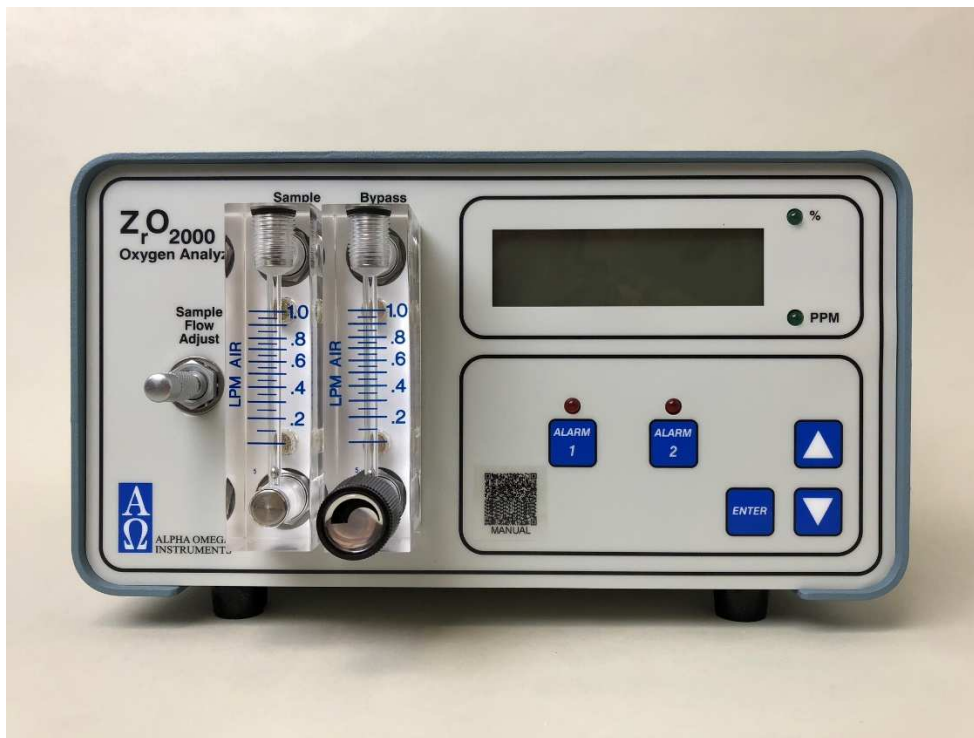

SERIES ZrO₂₀₀₀ FAST RESPONSE OXYGEN ANALYZER

CAUTION

Please take the time to read the manual before starting to use this product.
The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is a high performance analytical instrument and in order to help ensure the long life of the product, care should be taken to operate it as prescribed in this manual.

Refer to Section 7.1.2 on page 7 of this manual for important information in preparation of start-up.



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SECTION 3.0 CAUTIONS

The cautions listed here are important for the proper operation of the analyzer. Please read the following carefully as there are several items to be aware of while operating the instrument.

3.1 Explanation of Graphic Symbols



GENERAL WARNING/CAUTION: Refer to the instructions associated with that section of the manual for specifics on the potential danger.

To avoid the risk of fire or electric shock, do not expose the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer to rain or water spray.



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.*



HOT SURFACE WARNING: *When powered, the sensor is extremely HOT (750 °C). DO NOT TOUCH!*



Potentially Hazardous AC voltages exist within the analyzer. All servicing should be performed by a qualified service technician. Disconnect all sources of power and external connections before removing the cover.



This system is designed for use with inert gases. The sample going into the analyzer must not contain any oils, combustibles (i.e. thread sealants), particulates > 3 microns (i.e. dust), reducing agents (i.e. hydrocarbons, CO, hydrogen, etc.), gases containing H₂S, SO_x, or gases containing solvents. These gases will have adverse effects on the sensor. **Flammable gases or gases containing halogen atoms (such as Freon) must be removed prior to analysis. Gases containing silicon vapors or adhesives must be avoided.** Also, gases with thermal conductivities that are significantly different than nitrogen may cause changes in the output of the sensor and therefore produce measurement errors.

3.2 Important Warnings

RF Disclaimer

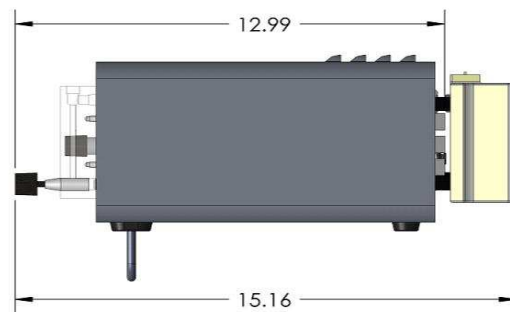
This instrument generates and uses small amounts of radio frequency energy, and there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, try to correct the interference by one of more of the following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

Section 4.0
General Specifications¹

Measurement Ranges	0% to 100%
Resolution	0.01 on highest reading and 0.001 ppm on lowest reading
Accuracy	Percent: ±2% of reading or 0.05% absolute whichever is greater. Trace: ±2% of reading or ±0.5ppm absolute whichever is greater.
Sensor Type	Zirconia
Maximum Sample Pressure	0.1 to 0.5 pounds per square inch gauge (PSIG)
Response Time	< 5 seconds at 0.15 liters per minute (LPM) over 1 decade
Display	0.7" (17.8 mm) high 6 digit liquid crystal display
Input Power	Universal 90-264 VAC, 50 or 60 Hz
Standard Outputs	(2) Selectable 0-20 mA DC or 4-20 mA DC, both scalable by the user
Audible Alarm	Internal Audible Alarm
Audible Alarm Cancel	Front Panel Switch
Oxygen Alarm Relays	Two (2) SPDT Form C contacts rated 10 A @ 30V DC / 115/230 VAC. Alarms may be cleared manually or automatically, by user selection.
Operating Temperature	50° to 104°F (10° to 40°C)
Sample Gas Moisture Limits	80% RH at 68°F (40°C) which represents a dew point temperature equivalent of 61.6°F (16.5°C)
Enclosure	Aluminum, rated NEMA 1
Enclosure Dimensions	13 inches (330 mm) – length 10.71 inches (272 mm) – width 6.3 inches (160 mm) – height
Weight (Bench top Configuration)	9.4 pounds (4.26 kg.) / 10.4 pounds (4.72 kg.) with pump.

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



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

SECTION 5.0 INTRODUCTION

5.1 General Description

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is a microprocessor based instrument designed to measure gas phase oxygen concentrations over a range of 0-100%. The sensor used in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is a Zirconia based type that exhibits fast response times and due to its inherent design, a low frequency of re-calibration.

The 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. Oxygen values are displayed on a 0.7"

(17.8 mm) high 6 digit liquid crystal display (LCD). The instrument is equipped with two oxygen alarm relays. Both relays are Form C (SPDT) types rated at 10 amps at 115/230 VAC/ 30 VDC and are user configurable for fail-safe operation. In addition to the alarm relays, the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer has a built-in audible alarm and red LEDs for visual indication of an oxygen alarm condition. There are also two green LEDs to indicate whether the LCD is displaying parts per million (PPM) or percent (%). The audible alarm may be manually canceled at anytime. 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). Two flowmeters are standard equipment for the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer, one for the "Sample Flow" and another for the "Bypass Flow".

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer comes equipped with two standard analog outputs. These can be configured for 0-20 mA DC or 4-20 mA DC separately. Both are scalable by the user. The analyzer accepts a universal input of 90VAC to 264VAC @ 50-60Hz.

5.2 Optional Equipment Descriptions¹

The Series ZrO₂₀₀₀ Fast Response Oxygen 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.

