explosion Hazards:

Lead acetate decomposes at boiling point and toxic gases are produced. Acetic acid vapors may flow along surfaces to distant ignition sources and flash back. Closed containers exposed to heat may explode.

SECTION IV - REACTIVITY DATA OF SOLUTION

	Stable
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/m ³
STEL:	Not Established
PEL:	0.05 mg/m ³
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 continued

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

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.
- 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.