5.2.1 Pressure Regulator Option

P/N ZR-PRR

Stainless steel pressure regulator with a 3,000 PSIG inlet capacity and an adjustable outlet pressure range of 0-5 PSIG. The regulator does not include a gauge.

5.2.2 Sample Pump Option

P/N ZR-PMP

Sample pump designed for applications where the sample pressure is insufficient to transport the sample through the sensor housing. Not to be used with any restrictions up stream (i.e. sample filter, pressure regulator, flowmeter, etc.).

¹ Please contact the factory for other options and accessories

SECTION 6.0 INSTALLATION PROCEDURES

6.1 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 nothing is rattling around, the installation procedure can begin.

6.2 Electrical Installation



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

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is shipped with a standard North American power cord, however this cord can be used to power the analyzer from a universal input of 90 VAC to 264 VAC @ 50/60 Hz.

6.3 Mechanical Configuration

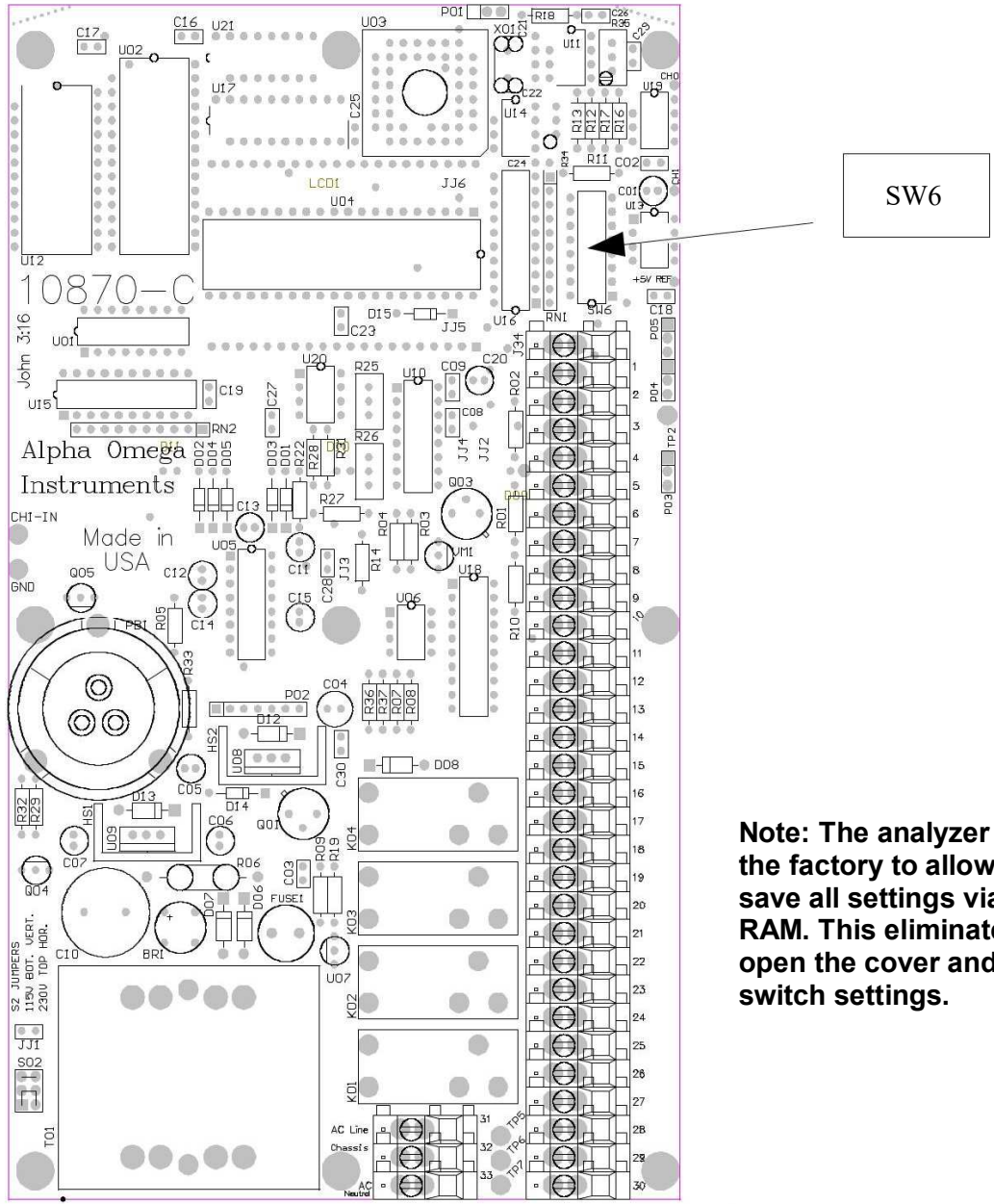
The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer has a switch bank located on the main system board that allows a number of options to be selected by the user. Please reference Figure 6.0 for the location of the switch bank (labeled "SW6").



WHEN POWERED, THE SENSOR IS VERY HOT! DO NOT TOUCH ANYWHERE NEAR IT UNLESS THE INSTRUMENT HAS BEEN POWERED OFF AND GIVEN SUFFICIENT TIME TO COOL!

To access the switch bank SW6, it is required to remove the cover to the analyzer. To accomplish this, first turn down the bail so the analyzer is **not** in the tilted configuration. Then carefully turn the analyzer upside down and remove the four screws on the outer edge holding on the cover. Once removed, carefully turn the analyzer back to its upright position and slowly slide the cover off towards the front. The SW6 switch bank is located towards the front of the analyzer on the right hand side down toward the bottom of the printed circuit board shown in Figure 6.0.

Note: It is not necessary to change the switch settings unless a specific condition must be controlled upon startup or unexpected power cycling. See section 7.3.2 for details on the Default / User settings.



Note: The analyzer is configured at the factory to allow the user to save all settings via battery backed RAM. This eliminates the need to open the cover and change the switch settings.

FIGURE 6.0

In some rare cases where it is necessary to have a default configuration of the switch settings, then the analyzer can be set up to read the switch settings of SW6 while turning on the analyzer or when initiating a “warm boot” (see section 7.2). In this mode, any changes made via the front panel will be remembered only until the next power cycle or “warm boot”. A full description of this option can be found in section 7.3.

6.3.1 Oxygen Sensor

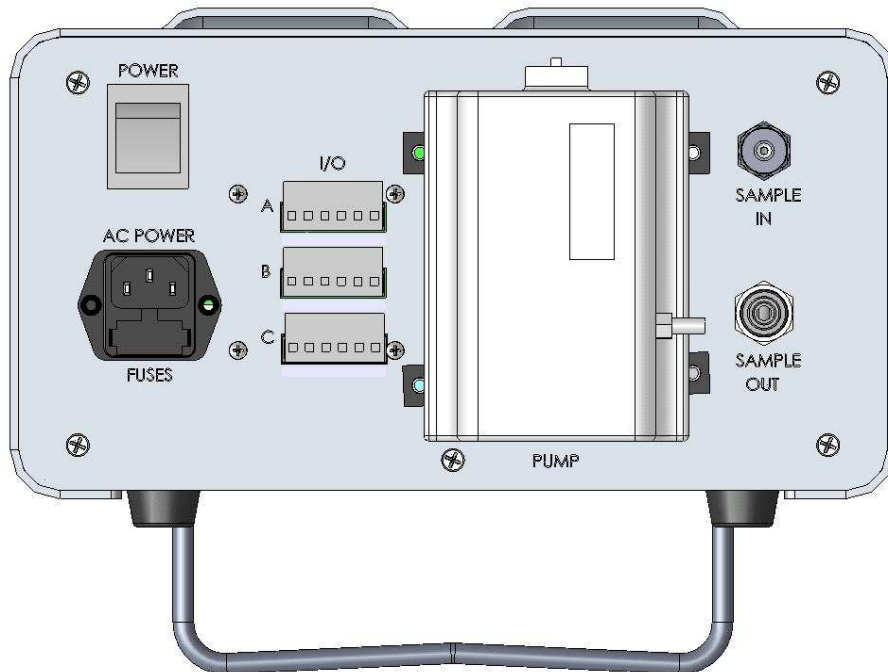
Wiring of the oxygen sensor has been done at the factory. For information regarding sensor wiring or replacement, please contact the factory. Proper use of the analyzer requires that the sensor be exposed to a reference gas of 20.9% (ambient air). To accomplish this, the analyzer must not be placed in an environment where the air around the outside of the enclosure is not 20.9% (i.e. a glove box).



FOR THE SENSOR TO WORK PROPERLY, THE OXYGEN ANALYZER MUST BE PLACED IN AN ENVIRONMENT WITH CLEAN FRESH AMBIENT AIR (20.9% OXYGEN). NEVER PLACE THE ANALYZER IN AN ENVIRONMENT WHERE THE OXYGEN CONCENTRATION COULD BE LOWER OR HIGHER THAN NORMAL BREATHING AIR (20.9%). PLACING THE ANALYZER IN A GLOVE BOX OR OTHER CONFINED AREA WHERE OXYGEN LEVEL IS NOT 20.9% WILL ADVERSELY EFFECT THE READINGS,

6.3.2 Wiring Alarm Relays

Access to the control signals generated from the Series ZrO₂₀₀₀ Fast Response Oxygen 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 1.1 for details on the connector pin outs.



**Figure 6.1
Rear View**

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is equipped with two single pole double throw (SPDT) relays with Form C contacts rated at 10 amperes @ 30 VDC and 115/230 VAC. Each oxygen alarm relay can be configured by the user and both alarms default to a factory setting of low oxygen alarms. To configure either of the oxygen alarm relays to act as a high alarm, please refer to Section 7.3.

Contacts shorted for each Alarm Relay	Alarm ON	
	Fail-safe ON	Fail-safe OFF
High or Low O ₂ Alarm1 / Relay 1	NC (C-1) to COM (C-3)	NO (C-2) to COM (C-3)
High or Low O ₂ Alarm2 / Relay 2	NC (C-4) to COM (C-6)	NO (C-5) to COM (C-6)

**TABLE 6.0
 RELAY CONFIGURATIONS**

TABLE 1.0 illustrates the various wiring configurations for the four alarms in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer based on whether the alarms are going to be configured for fail-safe or non fail-safe operation.

6.3.3 Wiring the mA DC Outputs

Terminal-Pin #	Description	Notes
A-1	Optional Pump Ground	Factory wired
A-2	Optional Pump Adjust	Factory wired
A-3	Optional Pump 24V	Factory wired
A-4	Future Use	Do not connect
A-5	Future Use	Do not connect
A-6	Future Use	Do not connect
B-1	Analog Output 1	0/4 to 20 mA
B-2	Analog Output 1 Return	
B-3	Analog Output 2	0/4 to 20 mA
B-4	Analog Output 2 Return	
B-5	Future Use	Do not connect
B-6	Future Use	Do not connect
C-1	Alarm 1 Normally Closed Contact	
C-2	Alarm 1 Normally Open Contact	
C-3	Alarm 1 Common Contact	
C-4	Alarm 2 Normally Closed Contact	
C-5	Alarm 2 Normally Open Contact	
C-6	Alarm 2 Common Contact	

**TABLE 6.1
 Customer Wiring**

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is equipped with two analog outputs, both of which can be user set to output 0-20 mA DC or 4-20 mA DC from the front panel. In addition, each of the two analog outputs can be scaled over a user selectable range. Reference Table 1.1 above to wire to one or both of the mA DC output(s).

Note: Do not connect anything to the unused outputs of the analyzer. These are for future use only.

SECTION 7.0 Operation

7.1 Preparation for Operation

7.1.1 Mounting Configurations

Bench Top / Portable (BTP Configuration) The BTP is the basic configuration for the Series ZrO₂₀₀₀ Fast Response Oxygen 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. See Appendix A for detailed dimensional drawings.

7.1.2 Initial Check

The Series ZrO₂₀₀₀ Fast Response Oxygen 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 startup. Please refer to Section 8.0 for details regarding routine calibration. **Note: All gas lines used to supply sample gas to the analyzer must be free of oil and rated for oxygen service. Residual oils can damage the sensor and this will not be covered under warranty. If uncertain where to obtain the proper tubing, we recommend contacting Winter Technologies (636-271-6400) and order their part number WT-304C-1/4. This is 304 SS tubing that has been cleaned of all residual oil.**

7.2 Operating Procedures

7.2.1 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 ZrO₂₀₀₀ Fast Response Oxygen Analyzer has battery backed RAM so that when the instrument is initialized, all values set by the user via the front panel will be maintained if switch #8 of SW6 is set to the "ON" position, otherwise referred to as the "User Settings" configuration mode (See section 7.3). Initialization gives the user the opportunity to make sure the microprocessor, internal memory, front panel LEDs, and the audible alarms are functioning normally. During an initialization sequence, the instrument's front panel liquid crystal display (LCD) will display a series of dashes like [----][---][___], each of the 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 on board switch settings such as [|||||]. This is the factory default. Switches #5-8 of SW6 are in the ON positions and switches # 1-4 are in the OFF positions. Finally, the instrument will start to warm up the sensor and indicate this on the LCD in the form of a scrolling message [Sensor Heating up]. The measured sensor temperature is shown briefly at the end of the message to give an indication of whether or not the system is heating up. Allow for at least 10 minutes to stabilize after warming up.

DANGER
HOT SURFACE
DO NOT TOUCH



DO NOT HANDLE THE OXYGEN SENSOR WITH HANDS AS IT WILL CAUSE SEVERE BURNS.

To initialize without the power cycling (referred to in the industry as a "warm boot"), and read the switch bank settings (as opposed to saved RAM variables), check that SW6 - switch # 8 is set to "OFF" and push the front panel UP, DOWN, and Alarm 2 buttons simultaneously. This causes the analyzer to perform a "warm boot" and initialize just as if the power had been cycled. Do not hold the buttons down very long after the display shows the dashes described above. The LCD will show the same sequence as above, however, switch #8 will indicate low. Powering on with switch #8 in the "OFF" position as described will cause the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer to read the actual switch settings of SW6 as opposed to using the saved RAM settings. See the description for SW6 in section 7.3 for details on user settings.

7.2.2 Front Panel Controls and Indicators

The front panel of the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer contains a 6 digit liquid crystal display (LCD), five (5) membrane switches (“Alarm 1”, “Alarm 2”, up, down, and “Enter”) , and two (2) alarm LEDs. An Audible Alert Indicator is located behind the front panel of the instrument. There are also two LEDs that indicate whether the LCD is displaying ppm or percent (%) oxygen. Note that the “ppm” and “%” LEDs only have meaning when showing oxygen values in the LCD. The 6 digit LCD display shows the concentration of oxygen in the sample being measured in terms of percent or ppm oxygen by volume and also displays messages or alerts from the microprocessor. Within approximately 15- 25 minutes after the analyzer is powered on and the sensor is heated sufficiently, the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer will measure and display the oxygen concentration of the sample gas being exposed to the sensor. Note: for calibrations of any kind, the analyzer should be running longer for better accuracy. See Section 8.0 (Calibration Procedures) for more details. If the concentration of oxygen should go below 1%, the LCD will convert the readings to ppm and the “ppm” LED will illuminate. When the concentration of oxygen is equal or greater than 1% then the LCD will convert the reading into percent and the “%” LED will illuminate.

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer alarms are set at the factory as low alarms. Any one of these alarms can be set by the user for operation as high alarms also. Please refer to Section 7.3, Alarm System, for instructions on how to set Alarms for either high or low operation and how to adjust the levels of the alarms.

7.2.3 Scaling the Analog Outputs of the Analyzer

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is equipped with two non-isolated analog outputs, both of which can be user set to an output of 0 -20 mA DC or 4- 20 mA DC. Each output can also have a user selectable oxygen range set to anywhere from 0.000 ppm to 100%. The analyzer is shipped from the factory with Output 1 set from 0.000 ppm to 100% oxygen and Output 2 is set from 0.000 ppm to 25.0% oxygen. These ranges are scaled to the user selected output current ranges of 0 to 20mA or 4 to 20mA. These options provide great flexibility in controlling the range over which the mA outputs control.

For certain applications, it may be desirable to change the analog output of the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer over a narrower range of measurement. For instance, if operating over the range of 0 to 10,000 ppm most of the time, it may be useful to scale the output for that oxygen range instead of the default of 0 to 100% or 0 to 25%.

Setting the Analog Output Range

To adjust the analog outputs, the instrument must be placed into the “menu mode” by pressing the “Enter” key while displaying the oxygen value. After pressing the “Enter” key the analyzer will be in the “menu mode” and the LCD will display the first menu item. Simply press the up or down buttons a number of times until the option [0.0 / L.0] shows in the LCD. At this point, pressing “Enter” again will allow the arrow keys to adjust the Output 1 Low setting. Adjust this value either up or down by using the front panel up and down arrow keys until the desired value is achieved. When the desired value is shown simply press “Enter” again to save the setting to RAM and automatically increment to the next menu item. Continually pressing the “Enter” key will cycle through the various menu items / settings by auto incrementing the menu items. At any time the user may arrow up or down to the menu item [NONE] and press “Enter” to return to the main screen to display the oxygen value. A quick alternative when displaying a menu item is to press the “Alarm 2” button to immediately exit the menu and return to the main screen. The [0.0 / L.0] setting works exactly the same as described above.

To adjust the span points of the two analog outputs of the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer, select the appropriate menu item [0E I HI] / [0E2 HI] and press "Enter". The instrument will display the value. Adjust as necessary and press "Enter" when finished. The span in our example corresponds to 10,000 ppm. The scaling software in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer has built-in safeguards that will not allow the analyzer to be adjusted so that the "Lo" value is set above that of the current "Hi" value, or have the "Hi" value set below that of the current "Lo" value. When the proper scaling values have been set, press the "Enter" key to auto increment to the next menu item.

Setting the Analog Output Type

Both analog output ranges can be selected to scale the user range over one of two types of current outputs. One type is 0 to 20 mA DC. The other type is 4 to 20 mA DC. The type corresponds to the low end of the mA DC signal output. This is typically set to 4.00 mA (default), which means that when the LCD is displaying the "Low" value (0.00 oxygen in our example), the output will read 4.00 mA. This can be changed to 0.0 depending on the [0E I TYP] / [0E2 TYP] setting. The [0E I TYP] / [0E2 TYP] settings determine whether or not the associated mA output has a "live" zero or not. The "live" zero allows the equipment monitoring the current loop to know that something is wrong when the current falls below 4.00 mA. The 0.00 mA setting on the other hand allows for easy scaling when using a resistor to convert the current to voltage. To select the offset type, toggle between the two options of 0.00 mA or 4.00 mA by pressing the up and down arrows. Pressing "Enter" will save the information into battery backed RAM. If switch #8 of SW6 is ON (default), then this setting will be remembered during a power cycle. Otherwise the system will default to the 4.00 mA option.

NOTE: Regardless of how the analog outputs are scaled, the analyzer will always maintain the capability of displaying oxygen concentrations over the instrument's standard range of 0-100%. Scaling the outputs does not scale the front panel digital display. Furthermore, oxygen alarm relays can be expected to change state if the oxygen values they are set to should meet or exceed the alarm setting (independent of the output scaling). Both alarms are set at the factory to values of 0.000 and set for a low alarm (see next section for more details).

7.3 Alarm System

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer incorporates an alarm system that can be controlled by the user from both the front panel and the on board switch settings. This section describes the function and control of each alarm type.

7.3.1 General Description of Alarm Processing

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is equipped with two (2) 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 Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer:

1. The LED associated with the oxygen alarm in question will illuminate.
2. An audible alarm will sound.
3. The relay associated with the oxygen 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 7.0) and/or the user settings saved in the battery backed-up RAM associated with the microprocessor.



FIGURE 7.0
SW6 SWITCH SETTINGS

Note: The factory setting for switch #8 is set to “User Configuration” or ON. This allows the instruments settings to be fully controlled by the user via the front panel menu system and remembered even after the power is turned off.

If switch #8 is changed to “Switch Settings” or OFF, then every time the analyzer is turned on, the settings will be read from the switch bank instead of the battery backed RAM. Therefore, any settings that were changed via the front panel menu system will be overwritten with the settings read from the switch bank. This is useful in certain situations that require a failsafe mode of operation, since every time the analyzer is turned on or re-booted, the settings will be restored even if inadvertently changed via the front panel menu system.

7.3.2 Default / User Settings

As described above, with switch #8 of SW6 in the "OFF" position, the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer reads switches #1 through #7 to configure all options. With switch #8 in the "ON" position, all user settings will be retained. The factory default is the latter and allows full control from the front panel menu. Note: to read the switches without turning off the instruments, initiate a "warm boot" with switch #8 in the OFF position or "Switch Settings" mode (See Figure 7.0).



IF ANY ALARM IS NOT GOING TO BE USED, IT SHOULD BE DISABLED (FACTORY DEFAULT). TO DO SO, CHOOSE THE ALARM TO BE DISABLED AND SET THE ALARM AS A LOW ALARM (SECTION 7.3.4), AND THEN SET THE ALARM TO 0.00 (SECTION 7.3.7).

7.3.3 Fail Safe

Switches #1 and #2 control the fail- safe operation for each of the alarm relays. Each switch must be turned "ON" to be fail-safe (refer to FIGURE 7.0). In the fail-safe mode, the normal or non-alarm state of each of the alarm relays is energized. When an alarm signal is generated, the respective relay for the alarm is not energized. This would be the same relay state (not energized) that would be achieved if the power source were interrupted. The factory default setting for switches #1 and #2 is "OFF" (normal operation or non fail-safe). These settings are also available via the menu as [F5 15E] & [F525E].

7.3.4 Oxygen Alarm Type

Switches #3 and #4 control whether the corresponding alarms are "high" alarms or "low" alarms. A "high" alarm will be indicated if the oxygen level is GREATER THAN the alarm setting. A "low" alarm will be indicated if the oxygen level is LESS THAN the alarm setting. These settings are also available via the menu as [AL 15E] & [AL25E] by pressing the up and down buttons simultaneously.

7.3.5 Output Type

Switches #5 and #7 control whether the corresponding analog output has a 4.00 milliamp offset or not. This results in two options for the analog outputs. Setting either of the switches to "ON" will enable the 4 milliamp offset and result in a 4.00 to 20.00 mA output for the corresponding output. Conversely, setting either switch to "OFF" will result in an analog output of 0.00 to 20.00 mA. These settings are also available via the menu as [OT 17P] & [OT27P].

7.3.6 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 of switch #6 of SW6. This setting is also available via the menu as [AutCLR].

¹ If the user should change any of the settings via the front panel controls (i.e. Low to high alarm) and cycle the power, switch #8 being "ON" causes the analyzer to ignore the switch settings #1 through #7 and use the settings currently stored in battery backed RAM.

When switch 6 of DIP Switch SW6 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.

7.3.6.1 Manual Clear Operation

In the Manual Clear mode (SW6, switch #6 is "OFF), the analyzer will not automatically clear the 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.

7.3.6.2 Auto Clear Operation

In the Auto Clear mode (SW6, switch #6 is ON), the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer will automatically reset the alarm indications mentioned above when the alarm condition clears. Under Auto-Clear operation, the silenced audible alarm may automatically come back on if the O₂ 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.

7.3.7 Setting the Alarm Levels

Assuming that no alarms are currently activated (no alarm LEDs are illuminated), press the desired alarm switch on the front panel, "Alarm 1" or "Alarm 2". 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. Each of the oxygen alarms can be changed from low to high level or vice versa by pressing the UP and DOWN arrows simultaneously. To set the oxygen alarm values, press the DOWN arrow to lower the oxygen 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 oxygen 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 oxygen concentration. If more than one alarm value or level is to be changed, repeat this procedure on the desired alarm channel.

An alternate method of setting the alarms is through the use of the menu by pressing “Enter” while the LCD is displaying the oxygen value. Simply select the appropriate menu item ([AL1Set] or [AL2Set]) and adjust as necessary. Note: The menu also supports toggling from “L” to “H” while setting the alarms by simultaneously pressing the up & down buttons.

7.3.8 Timing Out During Alarm Setting

If the user is adjusting the alarm values and other settings in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer and no adjustment has been made for approximately 2 minutes, the analyzer will automatically revert back to displaying the oxygen value in the LCD. **NOTE: 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.** This feature helps to prevent the user from inadvertently keeping the analyzer off-line for a prolonged period of time.

7.4 Sample Gas Handling

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is shipped with stainless steel 1/4" sample gas fittings on the sample inlet and quick connect style for the outlet port of the analyzer. Both fittings are designed to be used with 1/4" OD stainless/plastic tubing respectively. The most critical item to pay close attention to is the delta pressure across the sensor. Other than the supplied factory pump, particular attention should be paid to ensure that there are no sample restrictions or sources of back pressure to the analyzer. The oxygen sensor used in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is a partial pressure measuring device and any changes to the total pressure will affect each of the partial pressures, oxygen being one. Fluctuations in sample back pressure are not corrected for and could lead to a significant error in the oxygen measurement. **Typically the instrument is either monitoring a pressure regulated source or drawing a sample from a source at atmospheric pressure.**

For low ppm oxygen measurements, it is imperative to scrutinize the entire plumbing system including the analyzer to determine the suitable components for measuring low ppm oxygen concentrations. For instance, stainless steel tubing is recommended to minimize oxygen adsorption on the walls of the tubing. Using tubing material other than stainless steel can adversely effect response time of the analyzer. Be sure to check all components in the sampling system for leaks (i.e. filters, valves, etc).

7.4.1 Positive Pressure Sampling

The standard Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer does not come equipped with a sample pump. In this case, the sample must be under positive pressure and the "Sample Flow Adjust" and "Bypass Flow" adjustments would be used to control the sample flow. The factory strongly recommends the sample gas to be allowed to vent to atmosphere to avoid errors in the measement due to back pressure.

7.4.2 Negative Pressure Sampling

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer can be ordered with a sample pump that mounts directly to the instrument on the rear panel. Alpha Omega Instruments Corp. strongly recommends using the optional pump supplied at the factory when drawing a sample from a source at atmosphere. The pump draws a slight vacuum from the "Sample Out" port which in turn will draw a sample from the "Sample IN" port. It is important to keep the "Sample Flow Adjust" control knob fully open (counter-clock wise) in this configuration. To adjust the proper flow rate, use the front panel controls to control the pump via the main menu item [FloSet] (Pump). The "Bypass Flow" adjustment knob can also be used to make final adjustments to achieve the proper flow rate of 0.15 LPM for the sample flowmeter. **Again, drawing a sample using a pump requires that the "Sample Flow Adjust" knob be OPEN (FULLY COUNTER-CLOCKWISE).** DO NOT turn the "Sample Flow Adjust" knob clockwise, otherwise this will cause a significant error in the oxygen readings due to the induced delta pressure drop. Instead, use the [FloSet] menu item or the "Bypass Flow" control knob to finely adjust the sample flow rate to the optimal 0.15 LPM. **Note: ideally the pump should be disconnected when a positive pressure sample is being used (i.e., Calibration gas cylinder).** To disconnect the pump from the "Sample OUT" port, simply disconnect the "quick-connect" fitting by depressing the ring and pulling the tube out when necessary. The other end will remain attached to the pump until the calibration gas is removed and the pump tube is pushed back into the "quick-connect" fitting for drawing the sample as described above.

¹ For best results, optionally apply the positive pressure sample to the "Sample IN" using a 1/4" stainless steel TEE and attach an 8" piece of tubing to the opposite side of the tee to minimize any back diffusion. This allows the calibration to be done while using the pump to draw the sample and minimize errors associated with switching from a positive pressure to calibrate and then a negative pressure to analyze the source sample.

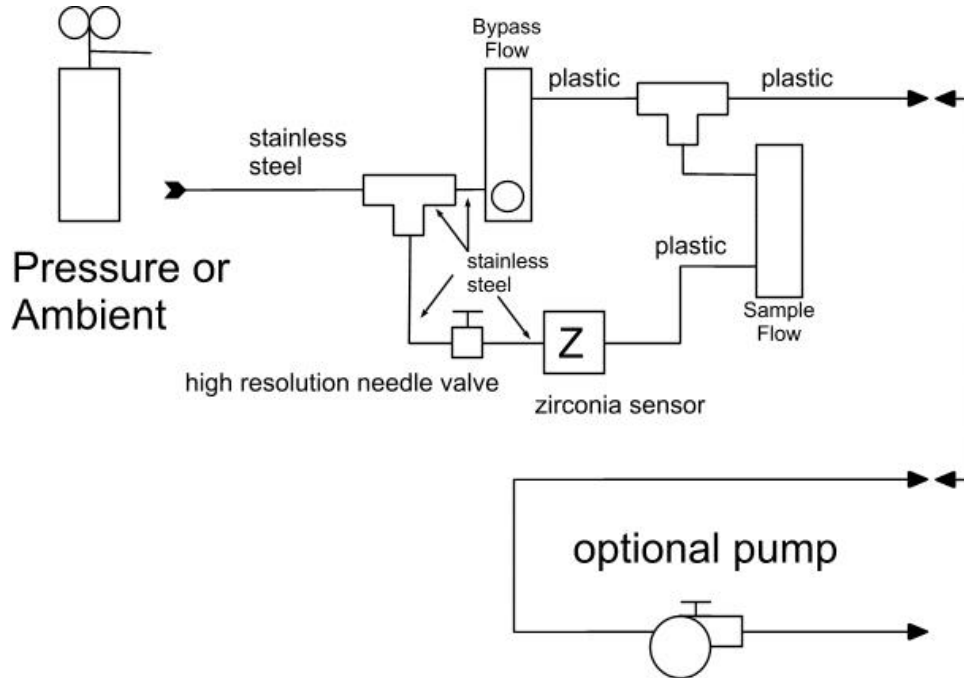


Figure 7.1
Typical Sampling System

It is recommended that the sampling lines be kept as short as possible to minimize the response time. Keep all sample lines leak tight and avoid the use of the gases listed in section 3.2. For specific sampling system questions, please contact the factory.

7.4.3 Gas System Pressure and Flow Limits

For sample gases and/or calibration gases that are under positive pressure, it is imperative that the input pressure to the sensor be kept under 2.0 PSIG. If the pressure is expected to be in excess of 2.0 PSIG it is advisable to use a pressure regulator (Alpha Omega Instruments model number ZR-PRR). The flow rate to the analyzer should be set to 0.15 LPM (± 0.03 LPM). Higher flow rates will cause errors due to a cooling effect on the sensor. For repeatability, always use 0.15 LPM (± 0.03 LPM).



Warning: When applying a calibration gas from a pressurized cylinder, the possibility exists that a high pressure pulse may be introduced into the sample system. To avoid any damage, it is highly recommended to turn the "Sample Adjust" control valve OFF (fully clockwise) until a reasonable flow rate of about 0.25 LPM flow is established in the "Bypass Flow" meter. Although the valves are rated at 100 PSI or greater, the sensor and or plumbing will dislodge and/or possibly damage the analyzer or sensor. **It is highly recommended to check the sample flow rate before connecting the sample to the analyzer.**

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

¹ It is possible to pump the sample into the "Sample IN" port, however the performance of the analyzer will be directly affected by the performance of the pump. Any leaks in the pump will cause significant errors in the readings

Another precaution is to ensure that the pressure differential across the sensor is minimized. Excess pressure differential may occur if the sample flow is either restricted or shutoff ahead of the analyzer (i.e. filter or valve) and simultaneously a sample pump was left on drawing a vacuum from the "Sample Out", therefore creating a delta pressure condition across the oxygen sensor. This condition should be avoided as large measurements errors will occur. Under normal conditions the differential pressure should be almost nil - less than 0.2 pounds per square inch differential (PSID). Maximum differential pressure should be kept to below 2.0 PSID. In general, as long as one side of the analyzer is at or about ambient pressure, the pressure differential (including the factory supplied pump) will be satisfactory.

7.4.4 Corrosive Gases

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

7.4.5 Orientation

Never mount the analyzer upside down or sideways. This could damage the sensor and will result in erroneous oxygen readings. The analyzer comes equipped with a bail on the front two feet to allow for better viewing at a slight angle. Please note that any calibrations should be done with the analyzer laying horizontally to allow for the correct flow showing in the meter. Using the bail to tilt the analyzer will not effect the output significantly, however the flowmeter will show a lower flow due to the design of the flowmeter. This flow error can be ignored and is only a result of the angle that the flow meter is in. To check the flow rate, simply put the bail down and lay the analyzer flat. Note: Do not readjust the flow rate when the bail is in use as this will cause significant errors in the reading due to an incorrect flow rate.

7.4.6 Condensable Gas Constituents

The Series ZrO₂₀₀₀ Fast Response Oxygen 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 is exposed to liquids, even in small amounts, erroneous oxygen readings will result. If the problem is severe enough, there may be permanent damage to the sensor. A water trap or absorbent system can be used to eliminate the condensate for some applications.

7.4.7 Sample Gas Moisture Limits

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer should not be used when the dewpoint temperature of the gas exceeds 61.6°F (16.5°C). This is equivalent to a relative humidity level of 80% at an ambient temperature of 68°F (40°C). Dewpoints higher than the aforementioned concentrations may cause erroneous oxygen readings particularly in the parts per million ranges.

SECTION 8.0 CALIBRATION PROCEDURES

8.1 Routine Calibration Check

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is fully calibrated at the factory prior to shipment. Alpha Omega Instruments oxygen sensors feature high accuracy and excellent long term stability characteristics. As a result, routine maintenance is kept to a minimum. As is the case with all gas analyzers, it is advisable to periodically check the overall system calibration [CALSPN]. 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 twice every year. It is also recommended to check the calibration just before taking any high precision measurements. A ZERO calibration [CALAIR] is also recommended when taking any measurements at or around ambient air (20.9%).

8.2 Calibration Gas

The oxygen sensor in the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer has a logarithmic output based upon the Nernst equation shown below.

$$E_{\text{cell}} = E_{\text{offset}} + \frac{(R \cdot T)}{(n \cdot F)} * \ln \frac{(\text{Reference})}{(\text{Sample})}$$

Where:

E _{cell}	=	Sensor output
E _{offset}	=	Sensor offset at ambient (209000 PPM oxygen)
R	=	universal gas constant (8.314510)
T	=	Temperature in Kelvin (~1023.15°K / 750°C)
n	=	4 (number of electrons transferred)
F	=	Faraday's constant (96485.3415 Coulomb/mol)
ln	=	natural log
Reference	=	209000 PPM
Sample	=	Oxygen sampled at "Sample In"

Nernst Equation

As a result, it can be calibrated using a single calibration gas. The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer removes any complexity by using ambient air as the reference gas, controlling the sensor temperature accurately, and removing any sensor offset at the factory. This is accomplished by calibrating the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer at the factory with ambient air (20.9% oxygen) and an NIST traceable standard (typically 2.0% oxygen) at the specified flow rate of 0.15 LPM. This is called a "two point calibration" and need not be repeated by the customer unless specific conditions exist that would warrant it (see section 8.0 – Calibration Procedures).

When shipped from the factory, the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is ready to measure any oxygen concentration from 0.001 ppm to 100%. After some time (often many months) it may be necessary to re-calibrate the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer. Since the sensor offset is already calibrated and canceled out, a simple single point calibration is all that is required to compensate for any changes in the system output over time.

The single point calibration should be performed at or around the desired operating point for best accuracy. For example, if the expected operating level of Oxygen is around 100 ppm, the calibration standard gas of 70 to 100 ppm (70-100% of reading) should be used.

The calibration gas should contain a defined concentration of oxygen with a balance of nitrogen (N₂). Alpha Omega Instruments recommends a calibration gas at or around 2.0% oxygen (NIST traceable). Note: the factory will perform a calibration on a specific NIST traceable gas. The [CAL GAS] variable will also be set at the factory via the main menu to reflect this NIST traceable calibration gas. Using a gas in the 2.0% range will give the best results over the whole range of the instrument for general use. For specific ranges of operation, the analyzer may be factory calibrated to a different gas concentration.

Note: The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is very repeatable and accurate as long as the flow rate is maintained to the designated flow rate of 0.15 LPM. When using a calibration gas to verify the analyzer, DO NOT recalibrate the instrument if the reading is not exact but falls within the uncertainty of specification of the calibration gas. Doing so may result in poor readings on other gases due to the error in the calibration gas. Many times the reading of the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is more accurate than the specified calibration gas. To verify a calibration, simply apply a second calibration standard gas to insure that the gain of the system has not been changed significantly. The second gas should be within the specified tolerance of the calibration standard gas.

If the analyzer is to be used primarily for the measurement of oxygen concentrations in the range of ambient air (20.9% O₂), make sure that a ZERO calibration is done [CAL AIR] while sampling a source of ambient air at 0.15 LPM. If there is any reason to question the composition of the ambient air to be used for calibration, the analyzer should be calibrated next to an open door or window where there is an ample exchange of fresh air from an outside environment. If the location of the analyzer precludes the use of a fresh air supply for calibration, compressed air from a cylinder source is the next best choice (do not use plant or shop air as oil vapors and/or water mist that may be entrained in the gas stream could damage the sensor).

8.3 Procedure for Checking Calibration Span

1. Power up the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer as described in Section 7.2. Make sure that the analyzer is warmed up for at least 2 hours for best results.
2. Select a cylinder or source of calibration gas as described in Section 8.2.
3. 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 2.0 PSIG.
4. In addition to the selection of the pressure regulator, care must be given to choose the correct sample tubing materials. For oxygen measurements below 1%, stainless steel metal tubing is recommended.



DO NOT USE RUBBER OR PLASTIC TUBING for calibration checks below 1%. Air contains 20.9% oxygen. A small leak of air into either the calibration gas or sample gas line can cause sizable errors in readings. Leakage can be through cracks in the tubing or by diffusion through the tubing.

5. To protect the sensor from accidental pressure pulses, turn the “Sample Flow Adjust” knob fully clockwise to close the valve.
6. Adjust the “Bypass Flow” adjustment knob so that it’s FULL counter-clock wise or OPEN

¹ Note that the uncertainty of the standard gas is around ±2% at an oxygen level of 20,000 ppm (or 2% oxygen)

7. Apply the calibration sample gas and slowly adjust the regulator so that the “Bypass Flow” meter reads 0.5 LPM. At this point, adjust the “Bypass Flow” control valve down to between 0.15 and 0.2 LPM.
8. Open the “Sample Flow Adjust” control valve until 0.15 LPM is flowing¹.
9. The reading in the LCD will now display the oxygen concentration of the calibration gas. If the oxygen 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 an offset adjustment is to be made, the instrument must be placed in the calibration mode. Before going into calibration mode, first monitor the analyzer response to the calibration gas, waiting until a stable reading has been established (minimum of 5 minutes). If the displayed reading does not stabilize, check your plumbing for leaks or other obvious problems. Be sure to allow the oxygen reading to come into equilibrium before making any adjustments.
10. With a stable oxygen sample being supplied, the calibration sample gas concentration needs to be entered into the analyzer. To do so, press the front panel button labeled “Enter”. This enters the main menu and the LCD will display the first menu item. Press the up or down buttons to cycle to the [CAL GAS] entry and press “Enter” again. Adjust the value with the up and down buttons. Make sure the appropriate green LED is illuminated (PPM or %) by simply ramping up or down the number in the display. The threshold for ppm to % is 1.00% and the analyzer will automatically toggle the range and the appropriate ppm / % LED will illuminate. For instance, if using a ppm level gas and the % LED is illuminated, simply press the down arrow until the LED switches to PPM and continue adjusting the value to the desired PPM. When finished adjusting the value, press “Enter” again. The firmware will automatically auto-increment to the [CAL SPN] option. **The [CAL GAS] entry will be remembered so that if at a later date the analyzer is re-calibrated, it is not necessary to reenter this information.** At this point proceed directly to the span calibration by pressing “Enter” or double check the oxygen reading by exiting the menu by pressing the “Alarm 2” button. Optionally scroll to the menu item titled “Done” and press “Enter” to exit the menu.
11. If the previous step exited the menu and the LCD is displaying the oxygen reading, simply press “Enter” to get back to the menu and arrow to [CAL SPN] again, otherwise, if already at the menu item [CAL SPN], simply press “Enter”. The firmware will briefly display [CAL], then display [YES] in the LCD. Using the arrows, select [YES] or [No], then proceed by pressing “Enter” again. If [YES] was selected, the analyzer will first display [-HOLD-] and then go through a series of tests and if there are any problems, the LCD will show an error message. **Note: Error messages will not time out! Pressing any key will acknowledge the error. The firmware will revert to the previous calibration to avoid strange readings.** It is strongly recommended to investigate the cause of the error and re-calibrate. Otherwise, the LCD will indicate a successful calibration and return to the next menu item.

During a [CAL SPN] calibration, the analyzer will determine if the calibration being performed is within $\pm 20\%$ of the [CAL GAS] setting. As an example, if the user should be monitoring ambient air (20.9% oxygen) and accidentally enter a calibration gas of 2% and then forget to apply the calibration gas to the analyzer, the system will show an error that it is out of range. In this case the analyzer will revert to the old calibration settings to avoid gross errors on the display. It is recommended to re-calibrate any time there is an error displayed on the screen after checking to see if the procedure was followed correctly. If the errors persist despite following the procedure correctly, please contact the factory for further instructions.

¹ Higher flow rates could cause cooling of the sensor resulting in errors.

8.4 Procedure for Checking Calibration Zero

Calibration Zero is misleading since the calibration is really performed at the level where there is no output from the sensor. This occurs when the reference gas (which is ambient air or 20.9% oxygen) is equal to the sampled gas. Therefore, all that is needed to check the Calibration at Zero is a source of fresh air or clean compressed instrument air. Make sure the analyzer is reading the oxygen value on the LCD, then follow these steps to complete the zero calibration:

1. Make sure the analyzer is sampling 0.15 LPM of fresh air or **clean** compressed instrument air. If the analyzer is equipped with a pump, simply open the “Sample Adjust” control valve fully and use the front panel menu item [FL₀SET]₁ to adjust the flow₂. Otherwise, apply the pressurized sample being careful to keep the inlet pressure to below 2.0 PSIG. Use the “Bypass Flow” control valve along with the “Sample Adjust” control valve to achieve the proper flow of 0.15 LPM.



Warning: Do not apply instrument air without first checking that the instrument air is free of any oils. Having oils present in the sample system could damage the sensor and may result in permanent damage to the analyzer.

2. Press the “Enter” button to enter the main menu.
3. Using the up and down buttons, scroll through until the LCD reads [CAL₀ r].
4. Press “Enter”. The firmware will briefly display [CAL], then display [YES] in the LCD. Using the arrows, select [YES] or [No], then proceed by pressing “Enter” again. If [No] was selected, the calibration is canceled and the LCD will show [CANCEL]. If [YES] was selected, this initiates the calibration on ambient air. The analyzer will first go through a series of tests and if there are any problems the LCD will show an error message. **Note:**
Any error message will not time out! Pressing any key will acknowledge the error. The firmware will revert to the previous calibration to avoid strange readings. It is strongly recommended to investigate the cause of the error and re-calibrate. Otherwise, the LCD will display [CAL₀] to indicate a successful calibration and return to the next menu item

During a [CAL₀ r] calibration, the analyzer will determine if the calibration being performed is within ± 20 mV offset. As an example, if the user should be monitoring a calibration gas (i.e. 2% oxygen) and accidentally initiate a [CAL₀ r], the system will show an error that it is out of range. In this case the analyzer will revert to the old calibration settings to avoid gross errors on the display.

8.5 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. NOTE: If the user is in a calibration setting sequence and the instrument times out, the calibration is canceled and the display will indicate this. This feature helps to prevent the user from inadvertently keeping the analyzer off-line for a prolonged period of time. The one exception to this is when an “Error” has occurred. You must press “Enter” to acknowledge the error and it is recommended to correct the error immediately.

¹ After entering the [FL₀SET] menu item, the firmware will wait until the up or down arrows are pushed. While waiting, the LCD will indicate the following: “[FL₀SET] >>> [ENT₀ r] >>> [IF] >>> [done] >>> [uP-dn] >>> [Lo] >>> [ch₀9E] “. Simply press and hold Enter until it beeps. This will auto increment to the next menu item.

² The “Bypass Flow” control valve can only be closed when drawing a sample via the pump. Under positive pressure, the “Bypass Flow” control valve should never be closed completely. This would create a “dead” volume of air that could adversely affect the readings.

**SECTION 9.0
 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, however there is also a sub-menu called the Factory menu. The following sections document the items available in each menu.

9.1 Main Menu

The Main Menu is where all of the important settings will be changed or viewed. The following table shows the main menu and the options available. Press the Enter key while in the normal operating mode of displaying the oxygen concentration value to display the menu as shown below:

Main Menu UP/DN Select Items ENTER to change A2 to exit	Press Enter To Adjust	Descriptions	Keys available after Enter: Note: Enter to exit and save
[AL1Set]	0.000 ppm to 100%	Alarm 1 Set point	UP/DN to change UP&DN toggles LO/HI
[AL2Set]	0.000 ppm to 100%	Alarm 2 Set point	UP/DN to change UP&DN toggles LO/HI
[CALGAS]	0.000 ppm to 100%	Calibration Gas	UP/DN to change
[CALSPN]	Yes No	Calibrate to "Cal Gas"	UP/DN to change
[Ot1`lo]	0.000 ppm to 100%	Output 1 Low output	UP/DN to change
[Ot1`Hi]	0.000 ppm to 100%	Output 1 High output	UP/DN to change
[Ot2`lo]	0.000 ppm to 100%	Output 2 Low output	UP/DN to change
[Ot2`Hi]	0.000 ppm to 100%	Output 2 High output	UP/DN to change
[Ot1typ]	4-20 or 0-20	Output 1 Type	UP/DN to change
[Ot2typ]	4-20 or 0-20	Output 2 Type	UP/DN to change
[autCLr]	Auto Man	Auto Clearing of alarms (set to Automatic or Manual mode)	UP/DN to change
[FS1SET]	Yes No	Fail Safe for Alarm 1 Setting (Yes = Failsafe, No = Not Failsafe)	UP/DN to change Enter to save
[FS2SET]	Yes No	Fail Safe for Alarm 2 Setting (Yes = Failsafe, No = Not Failsafe)	UP/DN to change Enter to save
[FLoSET]	Explanation shown on LCD	Flow Set using the pump (use the flowmeter for visual feedback)	UP/DN to change
[CaLair]	Yes or No	Calibrate on Ambient Air	UP/DN to change
[FACtry]	Sub-Menu See next table	Factory diagnostic readings	UP/DN to change
[done``]	Sub-Menu See next table	Factory diagnostic readings	UP/DN to change

**TABLE 9.0
 Main Menu**

9.2 Factory Sub-Menu

The [FACtrY] sub-menu is used for diagnostic purposes only. This menu will not be accessed under normal operation as it has no means of making any changes. To change to this sub-menu, simply select it with the Enter key from the Main Menu.

The following table shows the Factory Sub-Menu and the options available:

Factory Sub Menu UP/DN Select Items ENTER to view and return to factory menu A2 to exit	Units or Type	Descriptions
[TCdegc]	°C	Thermocouple Sensor temperature
[2out-U]	mV	"Zout-U" - Uncompensated sensor output
[2out-Z]	mV	"Zout-Z" - Zero Compensated sensor output
[2out-C]	mV	"Zout-C" - Zero & Spane Compensated sensor output
[2ero-f]	mV	Sensor factory zero offset stored in ROM (Read Only Memory)
[2ero-t]	mV	Sensor zero offset stored in volatile memory
[2ero-s]	mV	Sensor zero offset sum
[GAIN-F]	Number	Sensor factory gain stored in ROM
[GAIN-t]	Number	Sensor gain stored in volatile memory
[GAIN-p]	Number	Gain product
[2ero-U]	Number	User calibrated zero offset stored in non-volatile memory
[SPAN-U]	Number	User calibrated gain stored in non-volatile memory
[Code-b]	Text	Base code version #
[Code-S]	Text	Sensor code version #

TABLE 9.1
Factory Sub-Menu

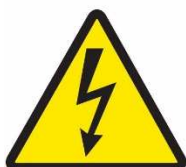
**SECTION 10.0
 MAINTENANCE AND TROUBLESHOOTING**

10.1 User Maintenance

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer requires minimum. 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 twice a year.

10.2 Serviceable Items

There are no end user serviceable items located inside the chassis. Do not open the chassis except in rare cases when the switch settings will need to be changed from their default settings described earlier in this manual.



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.**

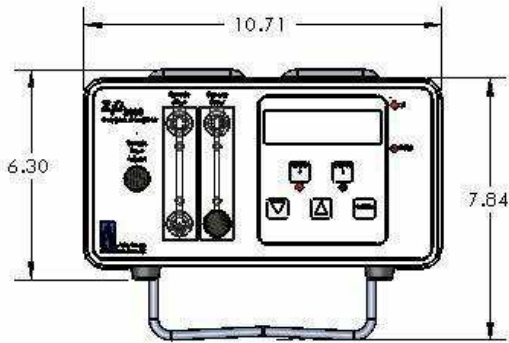
10.3 Troubleshooting

In the case that readings are incorrect, use this table to try and determine a possible solution:

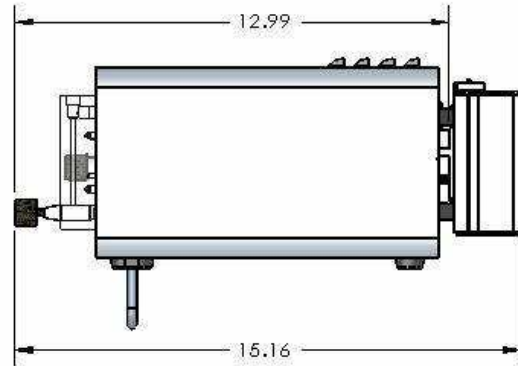
Condition	Possible Problem	Notes
Low readings	Reducing gases in the sample gas	This can damage the sensor
	Calibration error	Check on traceable gas standard
	Delivery system leaks on gases above ambient	Check the integrity of the sample lines
Erroneous readings	Flow rate too high or too low	Use recommended flow rate of 0.15 LPM
High readings	Gas source contamination	Check the integrity of the sample lines
	Delivery system leaks on gases below ambient	Check the integrity of the sample lines

**TABLE 10.0
 Troubleshooting**

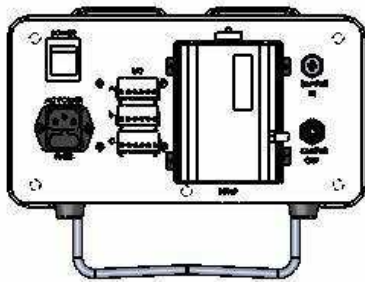
SECTION 11.0
APPENDIX A



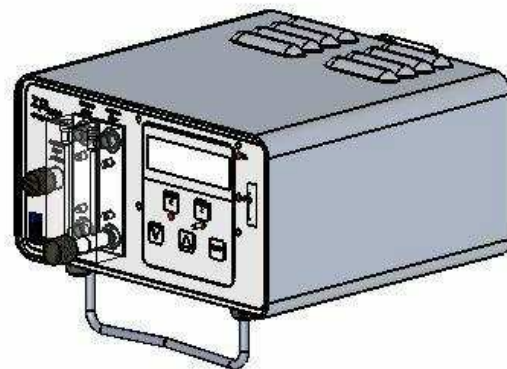
Front View



Side View



Rear View



Three Dimensional View

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

SECTION 12.0 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 **two** years (one year for sensor) from the date of shipment and found to Seller's satisfaction to have been so defective.

Alpha Omega Instruments' **one (1) year sensor** warranty offers protection for one year from the date of shipment of the Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer. Any sensor from a Series ZrO₂₀₀₀ Fast Response Oxygen 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

The Series ZrO₂₀₀₀ Fast Response Oxygen Analyzer is designed to provide valuable operating data. The information gathered from the analyzer may be used to help eliminate or diminish potentially hazardous conditions associated with the process environment. However, it is imperative that personnel involved with the operation of the analyzer be properly trained and fully acquainted with the process as well as the analyzer. Personnel safety is the responsibility of those in charge of the process and the surrounding environment. Though this analyzer should, under the correct operating conditions, provide early detection of a process upset or disruption, it cannot overcome operational deficiencies that could lead to the creation of a hazardous situation. The purchaser is responsible for the process and any and all hazardous conditions that may result from normal or abnormal operating conditions. The purchaser has the added responsibility of training personnel involved in the application for which the analyzer is used. 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 held 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.